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Supply Chain Management for Competitive Advantage

Concepts & Cases

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Tata McGraw-Hill Publishing Company Limited
NEW DELHI

McGraw-Hill Offices

New Delhi New York St Louis San Francisco Auckland Bogotá Caracas
Kuala Lumpur Lisbon London Madrid Mexico City Milan Montreal
San Juan Santiago Singapore Sydney Tokyo Toronto

Tata McGraw-Hill

Published by Tata McGraw-Hill Publishing Company Limited,

7 West Patel Nagar, New Delhi 110 008.

Supply Chain Management for Competitive Advantage: Concepts & Cases

ISBN (13): 978-0-07-022163-5
ISBN (10): 0-07-022163-4

Managing Director: *Ajay Shukla*
General Manager—Publishing (B&E/HSSL and School): *V Biju Kumar*
Editorial Manager—B&E: *Tapas K Maji*
Junior Editorial Executive: *Hemant K Jha*
Junior Editorial Executive: *Rajneesh Roy*
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General Manager—Marketing (Higher Education & School): *Michael J. Cruz*
Asst. Product Manager: *Vijay Sarathi Jagannathan*
Controller—Production: *Rajender P Ghansela*
Asst. General Manager—Production: *B L Dogra*

Typeset at Text-o-Graphics, B1/56 Arawali Apartment, Sector 34, Noida 201 301 and printed at
Avon Printers, Plot No. 16, Main Loni Road, Jawahar Nagar Industrial Area, Shahdara, Delhi 110 094

Cover Design: K Anoop

Cover printed at: Rashtriya Printers

RYRQBRYFRXDBR

Preface

This book is positioned to serve two audiences: the MBA and senior student in a business programme, and the professional working in industry who wishes to gain a deeper understanding of supply chain management and logistics especially in an Indian context. The book thus provides an overview of concepts as well as intensive material for analysis and training in the area that has come to be known as Supply Chain Management. The topics covered are far reaching in practical scope.

A special feature of the book is the collection of detailed cases. All cases are situated in the Indian business environment, as it makes a transition from traditional business practices to new ones in an arena of global competition. This attempts to fill a stated gap in the academic and business literature in the area. The cases are all drawn from real organisations and many are presented with actual data and descriptions that provide a realistic picture of issues in supply chain management.

The conceptual material in the book presents a set of integrative viewpoints on the area. Chapter 1 discusses the drivers of supply chain management, such as technology, and increased consumer power in a global market. The chapter discusses how supply chain management practices have evolved over time to cope with these drivers and highlights organisations that have benefited from better supply chain management. Chapter 2 analyses the dynamics in a supply chain, and shows how lead time reduction and better information management are vital to supply chain performance. The importance of big picture thinking is underscored in this chapter. Chapter 3 talks about supply chain design and presents a roadmap for designing and managing the lean supply chain. It discusses how the design can be adapted based on the products managed by the supply chain. The role of performance measurements is highlighted in Chapter 4. This chapter uses a case to demonstrate how organisations within the supply chain can benefit by shared metrics. Chapter 5 discusses supply chain efficiencies and the benefits gained by applying lean principles. Manufacturing is presented as the primary driver of benefits in value addition in material processing and transformation. The implications of this emphasis on supply chain efficiencies on other parts of the supply chain are explored. From a single supply chain player's point of view, upstream and downstream interface management are taken up in a symmetric manner in Chapters 6 and 7. A special focus of the book is to look at transportation and transfer of material between supply chain entities in the language of SCM, in Chapter 8. Chapter 9 presents the pervasive role of modern information technology in supply chain management and finally, Chapter 10 presents a range of quantitative tools and techniques that are used in different facets of decision making in this area.

The cases are then presented and are intended to be read as stand alone pieces of analysis and as a tool for integrated learning. The very essence of supply chain management is a holistic, multi-actor, multi-departmental view of decision making and the cases reflect that concern. In some cases, a particular sub-area of decision making can be isolated, but in general, the scope of analysis and decision making has to be inferred and proposed in an open way. This delimiting of the scope of analysis in a coherent manner is part and parcel of the learning objectives of the course.

We have instructor suggestions and teaching notes as support for many of the cases, to be provided through the publisher. We also provide a teaching plan for some typical course offerings in this area.

As a guide to students, a brief overview of each case, and some questions for analysis and an approach is suggested. A case positioning matrix helps in selection of cases for reading, and puts them in context. We emphasise that in our opinion, the cases, although extensive, need to be read in their entirety and instructors and students need to absorb the business logic and propose areas of analysis and appropriate techniques from a wide selection. This breadth of vision and judgement in selection is part of the training that distinguishes a true supply chain manager from a routine application oriented view of highly specific techniques within artificial functional boundaries.

The case material, while dealing with Indian companies, does have global conceptual validity in the general concerns of supply chain management. However, in appropriate places, the specific conditions of the Indian sub-continent in terms of business practices and overall ethos, and of infrastructural realities are emphasised upon.

Finally, the book provides some links to contemporary developments in the area and can even serve as the starting point for some applied research. Apart from its use as a textbook and as a guide to practitioners, it is of some value to researchers as well.

Narayan Rangaraj
G Raghuram
Mandyam M Srinivasan

Acknowledgements

I wish to acknowledge a number of people for their help and contributions: Suchir Sinha, Sanjeev George, Manik Bahadur, Tilak Raj Singh, Piyush Verma and Manish Singh for some of the exercises and collection of material and references, N. Hemachandra and Jayendran Venkateswaran for professional inputs and Deepa Hari for personal support during the writing of the book.

Narayan Rangaraj

I thank the following co-authors of the cases for allowing us to use the material for publication in this book:

Tathagata Bandyopadhyay
Faculty, IIMA

Bibek Banerjee
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Saral Mukherjee
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Preeti Monippally
PGP Student, IIMA

Rohit Pathak
PGP Student, IIMA

Malavika Pillai
PGP Student, IIMA

R N Prasad
Faculty, Railway Staff College, Vadodhara

Rohithari Rajan
PGP Student, IIMA

Neeraj Sisodia
Research Associate, IIMA

Chetan Soman
Faculty, IIMA

The organisations that have rendered direct support in the material development efforts include:

Rajashree Cement, Grasim Industries and South Central Railway
Titan Industries Limited
CONCOR
Spices Board of India

Bayer CropScience Limited
FoodWorld
Airfreight Limited
and four others (who choose to remain anonymous)
Laxmi Transformers
Western Oil Limited
Farmaid Tractors Limited
Seth Dhaniram
We acknowledge the research assistance for case writing provided by:
Premlata Agarwal
Anita Basalingappa
Sushma Choudhary
Ameesh Dave
Kapil Jain
Sunil Jaryal
Vishal Kashyap
Darshana Padia
Biswajyoti Pal
Parvathy Raman
Shivani Shukla

We also thank Macmillan India Ltd for permitting us to print the cases *Laxmi Transformers* and *Airfreight Limited*, and *Vikalpa, the Journal for Decision Makers*, for the case Chilli in Soup (A).

G. Raghuram

I thank the College of Business Administration at the University of Tennessee, Knoxville, for supporting this book project, and Cengage Learning (formerly Thomson Learning) for permission to use material from two chapters in my book, Streamlined: 14 Principles for Building and Managing the Lean Supply Chain, published by Cengage in 2004. I wish to thank Dr. James Reeve for permission to use the Integrity Motors case, and Dr. Kenneth Gilbert for his keen insights, support, and encouragement.

Mandyam M Srinivasan

The authors wish to thank Milind Padalkar for his co-writitng of Chapter 9.

They also wish to thank and N. Kumar and N. Chandrasekaran, both associated with the CII Institute of Logistics in Channai at the time, who played a big role in bringing them (the authors) together to work on this book and thereby provided the physical and mental space that sparked this joint initiative. The authors also acknowledge the help provided by Tapas Maji, Anubha Srivastava and Hemant Jha of TMH.

Authors

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List of Abbreviations

ABC	Activity Based Costing
ATO	Assemble to Order
BTO	Build to Order
BTS	Build to Stock
CFA	Carrying and Forwarding Agent
COGS	Cost of Goods Sold
CPFR	Collaborative Planning, Forecasting and Replenishment
DEA	Data Envelopment Analysis
EOQ	Economic Order Quantity
ERP	Enterprise Resource Planning
ETO	Engineer to Order
EU	European Union
FMCG	Fast Moving Consumer Goods
GM	General Motors
HUL	Hindustan Unilever Limited
IP	Integer Programming
IR	Indian Railways
IT	Information Technology
JIT	Just-in-time
JITD	Just-in-time Distribution
LP	Linear Programming
LT	Lead Time
MIP	Mixed Integer Programming
NDDB	National Dairy Development Board
OLAP	On Line Analytical Programming
OR/MS	Operations Research / Management Science
POS	Point of Sale
PPV	Purchase Price Variance
RAP	Raw as Possible
RAPS	Request for Price Quotes
RERUNS	Annual Renewal of Existing Policies
RFID	Radio Frequency Identification
ROI	Return on Investment

RUNS	Requests for Underwriting
SKD	Semi Knocked Down
TH	Throughput Rate
TOC	Theory of Constraints
TPM	Total Productive Maintenance
TPS	Toyota Production System
TQM	Total Quality Management
TSP	Traveling Salesman Problem
VMI	Vendor Managed Inventory
VRP	Vehicle Routing Problem
WIP	Work-in-process

Case Abbreviations

LT	Laxmi Transformers
RCL	Rajashree Cement: Engine on Load
WOL(A)	Western Oil Limited (A)
FTL	FarmAid Tractors Limited
TITAN	Supply Chain Management at Titan Industries Limited
CONCOR	CONCOR: Tea Transportation
CIS(A)	Chilli in Soup (A)
BCS	Bayer CropScience: Science for a Better Supply Chain
FW(B)	FoodWorld (B)
SDR-C&FA	Seth Dhaniram – C&FA
AFL	Airfreight Limited

List of Cases

S No	Case	Context
1.	Laxmi Transformers	Mode choice and logistics driven market choice for a sponge iron manufacturer
2.	Rajashree Cement: Engine on Load	Implications of a bulk cement supply chain for Railways
3.	Western Oil Limited (A)	Determination of optimal jetty capacity for a petroleum supply chain
4.	FarmAid Tractors Limited	Distribution logistics for a tractor manufacturer
5.	Supply Chain Management at Titan Industries Limited	Integrated view of issues in supply chain management for a watch manufacturer
6.	CONCOR: Tea Transportation	Marketing strategy for containerized tea transportation
7.	Chilli in Soup (A)	Choices for the Spices Board of India to improve the image and quality of chilli exports in the context of detection of banned substances in the product by EU
8.	Bayer CropScience: Science for a Better Supply Chain	Supply chain improvement possibilities for a pesticide firm
9.	FoodWorld (B)	Supply chain strategy for a large food retailing company
10.	Seth Dhaniram – C&FA	Role of a C&FA in the context of whether to continue a business relationship or not
11.	Airfreight Limited	Strategy for developing a third party integrated logistics business, based on the strengths of a courier business

Decision Areas and Positioning of Cases

	LT (1990)	RCL (2004)	WOL (A) (2007)	FTL (1999)	TITAN (1996)	CONCOR (2000)	CIS (A) (2003)	BCS (2005)	FW (B) (1998)	SDR (1999)	AFL (1997)
Choice of markets and contracting	*		*								*
Choice of sources and contracting					*						*
Plant location											
Production structure							*				
Production outsourcing and contracting					*			*			
Distribution network design	*			*				*			
Procurement network design	*					*					
Logistics outsourcing to 3PLs and contracting		*						*	*		
Warehouse location	*			*							*
Allocation	*			*				*			
Plant layout and logistics		*									
Procurement planning											
· Planning horizon					*				*		
· Order quantity					*				*		
Production planning											
· Planning horizon					*						
· Batch sizes					*						
Despatch planning											
· Planning horizon				*				*	*	*	
· Order processing			*	*			*	*	*	*	
Inventory stock norms	*			*	*				*		
Warehouse operations				*					*		*
Transportation											
· Mode choice	*					*					*
· Investment planning	*	*	*								
· Shipment size	*		*			*				*	*
· Routing	*									*	*
· Contracting	*	*	*			*				*	*
Packaging and material handling								*			*
Information issues							*	*	*		
Quality issues				*			*				

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CHAPTER 1

An Overview of Supply Chain Management

CHAPTER OUTLINE

Introduction

1.1 Ownership of the Supply Chain

1.2 Supply Chain Drivers

- 1.2.1 Technology
- 1.2.2 Competition
- 1.2.3 Business and Social Environment
- 1.2.4 Policy and Regulation Environment
- 1.2.5 The Move from a Producer-Centric to a Customer-Centric Focus

1.3 Supply Chains in the Producer-Centric Era

- 1.3.1 The Rise of Batch Production
- 1.3.2 Management Structures in the Producer-Centric Era
- 1.3.3 The Rise of Cost Accounting

1.4 Financial Management and Return on Investment

1.5 Supply Chains in the Customer-Centric Era

- 1.5.1 New Business Environments Need New Management Systems

1.6 Examples of Well-Run Supply Chains

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INTRODUCTION

What is a supply chain and what is supply chain management? While researchers and practitioners provide multiple definitions to describe these terms, a simple definition for a supply chain is that it is a set of organisations engaged in the delivery of a product or a service to the customer or the end user. Organisations in the supply chain include the suppliers, intermediaries, transportation and logistics providers, and customers. Supply chain management also requires the coordination and collaboration of all the organisations in the supply chain. It is the management of all activities involved in sourcing, procurement, conversion and logistics management to deliver the right product or service to the customer at the right time, in the proper quantity, and in the most cost-effective manner.

Organisations that successfully apply good supply chain practices usually incur lower costs than their competitors. A survey conducted in 2001 by the Supply Chain Council in the United States found that, on an average, organisations spent about 11 per cent of revenue on supply chain management. In contrast, the corresponding figure for best-in-class organisations was between 3 per cent and 6 per cent. The impact of these numbers can be understood from the fact that supply chain management costs accounted for approximately 9.5% of the Gross Domestic Product of the United States that year. A reduction of 5 per cent in these costs would result in a savings of about US*$50 billion*—that is not small change.

In addition, logistics is only one of the many cost components in the supply chain. If other costs such as order processing, materials acquisition and inventory, supply chain planning, supply chain financing, and information management costs are considered, the potential savings from effective supply chain management would be much higher. Furthermore, these figures do not consider a multitude of hidden or unknown costs. They also do not consider the possible benefits. These figures do not, for example, consider the increased market-share potential for supply chains that are able to respond faster to customer needs. A study by [R. D'Avanzo, H. von Lewinski, and L. N. Van Wassenhove, 2003], which analysed the link between supply chain and financial performance, revealed that virtually all winning business strategies have, at their core, supply chain strategies that provide a competitive advantage.

1.1 OWNERSHIP OF THE SUPPLY CHAIN

Based on the definition of supply chain management provided above, it is clear that multiple organisations are involved in the delivery of the product or service to the end-user. The successful design and operation of the supply chain thus clearly involves effective management of the interactions between organisations. That raises the question as to whether there is an obvious owner of a supply chain. In other words, when we talk about supply chain management, does it implicitly assume a single dominant entity that manages the entire supply chain? Although one often thinks of a manufacturer as the dominant entity driving the operations of a supply chain, coordinating its activities with its suppliers and distributors, this is often not the case. In some cases, a large retailer could be driving the supply chain in a significant way and in other cases, a powerful supplier could be controlling the evolution of a supply chain.

It is therefore helpful to look at the gamut of possibilities, and to look at each entity (suppliers, manufacturers, distributors, retailers and even transporters and warehouse operators) in general, to understand how supply chains function. It should also be evident that an entity could be part of more than one physical supply chain and some of the effectiveness of supply chains could be influenced by the asset utilisation policies of this entity. This aspect is explored in subsequent chapters.

1.2 SUPPLY CHAIN DRIVERS

A number of forces, or drivers, have played a role in the evolution of supply chain management strategies over time. A few important drivers are listed and discussed below.

1.2.1 Technology

Two technological developments that have had a big impact on supply chain structure and operations are information and communication technology, and flexible manufacturing technology. Information and communication technology allows a host of possibilities simply not imaginable even a decade ago. Flexible manufacturing technology facilitates efficient small batch manufacturing, greatly enhancing the ability to customise product offerings to match demand in a better way.

We must, however, also acknowledge that logistics and supply chain management practices are significantly affected by technologies based on economies of scale that continue to emerge. One example is process technology, specifically in oil refining. Today's refineries are bigger than ever before, and this has implications on the logistics of movement of crude oil and finished products, and batch sizes in production. Another example is of ships that carry bulk or container cargo across the ocean. The most cost efficient of them carry huge payloads, requiring very large batch handling at ports (not all ports can receive such ocean liners). The attendant large batch sizes for such operations present the inevitable synchronisation problems with the rest of the supply chain.

1.2.2 Competitive Factors

The major competitive factors for supply chains typically relate to cost and availability measures. Availability is related to inventories; organisations generally agree that they carry more inventory than they need to, and that lead times are significantly more than the technological minimum. Surprisingly, organisations that focus on managing inventories end up with reduced inventory related costs, along with improved stock-out performance, due to faster access to markets and other process improvements.

1.2.3 Business and Social Environment

While competition is severe, it is now recognised that the battleground has shifted from competition between organisations to competition between supply chains. Members of the supply chain are now more receptive to the idea of collaboration. That said, such collaboration is not always successful, but it has led to a different model of business. The other influential change is that of continuous improvement.

1.2.4 Policy and Regulation

Many policy and regulatory acts have a direct bearing on supply chain initiatives. For example, the phasing out of central sales tax in India and replacement with value added tax regime will have an impact on distribution and retailing strategies of companies, including warehouse location. Similarly, industry initiatives in standards of technologies such as Radio Frequency Identification Device (RFID), container dimension standards, and software protocols and standards, do affect supply chain practices.

While the above four drivers have played a significant role in the evolution of supply chain management practices, probably the biggest driver for change has been the shift in focus from producer-centric supply chains to customer-centric supply chains. This shift, with all its ramifications, is discussed in greater detail below.

1.2.5 The Move from a Producer-Centric to a Customer-Centric Focus

It should be noted that supply chains have been in existence for many centuries. The earliest supply chains were *trading supply chains* that were predominant until around 1750 A.D. These supply chains primarily involved producing goods at one location, and then moving them to other locations where they were sold or exchanged. The Industrial Revolution that began in Great Britain in the 18^{th} century and spread throughout the world shortly thereafter, however, changed everything. A direct consequence of the Industrial Revolution was that an economy based on manual labour was replaced by an economy dominated by industry and machinery. This led to the next generation of supply chains: the supply chains in the *producer-centric era*. During this evolution, from 1880 to 1980, the customer greatly benefited because the cost of delivering products and services decreased in a dramatic manner. However, as we will see shortly, supply chains in this era developed numerous practices that are no longer effective in the current era, the *customer-centric era*.

The customer-centric era is an era of global competition. Many organisations that built their empire based on practices that worked very well in a producer-centric era are now finding that these practices significantly inhibit their ability to compete successfully in the customer-centric era. In other words, the tools and techniques used to manage supply chains in a customer-centric era are significantly different from those used in a producer-centric era. To understand the significance of this last statement, it is informative to briefly review supply chains in the producer-centric era.

1.3 SUPPLY CHAINS IN THE PRODUCER-CENTRIC ERA

A number of developments served as catalysts for the evolution of supply chains in the producer-centric era. For instance, the utilisation of electric power to drive machinery was a major force. This one development alone was responsible for most of the advances that took place during this period. Other key catalysts were the introduction of airplanes, automobiles, and telecommunication. Industries in the

West flourished during this period. In particular, the U.S. industry flourished during this period.

An important point to note is that since numerous organisations are involved in a supply chain, their activities have to be coordinated. If individual organisations in the supply chain undertake decisions that optimise their own operations without much thought given to the overall supply chain's operation, the product or service will not be delivered as effectively with regard to cost, quality or delivery. Unfortunately, coordination between supply chain partners was not a major concern in the producer-centric era.

In the production-centric era, demand for goods and services often outstripped production capacity. It was a time when the customer was typically willing to buy anything that the manufacturers had to sell. The producers had the maximum clout in the supply chain, charged what the market would bear, and operated businesses to maximise the utilisation of their own scarce capacity. Organisations were able to run their business in relative isolation, formulating strategies that optimised their own operations, with little regard for the effect of decisions on other organisations in their supply chain.

Many large organisations grew and flourished in the producer-centric era. This period was perceived as a 'golden era' for the U.S. industry. However, this was actually a problematic period in a number of ways. Lack of global competition created, in effect, domestic cartels in many industries that dictated the price the customer paid for the product. For instance, the big-three auto companies were effectively a cartel led by General Motors. But cartels, like their more integrated cousins, monopolies, tend to get inefficient and ineffective because they can afford to be. Although the U.S. industry, pioneered by individuals such as Henry Ford, had led the world in innovation in its early days, it started to take a back seat after the war. For example, in the automobile industry, automatic transmission, which first appeared in the 1940 Oldsmobile, was the last major innovation. While there appeared to be an abundance of popular features promoted with each new model, there was little to distinguish between the cars that were made in the 1960s through 1973, from their counterparts of the 1950s.

1.3.1 The Rise of Batch Production

The desire to maximise utilisation of scarce capacity led to products being produced in large batches. In academic circles, there was a tremendous amount of research expended on determining optimal batch sizes, and the concept of an *economic order quantity* (EOQ) was born. While large batches increase the efficiency of the resource producing the batches, it often negatively affects other resources in the supply chain. For instance, in the automobile industry, batch production resulted in plenty of inventory of finished cars, as well as work-in-process inventory (WIP) within the factories. Large batches tend to hurt quality since defects found on the shop floor do not generate a sense of urgency to fix the problem so that it may not recur. This was because there was plenty of WIP to buffer any production delays and so the real impact of the quality problem was marginalised. Worse, quality problems often escaped unnoticed and were not caught until after the product was sold. The consumers suffered from poor quality since the cars were often riddled with defects and needed frequent repairs. This topic is further explored in Chapter 2, in the context of inventory and its affect on the supply chain.

Since a natural consequence of batch production is larger inventories of finished goods, there was a need to find efficient ways of storing and distributing these goods. Organisations had to wrestle with the problem of how to select the combination of distribution channels and supply chain partners that would provide the most profitable operation in the long run. Since distribution was often fragmented, distribution costs were high. Consequently, a large number of organisations strove to reduce distribution costs by viewing this activity as an integrated, rather than a fragmented, activity that took place in various parts of the organisation. Hence distribution experienced increasing importance during this period especially since mass production and economies of scale were the mantras of the day. Logistical activities were increasingly apparent in U.S. industry. The automakers set up dealer networks to stock and sell their cars. In a similar manner, the mass producers in other industries fostered the growth of large warehouses to stock finished goods.

1.3.2 Management Structures in the Producer-Centric Era

The emergence of the large industrial corporation owes much to the organisational structure and management systems developed and implemented by the U.S. auto industry during the producer-centric era. The partitioning of organisations into divisions and sub-units of divisions is largely attributed to Alfred Sloan and General Motors, and the accounting dominated control systems discussed in the next section owe much to automobile manufacturing organisations, primarily the Ford Motor Company in the years after World War II. The core objective for these organisational and control structures was to design a system in which the people responsible for managing the smaller units could focus solely on their domain of authority; moreover, all decisions and actions that crossed domain boundaries were to be the responsibility of managers covering both domains. Units could be treated as either 'cost centres' or 'profit centres' and assigned targets. Managers of these units would manage their domains to achieve and even beat these targets. The result was an organisational structure in which each unit was charged with and focused on improving its local performance. The logic went that if every unit improved then, *ipso facto*, the entire organisation would improve.

Consequently, organisations operated with the belief that local optimisation would result in global optimisation. This belief facilitated management of large complex organisations by breaking them down into smaller units that, in turn, could be broken down into yet smaller units. It was recognised that this would result in mismatches at the boundaries of the units. However, the costs in time, money and customer satisfaction were smaller than the costs that would result from being totally disorganised. This system of operation was phenomenally successful in the sense that most post World War II organisations that were organised around this model grew their business significantly. Policies, procedures, performance metrics and all other elements that define organisational structure and function were based on this implied belief in local optima. Since financial data (actually cost data) was among the few quantitative data that were available and deemed important by accounting departments, local optimisation came to be understood as cost minimisation or cost control. This philosophy drove the management of most operational functions such as production, distribution, and procurement.

Thus, during the producer-centric era, organisations were managed typically through conflicting departmental goals that resulted from the emphasis on local optimisation. Each department attempted to maximise its own objectives, objectives that often went counter to the objectives for other departments. Commercial activities external to the organisation, such as buyer-supplier relationships, were essentially adversarial in nature. The conflicting departmental goals and adversarial relationships between the members in the supply chain hindered the move towards building more efficient supply chains.

1.3.3 The Rise of Cost Accounting

With the increase in the size and scope of industrial organisations there was a need for the owners and managers of these large organisations to obtain information that could help them undertake better decisions. The discipline of accounting was ideally suited for this purpose. As defined by the American Accounting Association, accounting is 'the process of identifying, measuring and communicating economic information to permit informed decision making by the receivers of the information.' Accounting is aimed at providing decision makers with information on the economics of providing goods or service, allowing them to manage organisations from remote locations. The railroads, for instance, were examples of the need for large business organisations to be managed from a different location.

Knowing what money was spent by which group and for what purpose was deemed to be extremely important by the accounting profession. As the Industrial Revolution generated demands on machinery, bankers and other lenders needed to know how the machines they were paying for would perform and help the business payback these loans. For an organisation that produced a variety of products, determining product costs was important in deciding whether the product was profitable or not. Products costs are typically composed of three components: direct labour, direct material and overheads. The first two were relatively easy to attribute directly to a specific product. Overheads, on the other hand were difficult to trace to specific products, and hence cost accounting focused on tracking these costs accurately, allocating them to specific products.

Oddly enough, while cost accounting owes much to Ford Motor Company in the days after World War II, it was not a major issue during the days of Henry Ford I. During his reign, overheads were relatively low, and typically only a single product was being manufactured. Hence, it was easy to allocate the overheads to determine product costs. Thus, whereas the accounting profession dates back to early trading networks, cost accounting gained prominence only as organisations diversified their product offerings. Indeed, the post World War II rise of the U.S. auto industry coincided with the rise of cost accounting as the primary decision making tool in all industries. The concept of Standard Costs and Allocation was born. Chapter 4 briefly discusses cost accounting, specifically standard costing and activity based costing. The discussion in that chapter will serve to highlight the benefits and potential drawbacks of these techniques in the context of supply chain management.

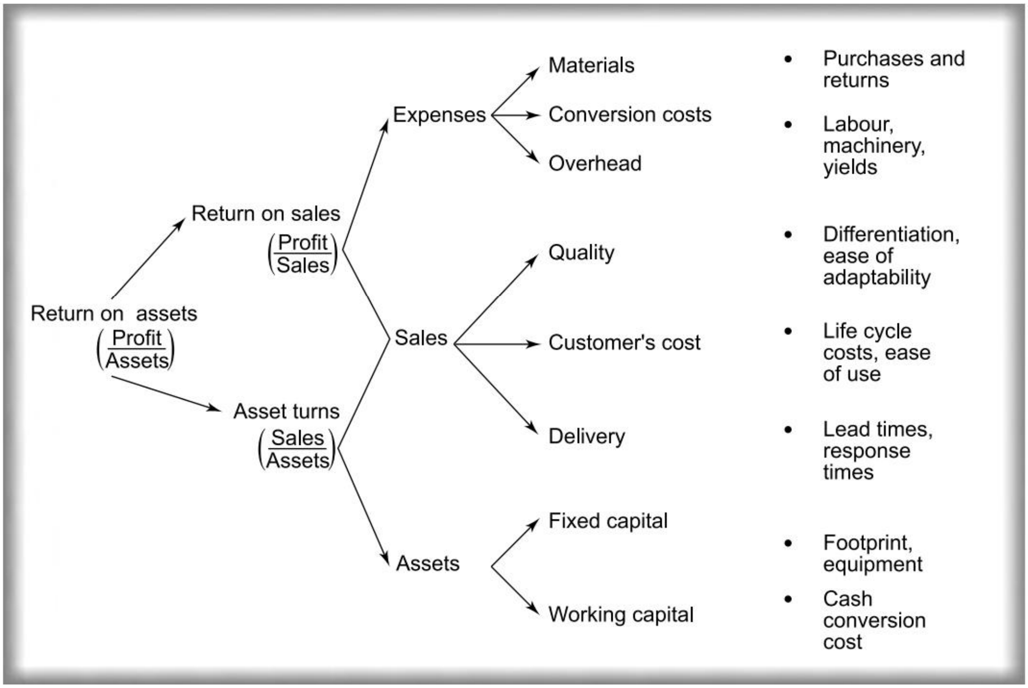
1.4 FINANCIAL MANAGEMENT AND RETURN ON INVESTMENT

Even as cost accounting was gaining ground, the management of most large industrial organisations still resided with the entrepreneurs who founded the organisations. While they reviewed the accounting information, they did not manage solely by these numbers. Identifying and seizing opportunities were the main vehicles for them to make money. A new tool for evaluating opportunities was required.

Pierre Du Pont refined the technique of Return on Investment (ROI) to manage the Du Pont Powder Company, one of the first modern American manufacturing organisations. Du Pont eventually succeeded Durant as president of General Motors and collaborated with Alfred P. Sloan to reorganise General Motors. The two men surmised that General Motors, with its multiple organisations, required a centralised organisational structure similar to that in use at Du Pont Powder Company. Therefore, they crafted a plan to structure General Motors as a collection of autonomous operating divisions coordinated by a strong general office. Under the reorganisation, General Motor's general office borrowed the ROI methods from Du Pont Powder Company to evaluate the financial efficiency of their processes and product lines.

The multidivisional, decentralised structure developed by these two entrepreneurs serves as the model for many organisations to this day. Indeed, the ROI model developed by Du Pont provides an effective framework for determining how to

Figure 1.1: The Du Pont Model for Leveraging Return on Investment



leverage an organisation's competitive advantage into effective shareholder value even in the customer-centric era. The figure below captures the Du Pont model for ROI. Essentially, the model shows the immense value of effective supply chain and operations strategies and how these strategies translate to a competitive advantage, paving the way for improved ROI.

As shown in this figure, effective supply chain and operations strategies can address all the elements presented on the extreme right hand side. These strategies will translate to improved attributes such as materials costs, conversion costs, quality, delivery, etc., leading to three important financial measures: Sales, Expenses, and Asset Use. Given sales and expenses, it is possible to calculate the return on sales as simply (sales – expenses)/sales, which is expressed in the above figure as profit/sales. The asset turns is calculated as shown in the figure. Multiplying return on sales by asset turns results in return on assets or return on investment (ROI). In Chapter 4, we provide a case study in which we guide the reader through a detailed numerical exercise that demonstrates the affect of good supply chain management practices on ROI.

We next discuss the customer-centric era and indicate why the management structure developed in the producer-centric era is inadequate to address the needs of the customer-centric era. However, the Du Pont model, which was developed during the producer-centric era remains valid in the customer-centric era as well, as we have noted earlier.

1.5 SUPPLY CHAINS IN THE CUSTOMER-CENTRIC ERA

The advent of the customer-centric era took place in the early 1960s, arguably during the heyday of the producer-centric era. This period, coincidentally enough, also marked the transition of the world economy from a U.S. dominated economy to a more global economy engendered, in large part, by the Japanese automakers, especially Toyota.

In 1960, Japan's auto manufacturers produced about half-a million vehicles. That same year America's auto industry built eight million vehicles. Who could have predicted that just 20 years later the Japanese auto industry would produce more than 11 million vehicles—three million more than their American counterparts manufactured in that same year—and become the world's leading auto producer for the next 10 years? And how did the Japanese manufacturers manage to overtake their American counterparts? The answer was that they adopted a number of management practices that were quite different from their American competitors.

In fact, the 1960s were pivotal years for Japanese manufacturers. They dedicated themselves as an industry to developing compact and sub-compact cars with excellent fuel economy. They succeeded in producing those vehicles at low cost by adopting the just-in-time (JIT) production management philosophy and system. The JIT management system had its roots in Toyota Motor Corporation, and owes its conception and subsequent development to two individuals, Kiichiro Toyoda and Taiichi Ohno.

Kiichiro Toyoda's goal was to initiate a production run *when it was needed*, rather than making a production run *in anticipation of a demand*. This was the *pull* method of production where a demand pull initiated a production run. The pull emphasis was a fundamental departure from traditional manufacturing methods that pushed production throughout the supply chain based on demand forecasts. He then began convincing suppliers to cooperate with his just-in-time system. Kiichiro Toyoda also changed the traditional physical layout of the plant so that machine tools were organised in a flow line. That made the supply line shorter and meant parts could get into the assembly process sooner. Taiichi Ohno embellished the techniques pioneered by Kiichiro Toyoda to make cars in small batches more efficiently than the big U.S. enterprises were able to.

A number of the TPS concepts used by Ohno were inspired by another U.S. automaker who had played a major role in the producer-centric era. This was Henry Ford, whose relentless attention to detail were greatly admired by Ohno. Like Ford, Ohno emphasised waste reduction. However, Ohno was also able to build on Ford's ideas. For example, Henry Ford had offered automobiles to his customers in only one color to reduce setup times when changing between paint colors. The Japanese were able to utilise Ford's ideas to provide product variety in their offerings.

Although Japanese autos had now become competitive against both U.S. and other foreign cars in quality and cost, the U.S. market was reluctant to accept these cars. They were perceived to be too small and of suspect quality. It took an unanticipated international crisis to serve as the catalyst for the acceptance of Japanese autos in America. The Arab-Israeli war in 1973 and the accompanying oil price increases caught the U.S. consumers, who favoured large cars with large engines, by surprise. The 'gas guzzlers' traditionally built by the Big Three lost their appeal and Japanese cars were suddenly in demand. Suddenly the world's largest market was clamouring for the small, fuel-efficient Japanese cars. Japanese cars flooded the U.S. market. The Japanese cars also found acceptance in the U.S. market because consumers quickly found much better quality than they had learned to expect from automobiles. This was due, in no small measure, to a handful of individuals such as Edwards Deming and Joseph Juran who had spread the quality movement from the U.S. to Japan.

Although the advent of the customer-centric era was arguably during the early 1960s, this era really started to manifest itself in the early 1980s. The 1980s also provided many organisations with the power of new management methods and techniques, such as those pioneered by Taiichi Ohno. However, most organisations were either reluctant to embrace these methods, or were ignorant of them.

1.5.1 New Business Environments Need New Management Systems

When it was first introduced, cost accounting was a powerful tool since it provided managers with the ability to make decisions that dramatically improved the performance of their areas and plants. However, as pointed out in [Lepore and Cohen, 1999], 'powerful solutions tend to make themselves obsolete … some of the basic assumptions of cost accounting became invalid in the 1940s, but as most companies were using the same concepts, the negative impact was not so noticeable.' Lepore and Cohen argue that the Japanese did not, and still do not, use cost accounting, and that those who tried to compete with them using cost accounting methods were forced into breaking the cost accounting rules in order to survive.

The *standard cost* accounting system was originally developed as a financial tool for controlling diverse activities. While industrial and mechanical engineers were developing standards for the discrete activities within production processes, accountants were working to create standard costing principles to allocate overhead costs. These indirect costs were typically allocated evenly across all the products. When product lines and indirect production costs were small, the distortions created by this simple allocation technique were not critical. Moreover, the market demand was enough to consume all products produced, allowing producers a considerable control of product prices.

Nonetheless, during the past decade the business landscape has changed dramatically:

➢ Consumers, not producers, have become the dominant component. Today the production capacity is greater than product demand for the majority of industries. Prices are determined by competitive market forces and not set by the producer. The purely internal focus of the standard cost system is no longer valid.

- The local optimisation view encouraged by the cost accounting model did not often result in global improvement. Quite to the contrary, actions taken to improve the cost performance at one stage actually created more costs elsewhere (but this was of no concern to the manager of that stage), creating higher inventories and other inefficiencies.
- Factors such as reliability of deliveries, quality of products, speed with which orders can be filled and variety of products offered are the dominant factors determining a company's competitive position. None of these are considered in the standard cost accounting model. Many of the actions required to improve performance against these elements appear to be bad decisions from a standard cost perspective.
- Direct labour costs, on which most allocation decisions were made, was no longer the major cost component. Starting with the end of World War II, the typical manufacturing company has added far more indirect labour employees than direct labour workers. It has added layers of personnel to handle management information, to design product and support the production process, and to provide the marketing, sales and services to customers.

We cannot deny the accomplishments of the producer-centric era, and batch production in particular, in making a very wide variety of products available to a very large segment of the population. However, the core management system developed to support batch production was out of sync with the business environment that prevailed in the customer-centric era. The local task improvement view at the heart of the management style in a producer-centric era must be replaced by a new approach that takes a systems view of the organisation and strives to deliver on the three factors of speed, variability and flexibility. As we will observe in subsequent chapters, a number of these problems are addressed with new concepts and techniques embodied in the management of supply chains in the customer-centric era. We will close this chapter by presenting examples of supply chains that are functioning very effectively in the 21st century.

1.6 EXAMPLES OF WELL-RUN SUPPLY CHAINS

We start with a number of examples involving organisations, primarily drawn from India and the U.S., that have achieved sustained success managing their supply chains. As we present these stories, we identify the key concepts that underscore these successes, and the chapters where these concepts are presented and discussed in more detail.

Even as we present these examples, the reader should note that there is no universal concept or approach that guarantees success. Indeed, some of these examples might even seem, at first sight, to present contradictory approaches to supply chain management. We can, however, assert that achieving sustained success requires significant effort. It requires a basic understanding of the macro-environment, the industry, the technology, and a variety of other factors.

Example 1.1

The Dabbawallas

Even as the producer-centric era tended to drive organisations to look for large distribution networks with large warehouses that tended to store goods for long periods of time, a quiet revolution in distribution activity was taking place in Mumbai, India, around the turn of the 20^{th} century. In the 1890s, Mumbai was growing rapidly due to migrants from various parts of India coming to Mumbai seeking work. These migrants found that there were no restaurants they could go to for their lunch, resulting in a real need for a method to deliver freshly prepared food to the workplace. The clichéd phrase, 'necessity is the mother of invention,' aptly describes what ensued: the *dabbawallas*.

The dabbawalla is a person whose job is to carry and deliver food prepared fresh, that day at home, to an office worker in a lunch box. They use an intricate delivery system that assigns each lunch box ('tiffin box') a code. The *dabbawalla* places the box in a large transport container ('pallet'). The coding system is now used to move these tiffin boxes through the metropolitan railway and bus transport network, using possibly handoff points 'stations'. At a given station, the tiffin box could be taken out of its pallet and placed on a different pallet to be transported by a different dabbawalla, depending on its destination, to possibly another station. The tiffin box could thus conceivably change hands three or four times before reaching its final destination. This intricate set of activities involving multiple splits and merges is essentially the idea behind *cross-docking* – a technique currently used by modern logistics providers to transport goods across large distances using sophisticated transport and communication systems, to track the progress of shipments in the supply chain.

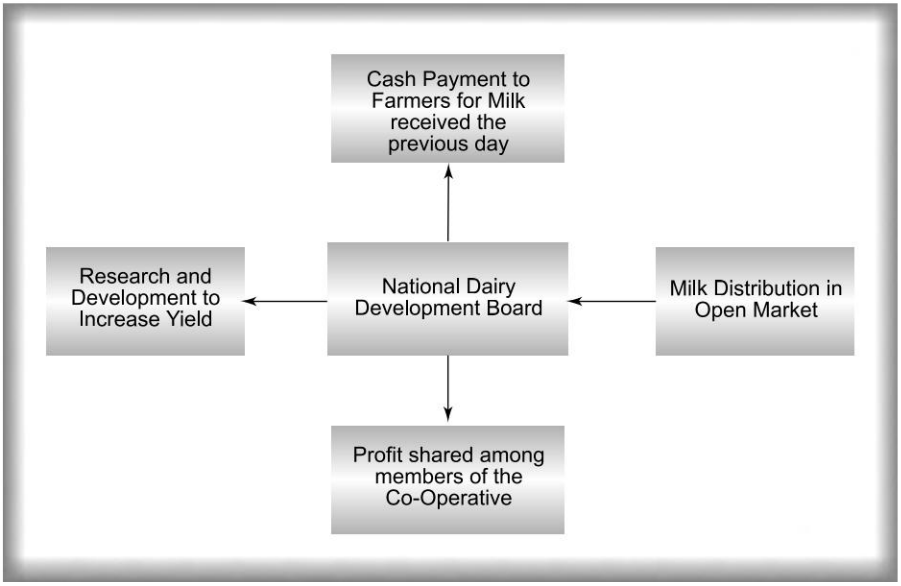
What is remarkable about the *dabbawallas* is that this system of operation has performed so well over the past 100 years, even as the world transitioned from a producer-centric era to a customer-centric era. The explanation is that the goal of the *dabbawallas* was always focused on delighting the end-customer. Remarkably, over the years the *dabbawallas* have been able to transport the tiffin box from origin to destination without the use of any communication device. Furthermore, their delivery accuracy is remarkable as well. Their error rate is reportedly just one in 16 million deliveries, resulting in the Forbes Global magazine awarding them its Six Sigma certification in 2001. According to Forbes the dabbawalas have a 99.999999 per cent accuracy.

Example 1.2

The National Dairy Development Board

A comprehensive example of supply chain integration with a focus on quality is the case of the National Dairy Development Board (NDDB) in India. NDDB began operations in 1965 initially focusing on milk procurement and processing, but over fifty years, it has forward-integrated the chain to include distribution, value added

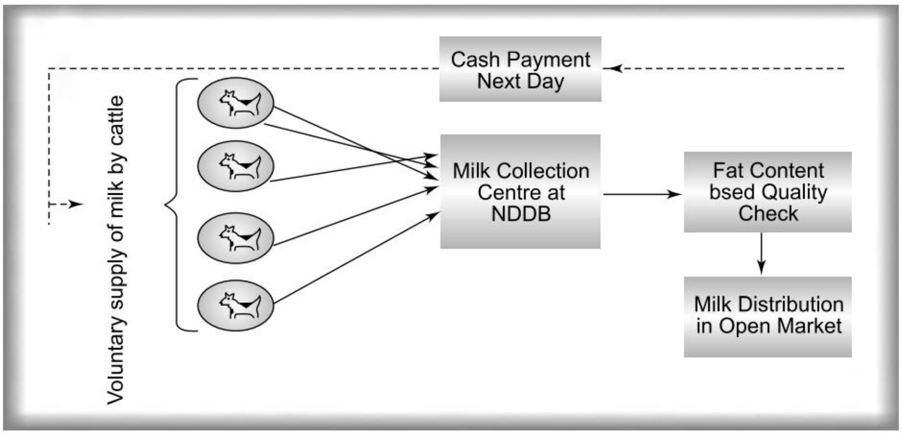
Figure 1.2: Cash Flow Chart for NDDB



products, and retailing. It has backward-integrated into animal husbandry, animal feed, and packaging.

Large dairy operations of this size are usually run with organised cattle rearing and milk production. In contrast, the operation of the NDDB supply chain is based on the voluntary supply of milk by hundreds of individual cattle owners, up to twice a day, on a regular basis. The NDDB operates in a co-operative mode, with cattle owners having a stake in the organisation.

Figure 1.3: Milk (Product Flow) at NDDB



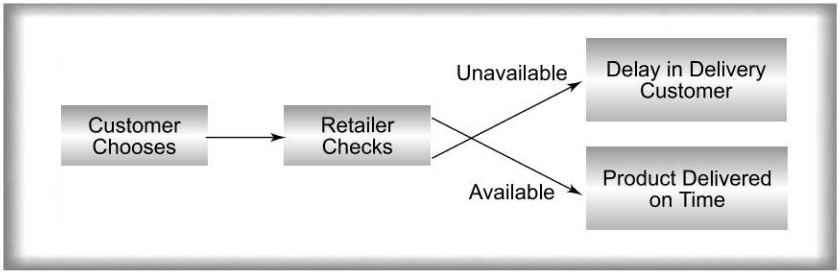
A key element in NDDB's supply chain relates to cash flow management. The cash flow logistics in this supply chain is unique in the sense that payment is made to cattle owners the day after they deliver the milk, based on a quality assessment of the milk supplied. This quality test (based on fat content) is quick, transparent and acceptable to the cattle owner and to NDDB. Paying individual cattle owners the very next day is crucial to the cattle owners' working capital management. Such a payment mechanism has been developed by NDDB over time. NDDB has also played a vital role in the development of inputs to the cattle sector to increase yields. Chapters 6, 7 and 8 discuss some key concepts driving procurement, distribution and logistics.

Example 1.3

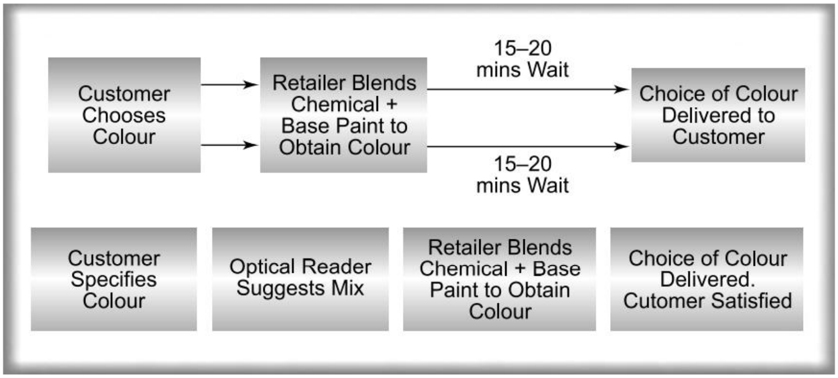
Asian Paints

Asian Paints (AP) is India's largest paint company and the third largest paint company in Asia today, with a turnover of Rs. 36.7 billion (around US$ 940 million). AP tries to gain a competitive advantage by providing quick and reliable delivery for their fast-moving paints products through an integrated supply chain. AP owns three layers of the supply chain – the paint factories, the regional distribution centres and the sales depots. A significant competitive edge is provided by AP's 'postponement strategy,' which allows it to meet varying customer demands with minimal inventory in its supply chain. Such a strategy mixes the colours and base paints at the retail site itself to get the exact shade of colour as per customer specifications, resulting in lower retail inventory costs while, at the same time, significantly increasing product availability.

Figure 1.4: Flow of Product from Retailer to Customer (Asian Paints)



Customised Option (after):



To understand how the postponement strategy works, consider a product portfolio consisting of 10 base paints with 50 shades in each, resulting in about 500 full form Stock Keeping Units (SKUs). If the retailer had to stock each SKU, it would result in a very high inventory cost. On the other hand, if the retailer tried to minimise inventory costs by only stocking the SKUs that were in high demand, there would be a likelihood of losing some potential sales. By adopting the postponement strategy, the retailer only needs to stock the 10 base paints along with about 10 chemicals, providing the same variety with appropriate blending, but by stocking only 20 SKUs. No doubt, the retailer has to spend about five minutes more to process each order. However, since paint is not an impulse buy, people are willing to wait or even come back later in the day since they are assured of getting their exact choice of colour. The blending equipment has to be available at retailers for this strategy. Another level of customisation allows the customer to specify the colour with the help of a sample. Through an optical reader, the menu for appropriate blending is developed and the desired colour is provided to the customer. Chapter 2 discusses the principle of postponement strategy in more detail.

Example 1.4

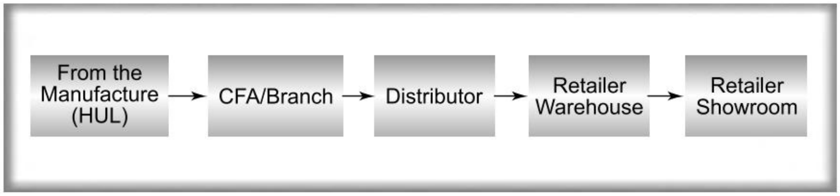
Hindustan Unilever Limited

Hindustan Unilever Limited (HUL) is India's largest consumer products company. Founded in 1933 as Levers Brothers (India) Ltd. it is a key player in the fast moving consumer goods (FMCG) industry in India. HUL has generally sought competitive advantage through a continuous re-engineering of the supply chain.

HUL is using different strategies to address its three major market segments: the 'modern trade' segment (the organised retail sector), the general trade segment and rural markets, creating dedicated teams to address the three segments. For example, in the rural market segment, a big opportunity lies in creating consumers out of non-users. The modern trade segment is driving HUL to focus on adding value by cutting down lead times. This segment is of large retailers and a forward urban market. Customers in this segment are usually serviced through a HUL warehouse that supplies to a cluster of retail locations. This approach minimises direct delivery to retail stores (except for perishables), allowing the retailers to concentrate on front-office and customer-focused operations. Back office, warehouse-related operations such as receipts, sorting and repackaging are done at the warehouse. If the volumes are large enough, HUL sends items directly from their branch, which acts as a Carrying and Forwarding Agent (CFA) to the retailers' warehouse (saving a 3–5 per cent margin that the distributor would have, otherwise, charged). In fact, where volumes are large enough, the large retailer is appointed as a 'CFA' that holds the stocks in a designated area at the warehouse, with ownership remaining with HUL. Once or twice a day, the stocks are transferred and money transfers are made and accounted for, accordingly. The typical margin for the CFA of half to one per cent would then be saved.

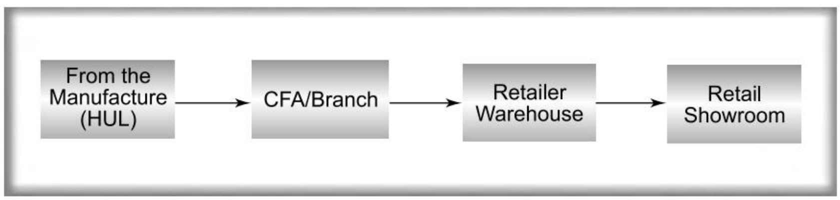
Figure 1.5: Product Flow of FMCGs (HUL)

Before:



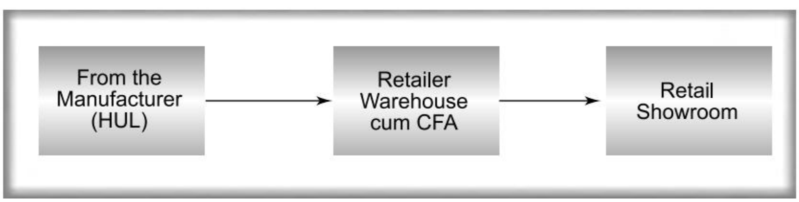
After:

For Large Sales:



(Saving of about 1.5 per cent over 'Before')

For Very Large Sales:



(Saving of about 3.5 per cent over 'Before')

Initiatives such as these facilitate the operation of Vendor Managed Inventory systems at customer warehouses. The general principle of vertical integration operates here in the sense that, for the particular market segment affected, the supply chain is shortened (in this case, by eliminating the company branch/CFA and the distributor stage). Another principle of horizontal differentiation operates, in the sense that there are different modes of supply for organised retail and for smaller independent retail segments.

A related and significant change is that the role of the sales personnel is now different in this configuration. Sales personnel associated with large customers are more relationship managers, dedicated to that customer and would do much more than traditional order placement and normal commercial functions. Procurement managers of the large customer can interact with the salesperson, allowing for initiatives such as test marketing, new product placements and co-ordination with brand managers of the manufacturer.

At a different level, HUL operates with a 'systems thinking' philosophy. It has a management cadre that is not departmentalised. Since people move across functions, there is not much of an 'us versus them' mind set within the organisation. Instead, local departmental objectives are treated in the context of the broader supply chain objective. In Chapter 2 we discuss systems thinking in the context of supply chain dynamics and in Chapter 3 we discuss basic concepts underlying supply chain design.

Example 1.5

ABC Bicycle Company

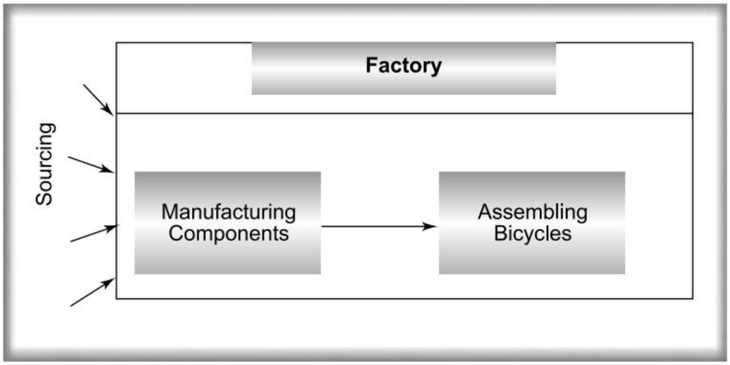
The concept of the supply chain has changed significantly for ABC bicycle company, an organisation in south India. This company began operations as a factory that sourced raw materials, made components, assembled bicycles, with warehousing, and delivery to dealer. The focus has changed to sourcing, kitting, warehousing, delivery to dealer, and assembly. Although the factory has lost some prominence as a result, the supply chain is leaner and more 'linear'. ABC Bicycle Company now focuses more on marketing, design, and quality control.

Originally, ABC operated a typical factory. It received raw materials, performed component manufacturing and assembly, and shipped finished products. It adopted a systematic vendor development strategy, starting with standard items such as components (e.g. carriers) that were outsourced. While the main driver was lower overhead costs for the vendors, ABC also realised that vendors had different expertise, for example, in working with different materials (steel, rubber and plastic).

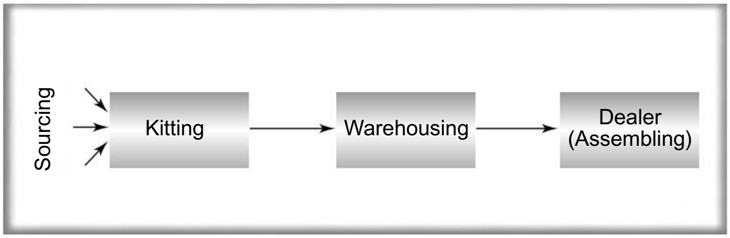
Although ABC's plant was in Southern India, the largest cycle manufacturing centre in India was in north India, in Punjab. Even with the distance, it became profitable to procure components from the industry cluster in Punjab. One of the larger outsourcees was also developed for kitting (for a particular model, it would collect items such as ball bearings, toothed wheel, pedals, chains, which would be issued as a kit to the shop floor). The factory in the south became a second level kitting centre. Over a period of time, the high precision components and the large components earlier which were outsourced locally (handle bar, main frame, mud

Figure 1.6: ABC Bicycle Company (Usage of Supply Chain Concepts)

Before:



After:



guard, wheel rim) were eventually also outsourced to Punjab, as per designs of ABC Company. Only painting and stickering was done at the factory.

Another motivating factor driving the move towards kitting was the observation that a kit occupied less volume in a truck compared to a fully assembled bike. Furthermore, retailers were getting more sophisticated in assembly. So it was decided to send bicycles to the retailers Semi Knocked-Down (SKD) kitted condition. Retailers moved to having SKD packs on display and only demonstration models on the floor.

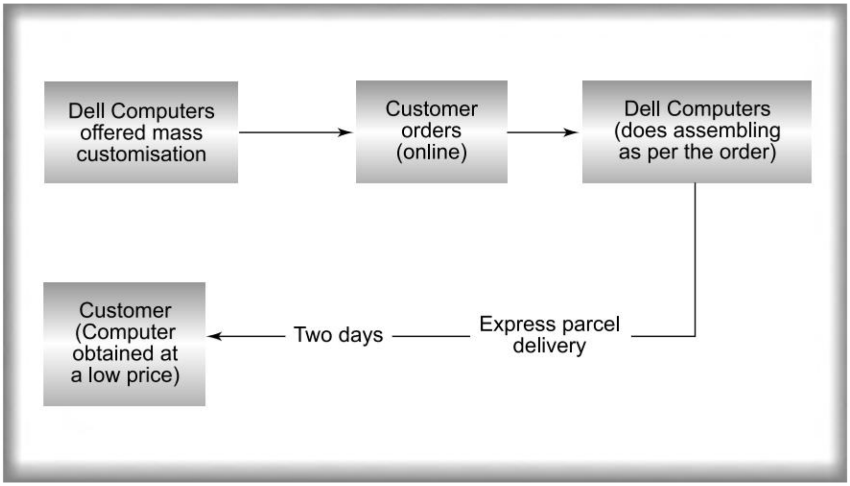
Then, it was found that 60 per cent of value and weight of the bicycle was coming from north India, and the company did operate in northern India markets. Therefore, second level kitting centres were developed in West India and North India, that would receive kits from vendors, prepare the SKD kits and then dispatch to retailers in that region. Lean operations are discussed in Chapter 5. Quantitative models for locating facilities are discussed in Chapter 10.

Example 1.6

Dell Computers

It is probably widely known that Dell Computers is a pioneer in lean supply chain management practices. Dell recognised that the market segment is (i) computer savvy, (ii) customisation sensitive, and (iii) price sensitive, and has designed its supply chain accordingly. It offers customers who buy desktops a two-day delivery at a low price by leveraging online (remote) ordering, assembling to order, and express delivery. The strategy that has sustained Dell so far can be summarised as mass customisation and a relentless focus on costs. Although Dell has come under increased scrutiny, especially as its competitors such as Hewlett Packard have emulated the famous 'Direct' model, the reader must keep in mind that Dell is a pioneer in mass customisation and cost reduction.

Figure 1.7: Dell Computers (Mass Customisation)



Dell is able to provide mass customisation because it maintains very low inventories, with suppliers delivering components to the assembly operations on a just-in-time basis. This practice has led many to speculate that Dell would be hard hit by unexpected disruptions, for instance, the 2002 port strike in the western coastal region of the United States. Dell's ability to provide mass customisation, however, has provided it with the same ethos of speed and flexibility to deal with such disruptions. Through its constant communication with its U.S.-based shipping partners and its parts makers in Taiwan, China and Malaysia, it was aware of the possibility of a lockout some six months before it occurred. When the strikes became a near certainty, Dell chartered eighteen 747 aircraft from UPS, Northwest Airlines, China Airlines, and other carriers, maintaining its costs to about US$500,000 per plane, and was able to keep its supply chain moving. See Chapters 3, 5, 7 and 8 for a more in-depth discussion on concepts in lean supply chain practice, lean operations, logistics, warehousing and distribution.

Example 1.7

Tata Motors

Tata Motors Ltd. is India's largest passenger automobile and commercial vehicle manufacturing company, with about a 60 per cent market share in the commercial vehicle segment. It is also the world's fifth largest commercial vehicle manufacturer. A key initiative in Tata Motors' supply chain management strategy is the ability to

Figure 1.8: Tata Motors Ltd. (Third Party Logistics Provider)

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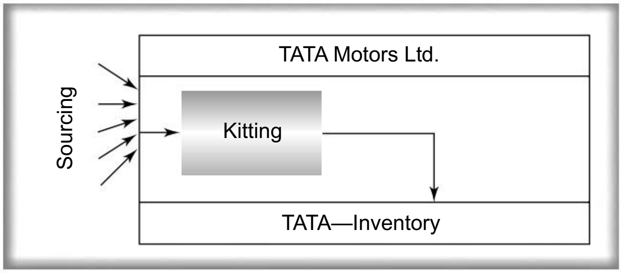

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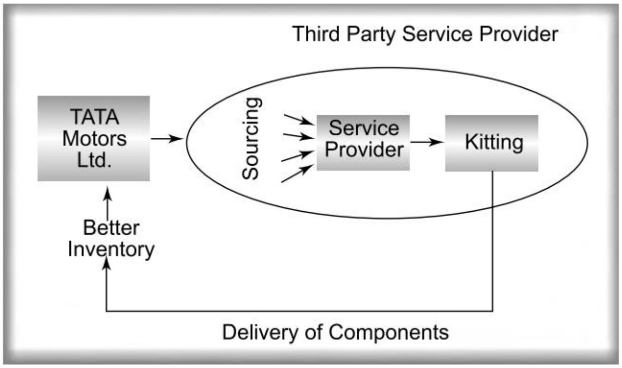


involve supplier participation at an early stage of its new product development cycle, an initiative that resulted in its winning a supply chain excellence award in 2005. This was a huge change in mindset for a vertically integrated company that believed in developing everything in-house. It is urging the suppliers to adopt a holistic approach, encouraging them to think about the overall vehicle and how their product fits into the overall plan.

Another key element in Tata Motor's strategy is the development of third party logistics providers to source, kit and deliver components. This initiative has significantly improved the inventory levels and inbound logistics costs for Tata Motors. See Chapter 8 on logistics for a brief discussion on third party logistics.

Example 1.8

Barilla SpA

Barilla SpA is a large Italian food company, founded in 1877 in Parma, Italy. A major food product for Barilla is pasta, a staple food for Italians. Barilla is the world's leading pasta maker, accounting for 40–45 per cent of the Italian pasta market and for 25 per cent of the United States pasta market. It has manufacturing plants in Italy, Greece and the United States.

Many people are familiar with the JIT philosophy for manufacturing that we discussed in section 1.5. Barilla is credited with the introduction of this philosophy to its distribution operations in the 1990s—the concept of just-in-time distribution (JITD). The JITD concept was introduced by Barilla to combat a number of operational inefficiencies and cost penalties that Barilla was facing during the late 1980s, as a result of large week-to-week variation in demands placed by its distributors on its manufacturing facility. Much of this demand fluctuation was due to the distributors artificially inflating the true customer demand (which had a relatively flat demand pattern) for a variety of reasons. We will discuss these reasons in more depth in Chapter 2 when we discuss a phenomenon often referred to as the *bullwhip effect.* For the moment, we will provide some insight into why such demand fluctuations take place. For example, the distributors were prone to stockpile inventory in anticipation of a price hike. Alternatively, whenever Barilla had a promotion for its products, (perhaps in response to its competitors offering a promotion) the distributors would stockpile inventory to avail of the price discount.

To cope with these problems, Barilla introduced the JITD system to determine what products it would ship to its distributors. Under the JITD system, rather than simply filling orders specified by the distributor, Barilla monitors the flow of its product through the distributor's warehouse, and then decides what to ship to the distributor and when to ship it. The JITD implementation allowed Barilla to better control its supply chain, providing it with a significant competitive edge.

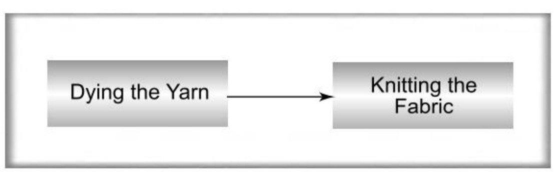
Example 1.9

Benetton

Benetton is an Italian clothing manufacturer that serves a global market. The textile and apparel industry has to deal with short product cycle for fashion articles, long production lead-time and forecasting errors for fashion items. Every season, Benetton used to follow the traditional way of making sweaters and hosiery: dye the yarn (fix the garment colour) and then knit the fabric (fix the style). However, it was never clear until well into the season about which colours would be the best sellers. That led to a buildup of unwanted inventory that had to be cleared through huge markdown sales—a chronic problem that plagues many organisations in the textile and apparel industry. Such markdowns also promoted the bullwhip effect that we discussed in the Barilla example.

Figure 1.9: Benetton (Technology Development)

Before:



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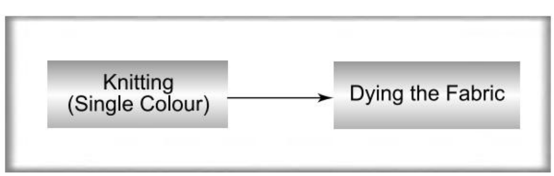


Benetton decided on a novel way to mitigate markdowns by understanding customer value. A systematic study of customer behaviour showed that it was easier to predict style choices than colour choices. Consequently, Benetton evolved a new process that changed the production sequence for their single colour fabrics to do the knitting first followed by the dyeing operation. Such a simple application of the principle of postponement resulted in a huge return for Benetton. By delaying the point of product differentiation until better demand patterns could be established, Benetton was better positioned to align its supply chain with true customer demand. As remarked earlier, the bullwhip effect is discussed in Chapter 2 and the principle of postponement is discussed in Chapter 3.

Example 1.10

Zara

Zara is a Spanish clothing manufacturer/retailer whose supply chain strategy is to set the industry standards for time to market, costs, order fulfillment and customer satisfaction. At the heart of this organisation's success is a vertically integrated business model that spans design, just-in-time production, marketing and sales. This model gives Zara more flexibility than its rivals to respond to fickle fashion trends. Unlike other international clothing chains, Zara makes more than half of its clothes in-house, instead of relying on a network of suppliers. Zara has adopted a number of lean supply chain techniques. For instance, it acquires fabrics in only four colors and delays committing these fabrics to the dyeing and printing operations until the last stage of production. By delaying commitment of the fabric to special colours, Zara substantially reduces the markdowns plaguing the textile and apparel industry as we discussed for Benetton above. Zara keeps designers attuned to changing customer preferences. Its sales managers send timely customer feedback from its 450 retail stores to in-house designers. As a result of better-managed inventories, reduced obsolescence, and tight linkages between demand and supply, Zara is well positioned to gain market share.

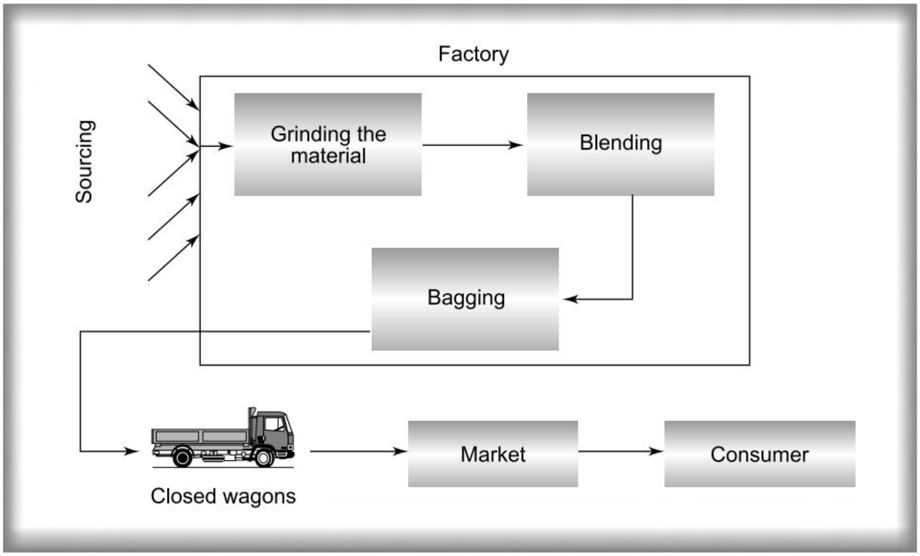
Example 1.11

Cement Industry in India

The cement industry has changed its production structure to enable greater flexibility in transportation (use of open wagons instead of only covered wagons, coastal transportation), by making cement in two stages, first as clinker near the raw material

Figure 1.10: Cement Industry (Transport of Cement)

Before:



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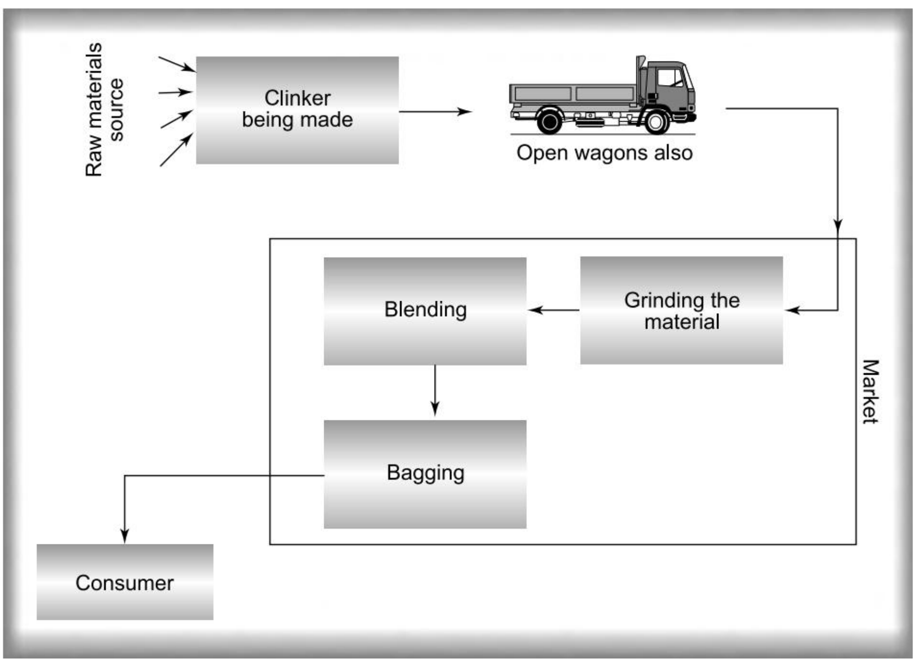


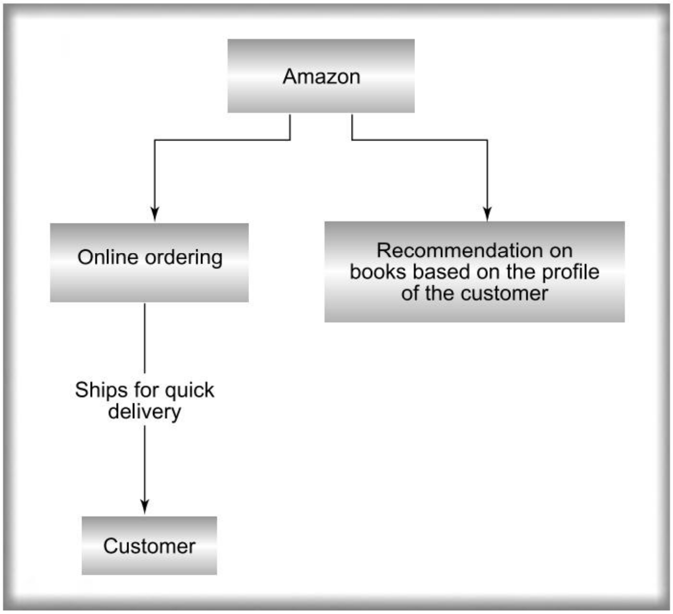
source, followed by grinding, blending and bagging near the market. The key elements of this strategy are flexibility and postponement (see Chapters 2, 3, 5).

Example 1.12

Amazon

Amazon.com has developed a customised supply chain to manage its demand planning, inventory planning, warehousing, transportation, inbound, and outbound shipping operations. Its business model has facilitated the automation of every step of the supply chain process, with an ability to update the information real-time. Such a strategic advantage allows Amazon.com a unique advantage of locating the optimal distribution centre from which to pick and ship inventory within minutes of a customer's order. The customer is notified, almost immediately, on how long it will take before the order is delivered to the customer. Amazon uses its information system to offer the customer recommendations on purchases based on a profiling of the customer. Some key elements in developing a sustainable supply chain strategy for Amazon were customer profiling through CRM and value addition.

Figure 1.11: Amazon (Value Addition)



Example 1.13

Pizza Hut and Domino's

Pizza Hut traditionally had eat-in and take-away channels. Domino's entered the market with delivery and take-away channels, providing more convenience at a lower price. Pizza Hut was forced to respond with a delivery channel. Corres-pondingly, to stay in the mind space of their customers, Domino's also opened eat-in restaurants at many locations. The main elements in this supply chain competition are to do with an appropriate combination of product plus service.

Figure 1.12: Pizza Hut (Addition of Service)

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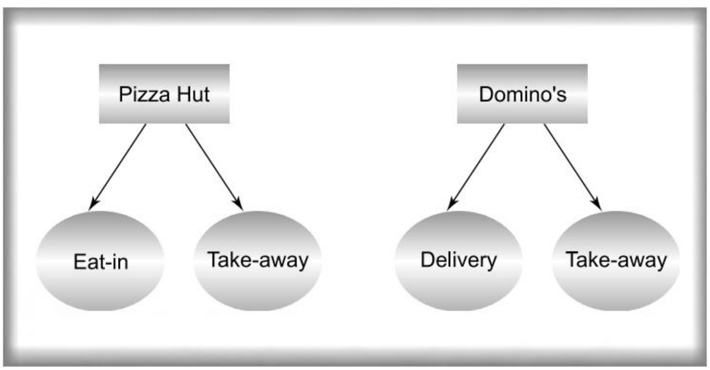

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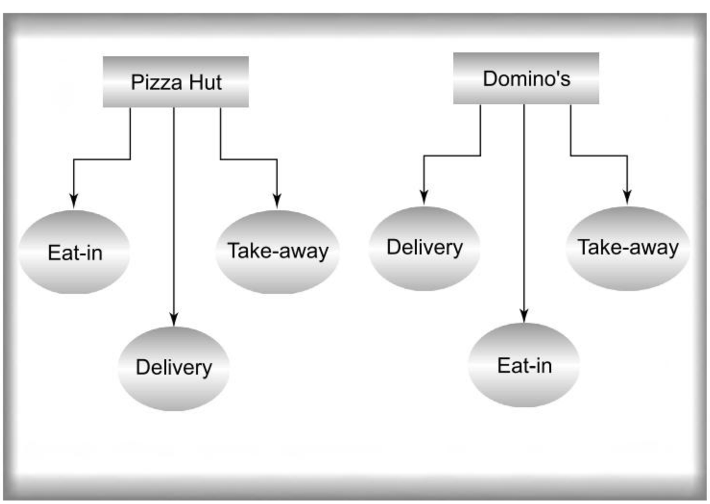

Example 1.14

IT Hardware Manufacture

IT Hardware manufacturers are continuously restructuring their distribution network to enable a responsive supply chain for products, spare parts, and repair and return. Third party logistics service providers have played a significant role here. The IT hardware industry relied on spare parts logistics, reverse logistics and third party logistics to sustain their supply chain effectiveness.

Summary

Supply chains have existed for centuries in various forms, starting with the trading supply chains that were predominant through circa 1750. These supply chains primarily involved producing goods at one location, and then moving them to other locations where they were sold or exchanged. Supply chains in the producer-centric era evolved following the Industrial Revolution and were propelled by advances in power generation methods and advances in transportation. The next hundred years witnessed an accelerating trend in the evolution of supply chains. A number of catalysts assisted this trend: electric power, airplanes, automobiles, and telecommunication. This period also brought forth a number of illustrious thinkers and doers who elevated supply chain management to new heights. These individuals include Henry Ford, Sloan, Kiichiro Toyoda, and Taaichi Ohno. It was an era in which manufacturers were able to charge what the market would bear and industry flourished during the initial years of this period, especially in the United States. Towards the end of this period, however, global competition threatened their virtual monopoly in manufacturing. With increased foreign competition, capacity also expanded and the world economy began to move towards a customer-centric economy.

It was probably a coincidence, but the enablers of efficient supply chain management appeared to take root right around this time. Indeed, by the end of the 1980s, there were a number of enablers of supply chain management in place. These include but are not restricted to the following: the internet, lean thinking, six sigma, mass customisation, organisation resources planning systems, disintermediation: the 'direct' model that works around the method of selling via the traditional distribution channels, and software tools for better information management.

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Case references : The case Seth Dhaniram (C and FA) deals with a possible re-structuring of the supply chain. Chilli in Soup (A) refers to the implications of supply chain structure on quality issues and product responsibility.

Exercises

1. Explain how Technology is an important driver of supply chain management strategies. Use examples from real-world organisations to support your answer.
2. What are the significant differences between supply chains in the producers-centric and the customer-centric eras? Give at least two such differences.
3. The chapter briefly describes some problems with batch productions, especially with regard to the resulting high levels of inventory. What are some of the other problems that result from producing and transporting large batches?
4. Give at least one example of how the local optimisation mindset could be detrimental to the overall functioning of the organisation.
5. Discuss how effective operations strategies, for instance a lead time reduction strategy, can help leverage an organisation's return on assets.

6. Why do you think the traditional cost accounting systems do not work too well in a customer-centric era.
7. How did the Japanese auto manufactures manage to significantly erode the dominance of the US auto manufactures?
8. This chapter presented examples of organisations with well-run supply chains. Can you think of other organisations that have well-run supply chains? If so, identify these organisations, providing specific aspects of the functioning of these organisations to support your answer.

The McGraw-Hill Companies

CHAPTER 2

Understanding Supply Chain Dynamics

CHAPTER OUTLINE

Introduction
2.1 Supply Chain Dynamics in Action
2.1.1 Coping with the Dynamics of the Supply Chain
2.2 The Bullwhip Effect
2.2.1 The Beer Game
2.2.2 Analysis of the Bullwhip Effect
2.2.3 Improved Forecasting and POS Data do not Eliminate the Bullwhip Effect
2.3 The Impact of Lead Times
2.3.1 Little's Law
2.4 Inventory Management and Supply Chain Dynamics
2.4.1 Risk Pooling
2.5 Offshoring and Outsourcing: Effect on Supply Chain Dynamics and Costs
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Conclusions
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INTRODUCTION*

In his path-breaking work on sys tems dynamics, Jay Forrester [J. W. Forrester, 1958] stated that 'there will come general recognition of the advantage enjoyed by the pioneering management who … improve their understanding of the interrelationships between separate company functions and between the company and its markets, its industry, and the national economy.' Forrester, in effect, was stressing the need for managers to understand supply chain dynamics and adopt a holistic view, or a *systems perspective*, to run their business. Forrester had essentially identified the key management issues associated with supply chain management.

Forrester illustrated supply chain dynamics and its effect on supply chain performance using a computer simulation. This simulation was developed in the early 1960s as part of his research on industrial dynamics and it illustrated the challenges faced in managing supply chains, including the bullwhip effect that we referred to earlier, and to be discussed in more detail in this chapter. The simulation has since been refined and is now played as the popular 'Beer Game' simulation [J. W. Forrester, 1961]. The game underscores the importance of understanding supply chain dynamics, applying systems thinking to coordinate activities within and between organisations, the crucial role lead times play in enhancing or inhibiting competitiveness, and the role of information systems in supply chain management.

This chapter is devoted to understanding supply chain dynamics. We discuss a phenomenon known as the bullwhip effect, a term we introduced in Chapter 1, in depth since this phenomenon is widespread and creates considerable difficulties in supply chain management. Understanding the root causes of the bullwhip effect will allow us to mitigate the deleterious consequences of this phenomenon. We start the chapter with a case study that demonstrates how this problem manifests itself in the supply chain.

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* A number of sections in this chapter are drawn from the book, *Streamlined,* by Mandyam M. Srinivasan. The authors thank Cengage (formerly Thompson-Taxere) for giving us permission to use this material.

2.1 SUPPLY CHAIN DYNAMICS IN ACTION

In the fall of 2000, Solectron, the world's biggest electronics contract manufacturer, knew something was going awry. The major manufacturers of telecommunication equipment, including Cisco, Ericsson, and Lucent were predicting an explosive growth in demand for networking gear and wireless equipment. These telecom giants were asking Solectron and other contractors to supply components and raw materials for their operations as fast as they could, assuring them they would pay for excess materials. Solectron, which supplied each major player, knew that the supplies demanded by its customers added up to a demand for telecommunications equipment that was unreasonably high, even under a best-case scenario. However, it was forced to produce at maximum output in order to meet customer demand.

Relying on forecasting software that projected continued growth, the top management at Cisco was seemingly oblivious to the problems that Solectron was observing. In 2001, 'irrational exuberance' clashed with reality. The explosive growth in demand forecast by the software did not materialise. Instead, Cisco's sales plunged 30 per cent in the third fiscal quarter of 2001. It was forced to write off US$2.2 billion in inventory and lay off 8,500 people. Cisco's stock sank to less than US$14 from a high of US$82 just 13 months earlier [S. Berinato, 2001]. When demand for their equipment shrank dramatically in 2001, the telecom giants scaled down their operations sharply and this, in turn, impacted suppliers in a big way. Many suppliers were left with excessive inventory that had been built in response to their customers' demand forecasts. Specifically, Solectron was left holding US$4.7 billion in inventory [P. Engardio, 2001].

2.1.1 Coping with the Dynamics of the Supply Chain

One could argue that the problems faced by Cisco and Solectron were precipitated by the dot com implosion. However, the fact is similar experiences are mirrored by enterprises in almost every industry although arguably not in such a dramatic manner. These enterprises experience huge variations in inventory levels, orders and shipments at each step in the chain, with the variations typically more pronounced as one moves further upstream. Such demand and inventory variations result in large inventory holding costs, lost sales from stock-outs, and most importantly a lack of responsiveness to customer demand. It turns out that much of the demand variation is caused *by the supply chain itself, not by the end customer.*

The fast moving consumer goods industry displays similar behaviour. Consider the production and distribution of diapers. Given the consistency in diaper demand, it would be natural to expect the diaper supply chain to operate efficiently. Indeed, when logistics executives at Procter and Gamble examined the demand for its diapers at retail stores, it found a relatively flat demand. However, the orders Procter and Gamble placed on its suppliers for this product showed considerable variation.

Understanding how supply chains and their constituents behave over a period of time is important because it affects all supply chain partners. Understanding this behaviour also forms the basis for planning capacities, strategies and operational decisions for transporters, traders and commercial entities that affect the end to end performance of a supply chain.

The pasta maker Barilla SpA that we discussed in Chapter 1 significantly mitigated the bullwhip effect by implementing a just-in-time distribution (JITD) system that provided Barilla information about the demands that customers made on its distributors and retailers. That information allowed Barilla to specify where inventory was to be held in the downstream distribution facilities [J. Hammond, 1994]. Barilla thus controls the flow of physical goods through the supply chain based on accurate demand information that is not biased by the distribution/retail centres perception of customer demand and Barilla's ability to deliver on these biased demand estimates. In effect, Barilla has taken on the vital task of matching the production and distribution network supply with the end-customer demand. The reader should note that this high degree of control of the supply chain is not always possible. Rather, Barilla, by virtue of its clout in the supply chain, is one of a relatively few organisations—such as Dell, WalMart, Hindustan Unilever Limited, etc., that are able to dictate how the supply chain operates. Even with this level of clout, it was not easy for Barilla to put through its just-in-time distribution system.

The JITD distribution system used by Barilla is a classic example of a *pull*-based demand-driven system. A dichotomy of terms used to describe how a supply chain functions is that of *push* and *pull*. The term *push* is used to denote the triggering of material flows downstream through planned dispatches, based on forecasts. In contrast, the term *pull* is used to denote the triggering of material flow through replenishment orders. Generally, cost control and capacity utilisation are primary concerns in parts of the supply chains where the push philosophy dominates, while customer satisfaction, inventory problems surrounding shortage and obsolescence, and effectiveness, are major concerns in the pull part of supply chains. The understanding of why and how push and pull systems, or a combination of them, work is important in the design of supply chains. Such understanding helps determine, for instance, where decoupling points – points at which inventory is usually held – should be located. This is discussed in the next chapter. In subsequent chapters, we also see how various entities can plan their operations from a supply chain perspective. An understanding of the dynamics discussed in this chapter would be crucial for this.

The examples presented above illustrate how minor changes in demand at the end-user or the retail level results in huge variation in demand at upstream enterprises in the supply chain. This phenomenon, termed the *bullwhip effect*, owes its origin to the fact that a slight motion of the handle of a bullwhip can make the tip of the whip thrash wildly at speeds up to nine hundred miles per hour, about 20 per cent faster than the speed of sound, creating a sonic boom. In the context of a supply chain, the bullwhip effect manifests itself through increasing demand variability as you move upstream in the supply chain. That is, small shifts in the level of customer demand experienced by the retailer are magnified as the demand information is passed up the supply chain creating increasingly higher variation in the orders received by upstream suppliers.

2.2 THE BULLWHIP EFFECT

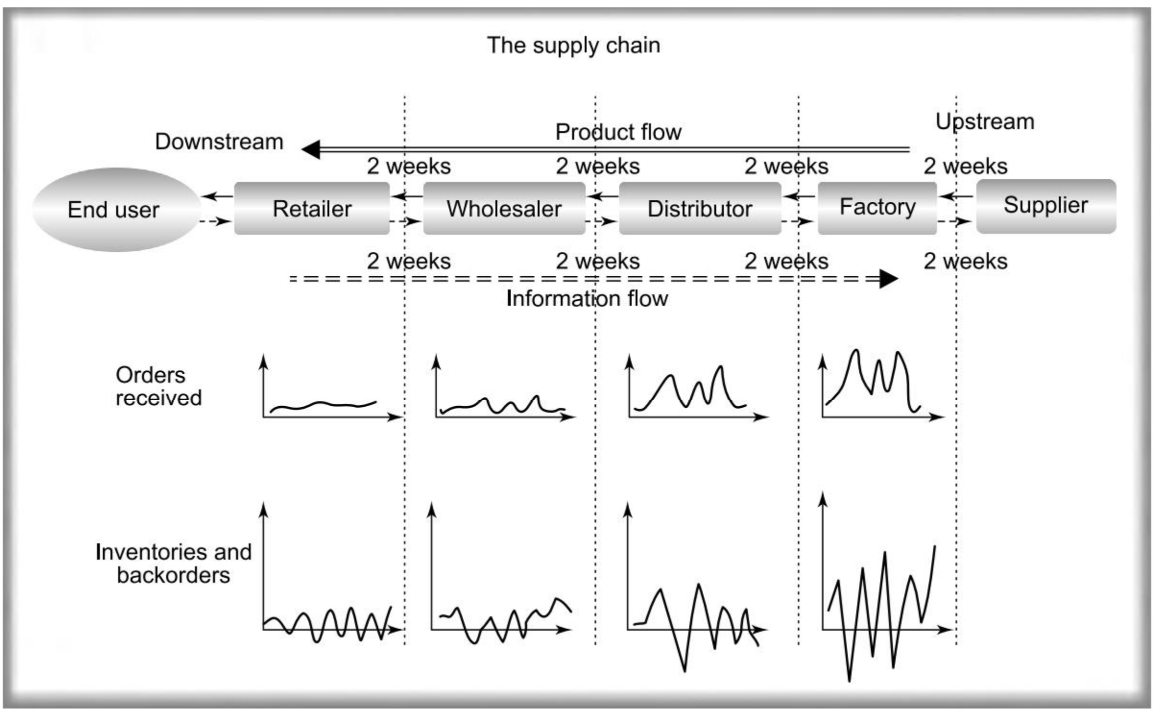
The bullwhip effect results in tremendous inefficiencies of the supply chain. It results in excessive inventory investment, poor customer service, lost revenues, misguided capacity plans and ineffective transportation and production schedules. Many enterprises have gained a significant competitive advantage by understanding the underlying causes of the bullwhip effect and working with their supply chain partners to reduce it. This, in turn, enables them to reduce inventories and become more responsive to customer demand. A very effective way to demonstrate the underlying causes of the bullwhip effect is through the Beer Game simulation.

2.2.1 The Beer Game

The beer game simulates the behaviour of a serial supply chain consisting of four enterprises engaged in the production and delivery of a single blend of beer: a factory, a distributor, a wholesaler, and a retailer. Figure 2.1, illustrates this linear arrangement. The goal of each enterprise is to manage the demand imposed by its customer.

Each week, an enterprise in the supply chain receives orders from its downstream customer and places orders with its upstream supplier. At each stage there is a time lag between having an order and compliance, besides costs for storage and rush orders. Initially, there is no information sharing beyond what is conveyed by orders and shipments. All four enterprises in the supply chain have to decide what to order from their upstream supplier based on the orders they receive from their downstream customer and their inventory on hand. There is a two-week lead time before an order placed by an enterprise reaches its upstream supplier. Similarly, there is a two-week manufacturing lead time, from the time an enterprise receives an order until a shipment against this order reaches the downstream customer. In effect, there is at least a four-week lead time from the time an order is placed by an enterprise on its upstream supplier until the time it receives a shipment against this order, as depicted in Figure 2.1.

Figure 2.1: The Bullwhip Effect in the Beer Game



At the start of the simulation, the system is in steady state with the consumer (end-user) buying four cases of beer each week, while each enterprise is ordering and receiving four cases of beer each week. Each enterprise is holding an inventory of twelve cases of beer. The retailer's demand is revealed at the start of each week—for the first few weeks this demand is steady at four cases per week. The demand on the other enterprises is determined by the orders working their way upstream—initially four cases per week. At the end of each week, each position in the supply chain decides the number of cases it wishes to order from its upstream supplier.

The steady state is now disrupted. For week five, the demand by the consumer increases to eight cases per week and is held steady thereafter. Even this one-time step change is enough to cause significant problems upstream. As the change in demand propagates upstream, shortages or surpluses accumulate at each stage in the supply chain. As indicated in Figure 2.1, orders and inventories spike wildly. These spikes become magnified as you move upstream.

2.2.2 Analysis of the Bullwhip Effect

The discussion in this section is based on a paper by K. Gilbert [2003], which explains how the beer game is able to demonstrate the importance of systems thinking and its impact on the supply chain. The game shows that a *locally managed* supply chain is *inherently unstable*. The systems perspective recognises that if each element in the supply chain tries to optimise its own operations in isolation, everyone suffers in the long run. In the context of the beer game, each enterprise in the supply chain makes decision in isolation without input from its immediate upstream and downstream supply chain partner. Moving from a local optimisation framework to a global optimisation framework poses a tremendous challenge for enterprises, as it is a radical shift from the traditional approach towards managing an enterprise. System thinking has been pointed out many times as strategically important, but is still not sufficiently understood.

Because firms work with limited information, it is thought that a major cause for the chaos in the supply chain is the lack of visibility. In the absence of communication, each firm in the supply chain acts in its own self-interest and on the basis of their own forecasts. The one thing you know for sure about a forecast is that it's wrong; the one thing you never know is just how wrong. If firms have visibility on the entire supply chain, chances are they would do much better. Therefore, a commonly held belief is that the bullwhip effect is mainly due to lack of point-of-sale (POS) data and/or good forecasts. In fact, obtaining POS data and good forecasts are often cited as the primary reasons why the enterprises in the supply chain should collaborate.

On the contrary, it turns out that the primary culprit for the bullwhip effect is *lead time*. Even when there are no breakdowns in communication, you will still feel the bullwhip effect due to procurement and manufacturing delays. This is not to say that POS information and improved forecasting have little impact. In fact, reducing lead time, in combination with improved visibility along the supply chain, can significantly and positively impact the bullwhip effect, as we demonstrate below.

So, what exactly is the impact each of these variables has on the bullwhip effect? We find it is instructive to analyse the beer game using a quantitative approach, to identify the impact of these variables a little more precisely. The beer game, it may be recalled, is started with each enterprise carrying twelve cases of beer, and experiencing a demand of four cases of beer each week. The lead-time for each enterprise to receive a shipment against an order is four weeks.

At the start of the simulation, the system is in steady state. The equilibrium is then disrupted and the end-user demand increases to eight cases from week 5. Consider the impact of the increased demand on the retailer. The retailer begins this week with twelve cases, receives four cases, but sells eight cases, and ends the week with only *eight* cases in inventory. The retailer must now decide how many cases to order.

Suppose that each firm's ordering policy is based on two very simple, but logical rules; one rule to provide the forecast and another rule to determine the order quantity:

> ***The forecast rule:*** The forecast of the weekly demand for each of the next four weeks is just the average of the weekly demand over the four immediately proceeding weeks.
>
> ***The order quantity rule:*** Based on this forecast, the amount ordered is just enough to replenish the ending inventory (four weeks from now when the order arrives) to a target of twelve cases.

Based on rule 1, the retailer forecasts his weekly demand to be five cases per week for each of the next four weeks: $(4 + 4 + 4 + 8)/4 = 5$.

Rule 2 requires that the retailer's inventory on hand plus the inventory on order to be sufficient to cover the forecasted demand for the next four-weeks and have twelve cases left in inventory. Therefore, the retailer must order the sum of the inventory target (twelve) plus the forecasted demand for the next four weeks minus the inventory that he already has on hand or on order:

Order = Inventory Target (12) + Forecasted demand for next four weeks (5 each) – Current Inventory (8) – Orders already placed for the next three weeks (4 each) = 12 + (5 + 5 + 5 + 5) – 8 – (4 + 4 + 4) = 12 + 20 – 8 – 12 = 12.

The retailer will thus place an order for twelve cases on the wholesaler.

A fundamental insight: The consumer demand increased by 100 per cent (from four cases per week to eight cases per week) but the retailer's order to the wholesaler increased by 200 per cent (from four cases per week to twelve cases for the following week). *The retailer thus doubled the variation in demand*. This increase in variation is due to the four-week lead time required to react to the forecasted increase in demand.

Next consider the wholesaler. Assume that the wholesaler behaves in an identical manner as the retailer, except that the wholesaler's demand is created by the retailer's orders. Initially the wholesaler receives four cases per week, sells four cases per week and ends each week with twelve cases. Then the wholesaler unexpectedly receives an order from the retailer for twelve cases. The wholesaler will begin the week with twelve cases, receive four cases, sell twelve cases and end with an inventory of four. The wholesaler uses the four week average forecasting rule and the inventory target of twelve cases to arrive at the following demand forecast for each of the next four weeks:

The wholesaler's forecast is: (4 + 4 + 4 + 12)/4 = 6 cases per week.

Hence, the wholesaler's order will be:

Order = Inventory Target + Forecasted demand for the next four weeks – Current Inventory – Orders already placed for the next three weeks = 12 + (6 + 6 + 6 + 6) – 4 – (4 + 4 + 4) = 20.

The wholesaler's order on the distributor has thus increased from four cases per week to twenty cases the following week, an increase of 400 per cent.

Following the forecasting rule and order quantity rule, the distributor reacts to the wholesaler's order of twenty cases by ordering thirty-six cases, an increase of 800 per cent. The factory responds to this order by ordering enough raw material from its supplier to make sixty-eight cases, an increase of 1600 per cent.

The variation is thus doubled at each stage. Of the sixty-four case increase in the factory's orders, *only four cases* were directly attributable to a change in consumer demand. *The lead times present in this value stream created 94 per cent of the variation observed in the factory's orders.*

We summarise the results of this analysis as follows: ***Lead times significantly exacerbate the bullwhip effect.***

For the beer game analysis with a four-week lead-time and orders placed using the forecasting rule described in this section, the variation in orders grows by a factor of 2 at each stage. In other words, the *increase in variation at each stage is multiplicative*. Using the computations above, we find that the variation in orders grows by a factor of 1.25 at each stage.

We thus observe that a moving average forecast does not reduce the bullwhip effect. We now show that the bullwhip effect is present even when there is *perfect information about the present and the future*, instantaneously available to all enterprises in the supply chain.

2.2.3 Improved Forecasting and POS Data do not Eliminate the Bullwhip Effect

Let us use the same beer game scenario as before except that each stage is instantly made aware of the consumer's orders. Let us assume too, that the consumer orders four cases for weeks one through four, and eight cases for week 5, as before. However, to enable a proper comparison with the analysis in the previous section, we will assume that the perfect information scenario reveals that the consumer demand for the following weeks (week six onwards) is five cases of beer. This assumption allows a fair comparison, because the forecasting method used in the preceding section predicts a steady demand on the retailer for five cases of beer for the following weeks. We also assume that this demand information is conveyed instantaneously upstream. In order to keep the comparison fair, we assume that the lead-time to react to an order is four weeks at each stage.

Following exactly the same approach as before, the retailer will order twelve cases of beer from the wholesaler for week 5 in order to bring the retailer's inventory back to the target level of twelve cases of beer. That is, the 100 per cent increase in demand on the retailer translates to a 200 per cent increase in demand on the wholesaler over the previous week as before. Since the retailer sees the demand for the following weeks to be five cases of beer, the retailer tells the wholesaler to expect a demand of five cases for each of the following weeks. The wholesaler who sees an order of twelve cases this week, is also aware that the retailer will order five cases each week thereafter, and is currently receiving four cases of beer from the distributor for the next four weeks. Thus, to bring the target inventory to twelve cases, the wholesaler orders sixteen cases of beer from the distributor. In other words, a 100 per cent increase in the demand on the retailer translates to a 300 per cent increase in demand on the distributor over the previous week. Similarly, the factory will receive an order for twenty cases, a 400 per cent increase in demand over the previous week, while the raw material supplier will receive an order for twenty-four cases, a 500 per cent increase in demand over the previous week.

This example, which assumes perfect information about the present and the future would require POS data to be available at all stages in the supply chain *and* a perfect forecasting mechanism. Admittedly, this is not a very likely scenario. The point of the example is to show that the bullwhip effect is still present even with such perfect information, albeit to a smaller extent. With such perfect information the variation in the orders generated at successive stages *does not grow multiplicatively; rather it grows additively* (by 100 per cent at each successive stage).

There is a variant of the beer game, termed *the near-beer game*, which demonstrates that POS data and good forecasting tools do not eliminate the bullwhip effect. In the near-beer game, the supply chain consists of three enterprises; a supplier, a brewery, and a customer. There is a single type of beer brewed. There is a delay of one week to receive raw material from the supplier. It takes one week to brew the beer and one week to deliver to the customer. The system is initially in steady state with the customer ordering ten cases of beer each week. The brewery has ten cases in inventory, ten cases of beer brewing and ten cases of raw materials arriving from the supplier. For week two, demand increases to fifteen cases per week and remains at fifteen cases thereafter. The simulation ends when the supply chain is back in equilibrium with fifteen cases of beer. In the near-beer game, the brewery has perfect information about the demand for beer, but the bullwhip effect does not go away.

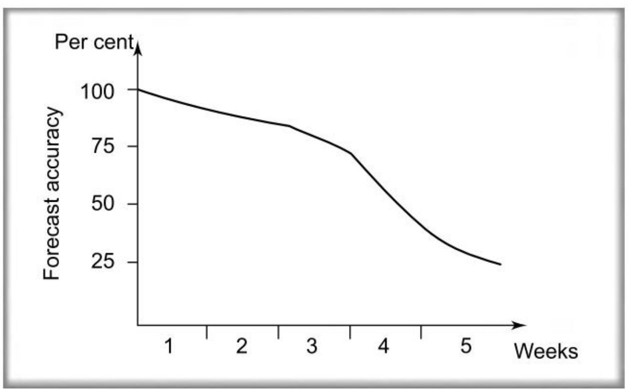
The near-beer game imparts all the lessons conveyed by the beer game. It also teaches one additional lesson that the original game does not: *the bullwhip effect is present even if there is perfect information* about the future that is shared among all channel partners. Note that having perfect information about the future is even better than having POS data and excellent forecasting tools. The near-beer game thus demonstrates that the bullwhip effect is best addressed by reductions in the manufacturing and order lead times.

2.3 THE IMPACT OF LEAD TIMES

The analysis provided above demonstrates that lead time affects the variation in demand in a multiplicative manner. That suggests we can minimise the bullwhip effect (demand fluctuations in the supply chain) by reducing lead times. Reducing lead times result in reduced operating costs as less capacity is needed to handle demand fluctuations.

Reducing lead times provides a number of other benefits as well. Lets look at how lead times affect forecast accuracy. Suppose the manufacturer in a supply chain operates in a build-to-stock environment. If the manufacturer requires, say, four weeks to build products, then the implication is that the manufacturer should build to a forecast four weeks further into the future. However, if the lead time is two weeks, then the manufacturer only needs to build to a forecast two weeks further into the future. Consider the implications. As Figure 2.2, indicates, the longer the time horizon for the forecast, the less reliable it is. Thus, a forecast made for a demand that is two weeks further into the future is clearly more reliable than a forecast made for a demand that is four weeks further into the future.

Figure 2.2: Forecast Accuracy Decreases as the Forecast Horizon Increases



Preparing for a forecast always carries with it an element of speculation. The enterprise that builds products based on forecasts typically pads the forecasted demand in order to buffer for the uncertainty in the forecast. Such padding further distances the amount produced from the true customer demand, adding to the variation in the supply chain; and the longer the lead time, the greater the amount of padding. Hence, *as lead times decrease, the demands by the elements in the supply chain converge more closely to a pure pull strategy in which there is no variation added by the supply chain.*

2.3.1 Little's Law

Reducing lead times has another important benefit. Lead time reduction results in lower inventory costs, as quantified by Little's Law. This important law states that the lead time in the system is directly proportional to the inventory in the system. In particular, Little's Law states that *the average system lead time is equal to the average inventory in the system divided by the system throughput.*

Little's Law is an exact formula; it also permits an intuitive explanation. To provide some intuition into Little's Law, suppose each job takes t time units to process. So the throughput rate, TH, which is the number of jobs processed per unit time is TH = 1/t. Suppose the work-in-process is W units. If a new order is now placed, then the lead time, LT, for this order will be the time it takes to clear the W units of WIP, namely, LT = W t. This gives W = TH × LT.

Little's Law is useful when we consider inventory stocking plans. For instance, if the lead-time for supplying material is high, then we need to carry more inventory somewhere in the pipeline to make sure we do not run out of inventory. An example will better clarify the last statement.

Example 2.1

CSN Inc., is an organisation located in Chennai that makes fabricated parts. It procures sheet metal from a supplier in Faridabad. CSN Inc., consumes 10 Kg of this sheet metal every day. The supplier has a 20 day lead time. What is the sheet metal inventory in the system? To make matters simple, assume that the supplier is extremely reliable, and that the lead time is exactly 20 days for every supply.

In this example, TH = 10 Kg/day, and LT = 20 days. So, the amount of inventory in the system (either at CSN Inc., or in transit) is W = 10 × 20 = 200 Kg.

The implication of Little's Law is that when lead times are high, it results in increased inventory in the pipeline. Conversely, when inventory in the supply chain increases, lead times will correspondingly increase as well. This problematic and cyclical relationship between lead times and inventory provides a powerful reason for reducing lead times.

Ideally, if lead times were small and every enterprise in the supply chain could react to a pure pull signal it would be possible to run the supply chain with near zero inventory. Each enterprise in the supply chain would wait for its customer to place an order before it ordered parts from its suppliers and would only begin production on the order when the parts arrive. Thus, they would not need to carry any raw material, work-in-process, or finished goods inventory. In turn, the lower inventories in the pipeline usually results in lower lead times, generating a virtuous cycle. Needless to say, the ideal is unlikely to be realised in practice for most supply chains unless lead times are reduced.

2.4 INVENTORY MANAGEMENT AND SUPPLY CHAIN DYNAMICS

The preceding discussion clearly points out the need for minimising inventories, emphasising the need for organisations to continue looking for opportunities to reduce inventories (and, therefore, lead times). However, there appear to be limitations on the extent to which inventory can be reduced, simply because of the nature of the production and distribution processes in the supply chain. Furthermore, quite often there is pressure from marketing, sales, and even the finance department to increase inventories. For instance, marketing and sales may exert pressure on the organisation to have high levels of finished goods inventory to provide better customer service. Economic/cost considerations may also dictate the need for higher inventories in the system.

We now present some guiding principles for good inventory management. To this end, note that from a supply chain perspective, inventory can be present in the form of raw material, work-in-process (WIP) or finished goods inventory. Note too that, from a supply chain perspective, for any organisation that is not at the downstream end of the supply chain, its finished goods inventory is simply WIP in the system.

The pressure to have increased inventories comes from the notion that a) customer demand is unpredictable, b) supplier and manufacturing lead times are long, c) the organisations in the supply chain have to deal with different products, not all of which can be produced at the same time within the organisation, and there are setup/changeover costs, d) customers need the product immediately, and will either buy a competitor's product or shop elsewhere if the product is not available on the shelf. While there are other reasons for driving up inventories, these four are fairly representative of the reasons for having higher inventories.

Consider first customer service. The pressure to have high finished goods inventory comes from the basic assumption that if you have finished goods inventory, then you will be better positioned to satisfy customer demand without incurring any delays due to manufacturing lead times. From a systems perspective, though, this finished goods inventory probably exists because it was built *in anticipation* of a future customer demand—one that may probably never materialise. (Presumably that is why the organisation is carrying finished goods inventory instead of having shipped it to its downstream customer.) In fact, Taiichi Ohno, widely acknowledged as the person responsible for the Toyota Production System, is reputed to have said, 'the more inventory you have on hand the less likely you are to have the one item your customer actually wants.' Also, in the process of creating finished goods inventory (which may not be consumed in the near future), the organisation has misallocated its capacity to produce the wrong product. Furthermore, it has used raw material that could have probably been used to produce an alternate product that the customer really wanted.

From an economic angle, the pressure to have higher inventories stems from the notion that if you build large batches, it will result in reduced setup/changeover costs; also, if products are produced and transported in large batches, it will reduce transportation costs. And it can be argued that higher (finished goods) inventories reduce stock-out costs. On the other hand, from an economic perspective, the pressure to reduce inventories comes from the fact that high inventory levels result in higher inventory carrying costs, storage and obsolescence costs, handling costs, etc.

The classic *economic order quantity* (EOQ) or *economic lot size* models attempt to balance these costs to arrive at the optimum batch to produce or procure, using quantitative analysis and reasoning. Chapter 10 discusses these models in more detail. In this chapter, we simply note that the notion of trade-offs between these opposing costs is very relevant. However, we note that these models often have some conceptual flaws. Consider, for instance, the classical EOQ model which provides a formula for the optimal order quantity. Rather than getting into mathematical details in this chapter, we simply present the intuition behind this formula.

The EOQ model assumes that there are two costs that have to be traded off. One is the inventory carrying cost, which increases linearly as the order quantity increases. The other cost is the ordering cost, which decreases in a non-linear manner as the order quantity increases (the rate of decrease becomes smaller as order quantities increase). Since one cost increases with increasing order quantity while the other cost decreases, it seems intuitively clear that there is an optimal order quantity value that minimises the sum of these two costs. Aside from the obvious over-simplification this model makes of the real world, namely merging all the costs into just two cost numbers, what is a possible flaw with this approach?

A flaw with the EOQ model is that it assumes the inventory carrying cost and the ordering cost are fixed. As a result, many organisations naively attempt to estimate these costs as accurately as possible using any available tools, determine the EOQ for their products or raw material components, and use these numbers to drive their procurement and manufacturing activity. When organisations operate in this manner, they typically neglect to drive down these costs. For instance, in the 1980s, even as the U.S. automakers were using the EOQ formula to drive purchasing or manufacturing decisions, the Japanese manufacturers refused to accept the costs as fixed, but instead focused on driving down setup times (and, thereby, the setup costs), which in turn resulted in smaller batch sizes being produced or ordered.

In sum, while there is often a pressure to hold more inventory for economical reasons or for improved customer service, such pressures often stem from a lack of a systems perspective. Organisations need to continue their efforts to drive down inventories as far as possible simply because the presence of inventories is a symptom or manifestation of long lead times; and long lead times only serve to increase the bullwhip effect.

2.4.1 Risk Pooling

Inventory reduction can be realised through a simple concept—*risk pooling*. This concept is typically explained using some statistical reasoning to explain how the aggregate of a number of individual demands will have less variation than the sum of the variation on the individual demands. Rather than getting into mathematical details, we resort to intuition and consider a specific example of a distributor supplying to multiple retail outlets. If each of these retail outlets serves their constituent customers, it has to carry inventory. The inventory carried by each outlet should be adequate to meet the average demand placed on it, plus an additional safety stock to satisfy the variation in the demand at the retail outlet. Thus, the total inventory in the system is the sum of the inventory required to satisfy the average demand at each retail outlet plus the sum of safety stocks maintained at each retail outlet.

On the other hand, if the entire demand was met directly from the distributor's facility, then the inventory the distributor must carry is the sum of the inventory needed to meet the average demand at each outlet plus a safety stock that meets the variation in demand *across all outlets*. As observed in the previous paragraph, the sum of the variation in demand at each outlet will be greater than the combined variation in demand across all outlets. To help the reader think this through, note that if the demands on the different retail outlets were independent of each other, then if one retailer encounters a demand in a given time period that is more than its average, it is quite likely that during this same time period another retailer would encounter a demand less than its average demand.

Next, we discuss offshoring and outsourcing in the context of their effect on supply chain dynamics. This discussion is pertinent because such activities, especially offshoring, typically result in higher inventories. For the purposes of our discussion, we define offshoring as the act of procuring, from a distant overseas location, goods (*not* services) that were formerly sourced from a nearby location.

2.5 OFFSHORING AND OUTSOURCING: EFFECT ON SUPPLY CHAIN DYNAMICS AND COSTS

The topic of offshoring/outsourcing is usually contentious and one can present very compelling reasons for and against offshoring or outsourcing. It is not our intent to discuss this topic in detail in this book. Rather, we restrict discussion to offshoring and briefly present its pros and cons, when viewed in the context of supply chain dynamics.

Organisations resort to offshoring for a variety of reasons. One reason is to locate manufacturing activity in a country where the organisation wants a global presence, usually to sell its products there. Another reason for offshoring is to use alternate sources for products or materials that local suppliers are finding difficult to supply. A third reason is to reduce costs; the intent is to source products or raw materials from the most cost-effective source. Let's look at these three cases, one by one.

In an era of global competition, many organisations are trying to establish a global presence for their products, attempting to penetrate markets in offshore locations. A direct consequence of this endeavour is that these organisations may offshore their procurement of raw material or components in order to manufacture their products from these remote locations. This is certainly a very good reason to offshore, since it can facilitate the organisation's goal to grow its business, profitably. Having local suppliers will very likely make the products more appealing in the public's eye, and can lead to generous tax breaks and other governmental incentives. Furthermore, a key benefit of having suppliers located close to the manufacturing site is that the lead time for supply, and therefore the bullwhip effect, is significantly reduced.

Organisations also identify offshore sources for products because they indicate difficulty sourcing these same products from nearby suppliers. While this might be a valid reason for offshoring, one has to question whether the organisation has systematically examined all possible alternative sources within its own borders. Quite often, organisations are trapped in a cost-world mentality and turn a blind eye to potential suppliers that might be willing to provide the product albeit at a higher price. That leads to the third reason for offshoring—the desire to reduce costs.

Offshoring, when used as a means of combating higher costs, has proven to be a mixed bag. Many organisations, especially in the U.S. and in Western Europe, have resorted to offshoring production to low-cost countries and the phrase, LCC offshoring (to represent offshoring to low-cost countries) has become a common buzzword in the 21^{st} century. More often than not, these decisions are a manifestation of local thinking. The purchase department is often rewarded on a metric known as purchase price variance (PPV) and that drives them to seek low cost sources without considering the ramifications.

2.5.1 The Hidden Costs in Offshoring Math

Consider a component required by a manufacturer to make its product. The manufacturer currently produces 1,00,000 units of this product every month. Suppose the product requires a component that is currently purchased by the manufacturer from a supplier located in close proximity for Rs 250 per unit, inclusive of all taxes and duties. Suppose a supplier from a low-cost country is offering the same product for Rs 125 per unit, FOB ('Free on Board') inclusive of all taxes and duties. On first glance, it appears that the manufacturer can potentially save Rs 1.25 crores by offshoring the procurement of the component. What are the additional costs the manufacturer may not have considered? As we outline additional costs, the reader should keep in mind that some or all of these costs may exist even with the local supplier—if they already exist, then the reader should also note that they will usually get magnified when dealing with offshore suppliers.

The first set of costs to be considered is possible additional transportation and handling costs incurred to move the product from the port of entry to the manufacturing site. This will include any custom duties and tariffs, brokerage fees, etc.

A second set of costs relates to risk in the form of currency risk, country risk and competition risk (intellectual property risk). The last risk is if the offshore supplier of the component decides to manufacture the product. This risk is also present with local suppliers, but there is even less control over offshore suppliers. Another risk is the so-called 'job-switching' risk. In a number of developing countries, many promising employees are lured away, often on a day's notice or even less, by a lucrative offer from another employer.

The third set of costs relates to warranty and obsolescence costs. The following questions need to be addressed: scrap cost per unit, inspection costs (do we need to have our inspectors on site), disposal costs (costs incurred when the project is complete), and warranty claims cost (who will pay—the offshore supplier or the manufacturer?).

A fourth set of costs relates to schedule of non-compliance. What is the expediting cost? How many expedited shipments are needed each year? What is the cost of stockouts and lost sales? This cost includes the cost of airplane trips made by high-paid executives to the offshore site for troubleshooting and/or root-cause analysis.

The fifth set of costs is probably one of the more insidious costs. It relates to the cost of additional inventory that now needs to be carried. This inventory manifests itself in the form of additional inventory in the pipeline since procurement lead times are now much longer (remember Little's Law), the additional safety stocks that need to be maintained since there is usually more uncertainty in supply, and the batch processing costs that may arise at the manufacturer's site since components now arrive in large batches with the attendant overtime costs. More importantly, additional inventory needs to be held to manage the bullwhip effect resulting from increased lead times—this is typically a very large amount that is extremely difficult to estimate.

There are other hidden costs that we may mention in passing—costs that are very difficult to estimate. They include the loss of innovative ability, brand and customer relationships, loss of productive time/recovery time for the busy executive to fly overseas for troubleshooting and root cause analysis, the lack of accountability, data security/patent issues, etc.

2.6 LESSONS LEARNED

The analysis we carried out shows that long lead times and the lack of POS data exacerbate variation in the supply chain. A direct consequence of this observation is that since lead times increase with more stages and handoffs in the supply chain, reducing the number of stages reduces variation in the supply chain. In the analysis we also observed how the variation at each stage is either additive or multiplicative, depending on whether or not the system had perfect information about the future.

The use of POS data can help reduce variation from a behavioural perspective as well. Managers of lean supply chains realise that end-user demand is more predictable than the demand experienced by factories. Hence, they are more likely to ignore signal distortions sent through the supply chain and instead focus on the end-user demand. Such a practice does not react to day-to-day fluctuations but instead favours running a level production schedule each day, helping mitigate variation in the supply chain.

It must be noted, though, that without perfect information about the future, sharing POS information does not give much leverage to the enterprises when the lead times are high. They still need to anticipate future consumer orders. Unless these consumer orders are steady, the bullwhip effect will not be additive. This leads to the following observation:

Point-of-sale data can reduce the bullwhip effect. However, without perfect information about the future, POS data does not eliminate the bullwhip effect. Lead-time reduction is also necessary.

Here are other ways to mitigate the bullwhip effect:

- Smaller order batches result in smaller fluctuations. This highlights the need to work with suppliers to enable more frequent deliveries in smaller order increments.
- Maintaining stable prices for products reduces the customer's temptation to over-purchase when prices are low and cut back on orders when prices are high. This leads to more steady demands from customers.
- Allocating products among customers based on past orders rather than based solely on their present orders will reduce hoarding behaviour when shortages occur. Unrestricted ordering capability can be addressed by reducing the maximum order size and implementing capacity reservations. For example, one can reserve a fixed quantity for a given year and specify the quantity of each order shortly before it is needed, as long as the sum of the order quantities equals to the reserved quantity. Leading enterprises like Barilla SpA adopt this approach in their distribution strategy.

A key learning point is that *structure drives behaviour*. The way in which the supply chain is designed largely determines how it will perform. The structural framework for the beer game has the following components, all of which play a role in enhancing the bullwhip effect:

- Lack of visibility along the supply chain—no POS data and a lack of coordination or communication up and down the supply chain
- Long lead times for material and information flow
- Many stages in the supply chain
- Lack of pull signals
- Order batching
- Price discounts and promotions.

The observation that structure determines behaviour is not a novel concept. Deming alluded to this phenomenon when he said that management must take the responsibility for poor performance and take steps to reduce process variation instead of blaming the workers for poor quality. However, there are behavioural phenomena, not necessarily driven by the structure, which also contribute to the bullwhip effect:

- Over-reaction to backlogs
- Withholding orders in an attempt to reduce inventory
- Hoarding—where customers order more than they need because they are anticipating a price increase or because the supplier has a promotional sale
- Shortage gaming where customers order more than they need because they do not have faith in the supplier's ability to deliver quality products and/or because they do not expect the supplier to supply the entire order
- Demand forecast inaccuracies where a customer adds a certain per centage to the demand estimates, resulting in reduced visibility of true customer demand
- Attempting to meet end-of-month, quarter, or year metrics.

In the beer game simulation, the bullwhip effect is observed even though the supply chain deals with a single product and there is just a one-time spike in demand. Enterprises in the real world usually deal with multiple products with demands that vary from period to period. Managing multiple products at a common facility leads to batching of production or processing of any one product, in an attempt to reduce the capacity lost while changing from one product to another. This adds to the bullwhip effect.

Furthermore, in the real world there are many other factors that play a role. Quality problems and unplanned events such as strikes and accidents induce additional variation in the supply chain, and exacerbate the bullwhip effect. With all these factors, it is easy to see why the bullwhip effect is present in almost any industry. One of the major bullwhip related costs is the cost of capacity which is required to meet some demand by customers, over a period of time. A simple analysis will show that meeting demand that is stable and known ahead of time is far less expensive than meeting the same demand in aggregate quantitative terms, but one which varies over time. If this variation is not known, and is unpredictable and has to be forecasted and protected with inventory, the costs are even higher.

As we noted earlier, one of the lessons is that structure drives behaviour. Many enterprises have gained a significant competitive advantage by understanding the underlying causes of the bullwhip effect and building the necessary structural framework within their own enterprise walls. These enterprises are also working with their upstream and downstream partners to mitigate the bullwhip effect.

CONCLUSIONS

The bullwhip effect underscores the need for enterprises to understand the dynamics of the supply chain and the primary causes of the bullwhip effect. The primary causes for the bullwhip effect are:

- ➢ Lack of visibility along the supply chain
- ➢ Long lead times for material and information flow
- ➢ Actions undertaken within the enterprise, such as order batching, price discounts and promotions, etc., exacerbate the bullwhip effect.

In particular, lead times significantly affect the performance of the supply chain:

- ➢ Longer lead times lead to increased inventory in the system. Conversely, increased inventory in the system causes lead times to increase, resulting in a vicious cycle
- ➢ Similarly, flow is enhanced by reducing lead times. Reduced lead times and improved flow go hand in hand, creating a virtuous cycle
- ➢ Lead times are also influenced considerably by the variation in the system, and therefore the manager of the enterprise should focus on reducing variation
- ➢ In particular, therefore, it is important to design products and processes so that they mitigate demand volatility.

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Case references : The issue of inventories is actually pervasive in supply chain management, and is present explicitly in a number of cases, such as Laxmi Transformers, FarmAid Tractors Limited, Western Oil Limited (A) and others. Perishable inventories are relevant in Bayer Crop Science and Food World (B).

Exercises

1. What is the major reason for the bullwhip effect?
2. How does better information improve the bullwhip effect?
3. Consider the beer game with four elements, the retailer, wholesaler, distribution and factory. Suppose that the demand on the retailer increases from four cases of beer to eight cases of beer in week 5 and remains steady thereafter, just as before. However, the lead time for an organisation to receive a shipment against an order is now two weeks, not four weeks. What is the resulting increase in the order placed by the factory on its raw material supplier?
4. What are the ways by which an organisation can minimise the bullwhip effect? Be as comprehensive as you can in your answer.
5. What is the significance of Little's Law? What implications does Little's Law have for effective supply chain management?
6. Suppose the average monthly demand for a certain product is 12,000 units. The organisation manufacturing these products works 20 days a month, and carries and average inventory of 3,000 units of this product. What is the expected time the organisation will take to respond to a new order?

7. Give the benefits and drawbacks of carring inventory.
8. What are some of the drawbacks of using the Economic Order Quantity formula to determine how much inventory to carry?
9. What are the benefits of offshoring? What are some of the drawbacks? Compare and contrast the benefits and drawbacks.

CHAPTER 3

Designing the Supply Chain

CHAPTER OUTLINE

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3.2 Steps for Designing and Managing Lean Supply Chains
3.2.1 Develop a Systems Perspective
3.2.2 Understand the Customers and Their Expectations
3.2.3 Map the Value Stream
3.2.4 Benchmark Best Practices
3.2.5 Design Products and Processes to Manage Demand Volatility
3.2.6 Create Flow Across the Supply Chain
3.2.7 Categorisation Based on Work Flow: The V, A, and T Configurations
3.2.8 Characterisation Based on Fulfillment Strategy: BTS, ATO, BTO, ETO
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INTRODUCTION

It has often been remarked that the design of any product usually locks in place as much as 80 per cent of the cost of producing and delivering the product over its lifetime. The same could be said of supply chain design. The manner in which the supply chain is designed plays a very significant role in the cost of operation of the supply chain. Ultimately, this cost of operation will affect the profitability and survival of the supply chain in the customer-centric era.

Supply chain design did not receive much attention for the greater part of the 20th century because most of the organisations operated in a production-centric mindset. Scale of economies drove the conceptual foundations of the supply chain. This worked well as long as demand outstripped supply and customers were willing to compromise their needs. However, such a mode of operation resulted in unwieldy behemoths—organisations that produced their products in large lots. These large batches of products were transported in full truckloads to regional warehouses and distribution centres from which they were delivered to retail stores or to other manufacturing facilities. A customer unwilling to buy the product had to place a special order and wait for a long time for the product to be manufactured and delivered. The lead time, namely the elapsed time between order placement and product delivery was usually measured in months. The suppliers to these manufacturing organisations, in turn, produced and delivered supplies in large lots. Manufacturers and the suppliers were able to co-exist, blissfully unaware of any perceived threats to their operation, lumbering along in true behemoth-like fashion.

The 21st century supply chain operates in a vastly different environment. Capacity now outstrips demand for almost any product or service demanded by an end-user, while the execution time is measured in days, hours, and sometimes, minutes. As we noted in Chapter 1, today's supply chain operates in a demand-driven, customer-centric world. It must respond quickly to rapidly changing customer demands in an agile, gazelle-like manner. To remain competitive in the 21st century, organisations must recognise that the competitive arena has shifted from competition between organisations to competition between supply chains. It is no longer a case of Hindustan Unilever Limited competing against Procter and Gamble. It is Hindustan Unilever Limited's supply chain competing against Procter and Gamble's supply chain.

This chapter presents some fundamental principles that organisations should undertake to design a supply chain. Specifically, it presents seven steps to design and build the necessary structural framework to enhance the performance of the lean supply chain.

3.1 SOME ISSUES IN SUPPLY CHAIN DESIGN

Which organisation in the supply chain should drive the supply chain design? Let us first consider situations where this is a relatively straightforward question to answer. Erecting the structural framework is, no doubt, an easier task for supply chains that have a dominant organisation in the supply chain. For instance, in the previous chapters, we discussed some organisations such as Barilla and Toyota that took on the responsibility for designing and managing the supply chain. In general, the organisation driving the supply chain is usually the one primarily responsible for the brand image. The brand owner could be:

- an upstream manufacturer such as Intel, who would have a significant influence on the supply chain because of the technology driven inputs to the supply chain, for example, through new product introduction
- a downstream manufacturer such as Hindustan Lever, which through a network of own and contract manufacturing could position brands and provide market inputs to the rest of the supply chain
- a retailer such as Walmart, which provides a large part of the final exposure to the market place
- a trading company in commodities, which is usually largely anonymous to the general business world, but which wields considerable influence through volumes of purchases

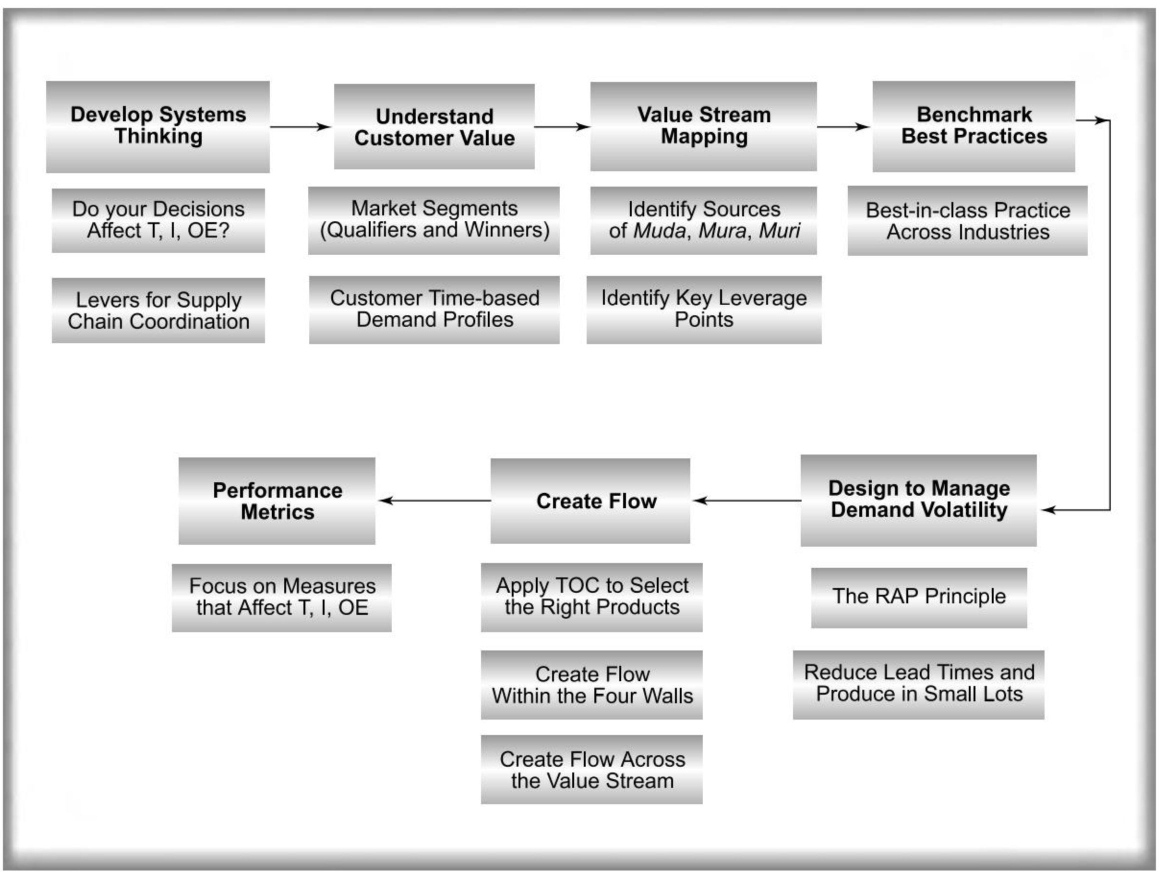
Firms that provide transportation, warehousing or logistics services tend to diversify their business across many different products and services. Consequently, these firms are generally unlikely to be brand owners. However, with international outsourcing, a number of these firms have vertically integrated into a number of businesses associated with logistics, such as global sourcing, quality certification, and transportation through different modes. Some of these firms also provide other key logistics services such as tracking and insurance, customs and commercial documentation. Consequently, they play an important role in the success of global supply chains.

In general, there are relatively very few supply chains that have a dominant player. However, even when there is no clearly dominant authority in the supply chain, it will benefit the members in the supply chain if they are at least aware of the steps they can follow to make their supply chain more competitive. The true competitive edge is realised only when all key members in the supply chain jointly agree to work with these steps. This chapter illustrates the principles of effective supply chain design, focusing on manufacturing and related activities, since that is where the primary value addition and technology inputs are high and where there is a lot of scope for improvement. Once that is achieved, those principles can perhaps be applied to other types of organisations, as elaborated in later chapters.

3.2 STEPS FOR DESIGNING AND MANAGING LEAN SUPPLY CHAINS

Figure 3.1 entitled 'The Lean Supply Chain Roadmap,' presents seven steps that organisations could adopt in their journey to develop lean supply chains. These steps are discussed in more detail below.

Figure 3.1: The Lean Supply Chain Road Map



3.2.1 Develop a Systems Perspective

The beer game discussed in Chapter 2 underscores the importance of systems thinking and its impact on the supply chain. The systems perspective recognises that if each element in the supply chain tries to optimise its own operations in isolation, everyone suffers in the long run. Thus, if each organisation in the supply chain makes decisions in isolation without input from its immediate upstream and downstream supply chain partner, that only serves to exacerbate the bullwhip effect. Moving from a local optimisation framework to a global optimisation framework poses a tremendous challenge for organisations, as it is a radical shift from the traditional approach towards managing an organisation.

For instance, an important element of supply chain management is long-term partnerships with key suppliers. Suppose management institutes a measurement system that rewards the Purchase department for obtaining products from its suppliers at low cost. No doubt, reduced material costs directly affect the profitability of the organisation. However, such a measurement system could drive the Purchase department into an adversarial position with its suppliers, encouraging Purchase to play off potential suppliers against each other in an attempt to drive them to lower their prices. The lack of a systems perspective has resulted in a situation where the organisation will now find it very difficult to establish long-term partnerships with its suppliers.

As another example, consider a supply chain consisting of just two organisations, A and B, where A is a supplier to B. Suppose A receives a mandate to reduce finished goods inventory and responds accordingly. From a local perspective, the performance of A is enhanced. However, if the inventory reduction at A is done in isolation, without any corresponding improvement in the pattern of B's demands on its suppliers, then A might be putting itself in jeopardy because it will be unable to react quickly to unforeseen changes in demand from B. In fact, from B's perspective, A will be perceived as less flexible, and so B may either decide to carry some inventory of its own or find another supplier. The lack of supply chain metrics has led the manager of A to make local improvements that did not lead to improved overall performance of the supply chain.

In hindsight, systems thinking is so intuitive that one may wonder why it was not applied to manage supply chains earlier. One reason is advocated by Senge [1994] who claims that organisations do not practice systems thinking because they are more absorbed with 'detail complexity,' as opposed to 'dynamic complexity.' A manager who deals only with detail complexity is obstructed from seeing how different types of interactions reach beyond his/her organisation, and change over time.

Another reason why systems thinking was not applied in the past was that until a few years ago, requiring the members in the supply chain to work towards a unified supply chain plan would have, at best, seemed a dream. However, the Internet and availability of technology that provides visibility on end-user demand to all supply chain partners, has led to a perceptible change. Supply chains that provide visibility on customer demand are in a better position to ensure that small fluctuations in end-user demand do not amplify into huge swings in the demands placed on the manufacturer. Recognising this fact, the members in many supply chains are now more willing to set aside their traditional arms-length relationships to build long-term partnering arrangements to achieve the competitive benefits derived from an integrated supply chain. The increased visibility on end-user demand also allows the managers of supply chains to better understand customer expectations.

The reader at this stage might be wondering how he or she could apply systems thinking in his/her organisation. We provided a specific example in Chapter 1, when we discussed how Hindustan Unilever adopts this philosophy to cut across departmental boundaries in its decision-making process. To answer this question in a more general framework, we will use a conversation that takes place in *The Goal* [Goldratt and Cox, 2004], which depicts the story of a plant manager, Alex Rogo, who is advised by his old physics professor, Jonah. Alex meets Jonah, by chance at an airport between flights and tells his professor that robots installed in his plant have increased productivity by 36 per cent. Jonah questions Alex whether his organisation is really making 36 per cent more money from your plant, just by installing some robots. Alex reflects on this question and says no. Jonah next asks Alex whether his plant was able to ship more products every day after installing robots. Alex again answers no. Jonah then asks Alex whether he fired anybody (answer: 'No') or whether inventories went down (again, answer: 'No'). Jonah now questions Alex decision on installing the robots in the first place.

The above dialogue between Alex Rogo and Jonah provides an operational perspective for applying systems thinking. For any decision under consideration, ask whether the decision will either:

- increase Throughput (*T*), namely, the money making potential of the organisation,
- reduce 'Inventory' (*I*) in the form of working capital and/or fixed assets, or
- reduce 'Operating Expenses' (*OE*) long-term, namely, result in any reduction in fixed expenses over the long haul.

If the answer to these three questions is 'no,' then the decision under consideration is very likely to be questionable. Thus, the three measures provided above (T, I, and OE) provide the levers for systems thinking and supply chain coordination.

The last item, reducing OE long-term, merits further elaboration. Quite often, managers are forced into some cost-cutting initiatives as a knee-jerk reaction to some external pressures, for instance, a desire to affect the stock price. However, unless the long-term ramifications of such cost-cutting moves are carefully considered, such moves will typically backfire, resulting in a sub-optimal conclusion.

3.2.2 Understand the Customers and Their Expectations

What is customer value? This is a crucial question addressed next. In the supply chain design, we must always address the question on whether the supply chain is designed to be responsive to customer needs and values. As we observed in Chapter 1, Benetton was able to gain a significant competitive edge when it decided to adopt a different process for delivering customer value by postponing the differentiation of its product. That process change allowed Benetton to significantly reduce the problem of markdowns that plague the textile and apparel industry. Similarly, Hindustan Unilever has the strategy of continuously re-engineering its supply chain, introducing vendor managed inventory concepts, adopting systems thinking, etc., as discussed in Chapter 1.

In sum, there is an opportunity for the supply chain partners to challenge the way in which product is traditionally being delivered. Understanding customer value means that you should, at the minimum, identify the attributes your product must have. You must identify the order qualifiers and order winners for your product [Hill, 2000]. *Order qualifiers* are attributes that the product must have for the customer to even consider purchasing it from you. *Order winners* are the attributes that will get you the customer's order. Order qualifiers and order winners determine the competitive priorities your supply chain should focus on. Should it be speed to market, product design, product quality, on-time delivery, or a combination of these? The answer to this question depends on what is important to the customer base.

Order qualifiers and order winners will, no doubt, be different for different customer segments. For instance, if the airline industry wishes to attract family vacationers travelling relatively short distances, then low price tickets could be order winners. On the other hand, for business travellers travelling coast to coast in the U.S., travel on wide-body jets may be the most preferred alternative. Thus, comfort and on-time travel would be order winners. Similarly, to determine order winners and order qualifiers for computer buyers, you need to segment the users into desktop and laptop user, and for, say, laptop users, you need to further segment them into business travellers, home users that primarily use laptops for word processing and email, and users that primarily use laptops for interactive games. Each market segment will have different order winners and order qualifiers that have to be determined by surveying a large number of users within each market segment. In addition to understanding what the order qualifiers and order winners are, you must also determine how you are currently performing relative to these attributes both in the eyes of your customers and relative to the competition.

Order qualifiers and order winners are important to the designer of the supply chain because they facilitate the dialogue between marketing, which identifies the voice of the customer, and operations, which is responsible for delivering on these attributes. Note that order qualifiers and order winners are dynamic attributes. Changes in the market place and changes in technology can change the order qualifiers and order winners. Over time, many perennial order winners may become mere order qualifiers as a result of tremendous advances made in the area of manufacturing technology, planning systems, and information technology. For instance, a combination of quality and low cost used to pack a winning punch only a short time ago, but it is no longer a differentiator. A key function of marketing is to stay abreast of these changes so the organisation can remain proactive in meeting customer expectations and continuing to increase revenues.

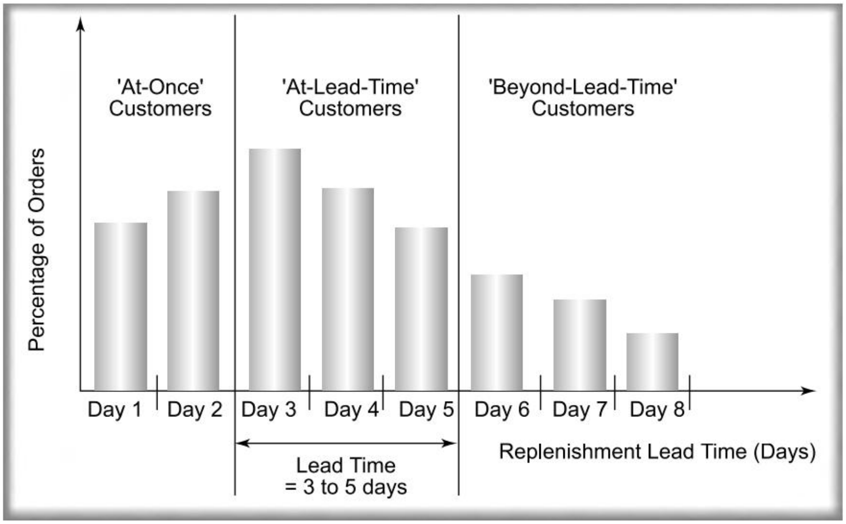
Once order winners and order qualifiers are identified, operations must evolve different product delivery strategies for the different market segments. Supply chains can be characterised as *build-to-stock* (BTS), *assemble-to-order* (ATO), *build-to-order* (BTO), and *engineer-to-order* (ETO). The BTS supply chain provides the fastest response to the customer, but is accomplished with pre-build end item speculation. In contrast, BTO and ETO provide a long response time to the initial customer order, but this is accomplished with little pre-build speculation. The customer must wait for most of the parts and components to work through the supply chain as custom parts. The ATO configuration provides a middle ground where the response time to the customer is confined to the assembly time. This is accomplished with pre-build speculation of components and modules, rather than end items.

The delivery strategy could thus be a combination of several models: BTS, BTO, ETO, and so on. At a macro level, the supply chain structure should delineate which segments are going to operate in a BTS mode and which segments will operate in a BTO mode.

As far as possible, we would like to wait for the customer's order and build the product per customer's specifications. However, customers have differing delivery expectations. Some customers would be prepared to wait for a product that is built exactly according to their specifications while others would prefer to compromise on some product features if they can purchase the product immediately. For the latter type of customer, the unavailability of a product could result in a lost sale, and the organisation may necessarily have to resort to a BTS mode of operation for such customers and maintain some finished goods inventory. However, finished goods inventories do not always solve the problem. As noted in Chapter 2, Taiichi Ohno is reputed to have said that 'the more inventory you have on hand the less likely you are to have the one item your customer actually wants.' In other words, the fact that you have a lot of inventory of a certain product is symptomatic of the organisation having built the *wrong kind* of finished goods inventory. Deciding on the right kind of finished goods inventory is always a challenge, and organisations would therefore like to maintain as little finished goods inventory as possible. For instance, in the electronic industry where some products depreciate almost as fast as groceries do, it is advisable to maintain as little finished goods inventory as possible.

It is therefore expedient to develop a *customer time-based demand profile* that identifies customer expectations in terms of lead time, and develop finished goods inventory strategies accordingly. To understand how the customer time-based demand profile could be used, consider, for instance, a product such as under-the-counter dishwashers. Customers for this dishwasher are individual homeowners, retail stores, or building contractors. The individual homeowner is either one who is in need of a dishwasher now, because his dishwasher is broken and not repairable, or is shopping around to replace a functioning dishwasher. For the homeowner whose dishwasher is broken, the lead time expectation on the order could be zero or, at most, one day. For the retail store owner, the lead time expectation could be one or two days, whereas for the building contractor, the lead time expectation could be one week. For the individual homeowner shopping around for a dishwasher, the lead time could even be as high as a month; this customer may wait until she gets a real good deal. Clearly, there are different types of customers, each with their own lead time expectations. Clearly, too, the manufacturer of dishwashers does not have to carry finished goods inventory for all customer types. If the manufacturer is able to build dishwashers to order in three days, then it only needs to carry finished goods inventory for retail store owners and customers seeking to replace a broken dishwasher. Figure 3.2 presents a customer time-based demand profile.

Figure 3.2: The Customer Time-Based Demand Profile



This profile identifies the percentage of customers who demand products with a lead time expectation of one day (they want their order filled right away), are prepared to wait for two days, three days, and so on. To arrive at this profile, the organisation should gather data on customer orders received (not customer orders filled), and the delivery time expectations that were associated with each order. Ideally, the organisation should also gather data on potential customers who decided not to place an order simply because the lead time was too high. Ideally, too, it is advisable to develop one such time-based demand profile for each product, rather than a generic profile for each market segment.

The time-based demand profile is a very useful tool to match customer expectations with operations capabilities. For instance, suppose the lead time for the organisation to fulfill demand is between two to four weeks. All orders requiring delivery in less than two weeks would have to be met with finished goods inventory. Customers that place such orders can be classified as 'At-Once' customers. Customers placing orders that fall within the lead time window are classified as 'At-Lead-Time' Customers, and those that are prepared to wait for more than four weeks would be 'Beyond-Lead-Time' customers. Ideally, the organisation would like to have more At-Lead-Time and Beyond-Lead-Time customers and no At-Once customers, because in that situation, all orders could be built to demand; that is, the organisation can operate in a pure BTO mode. The At-Once customers, on the other hand, require a BTS delivery strategy [Reeve and Srinivasan, 2005].

The time-based demand profile highlights the importance of lead time reduction, because the At-Once customer base becomes smaller as the lead time to process an order decreases. To enable lead time reduction, the organisation could pursue a postponement strategy as we discuss in a subsequent section of this chapter. The time-based demand profile could also be used to develop pricing strategies. For instance, At-Once customers could be charged a premium, whereas Beyond-Lead-Time customer could be given a discount. In this manner, it is possible to influence the demand profile itself so that more customers become At-Lead-Time or Beyond-Lead-Time customers.

3.2.3 Map the Value Stream

A value stream map illustrates the structure of the physical flow of goods and information flow, and highlights areas in the value stream (supply chain) that require more attention. It is not the intent to provide a detailed discussion on the topic in this book. We will simply discuss the vital importance of value stream mapping in supply chain design and identify a number of sources to the reader interested in further pursuing this topic [M. Rother and J. Shook, 1999; M. Rother and R. Harris, 2001; J. P. Womack and D. T. Jones, 2002].

A typical approach to value stream mapping is to first select the product family for which the value stream should be mapped. The product family is often chosen simply based on the biggest customer for the organisation. The next step is to draw an existing value stream map (an 'As-Is' map). The non-value added work and constraints are then minimised to design a map of the desired end-state value stream (a 'To-Be' map).

As shown in Figure 3.1, the intent of a value stream map is to provide opportunities for removing *muda*, *mura*, or *muri*. These are three Japanese words that respectively mean wastefulness, unevenness and overburdening. *Muda* exists in every organisation, in the form of unnecessary delays, inventory, motion, transportation, and so on, none of which add any value to the customer. *Mura* exists in a variety of forms—unevenness in quality, unevenness in sales and production (which could be caused by poor use of incentives and promotions, or simply the desire to meet quotas), or unevenness in supplier delivery performance. All of these can result in *Muri*. For instance, when there is unevenness in the demand, that could well translate to overburdening some of the resources, albeit temporarily. However, *muri* could also exist due to the presence of either physical constraints or simply due to some policies that create artificial constraints. In summary, *muda*, *mura* and *muri* result in wasteful use of resources in an organisation. The focus of the value stream map is to highlight the sources of these problems and to initiate the steps that would remove these problems.

It is usually hard to determine the degree of detail for a value stream map. The manager of an organisation is mainly interested in the immediate linkages the organisation has with its upstream and downstream partners. In that regard, broadening the map to include organisations beyond the immediate upstream and downstream organisations can result in loss of detail. However, if one can map the flow in this manner to second tier suppliers, and/or to the organisation's customer's customer, it may be easier to visualise the kind of systems that must be put in place to achieve better customer service.

To get started on the value stream mapping exercise, Rother and Shook [1999] recommend starting with a 'door-to-door' value stream map, and working on a process that can typically be improved within around 90 to 120 days. Such an approach has the advantage of providing momentum to lean efforts. A potential disadvantage is that it could lead to missed opportunities since a door-to-door map might not capture operational inefficiencies outside the organisation, where improvements could provide more impact.

Advances in IT have significantly facilitated value stream mapping. They now allow the capture of a much higher level of detail than was possible in the past. Moreover, computer systems make it possible for a manager to look at the degree of detail necessary to effectively manage his area. Once the As-Is map is complete, key structural elements should be examined in detail to identify how it should be managed so as to best impact the performance of the entire value stream. From an operational point of view, there are several key areas of concern in any product/work flow. These include:

- Segments of the value stream where processing times are large. Time is a key element in gaining a competitive edge in the consumer era. Segments of the value stream that have difficulty in responding quickly to changes should be scrutinised and managed carefully.
- Any segment or path that contains physical constraints—either in the form of material constraints or capacity constraints. Effective management of the value stream is impossible without knowing where the constraints are and how they influence the performance of the value stream as a whole.

- Points where there is a high degree of resource sharing. When the same resource is required to process a variety of products, contention for priorities will arise and any mismanagement of these priorities can result in delivery issues.
- Points where common materials are transformed into different product streams. An example of this is the steel making process in an integrated steel mill where the basic pig iron can be converted into a variety of different alloy steels. Once this transformation is complete the processes cannot be reversed. If the wrong product is produced, we end up with inventory (the product just produced) and an urgent shortage (the product that should have been produced).
- Points where multiple materials must come together. These are assembly points. Since the assembly process requires all required materials to be available, the logistical challenge of making sure that all the different materials required arrive on time is significant.
- Points of excessive variation.

A comprehensive value stream map can thus highlight the weakest linkages, indicate points in the value stream which have high lead times, and so on. You can identify where there are insufficient resources available to manage supplier relationships, whether there is a proliferation of suppliers at some of the organisations, or whether the size of the supply chain allows you to develop sound supplier development strategies.

3.2.4 Benchmark Best Practices

Benchmarking is a continuous, systematic procedure aimed at measuring the organisation's products, services and processes against the best-in-class practices. Benchmarking is not aimed at imitation. Rather, it is focused on studying and learning from others and adapting practices that best suit the organisation. Organisations can choose to perform *competitive* benchmarking or *functional* benchmarking. In the former case, the focus is on comparisons with leading organisations in the same industry. Competitive benchmarking usually involves the organisation benchmarking itself with the leader in that industry. Such a form of benchmarking allows the organisation to avoid making some of the mistakes that the leader may have made in its journey to become the best in the industry. The obvious disadvantage of such a form of benchmarking is that the organisation becomes a follower. Typically, the leader will be one step ahead of the competition.

Functional benchmarking, on the other hand, compares processes and activities such as customer service, the design process, and the product delivery system against exemplary practices by best-in-class organisations in any industry. This is the more ambitious form of benchmarking since it selects organisations recognised as world leaders in some processes and attempts to match up to them. For instance, organisations may choose to benchmark Disney for customer service, Dell for rapid customisation, Toyota for process execution, and *American Express* for its ability to get customers to pay quickly.

The advantage of functional benchmarking is twofold. Since it is not comparing itself with the leader within an industry, the organisation carrying out the benchmarking does not need to worry about following the leader. Second, and more important, functional benchmarking provides opportunities for the organisation to identify new and innovative ways of fulfilling customer demand. For instance, Taiichi Ohno credits his contributions to this system to two concepts: the moving assembly line pioneered by Henry Ford, and the supermarket [Ohno, 1988]. In a visit to the United States in 1956, Ohno observed how supermarkets used a continuous replenishment of merchandise. This concept gave Ohno the idea to set up a pull system in which each production process became a 'supermarket' for the succeeding process. Each process would produce to replenish only the items that the downstream process selected. When Ohno adopted the supermarket concept for Toyota, he had a competitive edge since this concept was not used by any of the other automobile manufacturing organisation at that time. The following lean supply chain principle [Srinivasan, 2004] summarises this discussion.

LEAN SUPPLY CHAIN PRINCIPLE

Focus on customer needs and process considerations when designing the product. Organisations can gain tremendous competitive advantage through best-in-class practices that cut across industries.

3.2.5 Design Products and Processes to Manage Demand Volatility

The beer game showed us how even a small change in demand can lead to large inventories upstream, especially when lead times are large. Hence, there is a clear case that can be made for the supply chain to design products and processes that can mitigate and/or cope with demand volatility. Demand volatility is an accepted fact of life in business that has become even more challenging as consumers grow more demanding. The first challenge is to design the structure of the supply chain and develop policies that will reduce demand volatility as far as possible. Having mitigated demand volatility, the next challenge is to manage demand volatility with existing processes and equipment and yet achieve high levels of customer satisfaction and operational effectiveness.

It is a remarkable fact that *much of the demand volatility is self-induced*. A classic example of self-induced demand volatility is the instability created by sales promotions or rebates, which usually generates a sharp surge in end-user demand and the inevitable bullwhip effect that accompanies such a surge. Managers of supply chains fail to recognise that quite often the volatility of demand is significantly influenced by an organisation's sales or marketing activities. Conversely, the sales and marketing group often fail to use appropriate tools and techniques that can help mitigate demand volatility. For instance, one simple approach to eliminate such self-induced volatility is to follow the every day low price concept, as offered by some organisations such as Wal-Mart. The end-of-quarter or end-of-year 'channel-stuffing' actions undertaken to show higher operating efficiencies and margins also increases demand volatility. Such actions merely serve to create inventory elsewhere in the pipeline that will then have to be disposed through a sale, further exacerbating the bullwhip effect.

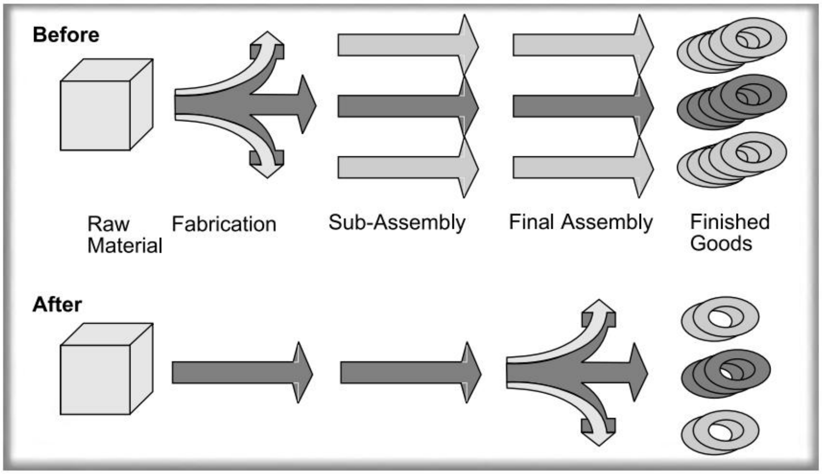
Another example of self-induced volatility arises as a result of batching. While the end-user demand for a product may be fairly level organisations often deliver the product in large lots to achieve economies of scale. The same practice applies all the way up to the manufacturer who resorts to a large-lot production strategy, choosing to wait until the cumulative demand reaches an 'economic lot size' before beginning production. From the beer game we observed that a single spike in demand created large ripple effects upstream. By batching a steady end-user demand, we immediately generate the bullwhip effect as far as the upstream suppliers are concerned. The solution here is to work with small batches and level production schedules. Working with a level production schedule, ignoring noisy data resulting from promotional activity or end-of-the-quarter channel-stuffing activities, will help prevent the bullwhip effect from propagating upstream.

Improving the responsiveness and reliability of the supply chain is yet another way to reduce demand volatility. It is important to understand how the responsiveness of the supply chain is itself a major determinant of demand volatility. First, as we observed earlier, the further out into the future one has to forecast, the more unreliable the forecast is. Hence, a supply chain that is less responsive (requires more time to deliver products to the consumer) has to contend with a demand forecast that is further out into the future and is correspondingly less reliable. Consequently, the variation in the actual demand observed is higher. Second, if customers sense that the supplier is unable to deliver what they want, and on time, then they will understandably hedge their requirements in possibly two ways. They will demand more product than their actual requirements and/or will ask for it to be delivered sooner than it is really needed. In either case, demand volatility is increased. On the flip side, if you respond quickly to customer demands, the customers will have more faith in your ability to deliver and are therefore less likely to pad their actual requirements or their desired due dates.

A very useful approach to manage demand volatility is to 'maximise external variety with minimal internal variety.' This phrase succinctly captures the basic principle that should be followed, especially when designing supply chains that deal with high product variety and demand volatility. This principle can be accomplished by structuring your product offerings so that commitment of material and resources can be postponed for as long as possible. In other words, we want to work with a relatively small number of standard products ('modules') internally in semi-finished or finished form to configure a large variety of end products. It will be convenient for us to refer to the above principle as the RAP (keep the in-process inventory as 'raw as possible') principle. Figure 3.3 illustrates the RAP principle. This principle is often referred to as the principle of postponement, and we saw some applications of this important principle in Chapter 1.

The RAP principle should drive the design of new products and services. It provides a very convenient way to meet customer demand quickly, without storing a lot of finished goods inventory. At the same time, it delays committing raw material, labour, and fixed assets to make products based on forecasts, in anticipation of future demand. As shown in the 'After' portion of Figure 3.3 differentiation of the product is postponed to the final assembly stage. By postponing differentiation to the final assembly stage, it is possible to maintain an inventory of the products in an undifferentiated 'Sub-Assembly' form, ready for conversion into one of three possible finished products relatively quickly.

Figure 3.3: The RAP Principle



The following lean supply chain principle [Srinivasan, 2004] presents this idea.

LEAN SUPPLY CHAIN PRINCIPLE

Maximise external variety with minimal internal variety. It is desirable to maintain inventories in an undifferentiated form for as long as it is economically feasible to do so.

The RAP principle is particularly valuable for managing short-life products. Postponement increases service levels while reducing costs and order fulfillment risk and is especially valuable when there are many derivative products and forecast error is high. The RAP principle has an added benefit. It is a well-known fact that when we aggregate a number of independent demands, then the aggregate demand has significantly less variation than the individual demands. When the RAP principle is adopted, the same standard modules go into a wide variety of end products. If we store modules, rather than end products, then we can manage demand volatility with much less inventory since the variation in the demand for modules is much less than the variation in the demand for end products. Applying the RAP principle thus helps reduce demand volatility.

Despite our best efforts to manage demand volatility using one or a combination of the approaches suggested above, suppose we still find demand variation present in the supply chain. What would you do to cope with this variation? The classical (and traditional) approach is to resort to finished goods inventory to buffer the variation. However, we have seen that using this approach has its drawbacks since inventory results in slower responsiveness and longer lead times. Taiichi Ohno is reputed to have said that 'Inventory is the root of all evil.' (We should state, instead, that 'Variation is the root of all evil,' because variation is the root cause for such inventory build-up.) Little's Law shows us that lead times and inventory go hand in hand, creating a problematic and cyclical relationship; and the beer game showed us the effect of lead times on supply chain performance. Moreover, when organisations are forced to commit their scarce and inflexible resources to produce finished goods inventory in the face of demand volatility, *they quite often end up mis-allocating the resources to produce the wrong kind of products*. Thus, there is a powerful incentive to reduce inventories in the supply chain. So, we come back to the question: how can organisations cope with demand variation in such a situation?

Instead of using inventory to buffer variation, a better approach is to buffer demand variation with a small amount of reserve capacity. This approach is likely to be met with some resistance from managers who do not view the supply chain from a systems perspective, but are driven by metrics that force them to cut costs and run their operations at full utilisation. Such metrics penalise managers if they do not use their flex capacity even though the situation may not warrant it. However, as we repeatedly emphasise throughout the book, a key factor in building lean supply chains is to maintain flexibility at every stage; and that is best achieved with capacity, not inventory. We can summarise this discussion with the following lean supply chain principle [Srinivasan, 2004]:

LEAN SUPPLY CHAIN PRINCIPLE

Buffer the variation in demand with capacity, not inventory.

While the ideal situation is to buffer variation with capacity rather than with inventory, there are a number of situations where you are compelled to use inventory to accommodate variation. For instance in the consumer products industry, if the end-user does not find the goods available on the shelf, he/she may go elsewhere. If you are forced to buffer variation with inventory, then a related issue is how inventory could be used more strategically. Should you have finished goods inventory or should you apply the RAP principle and have partially processed items, ready to be assembled to customer order, so that you preserve some flexibility? The answer, of course, depends on the lead time expectations of the customer. The point is that you have to decide where to *strategically* locate the inventory to meet these expectations. You must determine how far upstream in the supply chain you can afford to locate inventory and still meet customer lead time expectations. We summarise the discussion on the different ways to mitigate and cope with demand volatility as follows:

- ➢ Avoid using sales promotions/rebates and metrics that promote the end-of-the-quarter syndrome to the extent possible. If possible, use an 'Every-Day-Low-Price' approach.
- ➢ Avoid batching. Try to work with small batches and a level production schedule.
- ➢ Improving the responsiveness and reliability of the delivery system will significantly reduce demand volatility.
- ➢ Maximise external variety with minimal internal variety. Be aware of the power of the RAP principle.
- ➢ Buffer variation in demand with capacity, not inventory.
- ➢ Where inventory is necessary, it should be placed at strategic locations in the supply chain to meet customer lead time expectations.

3.2.6 Create Flow Across the Supply Chain

The ability to react quickly to customer demand without carrying large amounts of inventory at various stages in the supply chain is better achieved if every organisation in the supply chain works in harmony to build products at the rate demanded by the end-user. This concept of *flow balance* essentially means that all the organisations are 'rowing the boat' at the same pace. Clearly, if some organisations in the supply chain work faster than some others, the imbalance in flow will result in inventory piling up in front of the weaker links, namely the organisations that work at a slower pace.

Balancing flow across the supply chain requires a systems perspective. The idea is to focus on the product and identify all the steps it goes through in the process of moving from the raw material stage until it is delivered to the end-user. Are there process steps that introduce unnecessary delays? Are there any unnecessary non-value-added activities that the product goes through? Where are the potential bottlenecks that delay the smooth flow of the product? Are some of these bottlenecks due to unnecessary processing steps? Have information-processing delays been eliminated? Such questions will bring forth problems with existing work practices that may hinder the smooth flow of the product.

A major impediment to flow is caused when organisations produce products in anticipation of future demand. When organisations use forecasts to drive their production schedules, the forecasting methods used can clearly impact the proper execution of schedules. A poor forecast may result in raw material not being available when the customer asks for a product to be delivered. Even when the organisation uses good forecasting techniques, the forecasting *process* could generate problems. Forecasting has historically been applied with a silo mentality, with multiple departments within the same organisation independently creating forecasts for the same products, using their own assumptions, measures, and level of detail. The impact of these localised forecasts on the supply chain is often considered only informally, if at all. The functional silos in the organisation worsen the situation. For instance, it allows the sales function to envision growing demand while the operations function is left guessing how much the customer really wants.

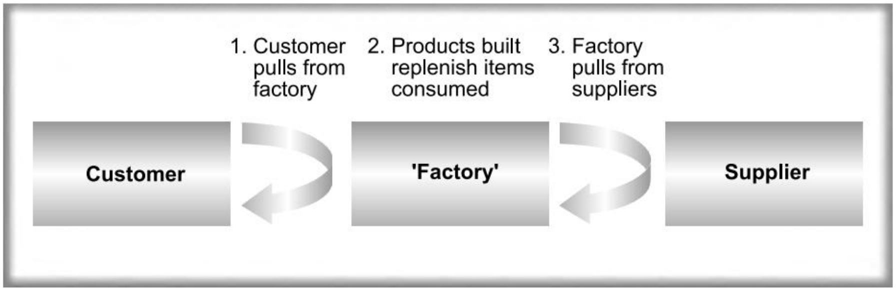
Although it is desirable to use pull systems wherever possible, organisations in a supply chain still have to anticipate customer's demands and must therefore rely on forecasts. The key is to resist the temptation to *execute* the production schedule based on a forecast. Rather the idea is to use demand forecasts for *planning* production and use pull signals based on true customer demand to *schedule* production. In addition, a system that responds to pull signals inherently has less variation than a system that pushes products through the supply chain. The following lean supply chain principle [Srinivasan, 2004] summarises the preceding discussion:

LEAN SUPPLY CHAIN PRINCIPLE

Use forecasts to plan and pull to execute. A system that reacts to pull signals will have less variation than a comparable system that adopts a push mode of operation.

No doubt it is desirable for these organisations to use pull signals to trigger supplies from their upstream organisations as well. Carrying this idea one step further, the intent is to start with the customer, deliver what is demanded, build what is sold, supply what is consumed, and above all, balance the flow. The essence of the lean supply chain is to create flow—across the supply chain. Figure 3.4 conveys this idea. This figure shows a simple relationship between the manufacturer ('Factory'), its customer and its supplier.

Figure 3.4: Use Pull Signals to Create Flow Along the Supply Chain



In essence, the lean supply chain is designed to just deliver what is demanded, build what is sold, and supply what is consumed, all the time maintaining a flow balance. These flow objectives are accomplished with high frequency pull signals at each level of the supply chain. Thus the vision of the lean supply chain is to have every upstream process react to a pull signal from its downstream customer and produce a product only when the customer demands it. Such a vision allows the members of the supply chain to delay commitment of their valuable resources and their raw material until there is a definite demand for their product or service. This vision is consistent with the familiar postponement design attribute that is key to most successful supply chain designs.

However, this pure conceptual vision must be adjusted for real-world imperatives. For example, in a retail environment, the consumer typically requires spontaneous fulfillment from stocked items. This requirement does not negate a lean approach to managing the supply chain. This is because the lean supply chain is *not* about zero inventories; it is about the strategic use of inventories. The question is: how do we ensure that the supply chain operates with minimal inventories at the right location?

To answer this question, let us use the model in Figure 3.4 as a canonical model replicated throughout the supply chain. That is, unless the organisation is a producer of the basic raw material used in the process, practically every organisation has a set of customers and a set of suppliers. We refer to this as a supply chain triad. Within this triad we will maintain the terms, customer, factory, and supplier.

To decide on how much inventory to hold, we categorise the supply chain along two dimensions—one based on *order fulfillment strategy* and the other based on *work flow*. The former was discussed in the context of understanding and responding to customers and their expectations. We now discuss the catagorisation based on work flow [M. M. Srinivasan and J. M. Reeve, 2006].

3.2.7 Categorisation Based on Work Flow: The V, A, and T Configurations

The flow of work through a production process has a direct impact on how the supply chain is designed, built, and managed. Practically every process can be categorised as belonging to one of three types of work flow, V, A, and T, or some combination of these three types. They are described below.

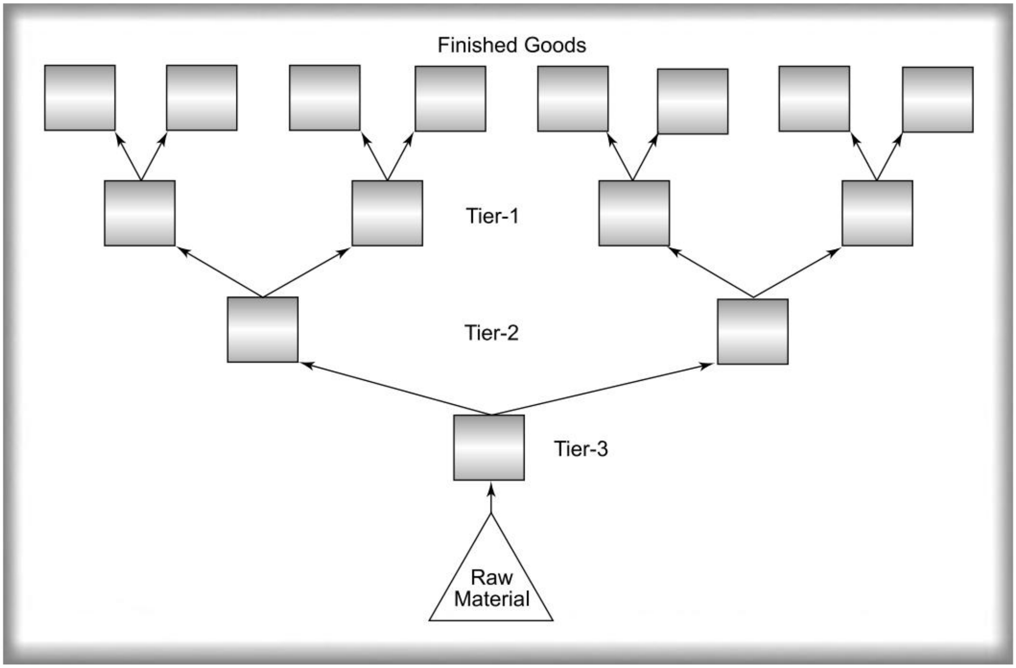
The V-Type Flow

A V-type flow occurs when a few basic raw materials are processed into a variety of end items. As shown in Figure 3.5, the product flow diagram resembles the letter V, hence the name. V-type supply chains are characteristic of food processing, metals, chemicals, paper, and other continuous or batch processing supply chains.

In a V-type supply chain the upstream elements are fairly uniform and simplified. As the product moves downstream it is split into different specifications, product codes, or sku's. In addition, V-type supply chains will also split the product into geographic locations in the downstream. For example, in papermaking, a common chip stream can be split into either bleached or unbleached pulp. These two streams can be produced into a wide number of grades and colours on a paper machine. After the paper machine, the paper can be converted into an even wider variety of cut sizes and package counts. Thus, the downstream end of the supply chain presents the greatest opportunity for mis-allocation in a V-type supply chain. In fact, it is safe to say that each individual divergence point represents an opportunity for material mis-allocation.

The mis-allocations are exacerbated by the desire to enhance efficiency, resulting in material being released earlier than needed. These actions result in excess inventory of some products and a shortage of others as highlighted earlier. As observed by Umble and Srikanth [1997], managers of plants that have a V-type flow are often puzzled when, despite holding large finished-goods inventory, they have to scramble to meet market requirements. They level the blame on the customer, pointing to the constantly changing demand pattern. They do not recognise that while demand changes do occur, most of the problems are self-inflicted.

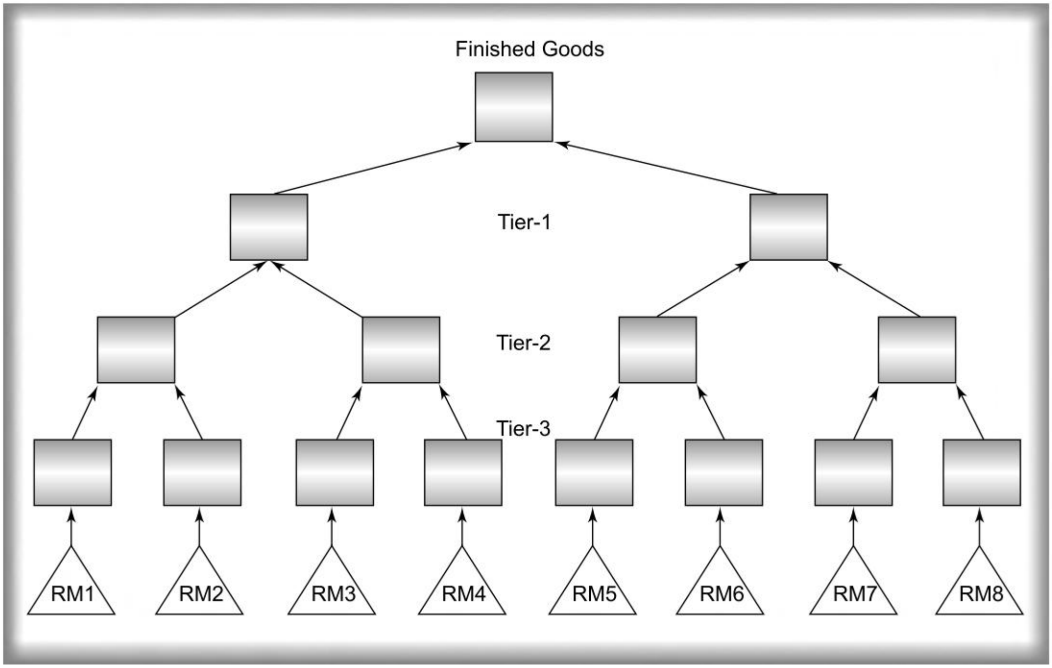
Figure 3.5: The V-Type Supply Chain



The A-Type Flow

A-type supply chains are characteristic of aerospace products, capital equipment, and consumer electronics. The A-type structure is the opposite of the V-type structure as shown in Figure 3.6. A-type supply chains have their greatest complexity on the upstream end. The upstream is characterised by hundreds and maybe even thousands of individual parts and components, that move through a variety of supply chain elements to a point of final assembly. After the product is assembled, often the distribution is fairly straight-forward. For example, a commercial airliner is very complex on the upstream end of the supply chain. Individual parts, such as flat pattern wing parts, are fabricated and assembled on to wings, which are then assembled to the fuselage. Complexity converges to final assembly. After assembly the downstream distribution end of the A-type supply chain is very simple.

Figure 3.6: The A-Type Supply Chain



Thus, the A-type supply chain manager's focus is upon upstream mis-allocation. Such mis-allocation can occur when upstream parts are being produced for forecasted product that is eventually not sold. The finished goods inventory, in this case, represents the mis-allocated capacity and materials for every sub-component and component in that finished item. These mis-allocations, of course, have domino impacts on other components that were not made (but should have been). A-type supply chains attempt to protect against assembly mis-allocation by committing to excess inventory of component parts. This, however, is an unattractive solution because it can lead to obsolescing parts, and hence forever losing the materials and capacity represented by those parts.

The A-type supply chain will have the same problems experienced by V-type supply chains when products are processed in large batches. This causes a wave-like flow of material, further aggravated by the bullwhip effect. The use of large batches at one level in the supply chain causes downstream customers to receive material in an erratic fashion, while causing serious stress on upstream suppliers. Some of the solutions we will discuss for the V-type supply chain apply equally well to the A-type.

The T-Type Flow

As the name implies, the T-type flow takes place when the flow across the supply chain resembles the letter T and it reflects a situation where a limited number of components are assembled into a wide variety of end items. T-type supply chains are commonly found in assemble to order (ATO) environments, where customer lead times are relatively short. The T-type supply chain has elements of both A and V, together. On the one hand, the T-type and the V-type flows share the common characteristic of divergence, although the divergence is concentrated in the final stages for the T-type supply chain. With a T-type flow, it is thus relatively much easier to avoid mis-allocation by delaying commitment of resources and materials until receipt of a firm order. The T-type and A-type flows are similar in the sense that they are both dominated by many interactions that occur at the assembly stage.

3.2.8 Characterisation Based on Fulfillment Strategy: BTS, ATO, BTO, ETO

While the nature of the product will dictate the V-A-T workflow configuration, customer requirements will influence the demand fulfillment strategy. In the ideal world, there is a marriage: as observed above, a supply chain with the T-type flow is readily amenable to an ATO mode of operation. Similarly, it is tempting to conjecture that a supply chain with a V-type flow is amenable to a BTO operation while an A-type flow is more amenable to a BTS mode of operation because of the relatively fewer products being processed. Indeed, as noted by Schragenheim and Dettmer [2001], some authors try to link A-type flows with BTS and V-type flows with BTO. However, aside from the close relationship between the T-type flow and the ATO mode of operation, in practice there appears to be little correlation between the type of flow and the demand fulfillment strategy. For example, an A-type supply chain may build to stock (automobiles) or build to order (construction equipment). Likewise, a V-type supply chain is used with BTO strategy (specialty chemicals) as well as with a BTS strategy (paper).

Applying Lean Principles to a BTS V-Type Process

Consider a beverage bottling facility. The customer demands bottled beverages instantaneously, and so the supply chain must be configured as BTS. In addition, the product and process streams are such that the process has a V configuration. That is, the scope of product is least on the upstream (flavours and containers), and becomes greater by moving downstream to sku's (stockeeping unit flavour and package combinations) and locations. Under this design, the supply chain is most vulnerable to mis-allocating capacity and materials to downstream sku's and locations, since product must be speculatively placed. Given this constraint, the supply chain responds best when the execution time interval is the least.

The objective of the beverage company supply chain is to build and deliver a product mix within a time interval that matches the demand mix. Thus, if all sku's are sold every day from every location, then the optimal supply chain design attempts to produce and deliver every sku to every location every day. This means the can supplier must produce every can specification every day, the plant must bottle every product every day, and distribution must deliver every product every day to every customer. This is the basics of achieving flow. Without this rapid execution cycle, the planning process must necessarily resort to more speculative placements. The design follows the basic principle of minimising the impact of variation to very short time intervals. Alternatively stated, the longer the time intervals, the greater the forecast errors.

Once the upstream executes within the time interval of demand, the supply chain will execute production and delivery from replenishment signals. That is, the actual sales of sku's from the shelves will provide the signals for upstream replenishment. These signals will be generated either by the route truck drivers, account representatives, or POS information. Thus, the complete supply chain is responding to demand, rather than anticipating demand with production.

This design has significant implications for the bottling plant. The plant is no longer concerned with plant efficiency. Indeed, the bottling plant may be inefficient in the classic sense, because its only responsibility will be to replenish what was sold during the previous day, regardless of the available capacity. Rather, the plant's improvement focus is to maintain capacity for immediate activation from replenishment demand signals. In addition, the facility must achieve fast flavour and container changeovers. These changeovers must be drastically reduced in order for the plant to economically produce every sku (or the Pareto 80 per cent) every day.

Flow and lead time are closely related. The lack of flow, or any imbalance in flow, results in long lead times; conversely, long lead times are symptomatic of poor flow. As we have observed before, long lead times negatively affect supply chain performance in a number of ways. If the supply chain is not very responsive due to long lead times, then it increases the volatility in demand. If one can respond to changes in customer demand quickly, then the fluctuations in production and inventory levels are considerably reduced. The ability to respond quickly to market changes allows small adjustments in production levels to meet market demand and promotes flow. On the other hand, if intervention must be delayed to accommodate an inflexible system, management is forced to make much larger changes in production levels, and that impedes flow. Therefore, one way to create flow is to focus on reducing lead times.

To reiterate, lowering lead times leads to lower inventories in the pipeline that in turn results in lower lead times, generating a virtuous cycle. Similarly, lowering lead times creates more flow in the supply chain which in turn reduces lead times, again generating a virtuous cycle. When lead times are reduced the organisation is also in a better position to implement pull systems that produce to actual customer demand rather than production based on forecasts. There are a number of ways in which the supply chain can reduce lead times and thereby increase flow. One way to reduce customer delivery lead times is to operate in a Build To Stock (BTS) mode. This way, the customer may pull from finished goods for an immediate response. However, as we indicated earlier, this often mis-allocates capacity and resources, because the organisation could end up producing, say, or light beer when customers are demanding premium lager beer. Adopting a mixed-model production schedule will reduce lead times. If every product is produced during every production period, then the product batch sizes are reduced. As a consequence, the organisation does not have to store as much inventory.

As noted in Figure 3.1, to create flow in the supply chain, you first need to identify the products that should be produced in the supply chain before attempting to create flow within the four walls of the organisation and flow across the value stream. The Theory of Constraints provides a way to identify the products that will help the organisation benefit the most. Discussion of the Theory of Constraints is beyond the scope of this book and the reader is referred to [Srinivasan, 2004] for this purpose.

3.2.9 Develop Metrics Using a Systems Perspective

When the CEO of an organisation is posed the question, 'How are we doing?' by the board of directors, what would the typical response be? The CEO would probably present the performance of the organisation in terms of measures such as return on investment, profitability, inventory turns and material costs. These are, no doubt, important measures to gauge the financial health of the organisation. However, all of these are internal measures, and may not adequately address the performance of the organisation in the future. We indicated earlier that the battle has shifted: from rivalry between organisations to rivalry between supply chains. Outstanding performance at one location in the supply chain is no longer adequate if the rest of the supply chain members are not up to par. The financial health of an organisation in the supply chain is directly affected by the overall performance of the chain. In the future, organisations must not only focus on performance within the organisation but on performance across the supply chain as well. That requires a radical shift from a local optimisation mindset to a global optimisation mindset.

The establishment of metrics is of utmost importance since they will drive the behaviour of the organisations in the supply chain. These metrics must be developed with a systems perspective: as the beer game demonstrates, a locally managed supply chain is inherently unstable. The next chapter discusses performance metrics in more detail. At this point we will just note that one approach to developing these metrics is provided by the Theory of Constraints(TOC). That is, when developing the metrics, it is worth considering the following questions (these are simple restatements of the questions that Jonah, the TOC guru poses to Alex Rogo in the book by E. M. Goldratt and J. Cox [2004]):

- Does the metric help sell more products, profitably—that is, will the metric help increase *T*?
- Does the metric help reduce investments in resources—that is, will the metric help reduce *I*?
- Does the metric help reduce payments/expenses, long-term—that is, will the metric help reduce *OE* (long-term)?

CONCLUSIONS

Ultimately, the true competitive edge is realised only when the members in the supply chain understand and agree to work with the following basic principles:

- The idea is not to simply benchmark your organisation against the competition. That will result in the organisation adopting the same practices (good and bad) of the competitor (the 'leader') and promote a 'follower' mentality. Instead, organisations can gain a tremendous competitive advantage by adopting best-in-class practices that cut across industries.
- The phrase, 'maximise external variety with minimal internal variety,' succinctly captures the approach towards designing the process used to

produce the products. The RAP principle ('keep the material as Raw As Possible') is a very convenient way to meet customer demand quickly without storing a lot of finished goods inventory. Adopting the RAP principle also results in reduced variation in the system because aggregated demand has significantly less variation than the individual demands.

- Buffer the variation in demand with capacity, not inventory. As far as possible, the demand variation should be met with additional capacity. While finished goods may allow the organisation to service customers faster, very often the organisation ends up carrying the wrong kinds of products.
- If you have to hold inventory, it should be located strategically in the supply chain. Use the RAP principle to determine how far upstream in the supply chain it can be located so that you can still meet customer lead time expectations.
- Use forecasts to plan and pull to execute. A system that reacts to pull signals will have less variation than a comparable system that adopts a push mode of operation.
- Develop metrics using a systems perspective.

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Case references: The idea of a value stream is useful in several cases, including those that have a marketing emphasis, such as CONCOR.

Exercises

1. Discuss some of the salient issues in supply chain design .
2. What are order winners and order qualifiers? Why are they important?
3. Give examples of organisations or supply chains that operate using a) a build-to-stock strategy, b) a build-to-order strategy.
4. What is the primary benefit of using a customer time-based-demand profile?
5. What are the benefits of competitive benchmarking? What are some drawbacks of competitive benchmarking?
6. What are some benefits of functional benchmarking? Can you think of any problems with functional benchmarking?
7. Can you think of specific examples where an organisation (or a set of organisations) has gained tremendous competitive advantage by benchmarking a process (or a set of processes) completely outside their industry?
8. What are the ways by which an organisations can mitigate the volatility of demand it experiences?
9. Give specific industry examples of the RAP principle and how it benefits the supply chain operations of the participating industry.
10. Give two examples each of industries that have an A-type supply chain, a V-type supply chain.

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CHAPTER 4

Performance Measurement

CHAPTER OUTLINE

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4.2 The Prisoner's Dilemma
4.3 The Integrity Motors Case
4.3.1 Current Mode of Operation
4.3.2 Integrity Motors Embarks on a 'Dell Strategy'
4.4 Evolving Supply Chain Metrics
4.5 Performance Monitoring
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4.5.4 Standard Costing and Activity-Based Costing
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INTRODUCTION

The performance of a supply chain is the result of policies and procedures that drive various critical segments of the supply chain. In all probability the current strategy and its resulting structure are a consequence of the individual segments of the supply chain making isolated decisions that make sense to them from their local perspective. These individual decisions result in an unsynchronised supply chain that is characterised by long lead times and many pockets of inventory. Traditional, locally focused, measures of cost and other performance measures are incomplete and lead to sub-optimal decisions. Metrics that are carefully evolved, with the goal of improving supply chain performance and competitiveness, can have a positive effect because they set in place these policies and procedures. Furthermore, over time, people and systems react according to how they are monitored and measured. In fact, Goldratt [1988] often uses the quote, 'Tell me how you will measure me and I will tell you how I'll behave,' to emphasise the importance of an effective measurement system. In a related vein, it is often said that what cannot be measured cannot be improved, and so there is a persistent desire to be able to measure appropriate indices that deal with supply chain performance.

A question we need to address carefully is, 'How can we design a process for managing organisations consistent with the fact that these organisations are components of complex and highly interconnected systems?' And a related question is, 'How can we devise metrics that can help these organisations better manage their processes?' Based on these two questions, we conclude that a key objective of supply chain metrics is to provide a basis for evaluating the performance of the whole supply chain as one system.

4.1 MEASURING SUPPLY CHAIN PERFORMANCE

Ideally, the supply chain should meet a number of different objectives, some of which may seem to be in direct conflict at least at first glance. Some common objectives are to:

1. Optimise customer service
2. Reduce time to market
3. Meet delivery performance parameters
4. Improve quality
5. Minimise costs and operating capital
6. Reduce the fixed assets employed
7. Minimise inventory
8. Maximise flexibility/agility

Numerous measurement services and benchmarks for meeting these objectives are provided by industry forums, consulting firms and academic institutions. Sector specific norms may be used for comparison although, as discussed in Chapter 3, significant insights can be gained by cross-industry comparisons. The following metrics have been suggested, to meet some of these objectives:

Customer Service Level

Fill rate, Perfect order percentage, Lead time, On-time delivery, Stock outs, Delivery consistency, Response time to Enquiries, Customer complaints, Sales force complaints, Overall satisfaction, Price competitiveness.

Cost Measures

Total cost, Cost per unit at each stage, Cost/sales, Inbound freight, Outbound freight, Inventory carrying cost, Inventory turn over ratio, Cost of returned goods, Cost of damage, Cost of back orders etc.

Quality Measures

Defect rates, Order entry accuracy, Billing errors, Number of customer returns, Shipping accuracy.

Productivity Measures

Partial factor and total productivities.

Asset Management Measures

Return on Investment (ROI), Return on Assets (ROA), Profitability of partners in the chain etc.

NPPD (New Product and Process Development)

Developmental lead time, Innovativeness, Frequency of new product introduction etc.

Besides meeting desired objectives, these metrics should ideally also facilitate business processes involved in supply chain management. These business processes include:

1. Customer relationship management
2. Order/Demand management
3. Production management
4. Supply management
5. Distribution management
6. New product and process development (NPPD)
7. Reverse logistics

Clearly there are some challenges. Developing metrics to accommodate potentially conflicting objectives that, at the same time, also address the different business processes is certainly a difficult task. In addition, these metrics should mesh with those developed for individual firms within the supply chain; and evolving "local" metrics for individual firms within the supply chain, in and of itself, presents a challenge. So, is the notion of "supply chain" metrics really practical or are we just trying to pursue an unrealistic, unattainable goal?

To answer this question, let us simply focus on organisations that are in business to make money for their stockholders, and identify some financial metrics that would be, more or less, universally acceptable to the individual firms in the supply chain. Clearly, Net Profit would be a universally acceptable financial metric. Another financial metric would be R. In the previous chapters, we introduced three metrics: T, I, and OE, within a Theory of Constraints (TOC) context. Note that Net Profit = $T - OE$, and ROA is, simply, $(T - OE) / I$. Thus, TOC presents a good framework to begin discussing metrics from a systemic or a supply chain perspective. Indeed, in Section 4.3, we present a case where the members in a supply chain evolve a strategy to jointly improve their individual net profits and ROAs.

Although these financial metrics can be acceptable to all supply chain partners, the reader may observe that unless the individual firms in a supply chain cooperate, it would be unreasonable to expect these firms to evolve organisational metrics that completely align with supply chain metrics. Co-operation between participating members in the supply chain is often a complex issue due to a lack of trust among the members. However, there are some clearly discernible mutual benefits to the supply chain members that should provide a powerful incentive for these members to jointly evolve metrics that are synergistic. That requires us to first identify where opportunities for such synergies lie, and then to evolve metrics that exploit these synergies. We will show how this is possible for multiple organisations in the supply chain. To that end, we introduce and discuss a game popularly known as the Prisoner's Dilemma.

4.2 THE PRISONER'S DILEMMA

The Prisoner's Dilemma requires us to introduce two terms: the zero-sum game and the non-zero-sum game. In *game theory*, the zero-sum game describes a situation where one player's gain (or loss) is exactly offset by the loss (or gain) of the other player. The term, zero-sum, thus describes a situation where a gain for one set of players is offset by a corresponding loss for another set of players. Chess is a zero-sum game because there is exactly one winner and one loser—it is impossible for both players to win (or for both to lose). Poker is another example of a zero-sum game, if the house's cut is ignored. In a more general setting, zero-sum games can also be thought of as constant-sum games where the benefits and losses to all players add up to the same value. In this regard, cutting a cake is a zero-sum (more precisely a constant-sum) situation because a larger piece given to one person implies there is less cake available to share among the others.

In contrast, non-zero-sum games describe situations where the sum of the aggregate gains and losses of the players is either less than, or more than zero. For example, Monopoly (or Trade) can be viewed as non-zero-sum games if they are not played with the intention of having just one winner. That is because all participants can win property from the bank. In principle, it is possible for two players in this game to reach an agreement and help each other in gathering a maximum amount from the bank although that is not really the intent of the game.

The Prisoner's Dilemma is, arguably, the most famous among all non-zero-sum games. In this game, two men fleeing from the scene of an armed robbery, firearms in hand, are apprehended and put in jail. We will refer to these two men as Prisoner A and Prisoner B. The prosecutor strongly believes these two men jointly attempted the armed robbery. However, since the crime was not captured on hidden camera, she can obtain a conviction only if at least one of them confesses. To obtain a conviction, the prosecutor first orders the prisoners to be held in separate cells. She then visits each prisoner individually with the following offer. 'You can confess or choose not to confess. If you confess and your partner remains silent, then you will walk free while your partner will undergo a jail sentence of 10 years. In the same manner, if your partner confesses but you do not, then he walks while you do 10 years in jail. If you both confess, both will go to jail but I will make sure you both get out of jail in six years. If neither of you confess, then you will only have to face a token imprisonment for one year for possession of firearms.' Table 4.1 presents this situation graphically. What do you think the prisoners will do in this situation?

Table 4.1: The Prisoner's Dilemma

	Prisoner A does not confess	Prisoner A confesses
Prisoner B does not confess	Prisoner A gets 1 year Prisoner B gets 1 year	Prisoner A walks Prisoner B gets 10 years
Prisoner B confesses	Prisoner A gets 10 year Prisoner B walks	Prisoner A gets 6 years Prisoner B gets 6 years

The surprising truth about the game is that no matter what the other prisoner does, it appears to benefit each prisoner to confess. To see this, consider the perspective of a prisoner, say, Prisoner A. Reflecting on the prosecutor's offer, he realises that if Prisoner B confesses, then he does better for himself by confessing for otherwise he will spend 10 years in jail if he chooses not to confess. If Prisoner B does not confess, then again he realises he will do even better for himself by confessing as he will be set free. In other words, Prisoner A realises quickly that confessing *dominates* not confessing. The same thought process would lead Prisoner B also to confess. But this outcome, where both confess, is arguably the worst outcome, resulting in a combined jail term of 12 person-prison years. If both of them had trust in each other and not confessed, they would have ended up with one year each in prison (2 person-prison years). In fact, even if one of them had confessed while the other did not, the combined jail term would have been 10 person-prison years.

The Prisoner's Dilemma shows that for many practical situations it is not a zero-sum game and that there are benefits to evolving joint strategies that mutually benefit multiple players in a supply chain. More to the point, it is possible for multiple organisations to jointly arrive at metrics that positively affect their individual performances rather than coming up with metrics derived in isolation that could, in fact, hurt their performance in the long run. That is, in the context of supply chains, it is possible to evolve strategies that result in a non-zero-sum game, benefiting multiple parties. We now present a case to demonstrate how a systems perspective facilitates the evolution of such a strategy.

4.3 THE INTEGRITY MOTORS CASE

The Integrity Motors case (Reeve, 2002) demonstrates how the Build-To-Order (BTO) strategy we discussed in Chapter 3 helps improve the financial performance of multiple firms simultaneously. The supply chain in the case has three firms involved in the manufacture and delivery of automobiles. We will first present the current mode of operation for the three firms and then present the scenario after the three firms work together to help support a BTO strategy.

Integrity Motors manufactures and sells automobiles. The supply chain involves over 1,200 different vendors who supply materials and parts to Integrity Motor's assembly plants. The assembly plants produce automobiles sold through a dealer network. Integrity Motors uses rail and truck transportation for their inbound and outbound transportation needs. In this case we focus on outbound transportation. Southern Railroad is a private enterprise that moves vehicles to a distribution and mixing centre, whereupon vehicles are delivered to local dealers (via truck). Integrity's transportation department interfaces with the railroad and motor carriers with orders for equipment. For simplicity, in this case we ignore the motor carriers and assume that the supply chain involves three major parties: Integrity Motors, Southern Railroad and the Dealers.

4.3.1 Current Mode of Operation

With the current mode of operation, each dealer receives a monthly allotment of automobiles that are sold to consumers at the dealer's premises. Most customers purchase cars from dealer's stocks. Integrity is never certain of its daily needs, and is therefore unable to provide the railroad (Southern Railroad) a good assessment of its needs. As a result, the railroad reserves railcar capacity to handle demand surges. These railcars are not constructively placed and thus are not subject to demurrage. Vehicles in-transit are owned by Integrity Motors. Figure 4.1 shows the supply chain. Lead-times for the current mode of operation are presented in the figure.

The following information is provided for each of the supply chain partners. This information can be used to determine the income from operations (net profit), and expected pre-tax return on invested capital or ROA, for the members in the supply chain.

Average Dealer:

1. Provides an average discount from manufacturer's suggested retail price of US$2,000.
2. Operating costs equal 10 per cent of Cost of Goods Sold (COGS).
3. Dealer's cost: US$25,000.

Additional Statistics:

4. Average dealer sold 480 vehicles per year
5.

	Days in Consumer Sales
Inventory (see Figure 4.1)	60 days
Accounts Payable (given)	45 days
Accounts Receivable (all cash sales)	0

6. Average total fixed plant: US$4,000,000 of which 60 per cent supports vehicle sales (the remainder supports vehicle service).

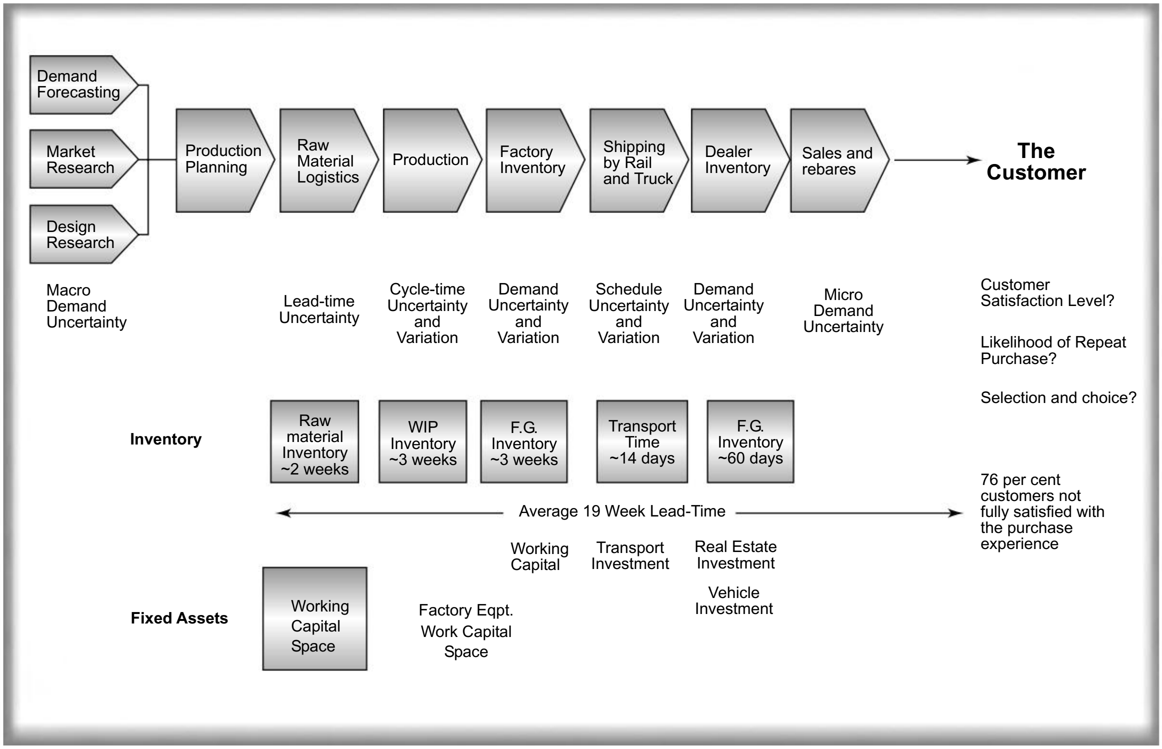
Integrity Motors

Integrity sells 27,50,000 vehicles per year.

1. Total dealer sales: US$68,75,00,00,000 or 27,50,000 cars, or US$25,000 per vehicle
2. Rebate average: US$1,100 per car
3. COGS: 85 per cent of dealer price
4. Selling, General and Administrative (SGA) expenses: 8 per cent of dealer price

5. Freight of US$350 per vehicle includes US$200 to motor carrier and US$150 to railroad. Integrity is responsible for freight and freight on board (F.O.B. dealer).

Figure 4.1: Supply Chain for Integrity Motors—Current Mode of Operations



Additional financial statistics:

	Days in Dealer Sales
Inventory (see Figure 4.1)	70 days
Accounts Payable	30 days
Accounts Receivable (see dealer)	45 days

Factory Property Plant and Equipment: US$16,50,00,00,000

Southern Railroad

Southern Railroad's costs, calculated in revenue ton mile (rtm) terms are as follows:

Cost Category	Cost Per Revenue Ton Mile
Wage	US$ 0.0150
Fuel	US$ 0.0120
Equipment costs	US$ 0.0080
Roadway maintenance/depreciation	US$ 0.0040
S, G, and A	US$ 0.0225

Terminal related costs are expressed in railcar terms:

Spotting and loading costs: US$128 per railcar

Switching and classifying cost: US$64 per railcar switch

Additional statistics:

Average weight of a vehicle	1.25 tons
Average distance moved (to mixing facility)	1,600 miles
Average number of switches per car movement	3 switches
Number of vehicles per railcar	16 vehicles
Total revenue ton miles	182 billion

Revenue per VIN number (vehicle) is same as Integrity's freight cost, US$150 per vehicle.

Additional financial statistics:

Revenue (current year) US$6,17,00,00,000

Selected balance sheet items	End of current year
Accounts receivable	US$47,50,00,000
Materials and supplies	US$9,00,00,000
Accounts payable	US$84,80,00,000
Property and Equipment	US$18,30,00,00,000

The following table, provided for a typical dealer, uses the above data to obtain income from operations and the ROA for the dealer. Use a similar approach to determine these numbers for Integrity Motors and for Southern Railroad. To help you fill out the rest of the numbers in the latter two tables, the answers for Income from operations per vehicle and the ROA are provided for Integrity Motors and for Southern Railroad.

Dealer: Current Mode of Operation **Calculation Explanation**

Manufacturer's suggested price	US$30,000	Given
Less: dealer discount	US$2,000	
Customer price	US$28,000	
Less: Dealer COGS	US$25,000	
Less: Operating Costs	US$2,500	10 per cent x $25,000
Income from operations per vehicle	US$500	
Investment per vehicle		
Inventory	US$4,109	60/365 *($25,000)
Accounts Payable	US$(3,082)	45/365 *($25,000)
Accounts Receivable	0	
Dealer Property and Equipment (sales only)	US$5,000	($4MM*60 per cent)/480 vehicles
Total investment per vehicle	US$6,027	
Pre-tax ROIC (ROA)	8.29 per cent	$500/$6,027

Integrity Motors: Current Mode of Operation **Calculation Explanation**

Dealer price	US$25,000	Given
Less: Rebate		
Net revenue		
Cost of goods sold		
Gross profit		
S, G, and A		
Freight		
Total operating costs and expenses		
Income from operations per vehicle	US$300	
Investment per vehicle		
Inventory		
Less: Accounts payable		
Accounts receivable		

Factory Property, Plant, and Equipment		
Total investment per vehicle	US$11,410	
Pre-tax ROIC (ROA)	2.63 per cent	

Southern Railroad: Current Mode Operation **Calculation Explanation**

Freight revenue	US$150	From Integrity (350–200)
Wages		
Fuel		
Equipment costs		
Spotting and loading		
Roadway maintenance/depreciation		
Switching and classifying costs		
S, G, and A		
Income from operations per vehicle	US$7	
Investment per vehicle		
Materials and Supplies		
Less: Accounts payable		
Accounts receivable		
Property and equipment (rtm allocation)		
Total investment per vehicle	US$194	
Pre-tax ROIC (ROA)	3.6 per cent	

4.3.2 Integrity Motors Embarks on a 'Dell Strategy'

Integrity Motors is planning a significant change in its supply chain strategy, moving from a BTS to a BTO car manufacturer. In this strategy, customers will order cars from a kiosk (an internet web site). The order will be electronically transmitted to Integrity, and an automobile built and delivered to the customer's specification. With this strategy customers can purchase cars 'their way.' Vehicles will need to be designed under a modular concept and the assembly plant will need to have 'plug-and-play' capabilities. The vehicle will need to be designed to transform nearly 3,000 parts to around 30 modules and options. Under this plan the following operating statistics are expected:

Integrity's Build-to-Order Plan

Total days in materials and work-in-process	2 days
Total days in finished goods	2 days
Total days in accounts receivable	–5 days
Total days in accounts payable	30 days
Shipping time (premium)	3 days
Elapsed time order-to-delivery	7 days

The –5 days in accounts receivable reflects the fact that Integrity collects money from the customer *before* it ships the product.

Additional Assumptions:

Dealer

1. Dealer earns a 3 per cent commission on sales price to consumer for sale support.
2. Dealer property investment for sales support reduced by 75 per cent.
3. Vehicle is paid for by consumer at time of BTO order. Dealer does not pay Integrity directly, but acts as a commission dealer without taking ownership of vehicles.
4. Consumer price for BTO is US$26,000 and not subject to rebates. (Price to consumer is better than previous case of US$30,000 – discount US$2,000 – rebate US$1,100 = US$26,900).
5. Dealer operating costs are 70 per cent of commission revenue. The reduction in selling expenses from reduced sales overhead costs (interest, space, property tax, etc) is offset by higher selling expenses.

Integrity

1. To simplify, assume all 2.75 million vehicle sales are BTO.
2. IT, engineering, and manufacturing infrastructure investment US$1,10,00,00,000.
3. Web site investment paid by integrity, US$1,00,000 per dealer.
4. Premium shipping costs, US$500 per vehicle, US$225 to railroad.
5. Additional general expenses for new BTO ordering system (including depreciation), US$55,00,00,000. Add appropriate amount to conventional SGA.

6. Additional annual manufacturing costs for new BTO system (including depreciation): US$82,50,00,000. Add appropriate amount to conventional COGS.

Southern Railroad

1. Railroad earns US$225 per vehicle shipment for premium shipment service.
2. Additional Railroad investment to support 'just-in-time' (JIT) rail service: US$5,00,00,000.
3. Additional railroad operating costs to support JIT rail service US$.02 per rtm.
4. Assume 12 per cent of railroad rtm traffic (182 billion rtm's) is related to automobiles. Assume 25 per cent of this traffic is Integrity's fast service JIT rail delivery.
5. With conventional rail transport a vehicle was on the railroad for 10 days. With the JIT plan a vehicle is on the railroad for 2 days. US$3 billion of the total US$18.3 billion property, plant, and equipment investment is due to railcars. Due to the higher velocity, railcar assets are used more efficiently than with a conventional approach. That is, Southern Railroad could make the same revenue shipments with less railcar assets (or ship more volume with the same assets). Adjust the assets for this improvement.

Dealer: BTO Scenario		Calculation Explanation
Dealer's commission	US$780	3 per cent x US$26,000
Less: Operating Costs		
Income from operations per vehicle	US$234	
Investment per vehicle		
Inventory	—	
Accounts Payable		
Accounts Receivable		
Dealer Property and Equipment (sales only)		
Total investment per vehicle	US$1,250	
Pre-tax ROIC (ROA)	18.7 per cent	

Integrity Motors: BTO Scenario **Calculation Explanation**

Revenue per vehicle	US$26,000	Given
Cost of goods sold		
Gross profit		
S, G, and A		
Commission to dealer		
Freight		
Total operating costs and expenses		
Income from operations per vehicle	US$970	
Investment per vehicle		
Inventory		
Less: Accounts payable		
Accounts receivable		
Kiosk investment		
Additional IT, Engineering, and Mftng.		
Factory Property, Plant, and Equipment		
Total investment per vehicle	US$4,892	
Pre-tax ROIC (ROA)	19.82 per cent	

Southern Railroad: BTO Scenario **Calculation Explanation**

Freight revenue	US$225	Given
Wages		
Fuel		
Equipment costs		
Spotting and loading		
Roadway maintenance/depreciation		
Switching and classifying costs		
S, G, and A		
Additional BTO operating costs		
Income from operations per vehicle	US$42	
Investment per vehicle		
Materials and Supplies		
Less: Accounts payable		
Accounts receivable		

Property and equipment (rtm allocation)		
Additional B-T-O investment		
Benefit from decreased railcar travel time		
Total investment per vehicle	US$186	
Pre tax ROIC (ROA)	22.50 per cent	

Supporting calculations—Integrity revenue ton miles (rtm):	
Total revenue ton miles on railroad	182,00,00,00,000
Per cent related to automobiles	0.12
Automobile revenue ton miles	21,84,00,00,000
Per cent related to Integrity	0.25
Integrity RTM's	546,00,00,000

Supporting calculations—Rail Throughput Improvement	
Conventional vehicle time on rails (days)	10
B-T-O vehicle time on the rails (days)	2
Improvement ratio	80 per cent

The calculations show that the ROA goes up significantly for all three supply chain partners. In addition, the income from operations per vehicle also goes up for Integrity Motors and Southern Railroad. No doubt, income from operations per vehicle drops for the Dealer. However, the reader should note that the dealers now *do not hold any inventory*. It is now easily verified that the dealers will still come out ahead (generate more profit) even if the released cash (from not having to carry inventory) is invested at a rate of return greater than 8.29 per cent (the pre-tax ROA under the current mode of operation).

What should be the driving metrics for the parties involved in the above exercise? Certainly, an important metric for Integrity Motors will be fill rate. For Southern Railroad, on-time delivery will be an important metric. You can identify other important metrics for the supply chain members that will help evolve their BTO strategy.

4.4 EVOLVING SUPPLY CHAIN METRICS

The preceding case clearly demonstrates the value of having shared vision and shared supply chain metrics. Indeed, many organisations have attempted to evolve supply chain metrics. However, the lack of a systems perspective has often hindered their efforts at identifying good metrics that would find ready support from other member firms in the supply chain. As a consequence, these organisations often end up with metrics that are very narrowly focused. Lambert and Pohlen [2001] indicate that many measures currently identified as supply chain metrics are, in fact, simply measures of internal logistics operations. In fact, typical metrics used to measure delivery performance, such as fill rate and on-time performance will be applied in a different context if a systems perspective is adopted. To give a simple example, an improvement in inventory turns by a retailer is likely to have a more significant impact on overall supply chain performance than a corresponding improvement in inventory turns by a supplier. The reasoning behind this observation is that as inventory moves closer to the point of consumption, it increases in value.

It warrants repeating: optimising the separate links of the supply chain independently does not optimise the supply chain. For example, consider an organisation that produces and ships products in large batches. No doubt this organisation has minimised its production and transportation costs. However, it has increased the inventory for the buyer. Moreover, viewed from the perspective of the supply chain, the long lead times created by big batches and shipping quantities are very costly. They force large amounts of WIP in the supply chain, further reducing the flexibility and responsiveness of the chain. So a question one can ask is, 'Is there a way to optimise inventory costs across the entire supply chain?'

Such a question would have been dismissed in the past as a theoretical exercise. However, this question is rapidly changing from a theoretical to a practical one as managers of supply chains face increasing pressures on customer service and asset performance. Sony, for instance, is acutely aware of the fact that any inventory of its products at Best Buy and Circuit City ultimately affects its profitability if it remains on the shelf for more than a few days. Sony has changed its delivery metric from 'sell-in' to 'sell-through.' The difference is that the former metric allowed its Sales department to chalk up a sale when the product was shipped to the customer (Best Buy, Circuit City, etc.) whereas the latter metric chalks up a sale only when the product is sold and paid for. To give another example, Procter and Gamble uses its VMI process to routinely measure both its own inventory and the downstream inventory of its products.

An important set of supply chain metrics relate to speed—timeliness, responsiveness and flexibility. About a decade ago, there was a major emphasis on time-based competition. This emphasis was, and still is, very important. As we have stated before, lead times play a crucial role in enhancing the competitiveness of the supply chain. The metric of interest here is the *supply chain lead time*, not the lead time for an organisation. It is measured simply by adding up the lead times at each stage in the supply chain. Hausman [2002] reports on one high-tech organisation that began to measure the supply chain lead time, once it was made aware of the benefits of such a metric. Soon the organisation was able to reduce the supply chain lead time from 250 days to less than 190 days by some obvious, simple improvements.

Another important metric that relates to speed is adherence to quoted delivery time. Some organisations such as Dell Inc., for instance, go to extremes to meet this metric. In fact, Dell has the motto of 'Under-Promise, Over-Deliver.' It quotes a five-day delivery for a BTO product and typically ships the product in four days or less. Its suppliers are well aware of Dell's emphasis on on-time delivery performance and are prepared to act accordingly.

From an individual firm's point of view, supply chain metrics can move in the following directions:

- Move from those focusing on one actor to those encompassing two actors, capturing their interface, e.g. fill rates or order processing times, rather than production volumes
- Measure outputs rather than inputs, e.g. number of customer complaints or response time for a service call, rather than number of employees trained
- Focus on distributions rather than averages, e.g. measure age-wise profile of inventory rather than average, monitor service times above a certain limit, or accounts receivables above a certain amount
- Focus on service measures in addition to product measures, e.g. delivery time, in addition to production quality aspects

A well-designed measurement system can significantly help align processes across the supply chain, targeting the most profitable market segments. Some of the key dimensions used to measure supply chain performance are speed, quality, service, and asset management. Speed relates to timeliness, responsiveness and flexibility as noted earlier. Quality can relate to a variety of measures including defect rate, reliability, and appearance. Service relates to the ability to anticipate, capture, and fulfill customer demand on time. Asset management relates to the efficiency with which the supply chain is able to provide return on its assets.

Finally, properly designed supply chain metrics help clarify the inter-relationship between organisation and supply chain performance. These metrics should encourage co-operative behaviour of functions within the organisation (*functional* integration) and across organisations (partnering in the supply chain). Supply chain metrics help align activities and share in joint performance measurement information to implement strategies that achieve supply chain objectives.

4.5 PERFORMANCE MONITORING

To help organisations improve their overall supply chain performance, it is useful to have a focused procedure based on a set of performance measures that will guide the process of improvement. One set of suggested guidelines for such an activity is presented below:

- Measure performance at every step of the supply chain, end-to-end—this guards against part optimisation, which is sometimes 'easy' to achieve and can sometimes lead to misleading, short-term benefits.
- Ask customers to control performance—this focuses on the overall effectiveness of supply chain initiatives. Contrast this global suggestion with the local one of measuring outputs (relevant to internal customers, perhaps), rather than inputs.
- Focus on Key Performance Indicators (KPIs) for each organisational unit.
- Use both financial and operational performance measures—attempts to balance the short term goals of cash flow, profitability and viability, together with the longer term strengths of process capability, flexibility and low waste.
- Monitor full supply chain costs—look at impacts in different parts of the chain, including one's partners
- Take action based on KPIs—so that there is a purposefulness and momentum to the measurement activity and people see the benefits of such activity.

4.5.1 Benchmarking for Continuous Improvement

Benchmarking is a process of explicitly comparing one's performance to that of others, with a view of identifying best practices leading to superior performance. While comparisons within a certain sector or industry segment may be most direct and meaningful, it is said that cross industry comparisons and looking for best practices *across* different industries can push organisations to achieve significant benefits. For example, one of the motivations for the Just-in-time manufacturing revolution in manufacturing in the automobile sector has been the retailing model in supermarkets, which is replenishment based.

Some steps suggested for a systematic benchmarking exercise are:

- Define and classify processes
- Identify core processes 'the vital few'
- Develop Metrics
- Monitor
- Global Benchmark
- Analyse performance gaps
- Pursue process improvement

4.5.2 Balanced Scorecard

The goal of the Balanced Scorecard is to align business activities to the vision and strategy of the organisation, to improve internal and external communications, and to monitor organisational performance against strategic goals. It was developed in the early 1990s by Kaplan and Norton, 1992, and originally used to provide a framework for measuring performance. Since then, this tool has evolved considerably. Now many organisations both from industry and government view it as a strategic planning, management and control system for managing their business.

In its original form, balanced scorecards consisted of simple tables divided into four sections to represent four different perspectives in business. These perspectives were labeled **'Financial,'** **'Customer,'** **'Internal Business Processes,'** and **'Learning and Growth.'** The balanced scorecard approach thus intends to represent a balanced representation of the financial, customer-related, operational, and human-resource-related measures that are relevant to an organisation. Figure 4.2 presents a schematic view of the balanced scorecard. As can be noted from the figure, the balanced scorecard presents four perspectives on organisational management. Interpreting these perspectives in a supply chain context is a useful exercise.

The Financial perspective considers the issue 'How do we look to shareholders?'

The Customer perspective captures the key dimension of 'How do customers see us?'

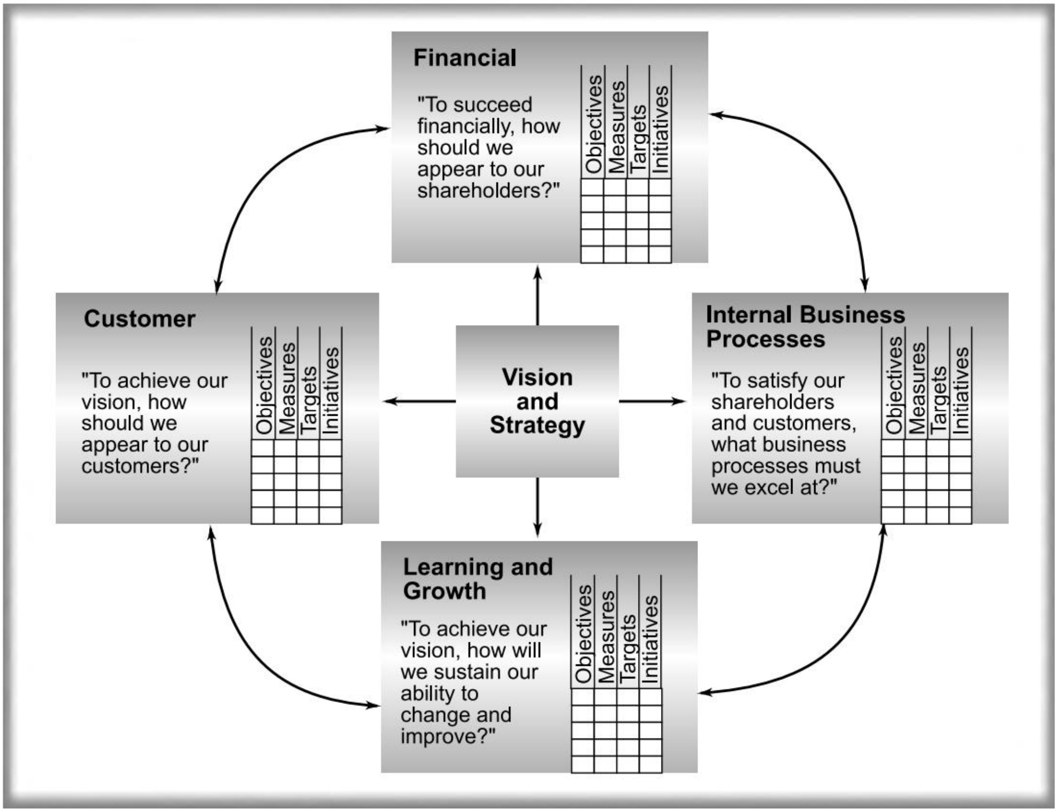
The Internal Business Process perspective asks the question 'What must we excel at?'

The Learning and Growth perspective addresses the issue of 'How can we continue to create and improve value?'

Designing the Balanced Scorecard requires the selection of five or six good measures for each perspective. Kaplan and Norton have observed that organisations are using the scorecard to drive strategy execution, make strategy more operational, align strategic initiatives, link financial budgets with strategy, and to conduct periodic strategic performance reviews to learn about and improve strategy. As observed by Kaplan and Norton, the idea is to retain financial measures, but these measures tell the story of past events and are inadequate for guiding and evaluating the journey that organisations in the customer-centric era need to make to create future value.

Figure 4.2: Balanced Scorecard Model (Schematic View)

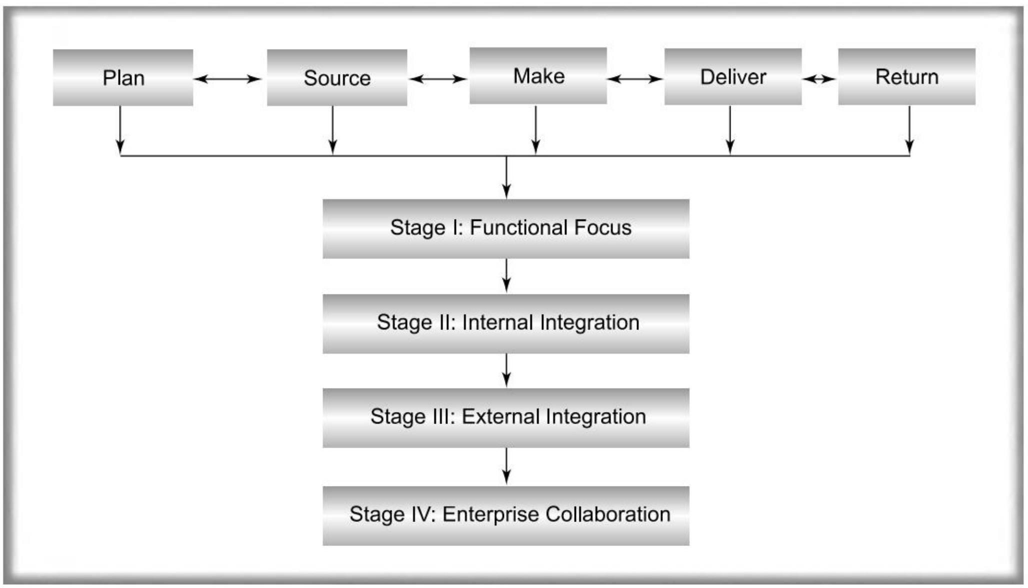
[See Kaplan and Norton, 1992]



4.5.3 The SCOR Model

The SCOR model was developed by the Supply-Chain Council (SCC). It integrates the concepts of business process re-engineering, benchmarking and process improvement into a cross functional framework. It tries to address management issues at the enterprise level rather than a functional level based on five distinct management processes Plan, Source, Make, Deliver and Return. For each of these, an increasingly holistic view of the supply chain is taken in four stages of management, starting from a functional focus and ending with enterprise collaboration.

Figure 4.3: The SCOR Model, Schematic View



A process reference model has been designed for effective communication among supply chain partners, ranging from supplier's suppliers to customer's customers. It is claimed that the SCOR model can be used to describe, measure and evaluate supply chain configurations. The model isolates key SCM processes and matches them against industry-specific best practices and thereby provides users with a framework for understanding where they need to make improvements

4.5.4 Standard Costing and Activity-Based Costing

Standard costing and activity-based costing (ABC) are tools for management and cost control. In theory, they allow management by exception, and ABC has been referred to as a powerful tool for measuring performance. To illustrate these two techniques, we will use data from a fictitious organisation, CSN Inc.

CSN Inc.

Three home-maintenance specialists, Cromby, Steele and Nash, have banded together to form CSN Inc., based in Baton Rouge, Louisiana, where it is sunny, the year round. They offer the following services: Plumbing, Window Cleaning, Installing Gutter Guards, and Landscaping.

The salaried staff at CSN Inc., includes a General Manager (Cromby), the Customer Service Representative (Steele), and the Front Office Person (Nash). The total monthly wages paid to these 3 men (the salaried staff) is US$18,000 including benefits (administrative overhead). Other non-administrative overhead costs amount to US$9,000 per month consisting of: Rental space (US$3,500), truck fleet maintenance to maintain three trucks (US$2,500), marketing and advertising expenses (US$1,500), and depreciation (US$1,500).

The current business climate for home maintenance services is very strong in Baton Rouge and CSN Inc., is seeing ample demand for each one of its products. However, there is also a severe limitation of qualified workers in the area. CSN Inc., has adhered to a motto: 'Teach Your Children Well,' ever since their younger days. So they have employed their own children, five excellent high-school graduates, to run the operations.

These five employees are each paid a competitive salary of US$2,000 per month including benefits. In return, they are each expected to work 200 hours a month resulting in a total of 1,000 hours of available capacity. CSN Inc., has thus fixed its labour rate as US$2,000/200 = $10 per labour hour. Table 4.2 presents the average time per job and some revenue/cost data for the services offered by CSN Inc., based on data gathered over the past six months.

Table 4.2: Data for CSN Inc.

	Plumbing	Window Cleaning	Installing Gutter Guards	Landscaping
Ave. Time Required/Job	Two hours	Four hours	Three hours	Five hours
Ave. Charge per job	US$130.00	US$170.00	US$200.00	US$250.00
Cost of Material	US$30.00	US$10.00	US$70.00	US$75.00

Currently, CSN Inc., is completing an average of 90 plumbing, 70 window cleaning, 80 gutter guards, and 60 landscaping jobs a month. At this output level, we note that CSN Inc., uses $(90 \times 2 + 70 \times 4 + 80 \times 3 + 60 \times 5) = 1{,}000$ hours, namely, all its available capacity.

Based on this data, CSN Inc., assigns labour costs to the four products as follows. Since it takes two hours for plumbing, the labour cost for a plumbing job is US\$10 × 2 = US\$20 per job. Similarly, the labour costs for the other three products are: Window cleaning: US\$40, gutter guards: US\$30, and landscaping: US\$50.

STANDARD COSTING

Standard Costing first identifies a 'cost driver' to spread fixed costs across the products. For our example, suppose the cost driver identified is production volume. Currently CSN Inc., is producing (90 + 70 + 80 + 60) = 300 jobs a month. Hence, administrative overhead charged to each job is US\$18,000/300 = US\$60.00. Similarly, the non-administrative overhead allocation per job is US\$9,000/300 = US\$30.00. Table 4.3 presents the allocation of the non-administrative and administrative overhead in two separate rows. The profit for each product, as obtained by Standard Costing, is also presented in the table.

Table 4.3: Profit Computation for CSN Inc. Using Standard Costing

	Plumbing	Window Cleaning	Installing Gutter Guards	Landscaping
Ave. Charge per job	US\$130.00	US\$170.00	US\$200.00	US\$250.00
Cost of Material	US\$30.00	US\$10.00	US\$70.00	US\$75.00
Labour Cost	US\$20.00	US\$40.00	US\$30.00	US\$50.00
Admin. O/H Allocation	US\$60.00	US\$60.00	US\$60.00	US\$60.00
Non-Admin. O/H Allocation	US\$30.00	US\$30.00	US\$30.00	US\$30.00
Profit	**US-\$10.00**	**US\$30.00**	**US\$10.00**	**US\$35.00**

Standard Costing usually has to reconcile all the overhead and labour costs at the end of an accounting period based on actual usages. This is not currently an issue for CSN Inc., since it is using all its labour capacity, and is absorbing all overheads. So there is no labour variance or overhead absorption variance to worry about.

At the current levels of output, the profit realised by CSN Inc., is 90 × (–US$10) + 70 × US$30 + 80 × US$10 + 60 × US$35 = US$**4,100** per month

The profit data reveals that landscaping is the most lucrative operation. Indeed, this is a product that CSN Inc., introduced into its portfolio only recently and it is a product that they wish to promote to the extent possible. The Customer Service Representative, Steele, is happy with the analysis. He is avidly promoting this product among CSN Inc.'s clients, singing praises on their capability to deliver on this product.

The General Manager, Cromby, is not quite sure whether Steele's pitch is off-key or not. He is worried about the seemingly arbitrary way in which the overhead is allocated. He has heard about a technique called Activity-Based Costing (ABC) which uses different 'cost drivers' for different categories of overhead.

ACTIVITY-BASED COSTING (ABC)

ABC is a technique that assigns costs to products based on the activities they require. ABC focuses on the activities of a production cycle. It is based on the premise that outputs (products or services) require activities to produce them, activities consume resources, and resources consume costs. In the context of our example, the four products require activity in the form of administration, marketing, transportation, etc. In turn, these activities consume resources in the form of administrative time, fleet usage, buildings, etc. The cost of the resources used for these activities has to be accounted for accordingly. Thus, ABC recognises the causal relationship of cost drivers to activities.

For our example, suppose that Cromby is not happy with the current choice for a cost driver to allocate either category of overhead. He wants to allocate administrative overhead based on the actual time and effort spent by the three managers on the various products. He also wants to allocate the non-administrative overhead using labour hours as the cost driver, instead of production volume. So he gathers information (expending some effort and cost) on the actual time Cromby, Steele and Nash spend on the various products. The data reveals the following breakdown on the time administration spends on the four products: plumbing: 30 per cent; window cleaning: 35 per cent; gutter guards: 20 per cent; and landscaping: 15 per cent. Based on this data, Cromby calculates the total administrative overhead dollars to be spent on plumbing as US$18,000 × 0.30 = US$5,400. Since there are 90 plumbing jobs completed each month, the administrative overhead allocated to a plumbing job is US$5,400/90 = US$60. In a like manner, the administrative overhead allocation to each of the other jobs is obtained as shown in Table 4.4 below.

Table 4.4: Administrative Overhead Allocation for CSN Inc. Using ABC

	Plumbing	Window Cleaning	Installing Gutter Guards	Landscaping
Percentage Effort	30 per cent	35 per cent	20 per cent	15 per cent
Admin O/H Allocated = percentage effort × US$18,000	US$5,400	US$6,300	US$3,500	US$2,700
Number of Jobs	90 jobs	70 jobs	80 jobs	60 jobs
Administrative O/H Allocation per job	US$60	US$90	US$45	US$45

To allocate the non-administrative overhead, CSN Inc., uses labour hours as the cost driver. Since the total non-administrative overhead is US$9,000, and since the total available labour capacity is 1,000 hours, the non-administrative overhead is charged at the rate of US$9,000/1,000 = US$9 per labour hour. Since plumbing takes two hours, the Non-Admin. Overhead allocated to a plumbing job is = US$9 × 2 = US$18. Thus the non-administrative overhead allocation per job is: plumbing (two hours): US$18; window cleaning (four hours): US$36; g. guards (three hours): US$27; landscaping (five hours): US$45. Table 4.5 presents the complete cost and profit data using ABC.

Table 4.5: Profit Computation for CSN Inc. Using ABC

	Plumbing	Window Cleaning	Installing Gutter Guards	Landscaping
Ave. Charge per job	US$130.00	US$170.00	US$200.00	US$250.00
Cost of Material	US$30.00	US$10.00	US$70.00	US$75.00
Labour Cost	US$20.00	US$40.00	US$30.00	US$50.00
Admin O/H Allocation	US$60.00	US$90.00	US$45.00	US$45.00
Non-Admin. O/H Allocn.	US$18.00	US$36.00	US$27.00	US$45.00
Profit	**US$2.00**	**US-$6.00**	**US$28.00**	**US$35.00**

With ABC, the profit data shows that while landscaping is still the most profitable operation, plumbing is now no longer a losing proposition, whereas window cleaning is.

Since ABC uses more meaningful cost drivers to drive the allocation of costs, it is widely accepted as a better method than Standard Costing for measuring performance. However, the improved accuracy of tracking comes at a cost. ABC requires more data to be gathered to monitor where costs are being expended, and a number of organisations find this task to be onerous.

Continuing with our example, suppose that the customer service representative, Steele, has discovered that there is ample demand for services offered by CSN Inc. He has estimated the following monthly demand for each type of service in the county:

plumbing:	250 jobs per month;	window cleaning:	160 jobs per month
install gutter guards:	145 jobs per month;	landscaping:	120 jobs per month

Suppose, too, that CSN Inc., is in a position to choose among the various products it offers, and pick the more profitable offerings. Based on the data obtained using ABC, the company would like to do as many landscaping jobs as possible first, since that would yield the highest profit per job. The next best offering would be gutter guards, and so on. Completing 120 landscaping jobs will use up $120 \times 5 = 600$ hours of capacity. The remaining 400 hours can be used for Gutter Guards, to complete $400/3 = 133$ jobs, leaving one hour of unused capacity.

The resulting profit from this product mix would appear to be 120 × US$35 + 133 × US$28 = US$7,924. However, this is not the true profit because there are unabsorbed overheads and unabsorbed labour, resulting in overhead and labour variances. These variances are reconciled as follows. The 120 landscaping and 133 gutter guard jobs will each recover US$45 of administrative overhead, that is: US$45 × 120 + US$45 × 133 = US$11,385. So, the administrative overhead Variance = US$18,000 – US$11,385 = US$6,615. The one hour of unused labour gives a labour usage variance of US$10 and a non-administrative overhead variance of US$9. So, the total of all the Variances is: US$6,634. Subtracting this amount from the apparent profit of US$7,924, we end up with a net profit of US$1,290. Thus, the 'optimal' profit is actually much less than the profit we obtained earlier (of US$4,100) using an apparently arbitrary product mix! Why do we obtain such a surprising anomaly?

The answer is that when we 'optimise' the product portfolio using ABC (or any other technique to allocate fixed costs), we use historical data to drive future decision making. However, in the process of doing so, if we end up with a different product mix, the allocated costs must be revised (or variances must be reconciled) to correctly account for the revised product mix. That can now provide a different cost/profit picture driving towards a new product portfolio, and so on, *ad nauseam*.

The above analysis thus allows us to make the following observation: 'ABC is good for tracking where costs were incurred, not for product mix decisions.' Indeed, that is where the strength of ABC lies: in tracking where costs were incurred, so that these costs can be better controlled in future.

4.6 COMPETENCES AND PERFORMANCE

Prahalad and Hamel, 1990, emphasised that an organisation should focus on developing core competences that help to create enduring customer satisfaction and loyalty. Core competences are embodiment of organisational knowledge built up over a time and not easily imitated, that yield competitive advantage to the firm. A firm's core competences reside in the accumulated intellectual capital of the firm and include its technologies, skills, experience, and management process. The resource based view which is gaining increasing acceptance in strategic management literature is based on the idea that a firm performs well over time because it develops a core competence which allows it to outperform its competitors. It is also argued in the literature that a firm should not be viewed as portfolio of assets (internal competences) but as a set of mechanisms by which customer pleasing capabilities are selected and built. Therefore development of competence for supply chain management requires the identification, selection and use of strategic Supply Chain Management (SCM) capabilities that can be directly related to the business objectives of the firm.

In the last two decades, with the adoption of supply chain management philosophy and increased outsourcing, the purchasing function got transformed from a routine activity to a strategic one. Firms started to develop competence in purchasing to gain competitive advantage in the supply chain. Currently, managers view purchasing, operations and marketing functions as intimately linked parts of the supply chain, each with the ability to contribute strategically to the firm. Past literature also suggests that supply chain competence can be conceived as consisting of three distinct competences: purchasing competence, production competence and marketing/logistics competence.

- In the fast changing supply chain environment, managers are beginning to realise that innovation and information technology (IT) are the prime movers of improved productivity and drivers of global competition. Examination of the supply chain success stories reported from India reveals strong support to this realisation. The competences in IT and innovation are essential for firms to integrate internally and also externally with its suppliers and customers.

CONCLUSIONS

Successful management of supply chain requires cross-functional co-ordination. SCM performance metrics, in this context, must be clear and accountability must be unambiguous. Well defined performance metrics, valid across the supply chain, is part of the seamless information flow to decision makers that is considered critical for supply chain success. The vision of supply chain performance metrics is no longer a distant dream. The internet can be a key enabler for monitoring supply chain performance since it facilitates the sharing of information in a collaborative and timely manner. One of the obstacles to developing supply chain metrics is that the members in the supply chain have to set aside concerns about sharing what is deemed to be confidential information. Many organisations are reluctant to even share their key performance indicators, much less divulge the values of these indicators. One way to work around such local thinking is to educate the supply chain partners and let them recognise that their performance is measured ultimately by the end customer. That is easier said than done; unless the partners can see tangible benefits, they may not be willing to give up their local thinking. A more practical way to address this problem is to develop trust so that those sharing information do not have to be concerned about the data being used against them. Such a trust is nourished by working with few suppliers on long-term contracts, and partnering with one or at most a select few logistics providers. This topic is addressed in more detail in subsequent chapters.

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Case references : Performance measures are almost essential for any case analysis and have to be considered carefully in any given context.

Exercises

1. For the Integrity Motors case, indicate what some of the metrics would be for the manufacturer, shipper, and dealer, to help them realise their BTO strategy.
2. Complete the tables for the current set-up and for the BTO strategy for the Integrity Motors case.
3. Discuss the four perspectives of the balanced scorecard in a supply chain context, providing specific examples of metrics that can be applied. Be sure to adopt a systems perspective when presenting these metrics.
4. For CSN Inc., is there an optimal product portfolio that maximises profits, given the constraint of 1,000 hours of labour capacity? If so, determine that profit.

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CHAPTER 5

SCM Effectiveness and Lean Thinking

CHAPTER OUTLINE

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5.2 Creating Flow: The Tools and Techniques of Lean Thinking
- 5.2.1 5-S
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INTRODUCTION*

In 1980, Japan became the world's leading producer of au tomobiles with production of a little over 11 million units out of a worldwide total of over 38.6 million units. That gave the Japanese automakers 28.5 per cent of the world market. Slipping to second place for the first time since taking the lead from France in 1904, the United States produced just over 8 million automobiles for a market share of about 21 per cent. In 1955, the Japanese auto manufacturers had produced about 69,000 vehicles, a year in which the U.S. auto industry built 9.2 million vehicles. Who could have predicted that just 25 years later the Japanese auto industry would produce more than 11 million vehicles—three million more than what their U.S. counterparts manufactured that same year—and remain the world's leading automobile manufacturer for the next 15 years?

Japan's rise to this pre-eminent position was fuelled by its application of lean thinking principles and concepts. It is a widely accepted notion that these principles and concepts originated from Japan. What is not as widely known is the fact that a number of these principles and concepts were originally developed in the United States. In fact, Henry Ford inspired a number of elements in the Toyota Production System such as kaizen, flow, pull production and the focus on eliminating waste.

* A number of sections in this chapter are drawn from the book, *Streamlined,* by Mandyam M. Srinivasan. The authors thank Cengage (formerly Thompson-Taxere) for giving us permission to use this material.

5.1 THE TOYOTA PRODUCTION SYSTEM

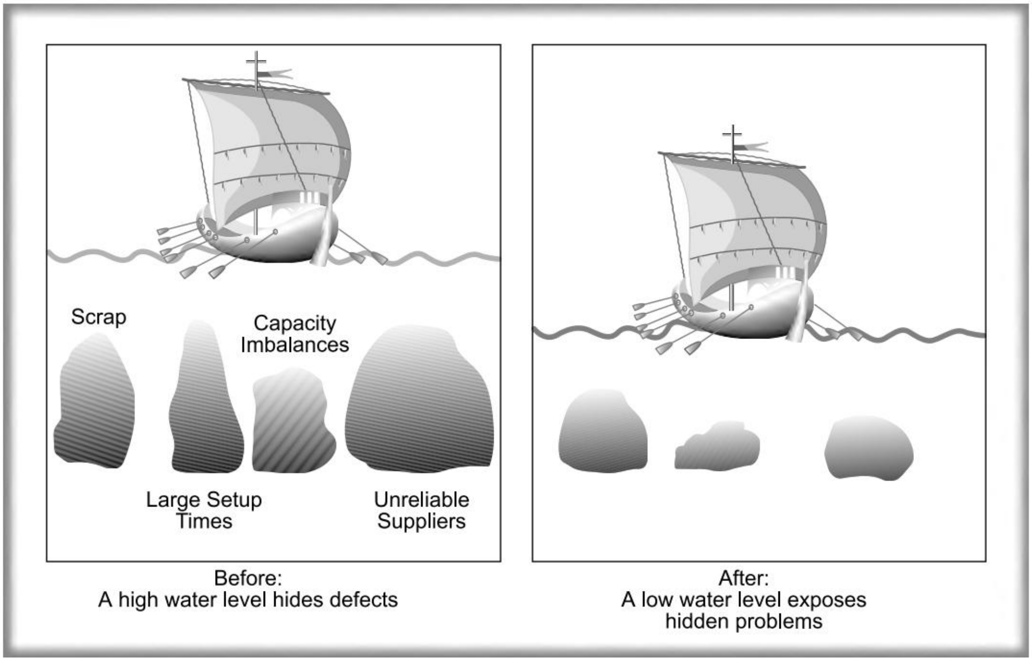
The Japanese automobile manufacturers succeeded in producing vehicles at low cost by adapting Henry Ford's ideas into their just-in-time (JIT) production management philosophy and system. The JIT management system had its roots in the Toyota Motor Corporation, and owes its conception and subsequent development to two individuals, Kiichiro Toyoda and Taiichi Ohno, although the latter is acknowledged widely as the creator of the Toyota Production System (TPS).

Inspired by Henry Ford's book, *Today and Tomorrow*, Kiichiro Toyoda had formulated, as early as 1936, a clear mental picture of the production system he wanted. The basic idea was to only produce what was needed on a given day, namely, to initiate a production run *when it was needed*, rather than making a production run *in anticipation of a demand*. He initiated this idea in the automobile department he had started within his father's organisation, the Toyoda Automatic Loom Works. Slips were passed around indicating the number of parts to be made or processed that day. This was the origin of the *kanban* method of production and it provided the basis for the JIT system. He began convincing suppliers to cooperate with his JIT system. He also changed the traditional physical layout of the plant so that machine tools were organised in a flow line. That made the supply line shorter so parts could get into the assembly process sooner.

Taiichi Ohno, who continued and improved on the processes put in place by Toyoda, credits his contributions to TPS to two main concepts [Ohno, 1988]. The first concept, from Henry Ford's book *Today and Tomorrow*, was the moving assembly line that provided the basis for the production and assembly system used in TPS. The second concept was the supermarket operations he observed during a visit to the United States in 1956, which provided stores with a continuous supply of merchandise. The supermarket gave Ohno the idea to set up a pull system, in which each production process became a supermarket for the succeeding process. Each process would produce to replenish only the items that the downstream process selected.

The Toyota Production System emphasizes working with *kanbans* and minimal inventories, but merely trying to reduce inventories without considering other factors can have serious consequences. The system is now much more vulnerable to disruptions. Figure 5.1 uses a 'river and rocks' analogy where the water level is analogous to the inventory level in a facility. A higher water level hides potential blemishes in the process such as unreliable suppliers, scrap loss, machine breakdowns, and so on. As the water (inventory) level is lowered, these problems surface, and forces management to work on correcting these defects. The key is to resist the temptation to reduce the water level (inventory) too quickly. Rather, the idea is to lower the water level a little, break apart the newly exposed rocks (obstacles), and then lower the water level once again.

Figure 5.1: Inventory Hides Defects



Before attempts are made to reduce inventory levels, some of the major elements that should be in place are reliable processes, preventive maintenance systems, cross-trained workers, setup reduction, and reliable suppliers. If these elements are not already present in a factory, then putting them in place takes time; certainly it cannot happen overnight. The Japanese spent perhaps close to 25 years perfecting the system before it was successfully applied on a wide scale.

Figure 5.1 also carries another important message. For the boat to move faster, all oarsmen should row at the same time. The most effective method of production within the organisation is to have all processes work at the same rate. There is no point in having some of the resources work faster than the others, because that will invariably pile up inventory in front of the slower processes. If all resources respond to *pull* signals, that will ensure a smooth flow of products across the organisation. The signal for a resource to produce could be generated simply when the downstream resource draws a unit of WIP from the buffer placed between the two resources.

The Japanese recognised that for the entire process to flow smoothly, it was necessary for suppliers to participate in this flow process, responding to the pull signals. The Japanese management system was thus built on partnering arrangements that had mutual benefits for both the automakers and their suppliers. For instance, suppliers were provided ample visibility on the automakers' assembly schedules, and these schedules were generally adhered to quite stringently. That made it easier for the suppliers to plan their own production schedules accordingly and deliver supplies in a timely manner without having to hold a lot of finished goods inventory.

5.2 CREATING FLOW: THE TOOLS AND TECHNIQUES OF LEAN THINKING

The preceding discussion clearly demonstrates the value of creating flow within and across organisations. Within the organisation, the important tools and techniques ('lean tools') used to promote flow are:

- 5S
- Flow Charts
- *Takt* Time
- Average Labour Content and Minimum Manning
- Mixed Model Scheduling and Small Batch Production
- One-Piece Flow
- Cellular Layout
- Standard Work
- Pull Replenishment
- Point of Use Material Storage
- Mistake Proofing and Method Sheets
- Total Productive Maintenance
- Continuous Improvement and the Pursuit of Perfection

Although these lean tools were originally developed for manufacturing organisations, many service organisations are finding them very useful as well. As we discuss these tools, think about how they apply in a service setting. For instance, the final product might be a piece of paper that reaches its destination in a more timely fashion. How often has one of your operators sat idle waiting for the next order to present itself? How often have you delayed a service delivery waiting for the paperwork to be completed?

Before we apply these tools, we must address the scope of the lean implementation. Organisations often create lean cells to put out products at a rapid rate, only to find these products queueing up at a downstream work centre. The questions that must first be addressed are as follows: should the organisation implement lean on *all* its processes and activities or should it focus *on a subset* of its processes? Similarly, should it implement lean on all its products or on a subset of them? It is recommended that the organisation choose one product family at a time and implement lean on *all* the processes and activities that apply to this product family, before moving on to the next product family.

5.2.1 5-S

The term 5-S is used to denote a systematic process for organising the workplace based on five simple, yet powerful, activities, each of them represented by a Japanese word that begins with the letter 'S.' The five Japanese words, with their English translations, are *Seiri* (tidiness), *Seiton* (organisation), *Seiso* (cleanliness), *Seiketsu* (neatness), and *Shitsuke* (discipline). Figure 5.2 presents the 5 S's and their definition. Corresponding to these five Japanese words, five English words that begin with the letter S and convey *nearly* the same intended meaning are also presented in Figure 5.2. Some organisations add a sixth S for Safety. Some of the intended meanings of the original Japanese words are, however, lost in the translation, especially when trying to capture the meaning with English words that begin the letter S.

The first step, *Seiri*, refers to taking out unnecessary items and discarding them. Literally, it means organising something that is disorganised. Every item in the work area is classified as either a necessary, unnecessary, or a 'red tag' item. Red tagged items literally have a red tag tied to them, indicating that it is unclear whether or not the item is needed. Items marked as unnecessary are disposed of immediately, following which an 'auction' is held wherein red tag items are displayed for anyone to claim them as necessary. Red tag items that no one claims are discarded.

The idea behind the second step, *Seiton*, is to arrange the necessary items in a proper order so that they can easily be picked up for use. In Japan, the words *Seiri* and

Figure 5.2: The 5 S's and Their Definition

Japanese	Definition	English	Example
Seiri	Tidiness	Sorting	Throw Away Rubbish
Seiton	Organisation	Storing	30-Sec. Doc. Retrieval
Seiso	Cleanliness	Sanitising	Individual Responsibility
Seiketsu	Neatness	Standardising	Clear Written Instructions
Shitsuke	Discipline	Sustaining	Do 5S Activities Daily

Seiton are often used in combination as *Seiri-Seiton* because there is not a big difference in their meanings. In any case, the second step is intended to create storage systems and provide visual information about what is stored and how much should be stored in a given spot. Standard, convenient locations are created for tools and devices used in the work area. For example, tools are typically hung on boards, with a 'shadow box' (a silhouette) of the tool painted on the board where the tool is to be hung. Drawers are sometimes filled with styrofoam, with cutouts of the items that are stored in the drawers.

The third step, *Seiso*, prescribes keeping the area clean, and to take pride in a workplace that is organised and kept in good condition. This step goes beyond simply making the area more pleasant to work in by sweeping the floor and cleaning up leaks and spills. It includes checks for malfunctioning machinery, loose parts on machines, etc. Aside from making the area more conducive to work in, the *Seiso* step provides other practical benefits. For example, if machines are kept clean, oil leaks will be discovered before a catastrophic equipment failure; if the aisles are kept clean and free of any oil spills, the chances of accidents are minimised, and so on.

The fourth step, *Seiketsu*, provides the basis for standardisation. Literally, *Seiketsu* refers to a condition where there is no smear, stain, etc. This step covers both personal and environmental cleanliness, and *defines the standards* by which personnel must measure and maintain 'cleanliness.' This step prescribes what the normal condition should be, as well as how an abnormal condition should be corrected. Visual management is an important ingredient of *Seiketsu*. Colour-coding and standardisation of colours are used for easier visual identification of problems. Personnel are trained to detect such problems using one or more of their five senses and to correct them immediately.

The final step, *Shitsuke*, relates to building discipline that will sustain the first four steps. Literally, *Shitsuke* refers to making a person keep a rule or order through training. The rationale is that it is often easier to clean up an area than it is to keep it clean. Thus an integral part of a 5-S programme should be a system for maintaining the first 4 S's. The *Shitsuke* step commits to maintain orderliness and to practice the first 4 S's continually, and it is vital that this step has full support from top management. Initially, it is very likely that top management has to provide the right incentives for this step to take place on a regular basis. Once the inertia is overcome, however, there is a lasting effect, and the process becomes self-sustaining.

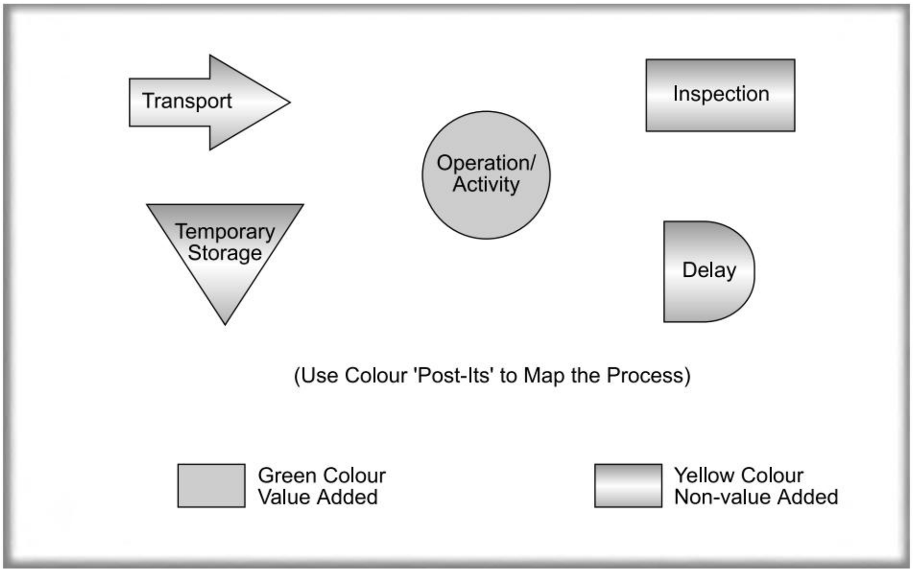
The 5-S programme improves safety, work efficiency, productivity and establishes a sense of ownership. These activities ensure a clean and orderly working environment and help employees become aware of their working environment and the condition of the tools and machinery they use. In many organisations, the benefits of a 5S programme are often so dramatic that there is a real danger that the organisation may step away from a full blown lean implementation at this stage, thinking that its mission is complete. It is, therefore important to note that the 5-S programme is just the starting point in the lean journey. Equally important to note is that the 5-S programme can actually hinder the lean journey if the vital fifth step (*Shitsuke*) is not practiced. A good 5-S implementation *builds the foundation for continuous improvement.*

5.2.2 Flow Charts

Anyone can visualise a process step. However, in a work environment it is often easy to miss the simple flow of a process from one step to the next. The flow chart is a powerful visual tool that can describe practically any process, be it a manufacturing process or a service process. Flow charts enable us to quickly identify the process steps we must eliminate in our drive for simplicity and waste reduction. Identifying and eliminating (or at least reducing) non-value-added activities is key to streamlining a process.

There are several alternate methods for capturing value-added and non-value-added activities using flow charts. One way is to use a *process flow chart* that captures the logical sequence of activities involved in delivering the product, in conjunction with a *spaghetti diagram* that depicts the physical movement of products through the plant or office. A process flow chart typically uses standard symbols, as presented in Figure 5.3 below, to identify different activities. The value-added activities are colour-coded green and the non-value-added activities are typically colour-coded yellow.

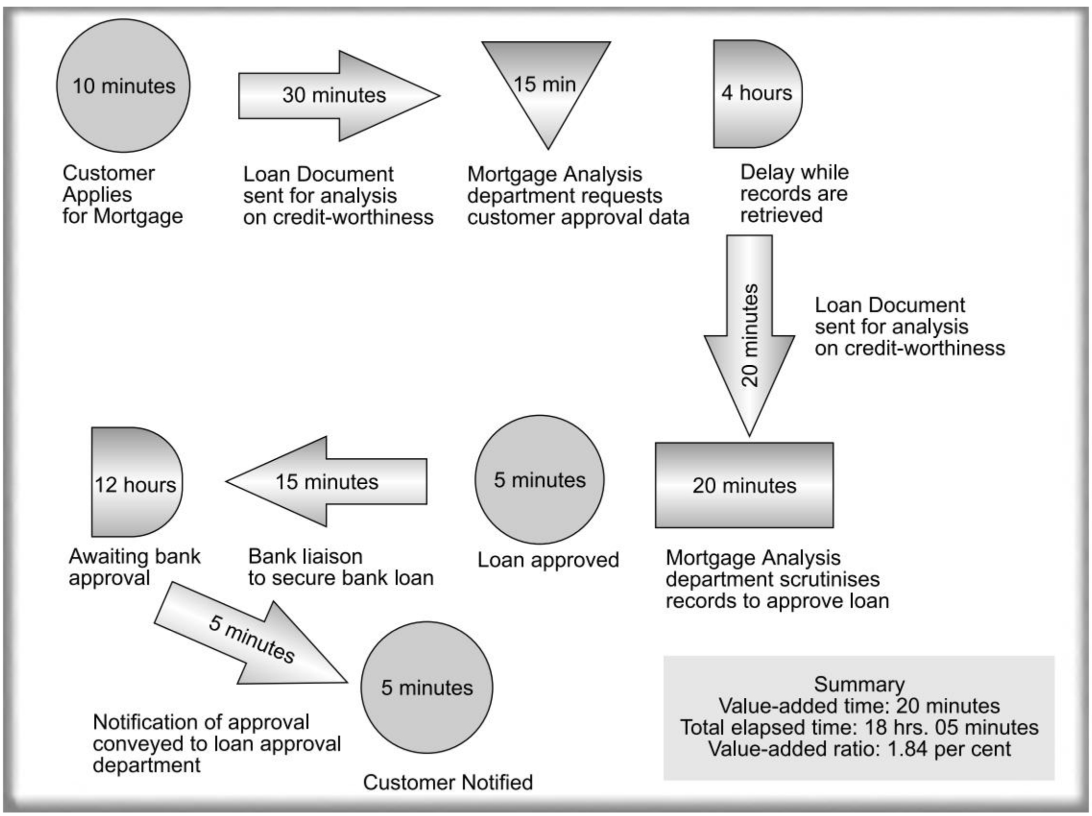
Figure 5.3: Process Flow Charting Symbols



Deciding what is a value-added activity and what is non-value-added can sometimes be a contentious issue. Does the marketing function add value? And does the logistics function add value? If so, which logistics activities are value-added? One way to resolve this issue is to define a value-adding activity as an activity that either actually transforms the product or one that the customer would be willing to pay for it to happen.

Figure 5.4 presents a process flow chart for a mortgage loan application. In this figure, the value-added ratio is obtained as the ratio of the actual value-added work expressed in time units divided by the elapsed time for the process to complete. The summary data in the figure presents the value-added ratio as 1.8 per cent; a remarkably low number, that is, unfortunately, all too typical of the value-added ratio for a majority of processes in the real world. It is also indicative of the amount of waste that is prevalent in the system, and the huge opportunities there are for lean efforts to remove waste. While it is difficult to specify what the value-added ratio should be because it depends on the industry, a ratio of 10 per cent has sometimes been specified as a goal—see, for instance [G. Conner, 2001].

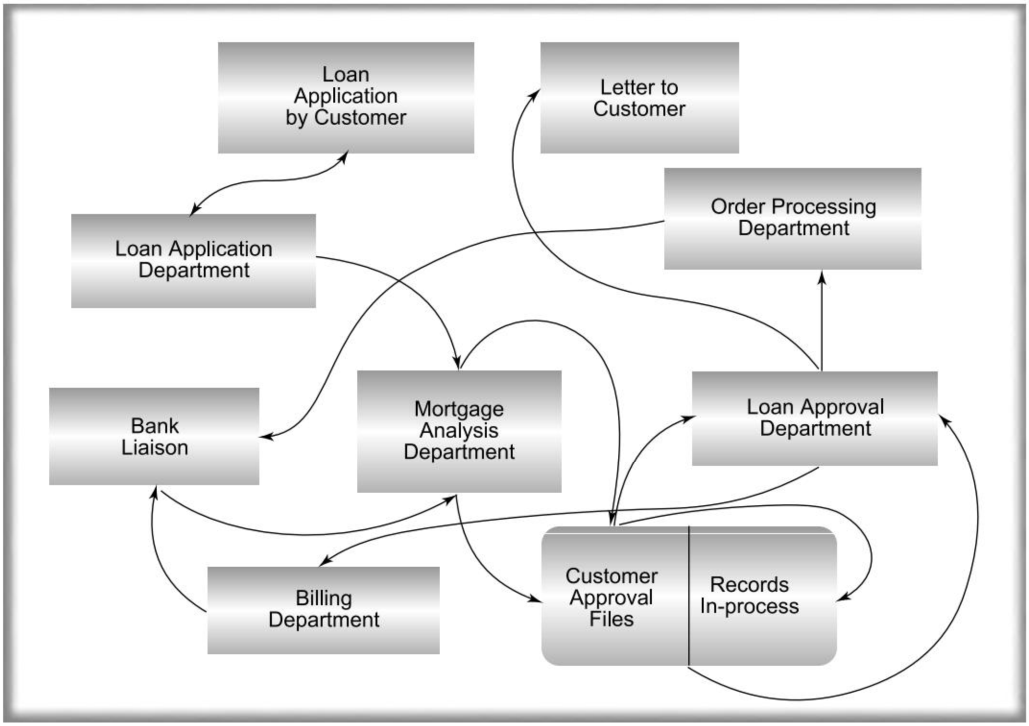
Figure 5.4: A Process Flow Chart for a Mortgage Loan Application



The formula described above, however, does not consider the actual effort expended in delivering the product. For instance, it is quite feasible that some of the steps, value-added or otherwise, may involve multiple employees working on the activities. In such situations, a more meaningful value-added ratio would have the total man-hours of value-added effort required to produce one unit in the numerator and the sum total of all the man-hours employed by the organisation to produce one unit in the denominator.

A diagram that is sometimes used to represent the distance travelled by the product is the spaghetti diagram. Figure 5.5 presents a spaghetti diagram for the same mortgage loan application process. The spaghetti diagram, used in conjunction with the process flow chart, can provide the analyst with valuable information in the effort to streamline the process. While the process flow chart will reveal the non-value-added activities, the spaghetti diagram will highlight the extent of travel, including any back-tracking that the product may undergo. It may suggest how the process could be streamlined through a better process layout.

Figure 5.5: The Spaghetti Diagram for a Mortgage Loan Application



The flow chart should be preferably drawn *after* the 5S programme is in place. If the flow chart is drawn before the 5S programme is initiated, the lack of attention to simple housekeeping may obfuscate some of the non-value-added activities that the organisation really needs to focus on. For instance, the operators could be taking more time to change tooling simply because they are difficult to locate and that may be reflected in the time standards developed for the tool changeover activity.

5.2.3 Takt Time

If someone compiled a dictionary of terms used in lean, they would notice a slew of Japanese words in the compilation. For instance, we have already discussed the 5 S's, *kanbans*, and *kaizen*. *Takt*, however, is a German word for a musical meter, that is used in lean, even in Japan. When German aerospace engineers helped Japan build aircrafts during the 1930s, they used the word *takt* to present an analogy of a conductor waving his baton to set the rhythm for the entire orchestra. After World War II, Toyota adopted this word and the accompanying concept as the basis for linking its production capacity to customer demand in the Toyota Production System. The customer demand became the cadence that dictated the pace of operations on the shop floor.

How do organisations apply *takt* time? First, it should be recognised that *takt* time represents the customer demand. *Takt* time is calculated as follows:

Takt time = Available time per period/Demand per period.

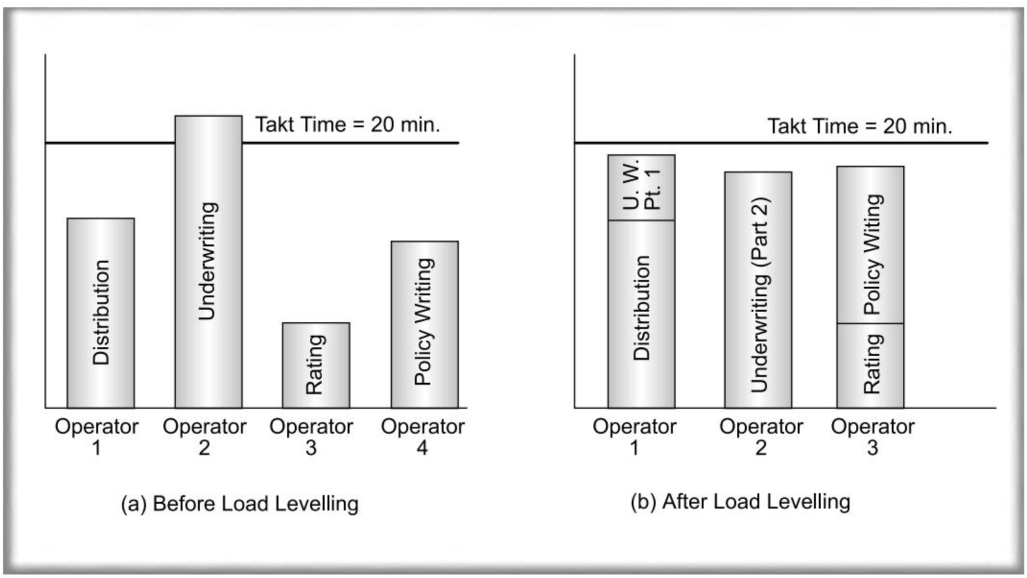
The duration of the 'period' could be minutes, hours, days, or weeks (so long as the same unit of time measurement is used in the numerator and the denominator). To illustrate the concept, we start with a simple example of an organisation working on a single product.

We consider an insurance agency, Hungama Inc., that processes applications for property insurance. Processing an application involves four steps: (a) Data gathering/ data entry ('Distribution'), (b) Risk analysis ('Underwriting'), (c) Computing the premium ('Rating'), and (d) Policy Writing. Suppose that the customer demand for this product is 20 policies per day, and suppose that Hungama operates a single shift of eight hours duration.

The first step in calculating *takt* time is to determine the available time per shift. Typically, the essential breaks such as lunch and bio breaks are deducted from the duration of the shift to arrive at an available time of, say, six hours and forty minutes (400 minutes) each day. Then the *takt* time is 400/20 = 20 minutes per unit. In other words, the organisation has to process one policy every 20 minutes. (If the organisation operated two shifts each day, then the available time per day is 800 minutes, and the *takt* time will be 800/20 = 40 minutes per unit.)

Continuing with this example, since the (external) customer demand is for one unit every 20 minutes, the organisation should match its (internal) resources to meet this demand. Suppose the average time it takes to process the four steps (the 'cycle times') are 14 minutes, 22 minutes, 6 minutes and 12 minutes, respectively. Suppose, too, that there is an individual dedicated to each of these four steps. Figure 5.6 shows a 'Load' chart depicting how these individuals are loaded. The figure has two parts, the first part corresponding to the current loading, labelled 'Before Load Levelling.'

Figure 5.6: Load Chart for Hungama Inc.



One of the main uses of the *takt* time calculation is to match internal resources to external demand, as alluded to earlier. When we examine how the operators are loaded in Hungama, it is apparent that the operator in charge of underwriting is overloaded because he is loaded beyond the *takt* time. In order to meet the *takt* time, this operator is presumably either working overtime, or working at a faster rate than called for, in which case there are opportunities for the operator to make errors. The load chart thus helps determine whether the work is assigned equitably and whether anyone is overloaded. At the same time, it also helps determine whether there is slack in the system, which is apparent in Figure 5.6 (a), since operators 1, 3 and 4 are underutilised.

What are the options available for Hungama at this stage? If some of the Underwriting work is reallocated to another operator, operator 2 could now work under *takt* time. Also, the workload for operators 3 and 4 could be combined and assigned to one operator. The second part of Figure 5.6 shows the 'After Load Leveling' scenario, where a task that accounts for five minutes of work is moved from operator 2 to operator 1. The loads on the three operators are now 19 minutes, 17 minutes, and 18 minutes, respectively.

The preceding discussion assumes that the time to perform each activity is accurate. That is an issue that must be resolved quite early in this decision process, and may require some time studies to be conducted. Once this issue is resolved, the next issue is to decide how the individual operators are loaded. If the operators are underutilised, there is a likelihood that the work expands to fill the time available, resulting in inefficiencies. On the other hand, loading each operator close to 100 per cent may result in lots of opportunities for error, particularly if the workload is highly variable with prolonged periods where the operator is loaded beyond capacity. Ideally, we want to buffer variation with capacity, not inventory. Loading operators close to 100 per cent leaves no room for accommodating increased customer demand without reallocating resources. Note that the *takt* time goes *down* when the demand increases. If the demand at Hungama increases by 10 per cent to 22 policies per day, then the *takt* time goes down to 18.18 minutes per job and operator 1 becomes overloaded. That said, in some situations it is advisable to keep operators loaded close to 100 per cent because that may motivate them to find creative ways of managing the workload so that the resulting cycle time is well within the allotted *takt* time.

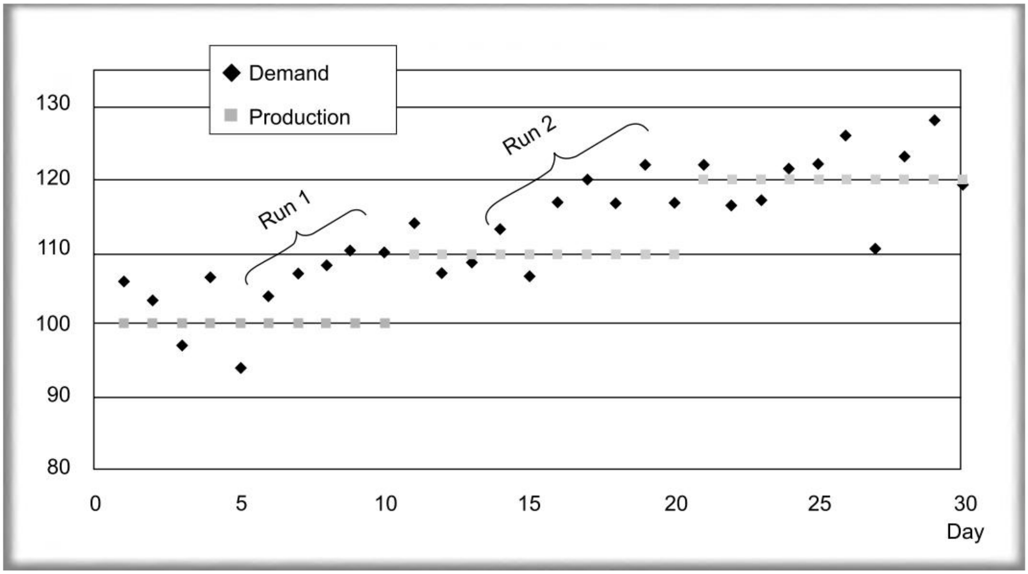
The above example used task times that were discrete. If it was possible to subdivide tasks even more finely, it would be possible to load each operator as close to *takt* time as desired. If such a fine division of tasks were possible, what would be the best way to load each operator? In the above example, the total workload is (19+17+18) = 54 minutes, and so the tasks could be allocated so that each operator had a cycle time of 18 minutes. However, as discussed above, that would uniformly under-utilise each operator. A better alternative may be to have the first two operators loaded with tasks that add up to the *takt* time of 20 minutes, leaving the third operator loaded only up to 14 minutes. Since the third operator has a loading that is significantly less than *takt* time he could help the other operators if they fall behind schedule. This operator could also be the one located at the end of the cell, where he can perform the material handling activity, moving parts into and out of the cell.

Working with a *takt* time has a number of advantages. If each operator is paced to *takt* time, that automatically limits one of the primary causes of inventory, overproduction. Limiting overproduction also stabilises the system, preventing the frequent stops and starts that inhibit a smooth flow. When a team of operators are asked to pace their work according to *takt* time, there is a heightened awareness of the output rates and potential problems that detract from achieving the desired output rate. The operators obtain immediate feedback if they miss *takt* time on a given cycle and make corrections accordingly. If feedback is only provided after many cycles, then the window of opportunity to correct errors may have passed. At the same time, *takt* time should be applied judiciously. This concept is more applicable in a *flow* shop that processes a set of products with relatively predictable demand that does not fluctuate a lot. *Takt* time may not be very relevant in a job shop environment, but calculating *takt* time is still useful because it helps determine the number of operators that must be assigned to a process.

How often should the *takt* time change? This question depends on the industry. Consider a manufacturing cell. If the *takt* time decreases, then it is not simply a matter of reallocating work to different operators. There might be equipment related issues as well. So, if *takt* time is adjusted daily, that could well result in chaos. At the same time, if the organisation is not flexible enough to react quickly, that may result in missed opportunities to fill demand or, conversely, lead to inventory build-ups. The key is to distinguish between 'noisy' data and trends. For example, a 'run' test could be applied to determine when the *takt* time should be changed. Consider the sequence of demands presented in Figure 5.7. The *takt* time (equivalently, the desired production rate) could be re-evaluated if the demand exceeds the set production rate for, say, five consecutive days as shown in the figure.

Consider how *takt* time works for the assembly operations at Dell. Dell assembles its desktop computers, in response to customer demand, using a number of assembly lines that operate in parallel. Suppose that, based on current customer demand, it has set its assembly *takt* time at 15 seconds per computer. Dell typically allocates one or at most two operators to assemble a computer on each assembly line. Suppose each assembly line has two operators and that each takes two minutes (120 seconds) to do their respective tasks. Since a *takt* time of 15 seconds does not provide enough time for the assembly operators on a given line to complete all assembly operations, Dell runs a number of assembly lines in parallel. If each assembly line puts out one computer every 120 seconds, then Dell needs eight lines to run in parallel, in order to meet a *takt* time of 15 seconds (120/8 = 15 seconds).

Figure 5.7: Re-Calibrating *Takt* Time



Now suppose that on a given day Dell finds that it does not have enough orders on hand to warrant a *takt* time of 15 seconds per computer, but instead the *takt* time works out to 16 seconds per computer. (Note that the *takt* time goes *up* when the demand goes down.) Dell has several choices at this stage. One alternative is to shut down one assembly line. But with 7 lines, each line assembling one computer every 120 seconds, it will take 17.14 seconds to assemble a computer (120/7 = 17.14 seconds), and that would not meet customer demand. Another alternative would be to ask each assembly line to work slower. A third alternative would be to run all eight lines at full speed, continuing to produce one computer every 15 seconds. This alternative causes minimal disruptions in the assembly process but the overproduction will result in some computers that are built to stock. These computers can either be sold at a discounted price, as Dell usually does, or it could serve as a buffer for a possible demand increase the following day.

To give another example, Toyota examines its production rate at 10 day intervals and adjusts the *takt* time if need be. Most of the time, Toyota may not need to change the production rate or if it does may decide to do so by changing the length of the workday (by working overtime), because changing the line rate on an automobile assembly line is a major undertaking. On the other hand a small manufacturing cell may change its *takt* time weekly or even daily, and adjust the number of operators accordingly.

Takt time is one of the most misunderstood concepts in lean manufacturing. I have been to several organisations where they prominently announce their *takt* time to be, say, '100 pieces per hour.' (Recall that *takt* time is time per piece, not pieces per time.) It is also not uncommon for managers to state that their machines have a *takt* time of five minutes. (*Takt* time is a measure of external demand, and has nothing to do with machine capacity.) In some instances, *takt* time has also been confused with lead time (or flow time). Quite often this is because organisations simply go through the motions and effect lean in a piecemeal manner without fully understanding the implications. Remember that the primary purpose of *takt* time is to match external demand with internal capacity. To sum up our discussion on *takt* time so far:

- *Takt* time is used to represent the customer demand. It is expressed in terms of the time available to make one unit that will keep pace with customer demand
- The primary purpose of calculating *takt* time is to match external demand with internal capacity
- *Takt* time should be adjusted when it is clearly evident that the customer demand has changed. Adjusting *takt* time too frequently to respond to small fluctuations could result in chaos. The key is to distinguish between 'noise' and a trend.

So far, the discussion on *takt* time has been based on a single product. The *takt* time calculation does not change when there are multiple products involved, but the calculations involving operator loading become just a little more involved. We demonstrate how the calculations proceed by expanding on the Hungama, Inc. example.

Hungama Inc. Revisited

Hungama Inc. processes four different kinds of property insurance applications: RUNS (requests for underwriting), RAPS (requests for price quotes), RAINS (requests for additional insurance on an existing policy) and RERUNS (annual renewal of existing policies). The daily demand for each type of application is provided in Table 5.1 below.

Table 5.1: Demand Data for Hungama Inc.

	RUNS	RAPS	RAINS	RERUNS
Jobs/Day	4	12	6	18
per cent of Total	10 per cent	30 per cent	15 per cent	45 per cent

Each product type requires some or all of the four steps indicated earlier, namely, distribution, underwriting, rating, and policy writing. The workload varies by product type. Table 5.2 presents the average labour content for each product type.

Table 5.2: Operation Times for Hungama Inc.

	RUNS	RAPS	RAINS	RERUNS
Distribution	58 min.	50 min.	44 min.	28 min.
Underwriting	43 min.	40 min.	23 min.	19 min.
Rating	72 min.	65 min.	68 min.	75 min.
Policy Writing	67 min.	0 min.	55 min.	50 min.
Total Labour	240 min.	155 min.	190 min.	172 min.

The *takt* time for this example is simply determined by adding all the demands to obtain a total daily demand of 40 units. Note that even though the time requirements for each product is different, this is not a matter of concern at this stage since we are only looking at external customer demand, not internal resource requirements. Assuming that the organisation works 400 minutes per day as before, the *takt* time is obtained as 400/40 = 10 minutes per unit.

5.2.4 Average Labour Content and Minimum Manning

The next step is to compute the minimum number of operators required to sustain operations. From the data given in Tables 5.1 and 5.2, the average labour content for a job is obtained as the weighted average of the labour content for each product type. This gives

$$\begin{aligned}\text{Ave. Labour Content} &= 0.10 \times 240 + 0.30 \times 155 + 0.15 \times 190 + 0.45 \times 172 \\ &= 176.4 \text{ minutes}\end{aligned}$$

Since the *takt* time is 10 minutes per unit, we need a minimum of 176.4/10 = 17.64 operators, or 18 operators to manage customer demand. Clearly, there will be some sharing of tasks since there will be at least 18 operators to do the four different activities. However, there are workload balancing issues that need to be resolved. As a starting point, we could determine how many operators need to be allocated to the distribution activity. The average labour content for this activity is $0.10 \times 58 + 0.30 \times 50 + 0.15 \times 44 + 0.45 \times 28 = 40.0$ minutes. Since the *takt* time is 10 minutes, the minimum number of operators allocated to this task will be 40.0/10 = 4 operators.

The average labour content for the underwriting, rating, and policy writing activities are computed similarly, and work out to be 28.3 minutes, 70.65 minutes, and 37.45 minutes, respectively. Therefore, these three activities require a minimum of 28.3/10 = 2.83, 70.65/10 = 7.065, and 37.45/10 = 3.745 operators, respectively. Workload balancing and related issues may thus result in more than 18 operators being needed. A load chart can now be constructed to determine how much each operator is loaded.

This exercise demonstrates the importance of scheduling the jobs in a judicious manner and avoiding large batches in order to achieve scale economies. Consider, for instance, the operators involved in policy writing. The RUNS, RAINS and RERUNS demand at least 50 minutes of effort per job. However, the RAPS do not require any time from the operators. If the jobs are scheduled using economies of scale, there will be long periods during which the operators will be overworked because they are working on a RUN, RAIN or a RERUN. This will be followed by a period during which they will be idle because RAPS are being processed by the other operators in Hungama. On the other hand, if a *mixed-model* scheduling approach is used, it is possible to level-load the operators and manage them much more effectively.

5.2.5 Mixed Model Scheduling and Small Batch Production

A characteristic of an efficient production system is that products flow smoothly through the organisation with no delays. The production schedule plays a significant role in effecting this smooth flow because it dictates the frequency with which products are scheduled at the various resources. In a perfect world, the organisation's customer would pull a product from the final assembly station and that would generate a signal on each upstream resource to produce exactly what was pulled by the customer. However, the reality is that quite often production constraints such as changeovers, material availability, operator availability, and so on would restrict how products flow through the organisation. In particular, the changeover time significantly influences the extent of batching. Furthermore, plants that make a variety of different products usually tend to produce the different products in large batches to exploit economies of scale.

Large-lot production, of course, sends a ripple effect throughout the organisation. In the beer game that we discussed in Chapter 2, a single change in demand at the retailer was enough to cause huge variations in demand four stages upstream, at the factory. Likewise, within the organisation, a small change in demand at the most downstream operation can cause significant demand variation at upstream resources, and batching only exacerbates this problem. Typically, these demand variations are absorbed by carrying large amounts of WIP between each stage. Thus, in-process buffers are one way to 'level' the production, and work with large batches. Needless to say, larger WIP inventories increase the lead time. There is a better way to level the production schedule. It is simply to produce every product as quickly as possible, at the same rate at which customer demands are made. This, in essence, is *mixed-model* scheduling. The Japanese term for mixed-model scheduling is *heijunka*, which refers to distributing the production of different product types evenly over the course of an hour, day, week, or month.

Suppose, for instance, that an organisation makes three products, A, B, and C each of which requires 10 minutes of assembly time. Assume that the final assembly shop works 10 hours each day, five days a week. Suppose the customer is demanding these products at a rate of three, two, and one, per hour respectively. The customer for these products could be demanding them every hour, but the organisation may choose to produce these products in large batches for reasons as indicated above. Suppose the final assembly shop decides to produce one week's demand of each product each time. In other words, the weekly schedule would be as follows: 150 A, 100 B and 50 C. Instead of receiving products every hour, the customer will receive the products once a week. In other words, either the customer or the final assembly shop will carry an average finished goods inventory of 75 A's (half the batch size, on average), 50 B's and 25 C's. If the final assembly shop had, instead, produced according to a mixed-model assembly schedule of 3 A, 2 B, 1 C, the finished goods inventory would be negligible since that exactly matches the customer's hourly demand rate. The six units produced in an hour could be even more finely sequenced as follows: A B A C A B.

The above exercise assumed that the assembly time is the same for each product. Mixed-model scheduling has an even greater impact on smoothing flow when different products have different processing time requirements as discussed earlier in the context of the Hungama Inc. case. No doubt true mixed-model scheduling requires set-up/changeover times to be minimal. As changeover times become more significant, it can be argued that the batch sizes should correspondingly increase. While there is some truth to this statement, we can still achieve short-cycle scheduling by producing in small batches in the presence of set-up times.

To sum up the discussion in this section, producing products in large batches:

- Creates an uneven workload
- Creates uneven demand for upstream processes, making pull impossible
- Causes production to be out of sync with customer demand.

On the other hand, mixed model production

- Creates a smooth work-load:
- Creates a smooth demand for upstream processes
- Allows production to match customer demand.

While mixed-model scheduling helps level the workload at each work centre, the true benefit of such schedules is realised when they are used in conjunction with another lean concept: one-piece flow.

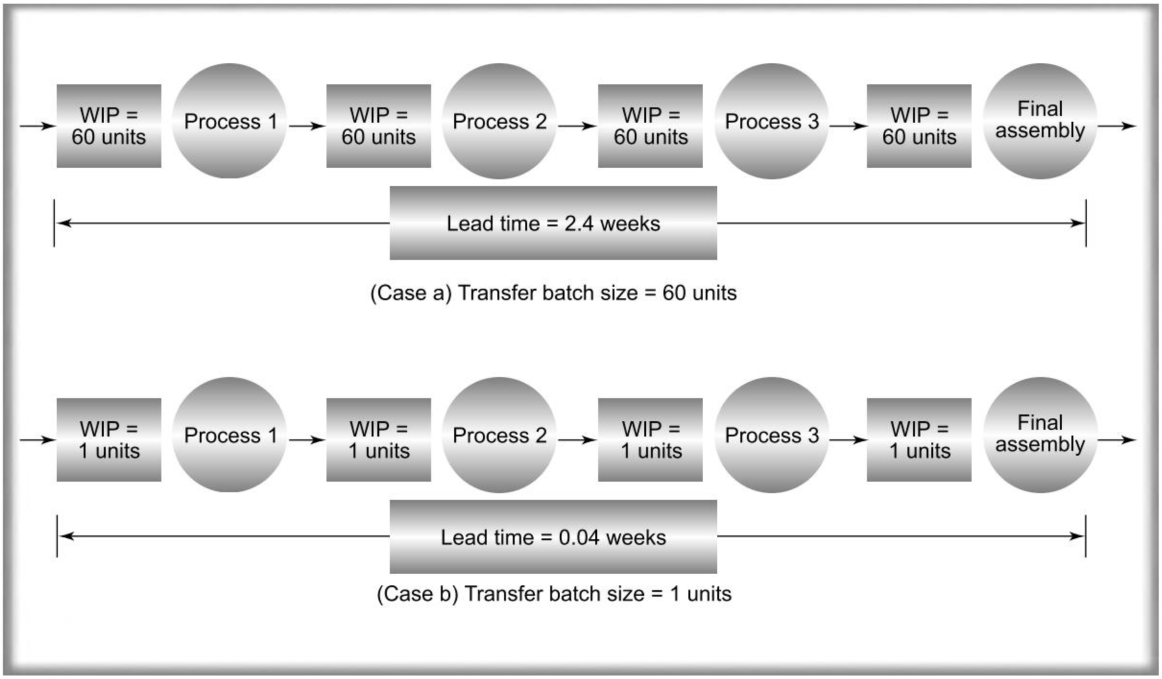
5.2.6 One-Piece Flow

In the extreme case, mixed-model scheduling refers to the case where each successive item processed at a resource could be a different product type. In other words, the products are *processed* in lots of sise one. One-piece flow refers to the concept of moving products one unit at a time between workstations. This is in contrast to the other extreme where we might process an entire batch of parts at a workstation before moving the batch to the next downstream workstation. Mixed-model scheduling, when used in combination with one-piece flow, thus results in keeping WIP inventories at the lowest possible levels.

The goal of one-piece flow is to reduce the lead time or equivalently reduce WIP inventory. Little's Law states that the average lead time is equal to WIP/throughput. Thus, if you have a week's worth of WIP inventory stored at an output queue, waiting to be transferred to the next station, it means you have added one week to the average lead time at that stage.

To elaborate on how one-piece flow affects the lead time, consider the example shown in Figure 5.8, consisting of a process with four stages of operation. Suppose the production rate at each stage is 100 per week, and that parts are transferred 60 units at a time, as in part a) of Figure 5.8. Since the total WIP inventory in the system is 240 units, Little's Law tell us that the average lead time = WIP/throughput = 240/100 = 2.4 weeks.

Figure 5.8: One-Piece Flow and its Impact on Lead Times



On the other hand if the items are transferred one piece at a time, as shown in part b) of Figure 5.8, then the total WIP inventory in the system is four units, and so the average lead time = 4/100 = .04 weeks.

One-piece flow also helps improve product quality, because it shortens the duration of the feedback loop. When parts are transferred one at a time between workstations, the downstream workstation is able to determine if the upstream workstation is producing defective items, almost immediately. As opposed to that, if one week's worth of WIP is transferred at a time, the entire week's output could be defective without anyone noticing this problem. The feedback delay is thus at least one week.

It must be clarified that one-piece flow does not necessarily mean that just one piece or one part is transferred between two processes each time. The unit of transfer could well be a pallet of parts, although clearly the smaller the number of units transferred at a time, the lower the resulting WIP will be. One-piece flow is an ideal that the manager should aim for because it minimises the hand-off time. Products do not have to be placed in the output queue of the upstream workstation, waiting for a batch of products to accumulate before the transfer to a downstream workstation is made.

While one-piece flow is an ideal that the manager should aim for, it might become counterproductive when the cell processes a large variety of products with different processing times and routings. There are a number of other situations where one-piece flow is simply not practical. For instance, if the upstream process is a heat-treatment operation that necessarily has to produce a batch at a time, it may not be very meaningful to move these parts one at a time since they would anyway come out of the furnace all at once. Similarly, if the downstream operation requires a set up each time it begins work on a new product, then one-piece flow may not be the right approach to use, to move parts to this operation. Finally, if material transfers are done by the operators themselves rather than through an automated conveyance system, then it does not make sense for the operator to be moving the parts one piece at a time if the transfer time is close to the processing time per part. In other words, if material handling costs are high, then it may be more economical to transfer the parts in small batches rather than one piece at a time.

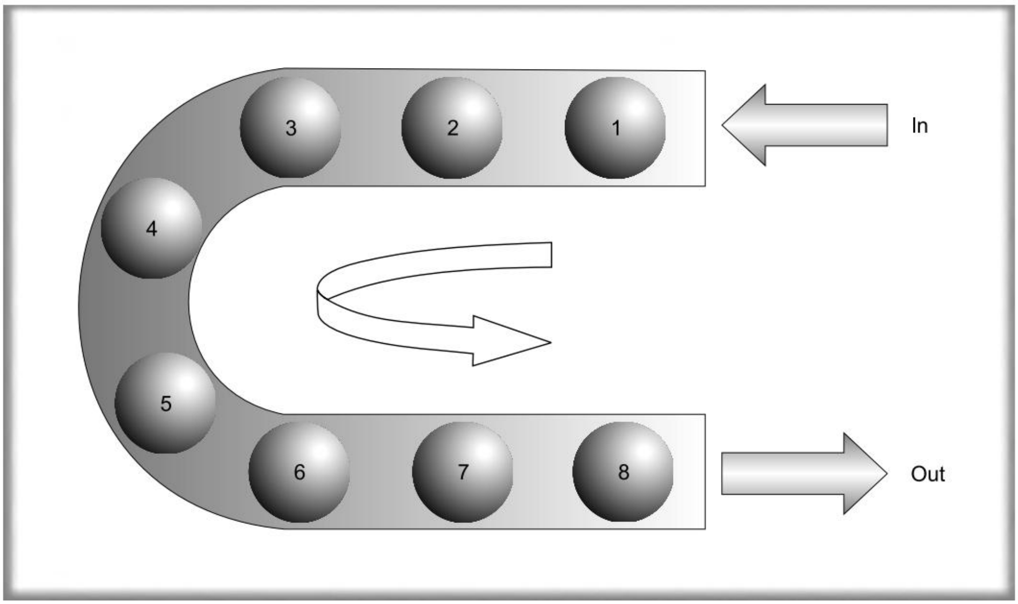
To implement one-piece flow, it is desirable to have little variability in the process times and the process quality at each of the steps linked in the one-piece flow. If one step is delayed it stops the flow of the entire process. The processing steps must also be located adjacent to each other, in order to facilitate moving only one piece at a time. One-piece flow is thus facilitated by a cellular layout.

5.2.7 Cellular Layout

One piece flow is significantly enhanced when the various processes are organised in a *cellular* layout (alternately, a *product* layout). A cell consists of the operators and the workstations required for performing the steps in a process segment, with the workstations arranged in the processing sequence. The cellular layout is to be contrasted with a *process* layout where the workstations are grouped by departments or functions. When these workstations are placed close together, then the products moving from one workstation to the next do not have to traverse long distances, and that facilitates one-piece flow. In addition to assisting one-piece flow, keeping workstations close to one another allows the operator at the downstream workstation to see what is being produced by the upstream workstation. That helps eliminate paperwork, which may otherwise be necessary to coordinate the different workstations if they were separated from one another by a significant distance.

A common layout used for manufacturing cells is a U-shaped configuration. This layout has a number of advantages. First, it provides more flexibility in allocating tasks among the operators. Consider, for example, the assembly cell shown in Figure 5.9, which has eight assembly tasks, each of duration 15 seconds. The *takt* time is currently 15 seconds, and hence each assembly task requires one operator.

Figure 5.9: A U-Shaped Cell



Now, suppose the *takt* time increases to 30 seconds. Since each assembly task still requires only 15 seconds, it is possible to operate the cell with four operators, allocating two assembly tasks to each operator. A U-shaped cell allows more flexibility in the allocation of tasks. For instance, it is now possible to allocate tasks 1 and 8 to one operator who is now responsible for monitoring the parts coming in and going out of the cell. Such an allocation of tasks would not have been possible with a straight-line layout. This layout also allows easy replenishment of materials from outside the cell. The U-shaped cell also promotes teamwork because the operators are located closer to one another.

Since the U-shaped cell gives a lot more flexibility in allocating multiple tasks to operators, there is a better utilisation of manpower. The U-shaped cell facilitates the re-allocation of tasks among operators when an operator is added or removed in response to a change in the *takt* time. Other common cell configurations include the T-shaped cell, the L-shaped cell, or a serpentine arrangement (a series of adjoining U-shaped cells).

In summary, some of the benefits associated with one-piece flow and cellular manufacturing include:

- WIP reduction
- Better space utilisation
- Lead time reduction
- Productivity improvement—more flexibility in allocating tasks to operators. Production lines can be re-balanced more easily to accommodate any absenteeism
- Quality improvement—provides immediate feedback on defects
- Enhanced teamwork and communication—Employees can better support co-workers who have fallen behind in their production schedule
- Better visibility of all tasks and operations

The next step is to identify the best method for performing a particular task and then develop a standard work procedure that anyone working on this task should follow. This is the concept behind *Standard Work*.

5.2.8 Standard Work

Standard work relates to a clear specification as to how tasks should be performed. The tasks are first organised in the best known sequence, and by using the most effective combination of resources. This task sequence and combination of resources is well documented and every operator is required to adhere to this task sequence and use the same resources. The intent is not to take away the creativity of performing tasks from the operator. Rather, the intent is to make every operator follow recognised best practices.

There are a number of reasons why standard work is important. First and foremost, standard work promotes consistency and promotes continuous improvement. If each operator performs tasks his or her own way, it would be very difficult to improve a process. A documented standard makes it easier to effect continuous improvement and increases the likelihood that the results will be consistent. Standardised work improves safety. Unsafe practices are mitigated when all operators are asked to follow the same routine when performing assigned tasks. Moreover, with standards established, it now becomes easier to measure performance fairly. It is possible to establish a 'fair' output rate and judge everyone by the same standards. Standard work is particularly useful while training new employees.

Standard work recognises that the best practice may be a moving target. Sometimes the operators performing the tasks may come up with a better method for accomplishing the tasks and therefore standard work practices could change over time. It is important to note that standard work represents a set of tasks allocated to an operator. Thus, standard work will change when the *takt* time changes or the model mix changes. The goals in setting standard work are to give each operator an amount of work less than or equal to the *takt* time while creating a compact foot print for each operator. The operators should be involved in developing standard work. That way, they will be more likely to do their job correctly and will help with continuous improvement efforts in the future. Many organisations have created standard work charts for different *takt* times, requiring various number of operators. These organisations are able to respond very quickly to *takt* time changes with minimal disruption since the standard work plan is already prepared.

5.2.9 Pull Replenishment and *Kanbans*

Pull replenishment provides a very convenient means of controlling the flow of products through the various production processes. The goal of pull replenishment is to contain inventory. Pull replenishment is achieved in most implementations using *kanbans* (the Japanese word for 'sign' or 'signal') although there are other methods for effecting pull. Pull replenishment uses *kanbans* and is quite simple in concept. The basic idea is to transfer production responsibility to the operators themselves, rather than have a production controller decide in advance what each operator should be producing during a given time period. The decentralised control of operations is accomplished by having each downstream operator signal their upstream operator(s) when parts are needed; *kanbans* provide this signalling mechanism. To use *kanbans*, the following conditions must typically be met:

- Demand for the item must be relatively repetitive.
- Lead times must be relatively short.
- Components must be available so an item can be produced on demand when the visual signal is generated.

The first step in designing a *kanban* system is to determine the amount of inventory that will be used to buffer the downstream operator from the upstream operator. Two types of *kanbans* that are typically used are 'in-process' *kanbans* and 'Material' *kanbans*. In-process *kanbans* are typically used when the upstream and downstream operations are fairly close to each other so that the upstream operator can be triggered simply by a visual signal from the downstream operation. Typically, in-process *kanbans* are implemented simply by allocating a physical location between the two operations and specifying the maximum amount of WIP inventory that can be placed in this location by the upstream operator. If the in-process *kanban* is full, the upstream operator must stop production until inventory is drawn from that location. It is common practice to paint a square or a rectangle on the shop floor between the two operations, indicating where the part (or a container of parts) should be placed. If there are multiple part types, each might have a different colour code. Each location or container has a number allocated to it, indicating the WIP inventory limit.

Material *kanbans* are used in a variety of ways. They are used by a production facility to signal replenishment of material from a supermarket/warehouse (a 'withdrawal' *kanban*), from another production facility (a 'production' *kanban*), or from a supplier (a 'supplier' *kanban*). A production *kanban* is used in place of an in-process *kanban* if the upstream and downstream processes are separated by a significant geographic distance, since the upstream operator has no visibility on the needs of the downstream operator. The replenishment signals are usually transmitted either through a card or an electronic signal. Each card requests a specific number of items to be replenished. At any point in time, the number of *kanban* cards (or, equivalently containers of parts) that are in circulation is determined using the following formula:

$$\text{Number of } \textit{kanban} \text{ cards} = \frac{\overline{D} \cdot KCT \cdot (1 + SF)}{\textit{Kanban size}} + 1,$$

where $\overline{D}$ is the average demand per time period, KCT denotes the replenishment lead time (*kanban* cycle time), and SF is a safety factor to buffer the combined variation in demand, the variation in replenishment lead time and variation in quality of the upstream supplier. The above formula assumes that the signal to replenish a container of parts is triggered when the container becomes empty. This formula has two unknown values—the number of *kanban* cards in circulation and the *kanban* sise (the term commonly used to denote the number of items in a container). Typically, the *kanban* sise is determined based on consultation with the supplier (or the upstream facility or the supermarket as the case may be), based on a variety of factors including standard container sizes, ergonomic issues, and so on. The formula is used to determine the number of cards in circulation. Alternately, some organisations decide to use a '2-bin' system of replenishment, that is, they start with two *kanban* cards and use the formula to determine the *kanban* sise. If that number is unsatisfactory, then the number of cards is increased by one and the computation is repeated until a satisfactory *kanban* sise is determined. Note that there should be a minimum of two cards, since there should always be one container at the workstation for the operator to pull parts from. The withdrawal *kanban* signals are typically generated from a production facility that keeps materials at point of use.

5.2.10 Point of Use Materials Storage

Point of use material storage places the materials at the point of use rather than in a central warehouse. The upstream process or external supplier delivers the material direct to the point of use, typically based on *kanban* pull signals. Typically materials are stored on flow-through racks located outside the cell. Flow-through racks are storage locations with shelves that can be replenished from the back and consumed from the front, like the beverage coolers in convenience stores. Flow-through racks preserve first-in first out material usage and allow material to be replenished from outside the cell. For material that cannot be stored at point of use, supermarkets (nearby storage locations) are often used in place of centralised storage. For example, a supplier may deliver a large batch of parts used by several cells, once per day. Those parts may be stored in the supermarket located near the cells and be pulled out in hourly quantities. A cell that produces in small batches may have only the materials needed to make one product at the point of use at any given time. The materials for other products will be stored at the supermarket.

5.2.11 Mistake Proofing and Method Sheets

Mistake proofing and method sheets are tools used to prevent quality problems. Mistake proofing or *poka yoke* is aimed at developing techniques to prevent defects from being passed to the next process. Mistake proofing requires quality checks to be built into the operations and equipment, using appropriate sensors to detect errors and stop the process when necessary. Combined with other lean tools, mistake proofing works to ensure that 100 per cent quality is built into the process and product. An example of mistake proofing is the three-prong electrical plug. There is only one way you can plug it into a wall socket.

Method sheets are visual instructions located at a workstation, showing how a job must be performed, the quality checks necessary, and the tools to be used. The instructions show pictures of each step to be performed. The goal is to make instructions so clear and unambiguous that a new operator can immediately understand them.

5.2.12 Total Productive Maintenance

Total Productive Maintenance (TPM) is a term used to denote the systematic execution of maintenance by all employees. The goal of a TPM programme is to significantly increase productive capacity and decrease process variation while, at the same time, increasing employee morale and job satisfaction. TPM is primarily an equipment management strategy, originally developed by Toyota in 1970 to support their Toyota Production System and it evolved from the Total Quality Management (TQM) movement pioneered by Deming.

TPM resembles TQM in a number of ways and the similarities are not coincidental. Traditionally, maintenance can be classified as Corrective, Preventive, Predictive or Proactive. Corrective maintenance waits until a failure occurs and then remedies the situation as quickly as possible. An example of corrective maintenance is a sensor failing in an automobile. Preventive maintenance aims at maintaining equipment at regularly spaced intervals to keep an otherwise troublesome failure mode at bay. An example of preventive maintenance is changing the engine oil for the automobile. Predictive maintenance examines vital signs displayed by the equipment, using instruments such as vibration analysers, to determine the health of the equipment. For instance, predicitive maintenance would analyse engine wear. Finally, proactive maintenance analyses why defects occur in, say, a machining operation, and then designs the problem out of the machine. When the problems of maintenance were examined as a part of the TQM programme, the general concepts did not seem to fit or work well in the maintenance environment. To solve this problem the original TQM concepts were modified to suit this environment. These modifications elevated maintenance to the status of a separate, yet integral, part of the overall quality programme and gave it the name TPM.

TPM is a manufacturing led initiative that emphasizes the importance of people, a continuous improvement philosophy, and the importance of production and maintenance staff working together. The focus is on maintaining the equipment and the processes that support manufacturing. It is a vital part of any lean implementation.

Because there is a natural tendency for people to follow the 'if it ain't broke don't fix it' philosophy, TPM requires top management commitment to sustain the initiative.

5.3 CONTINUOUS IMPROVEMENT AND THE PURSUIT OF PERFECTION

Complacency can become the toughest challenge in any lean transformation process. Lean is not a one-time implementation effort, nor is it a quality programme of the month. It is an ongoing journey that requires a sustained effort at continuous improvement. The transformation to lean is not just an application of a few techniques; rather, it is a whole new way of looking at the operations of the organisation. Because lean tools and techniques are often quite different from traditional tools, there must be a sustained effort to operate with these tools. As we all know, organisations that do not aim to continue an upward momentum will falter and fall behind their competitors. It is essential to continuously re-examine processes and look for ways to take out waste and non value-added activities if organisations are to gain significant financial performance improvements.

To sustain lean implementations, it is therefore necessary for organisations to constantly initiate *kaizen* events that promote continuous improvements. At the same time, there is a need to promote *kaikaku*, the radical re-design of processes and methods geared for achieving breakthroughs in performance and growth. (This step is often referred to as a *kaizen* blitz.) Once a *kaikaku* step is applied, *kaizen* becomes a powerful follow-up drive to perfect the processes and methods and to continue to adapt and be relevant.

As Womack and Jones [1996] suggest, 'dreaming about perfection is fun.' However, lean thinking provides ways to make these dreams a reality. Applying lean thinking and implementing the tools and techniques to create flow result in a fundamental change in the way the organisation thinks about its operations. The employees soon realise there is no end to the pursuit of perfection—efforts aimed at reducing effort, time, space, cost, and mistakes in the process of producing and delivering a product. When products flow faster through the organisation, they expose hidden waste in the value stream. The harder you pull, the more the obstacles are revealed so they can be removed.

While lean implementations must have commitment and support from top management, the shop floor personnel are also critical to the success of lean. Many organisations have initiated their lean efforts from the bottom up. Continuous improvement (*kaizen*) events play a vital role in getting them engaged in the lean journey, and that pays dividends. Managers at all levels become lean thinkers and change agents. A truly lean organisation makes it much easier for everyone, including shop floor employees, supervisors, lean champions, subcontractors, or first-tier suppliers, to discover better ways to create value. Because the feedback loops are significantly shortened, there is a faster feedback to employees, providing a more conducive environment for employees to pursue perfection.

CONCLUSIONS

Thomas J. Watson, Jr. once said 'Whenever an individual or a business decides that success has been attained, progress stops.' Lean is a journey—an ongoing journey that requires a sustained effort to maintain the momentum. At the same time, once the initial resistance is overcome, it becomes much easier to maintain the tools and techniques of lean. Once there is a sharpened awareness, among the employees, of the waste present in the system, there will be a concerted effort to maintain the momentum if the right incentives are provided. All types of organisations can benefit from lean thinking, regardless of whether they are involved in manufacturing, process, distribution, software development or financial services. Some of the important points that organisations should keep in mind when embarking on a lean journey are as follows:

1. While the goal of lean has often been identified as the removal of *muda* (waste), it is important to note that removing *muda* is just a means to an end.
2. The real goal of lean is to reduce lead time. *Lean is all about lead-time reduction and creating flow.*
3. Some of the more important steps that organisations can take to create flow are *takt* time, standard work, pull replenishment and 5S. Incidentally, all of these are steps that readily apply in a service setting as well.
4. Steps such as 5S and *takt* time are often misunderstood or misused. For instance, the fifth step in the 5S programme, *Sustain*, is vital for sustaining the momentum. Once a 5S programme is put in place, some organisations neglect to practice this step. Lean is a *journey* one that really never ends.
5. Organisations that embark on the lean journey typically should therefore start by identifying a product family they can apply lean principles to.

6. Lean thinking must be applied to all the processes in the organisation that work on the selected product family(ies). The idea is *not* to simply lean out some of the process steps and create a few *islands of excellence*. While some waste may be removed in the process of creating such islands, the products flowing out of these islands will end up stored elsewhere in the organisation. In particular, they will queue up in front of the constraint resources. (This points out the need to apply lean thinking in conjunction with the Theory of Constraints.)

➢ Finally, the lean supply chain is the ultimate goal. It is the responsibility of the lean organisation to collaborate with upstream and downstream supply chain members to successfully develop the lean supply chain.

References

Conner, G., (2001), Jack Sprat Speaks: Tips on Lean Manufacturing, http://www.thefabricator.com, August.

Ohno, T., (1988), *Toyota Production System: Beyond Large-Scale Production*, Cambridge, MA: Productivity Press.

Womack, J. P. and D. T. Jones, (1996), *Lean Thinking*, New York: Simon & Schuster.

Case references : The impact of lean thinking principles can be applied in the cases Titan Industries Limited and Western Oil Limited (A), with special reference to product variety.

Exercises

Volpens Inc., is a company that assembles and markets ballpoint pens in three colours. It is in the process of implementing a pull system for its operations, and has identified the following monthly demand for its pens and shells.

Blue Pens: 3200	Red Pens: 2000	Yellow Pens: 1600
Blue Shells: 1200	Red Shells: 1200	Yellow Shells: 800

The plant works five days a week, and runs eight hours each day. Coffee and lunch breaks account for 80 minutes of a workday. (Time available per day is 400 minutes.) Assume that there are exactly four weeks in a month.

Use the above data to answer questions 1 through 4.

1. What is the takt time?
2. At the final assembly shop, the total labour content for assembling a pen is 100 seconds, while the corresponding number for a shell is 30 seconds. What is the minimum number of operators that Volpens must have in its final assembly shop in order to meet customer demand?
3. Volpens, Inc., wants to develop a kanban plan for yellow barrels. The lead time for yellow barrels is two weeks. The supplier wants to ship the barrels in pallets that can hold five dozen barrels. How many kanbans are needed for the yellow barrels? Assume that a replenishment signal is faxed to the supplier as soon as a pallet becomes empty. Use a 20 per cent safety factor. (Note: A yellow barrel is needed for each yellow pen/shell.)
4. Volpens wants to develop the mixed model sequence. Help Volpens get started on this process by identifying the smallest possible repeatable sequence, that will include all six models assembled by Volpens, and determine the number of units of each model that should be present in this sequence. (Note: I am not asking you to develop the complete mixed-model sequence. That is, I do not need the exact order in which the pens/shells will be assembled.)

For the next four questions (questions 5 through 8), you will use the data provided below.

The Pleasant Valley Health Clinic treats patients with respiratory illnesses. It classifies patients according to four different types of respiratory problems (commonly referred to as Diagnostic Related Groups, or DRGs): Bronchiolitis (BRO), Pneumonia (PNE), Pharyngitis (PHA) and Sinusitis (SIN). Based on data averaged over the past six months, the number of patients it treats under each category is as follows: BRO: 15, PNE: 24, PHA: 25, SIN: 36. The clinic works two shifts, from 7:00 am to 3 pm and from 3 pm to 11 pm. During a shift, the staff is given a half hour lunch break and two rest breaks of 15 minutes each.

Each patient requires four process steps: Check-In (weigh-in, blood pressure check, etc.), Evaluation (by a physician), Testing (X-rays, administering respiratory instruments like Pulse Oximeters, etc.), and Assessment (diagnosis and future scheduling). Average task times for the processes (in minutes) are given in the table below:

	BRO	PNE	PHA	SIN
Check-In	30 min.	30 min.	30 min.	30 min.
Evaluation	20 min.	15 min.	10 min.	12 min.
Testing	45 min.	40 min.	15 min.	15 min.
Assessment	15 min.	15 min.	10 min.	10 min.
Work Content	110 min.	100 min.	65 min.	67 min.

In this clinic, tasks 1, 3, and 4 are typically handled by Licensed Practitioners (LPNs) and Registered Nurses (RNs). Task 2 is handled by a physician. For simplicity, in these exercises we will assume that all tasks are administered by RNs. For simplicity, again, we will assume that the arrival rates of patients are constant through both shifts.

5. What is the takt time for Pleasant Valley Health Clinic?
6. Determine the average work content ('labour content').
7. Determine the minimum number of RNs required using the average total work content and the takt time for given demand ('minimum manning').
8. If the per cent demand for each request type remained unchanged, but the total daily demand increased to 120 patients, how would the answers to 1 and 2 change?

CHAPTER 6

SCM Across Organisations: Upstream Interface

CHAPTER OUTLINE

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INTRODUCTION

The previous chapter presented some principles for managing a supply chain that would apply to an organisation. These principles are largely influenced by the lean manufacturing paradigm. We now address supply chain management across organisations. Managers and analysts realise that it is the combined activities of a number of supply chain partners that results in value being generated for end customers. Management and IT tools are now available that allow, at least in principle, for better end-to-end management of resources, such as for tracking the flow of commodities and sharing information among supply chain partners.

Even though a number of these useful supply chain management tools are still being developed and refined, when we go beyond data visibility and try to pin down decisions, the following dilemma emerges. When there is more than one organisation, it is not clear who is doing the managing and more fundamentally, whether there is anything to manage. The market as an interface between two firms may be too restrictive if it is the only mechanism available for managers. As a first step, we therefore look at some issues to do with actively managing activities across a firm's boundaries.

The classical managerial decision at the top of the hierarchy is the decision of ***'make versus buy'***, including in a very general sense, the decision as to what business to be in. A decision by a firm to attempt to add value in some aspect of a product or service presumes that the remaining part will be bought or sourced. This goes back to the very core of specialisation, competence and factor endowments (mainly physical) that determine what economic activities take place in a given location. So Japan has steel plants with iron ore sourced from India and South America (and Japan often sells steel to other parts of the world). The implication is that Japan is, in this case, forced to procure this raw material. The U.S. has refineries which source oil from various parts of the world including its own oilfields, as a strategic measure. India sources engineering goods for construction and projects from some parts of the world because of the technology and cost-effectiveness involved in those products. The financial sector outsources technical services from India and Eastern Europe for cost considerations. More recently there are a few instances involving outsourcing of engineering goods such as automobile components from India.

The 'make versus buy' decision was initially discussed in an era where technology was scarce and, provided a reasonable product could be made, goods could essentially be pushed into the market. Over time, similar decisions needed to be made on the market side, as to whom to sell to and what to sell. In some cases, additional activities were taken on board to address needs of consumers (such as packaging). For some other cases, such as advertising and distribution, other partners were needed. In yet other cases involving modern international supply chains, organisations are finding the need for a whole host of trade-related partners such as customs agents, export-import houses, transporters, warehousing agents, etc.

The net impact of this is that a host of decisions have to be made, both upstream and downstream by any given player in a supply chain, as to what to procure and whom to procure from on one side and, on the other side, whom to collaborate with for distribution. We first discuss sourcing and procurement. We follow that up with a discussion on distribution, and include a discussion on contracts, which presents an important way to deal with supply chain partnerships in today's world. We take a broader view of procurement, to include capacity procurement and services procurement, in addition to the procurement of material and components.

6.1 PROCUREMENT

The activity of procurement is economically justified by a number of reasons, including availability of material, capability of conversion, and cost effectiveness of conversion—due to superior technology or lower factor costs such as labour. In some instances, the procurement activity is justified by the presence of regulatory regimes. The last one is a contentious activity worldwide, where ecologically harmful activities are farmed out to regions that have less legislation and controls in place.

The materials procured can be raw materials, components or semi-finished assemblies or complete assemblies, complete kits or of course, the entire product, which is then traded. Procurement generally would have two aspects, a strategic element in the form of sourcing and an operational element in the form of the purchasing activity.

6.2 STRATEGIC ISSUES IN PROCUREMENT: SOURCING

Sourcing refers to the strategic aspect of procurement, including the identification and selection of sources, the structure of the sourcing arrangement and the geographical spread of the activity. A simple view of the sourcing activity could be the matter of selecting, from among numerous options, where and how materials and services are procured. The selection is typically based on some economic criteria. However, even for this relatively straightforward decision there are a number of issues that should be considered. Some of these are discussed below in more detail.

6.2.1 Single Source versus Multiple Sources

As the term implies, single sourcing refers to the procurement of a given material or service from a single source. The known advantages of single sourcing are the possibilities of large volumes of business and therefore lower prices, ease of long-term relationships and collaboration in design and other initiatives and ease of traceability (for quality related diagnosis and commercial matters like warranties). A single source is more likely to be persuaded to align strategically with the buyer, make investments in resources and technology on the buyer's behalf, and form closer relationships with the buyer, all of which have some clear advantages.

The flip side of the coin is that a single source makes the buyer vulnerable to the performance of the single supplier. There is not much insurance against geographical or other physical disturbances. More importantly, the sources for technological and managerial innovations are now confined to a single source. These considerations and the persistent search for cheaper sources lead organisations to look for, and contract with, multiple sources. In recent times global sourcing possibilities because of reduced trade barriers and also because of technologies such as the internet, may have led to an opening up of the supplier base, for many multinational operations. This may settle down to a new smaller set of suppliers (if not a single source), in many cases.

6.2.2 Long-term Contracts versus Spot Purchases (Markets)

Broadly speaking, we can identify two extreme modes of sourcing. One is through a contract, which would typically be used when supply sources are uncertain—say, because markets are not well developed, quality assessment of the supplied products is difficult, and when there is a longer time frame intended for the transaction. The other extreme is through spot purchases that take place in a market with many suppliers present, where each transaction involves a short time duration and where the quality of the product is standardised and easy to assess.

Sourcing arrangements with suppliers can be over different time frames. The issues are somewhat similar to the single source versus multiple sources discussed above. A long-term contract allows a supplier to offer discounts, as his capacity utilisation is assured and he is willing to pay something for the risk free operation. On the other hand, spot purchases may permit the exploitation of locally good prices, with the downside that prices could go up as well. The other advantage of longer-term contracts is the ease of making logistical arrangements over a period of time.

A brief discussion of these issues in the context of global sourcing is made in Section 6.2.4 below.

6.2.3 Criteria for Supplier Selection and Assessment

Let us consider a number of suppliers, each of whom is technically qualified to supply an item or a service. Apart from the unit price (cost to the buyer), which will always remain the most important criterion, buyers are realising the importance of many other factors. It can be argued that all these other factors (like quality, reliability of delivery, matching with schedules of buyer, handling efficiency, etc.) add to cost when suitably defined. While this is true, it does make the various criteria more transparent and may be more convenient to monitor and assess. A criterion that is not easy to put in cost terms is the design and innovation capability and flexibility provided by the supplier. This has to be assessed in a strategic manner.

Apart from this, there is the obvious difficulty of somehow converting all these factors to a common cost denominator. Multi-criterion methods and techniques to discover weights and overall performance can be suggested here, such as the Analytic Hierarchy Process (AHP) and Data Envelopment Analysis (DEA).

A similar set of criteria is actually relevant for continuing supplier assessment over a period of time. Monitoring of supplier performance, with benchmarks for key indicators is a part of the sourcing strategy of any organised supply chain player, today.

6.2.4 Global Sourcing

Global sourcing was always there for commodities, since producing regions are strongly influenced by availability and extraction capability. At the other end, retailers have been importing finished goods for local consumption based on price advantages of the supplier (perhaps due to specific technologies and scale benefits).

What is relatively new is for manufacturing firms to source intermediate manufactured goods—not raw materials or finished goods, but products that go into other products and are either further manufactured or assembled as part of a larger product, equipment or plant. These sourcing decisions are largely driven by a desire to reduce costs. Indeed, the procurement function in many organisations is measured by a metric called purchase price variance (PPV). Essentially, the PPV approach compares the current cost of procuring the material with the landed cost of procurement from an overseas supplier. However, unless these decisions are very carefully considered from a systems perspective, it could result in some serious problems.

Consider, for instance, the ramifications of sourcing a product from an overseas supplier, as opposed to sourcing the product locally. There are a number of hidden costs that need to be carefully considered. One of these is the additional pipeline inventory that will inevitably accompany such a decision. Thus, if the lead time for the local supplier was one week, then the pipeline inventory will be one week's supply of material. If the lead time for the offshore supplier (due to increased distance) is four weeks, then the pipeline inventory will be four weeks of material. If the product is a commodity product, then the effect of lead time may, arguably, be small. However, as the beer game clearly demonstrates, the bullwhip effect will be much more pronounced. Furthermore, there is a cost due to a loss of flexibility which is extremely difficult to measure.

Many organisations are now realising that they need to take a more systemic view of their offshoring decisions. They are trying to come up with a "total cost of ownership" (TCO) instead of simply using the PPV metric.

If the outcome of a careful TCO analysis is to still source the material from an overseas country, then it requires follow up action. Large firms would now need to segment their procurement activities into two or more categories, one through dedicated suppliers, located anywhere in the world and second, through exchanges, from a pre-approved set of global suppliers who bid on supplies for specific requirements. A third category of occasional procurement can be through spot purchases. The criteria for deciding which items are procured through which mode would depend on factors, such as the need for strategic investments by dedicated suppliers (which would then limit purchasing options by the buyer as part of the incentive for the investment decision by the supplier). Another factor would be the standard design and specification of the items or materials to be procured, which would be amenable to purchase through an exchange.

6.2.5 The Logistics of Procurement

Materials that are procured have to be moved physically to their point of use. This has to happen in a timely and effective manner to keep costs in control. The gamut of issues to do with their logistics could well be the concern of the procurement function, especially when the buying firm is a larger, more organised one. Even otherwise, firms may find it advantageous to influence the logistics of the supply, for example, the warehousing locations that are used, the mode of transport or the timing of shipments.

These issues per se may equally well be the concern of the supplier firm (as part of *its* distribution function), and with this in mind, we take them up in the next chapter. If they are managed by the buyer, the span of decision making would be different, but the substantive issues (costs, criteria for decisions in this area, etc.) would be the same. For example, Tata Motors may like to influence the location of a warehouse near JIT supply of components from key suppliers. An organised sector buyer for food processing may take the initiative in mode of selection for transport and help in getting good rates.

6.3 OPERATIONAL ISSUES IN PROCUREMENT: PURCHASING

Once the strategic (and tactical) part of procurement, which we have called sourcing, is done, the remaining operational part of the activity is referred to here as purchasing. As a commercial activity, purchasing is well understood in the business world. Some relatively new elements to the purchasing activity are now discussed.

6.3.1 Quality Regimes (Change from Inspection to Certified Quality)

The Total Quality Management as well as the JIT revolution in manufacturing has led to changes in the purchasing function in the organised sector. The notion of purchasing being tied up to inspection and the provision of a store for incoming materials (with areas for inspection, return, rework) is giving way to quality as source, self-certified supply (perhaps with third party audits occasionally) and direct supply to points of use (lines or shelves as the case may be).

6.3.2 Dynamic Prices

Purchasing in the electronic age means that prices of items may fluctuate from time to time, sometimes day to day. Systems of purchasing have to be oriented to this, if beneficial to the firm. The possibility of hedging against this uncertainty through contracts or through futures is a realistic option, with the caveat that such strategies also lead to fluctuations in inventories and quantities in the pipeline, adding to the causes of the bullwhip effect.

6.3.3 Electronic Exchanges and Auction Based Purchasing

For commodity purchases and in selected industry niches, procurement through electronic exchanges and partially automated auctioning mechanisms is now a reality. This calls for strategies on the part of the buyer (and of course, the seller) to optimise performance in this setting. A challenging issue in this context, which is very relevant, is the *combinatorial* auction, where there are significant benefits in joint supply (and therefore joint purchases) of items. This now has a large literature and some applications that have succeeded in bringing about efficiencies both for suppliers and buyers.

Examples of electronic exchange based purchasing can be found in the pharmaceutical industry, construction industry and chemicals industry. The automobile industry has made attempts to set up standards to facilitate such procurement, but the attempt is yet to stabilise into a system where a large number of different buyers can participate.

6.3.4 The Role of Radio Frequency Based Identification and Information Technology

An enabling technology that permits tracking of items across the supply chain and potentially well into the usage cycle of the customer is RFID (Radio Frequency based Identification). Through a combination of tags and readers at various locations in supply chains, this technology promises a previously unattainable level of supply chain visibility. Because of high profile initiatives of retail giants such as Walmart and Target, suppliers worldwide are being forced to move to pallet or carton level adoption of RFID.

The general perception is that large retailers have more to gain from this as their availability and supply efficiency is improved. Questions that are being debated are whether suppliers have any direct benefits in this technology, and what is the optimum time to adopt the technology.

Associated with the RFID question is the issue of IT system alignment of the supplier with the planning systems of the buyer. ERP systems and SCM software platforms promise planning options across enterprises, but there are many decisions that supply chain partners have to take for this to happen.

6.4 ITEMS OF PROCUREMENT

We now look at another dimension of procurement, which is to do with what is being procured. Broadly, we can think of procurement of raw materials or components, conversion capacity and services.

6.4.1 Raw Materials

Raw material procurement is now global as trading barriers have reduced, currency exchange and a global financial system in place (barring a few pockets), and where there is commodity standardisation so that customers in one part of the world can procure and use raw materials from another part. The sources of major raw materials are obviously limited to those areas where geographical conditions permit extraction and transport. Logistical costs of handling and movement dominate the considerations at this stage in the supply chain, although some conversion (e.g. washing of coal, or sorting and grading of agri-commodities or pre-processing of iron ore) could be there in some cases.

One reason that direct logistics costs form a large part of the costs at this stage, is because the material is in pre-processed form and is bulkier. Also, since the value addition is not so high at this stage, service related costs are comparatively lower. Transportation costs are an important consideration. An important point is that different transport modes may provide the opportunity of different unit freight rates, but what matters is the end-to-end movement cost of the commodity. This results in low unit freight modes (such as water movement and rail movement) having to provide interfacing facilities to be able to compete with end-to-end modes (such as road movement). In trans-continental movement, the economies of scale in cost are so significant that large ocean going carriers are the dominant mode, even though there are significant batching costs.

6.4.2 Components

In the context of discrete manufacture, component procurement is a key strategy to reduce complexity, to cut costs (by looking for low cost sources) and sometimes to take advantage of high technology suppliers worldwide. The standard example of the automobile is very relevant here because a typical automobile has thousands of components, and these (often in sub-assembly form or in kitted form) are procured from a variety of sources by manufacturers. For components, the design and fit into the final product assembly and the resultant performance is quite crucial (as opposed to logistical costs). A general principle is that at stages where there is active value addition through technology, closer communication is required, between buyer and seller. The information component in the procurement activity is much more because apart from designs, specifications and quality records, there is the issue of synchronisation with assembly schedules.

This concept is extended from components to sub assemblies to assemblies (e.g. a pump manufacturer procuring assembled motors from a supplier), to of course the entire product (which then makes the procurer a trading and marketing partner in the supply chain).

6.4.3 Conversion Capacity

Another resource that can be procured is conversion capacity. Here, the buyer retains the engineering and technology of the process (designs and specifications) and only procures standard capacity (like machine hours on standard equipment). The cost advantages are significant if the capacity is used by multiple users, in which case the fixed costs are spread across different users. The main issue for procurement is the reliable availability of this capacity when required. If this is to be formalised, it leads to different types of contracts (discussed later in the chapter).

6.4.4 Services

An increasingly important element of procurement is that of services. This can range from logistical services (the emergence of third party logistics service providers and developments thereof), to certification and audit services, to specialised services in the areas of maintenance, after sales support etc.

6.5 CONTRACTS

We look at contracts as a means of achieving supply chain related goals through working with multiple organisations. Contracts provide the language and the mechanism to specify and enforce supply chain performance measures across the boundaries of firms. Contracts are of many types, to do with quantity commitments (so as to plan capacity and utilisation), quality, delivery (so as to cut logistical costs due to uncertainties) and so on. Supply chain contracts are extensions of legal and trade contracts which are more to do with specification of the transaction, ownership issues, regulation and safety of consignments, supply etc. The enhancements come about by analysis of the relevant supply chain and understanding its performance measures and their link with contract parameters.

Shippers who need logistics service providers and firms engaged in logistics services today are grappling with a fairly fundamental issue of business significance. It is the issue of defining service measures and contract parameters that would enable them to operate fairly (vis-à-vis supply chain partners), while being competitive (vis-à-vis other supply chains). This is true the world-over, but is of increased significance in the emerging markets of Asia. One reason is that the large, and diversified markets that are emerging in this part of the world are not necessarily very high value-seeking ones and manufacturers and service providers have to provide customised products and services but with lower margins. Added to this is the fact that assets and capital are relatively scarce in this region and infrastructure is comparatively strained and unreliable.

In concrete terms, this means that logistics service providers have to plan for cost optimal asset utilisation plans, while at the same time account for the supply chain consequences of poor service parameters. Eventually, this would have to be quantifiably captured and be part of contractual agreements between providers and users of logistical services.

6.5.1 Illustrations

Let us begin by examining a few examples that illustrate the importance of this issue.

Example 6.1

An export oriented iron ore trader negotiating with the railways in India for supply of ore from mines to port.

In earlier days, if the Indian Railways (IR) were a feasible mode of movement of iron ore, costing was done as per railway classification of commodities. This costing is based on a complex mix of haulage cost for railways, ability of customers to pay, strategic significance of the commodity and finally the lobbying power of the industry in question. In a few cases, there would be a favoured customer status based on volumes provided and some benefits in case the shipper participated in asset creation such as the Own-Your-Wagon scheme. But contracts were on quantities only, and individual shipments would be carried as per traditional order placement, indenting, rake supply as per availability, loading as per siding conditions (partly controlled by IR and partly by the shipper), transit as per operating conditions on that part of the railway network, and finally unloading governed by conditions similar to what is faced in loading (and additionally governed by port conditions in this example). IR would attempt to protect itself against the risk of inefficient asset utilisation (of wagons or rolling stock), by charging demurrage to customers who detained railway rakes beyond a permissible limit, and by charging wharfage to customers who utilised railway storage space.

At one level, these charges (demurrage and wharfage) can be considered simply as asset utilisation charges that any service provider would use. But if these assets are used dynamically for many different customers and usage by one customer impacts reliable service offering to others in the system, the equation changes dramatically. Demurrage is then a dynamic quantity reflecting opportunity costs or shadow prices for different customer supply chains. Reflecting this accurately is one challenge facing IR.

A more serious issue today, is that a project investor would ideally like a *two-sided* contract, which would protect it against risks in a quantifiable manner. This would imply that the shipper would be willing to pay a premium in freight, but only for reliable service. The flip side of a premium for reliable service is a penalty for unreliable service. All service providers would have to gear up to be able to compete in such situations.

Example 6.2

Consider an express cargo mover specialising in re-location of household effects. Timing of its movements to enable customers to plan their moves is quite important. Such a 'move management' company may not own all the resources required for the activity and may in turn hire assets from the market. While this keeps costs under control and provides flexible capacity, it does provide for occasional unreliability of operations (flexible capacity is inherently unreliable as investments are made with multiple customers in mind and there is occasional pressure on resources). In such a situation, a response of 'This very rarely happens!' or even 'This has never happened before!' is not reassuring to customers, even if the statements are true. The immediate customer would like evidence of a contingency plan, which could include different types of service.

With modern day customer referral systems and reviews on the internet, it is not convincing to proclaim 100 per cent service, which customers would realise is a pipe dream. More reliable reporting of service levels (hopefully good enough to inspire confidence, and increasing with time), with back up plans in case of failure, can be more effective.

Example 6.3

An owner of a small fleet of trucks receives a request from a larger transportation company to provide resources for an 'urgent' shipment, which has got a deadline to meet at a port. The transportation company is liable for costs of movement by a more expensive, express mode, if the shipment is not made on time. It wishes to pass on some of this risk to the trucker. Should the trucker agree or not, and if so, what would be the arrangement?

Note that we are not highlighting the long-term effects of poor service (in the first case, the iron ore company may develop an alternate mode over time, in the second case, the logistics service provider may lose clients and in the third case, the small trucker may lose business with the transportation company). We are trying to see if the short term, immediate consequences of service can be accounted for in a supply chain transaction and set of activities. To an extent, this is healthy as it aligns short-term incentives for action, with long-term goals.

We now explore some conceptual and managerial issues in this context.

6.5.2 Service Measures and Performance Measures in Procurement

There are a number of service measures that can be used to monitor the effectiveness of logistics operations. Type-one and type-two service measures look at the number of shipments or transactions that are on time, and the total quantity of supply that is on time, respectively. Such measures are also used in measurement of distribution efficiency in supply chains moving, for example, consumer goods. The type-one measure respects each transaction and in a sense protects smaller customers, and the type-two measure takes a more aggregate view of service.

A minor modification of service measures of this type is to include an allowance of some kind (such as the punctuality statistics published by Indian Railways(IR)). This is actually unnecessary in real terms, as it depends on a self-defined allowance or window of tolerance.

An internal consequence of using such measures in planning is that managers would factor in a safety time in operations, so that time reliability can be attained. An example of this would be the cut-off time announced by courier collection centres for making connections at hubs. When transport and other operations are moving smoothly, customers who miss the cut-off times often find themselves accommodated. Passenger train timetables on IR have considerable slack times before arrival at the destination (which ensures good customer oriented on-time performance) and at key intermediate points (which ensures good utilisation of synchronised assets like crew and locomotives, sometimes at the expense of unnecessary waiting on the part of customers). Such safety times and slacks are a part of the premium many people are willing to pay for achieving reliability. One reason is that synchronising actions across supply chain partners is more expensive than either synchronising internally or incurring additional asset utilisation costs internally.

6.5.3 Penalty Costs

A long-standing difficulty in the analysis and management of supply chains is to quantify the costs of not achieving service targets. Penalty costs, shortage costs and other similar costs are widely used in the analysis of inventory and other strategies, but they are usually too notional and imprecise to form parts of practical planning systems. Conceptually, such costs are clearly recognised at the strategic level of any management. They include cost of express shipments or contingencies, costs of storage of undelivered items, cost of returns, opportunity costs of lost sales and more and more, the loss of customer good-will, reputation and business because of poor service. Managers therefore have increased the notional value of shortages and self-imposed penalties for targets, compared to what they used some years ago.

In retail environments, stock-outs are increasingly visible and given the average rates of sales, one can reasonably estimate direct loss of revenue due to stock-outs.

One challenge of supply chain managers would be to translate perceived penalty costs and shortage costs to meaningful service measures which internal operations managers can factor into their planning. Logistics operations that are time-based are especially suited to measurement through service levels, as they are quick to measure and display. The impact of investments on such a measure is however more difficult to estimate and if required to be done a priori, would require tools such as simulation or somewhat sophisticated stochastic models.

6.5.4 Contracts and Supply Chain Goals

Finally, we highlight some of the ways the above concerns could be addressed in a business setting. Contracts are a means of supply chain co-ordination and risk sharing. Over a period of time, contracts have become increasingly meaningful and significant. They first arose in supply chains to facilitate transfer of ownership legally, then acquired commercial significance in booking capacity and assuring business volumes, and subsequently have been used to specify quality norms in service. Today, they play an important role in the significant areas of value addition and competition, namely logistics services. A complete discussion of contracts of various kinds is beyond the scope of this chapter, however.

Logistics contracts relevant to the discussion in this article would specify delivery terms of handling and storage, quantities and dates of supply at origin, and desired times of delivery. Penalties, one or two sided, could be part of the contract. Finally, cost per shipment would always remain the most important part of a contract. Risks of many kinds could be covered in contracts, such as price protection against freight rates. Considerable background analysis of operations (in addition to legal implications, which dominated contract preparation in the past) is now required to draw up a meaningful contract between supply chain partners.

Analysis shows that there is considerable scope for a supply chain driver to set reasonable contract parameters that achieve overall supply chain goals as well as incentivise local decision makers to choose 'globally optimal' operating parameters. Contracts are finally agreed upon through a process of bargaining, negotiation and co-operation between supply chain players. In some cases, inherently, supply chain goals align with optimal decisions through supply chain contracts that arise naturally through negotiation between supply chain partners. In other cases, incentives outside a single contract may be required to achieve such goals, and these require innovative measures. Contracts are again discussed in the context of distribution systems, at the end of the next chapter.

6.6 MARKETS AND AUCTIONS

In certain sectors such as the procurement of agricultural products, markets and auctions are well-developed mechanisms of business. There would be a large number of suppliers (e.g. farmers) and perhaps some number of buyers who would need to interact in a systematic way to achieve supply chain effectiveness. Some dimensions of these mechanisms are now addressed.

6.6.1 Illustrations

Let us begin by looking at some illustrations of markets and auctions. Procurement of copra by Marico all over the country is an example of an electronic auction. This allows several small producers to interact with a key buyer (who accounts for some 25 per cent of the total purchases in this market). With self certification of quality based on a small set of critical product quality parameters—such as moisture content—it becomes an efficient means of procurement without physically moving material to a site simply for effecting the commercial transaction. Now material can go straight to the processing facility.

Procurement of tea in auctions in Kolkata and Guwahati are examples of physical auctions. Here, the variety of products in the market is an important factor for buyers who seek particular blends. So in addition to contractual buying from established gardens (which is again picking up as a mode of procurement), auctions provide a convenient single point meeting of multiple buyers and sellers and outweigh some of the logistical costs that are involved in this. The trade off between physical and electronic auctions is discussed in Section 6.6.3.

Other examples of markets in the sourcing activity are tobacco, among commodities, electrical and mechanical component markets (for standard components for products such as motors, fans and the like) and the transport market for trucks.

6.6.2 Price Discovery

Economic theory tells us that auctions are a good means to 'discover' the true price of a commodity, as it allows for information exchange and revelation of the true costs and values to sellers and buyers respectively. Although theoretically a single shot auction would serve the purpose (with the modification that the winning person gets the second highest bid—the so-called Vickery mechanism), in actual practice, a multi-call auction may be more effective to facilitate information exchange among bidders.

6.6.3 Physical versus Electronic Auctions

Physical auctions of commodities like tobacco, tea and other agricultural products were a common phenomenon in past years and still have a value in terms of bringing buyers and sellers to a common platform. It is being replaced in some instances by e-auctions where transactions are carried out on the internet, using a variety of mechanisms to share information about bids, prices, quantities and other attributes of a transaction between two parties. Electronic auctions, extending to commodity trading, have some benefits such as simultaneity of transactions, information visibility—provided for in different ways, decision making in one's own managerial context—which allows consultation and integration with other functions in a firm, and finally, logistical cost effectiveness, as the commodity does not have to move physically to a common location. This last point is true so long as the self certification by sellers is reliable. This relates to the quality discussion in Section 6.3.1.

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Exercises

1. For any typical assember of a complex product, e.g. an automobile assember, make a list of components and sub-assemblies that you would propose for single sourcing versus multiple source of supply. The criteria for doing this should be spelt out.
2. Continuing with the above situation, identify the items that can be purchased in spot markets. What are the benefits of contracted procurement? For the automobile sector, identify some mediums which facilitate spot purchases of standard items.
3. What is the implication of RFID technology for monitoring of inventory and the related inventory management system from the buyer's point of view? How does it affect supplier decisions? Is RFID technology driven by customer requirements or by supplier capability? What are the benefits of an RFID system and investment in this for a supplier?
4. For any auction mechanism that you are familiar with or can explore, try to see (a) What incentive suppliers have to reveal their true prices? (b) How information is exchanged among the buyers and amongst the suppliers? (c) What are the considerations for designing a good auction system (say for a standard component or commodity)?
5. If a supplier enters a contact with a guaranteed service level, what are the implications for its capacity planning? (You can assume a penalty of some amount if the availability condition is not met.)
6. From an industry of your choice, identify whether incoming items are subject to inspection and whether any scheme is followed for this (e.g. 100 per cent inspection,

sampling). Why are organisations moving towards quality at source and certified quality instead?

7. As a supplier, would you like to offer stable prices or would you prefer varying prices for your customers? What are the pros and cons of doing so? In, either case, think of a mechanism to decide your price of supply.
8. Your purchase manager comes to you and says that she has negotiated a large discount in price from a supplier, provided the item is procured in bulk at a single time (for example, the quantity discount is given because of a saving in transport cost by the supplier). How would you react to this and in particular, how would you estimate the overall savings as a results of this deal?
9. What are the benefits of outsourcing services, such as maintenance of equipment, in your supply chain? Are there any drawbacks? What indicators would you use to judge if you need to (a) enter into a structured contract, or (b) take over this task yourself in future. For any service that you can define, try to design a structured contract with a supplier (i.e. what conditions need to be specified, and how you would try to cost it?).

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CHAPTER 7

SCM Across Organisations: Downstream Interface

CHAPTER OUTLINE

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INTRODUCTION

It would be fair to say that the spatial aspects of supply chain management have been revolutionised by developments in distribution and logistics in the last two decades, with the pace of innovation in these fields outstripping those in manufacturing and conversion technologies. An inevitable consequence of customer centric manufacturing and supply of goods and services is that distribution, including the last mile provisioning of requirements to the doorstep of the customer becomes more and more important. In many categories of goods today, the basic technology does change, but not as fast as innovations in marketing, distribution, servicing, financing customer purchase, and the accompanying areas of packaging, storage, documentation, warranties and other value added services that meet needs of value seeking customers.

7.1 DISTRIBUTION MANAGEMENT

This chapter surveys some of the major developments in this area and techniques and technologies for managing this increasingly important aspect of supply chains. The chapter takes an operations oriented view of this activity rather than a marketing oriented view and so we make only a passing mention of several important activities involved in this part of the supply chain, such as product positioning, display, pricing, promotions, advertising, customer behaviour analysis, sales force management and so on. We focus on material movement, storage, stocking and related technological and methodological issues.

We note that distribution (from the view point of any one player in the supply chain) has a big impact on the value of a product upstream in a supply chain, and there, choice of mode and other strategic decisions of transport, handling and storage need to be made. This is true for all bulk commodities (such as iron ore, steel, coal, petroleum products). On the other hand, in downstream parts of a supply chain, where there are semi-finished or finished goods, logistics costs may not play a big role, but they impact service measures and customer satisfaction in a big way.

This chapter also sets the tone for the next one, which deals with the decisions and management issues facing a logistics service provider. These players, who form a fast growing business segment, especially in emerging markets, would plug into distribution or supply needs of manufacturing or trading firms, so the issues discussed in this chapter form the market context for those players.

7.2 STRATEGIC DECISIONS IN DISTRIBUTION MANAGEMENT

The major decisions to do with distribution management at the strategic level are structuring the channels of distribution and fixing the level of outsourcing for the various activities in distribution. These are now taken up.

7.2.1 Channels of Distribution

Even after the manufacturing part of the supply chain, there are often multiple stages in a supply chain. For some products, these stages may involve repacking or break-bulk operations, also called toll-packers in India, and other packaging related activities. Although the internet and other means of direct marketing and supply are now quite well organised with fewer intermediate stages of information and money flow, there are often multiple stages of physical supply, for various reasons. After sales servicing of products is one reason, and stocking a variety of products is often best achieved by levels of the supply chain closer to the customer.

For commercial reasons, material is moved under own title close to various points of final sale. For example, in India, central sales tax is applicable for sale by one entity to another entity across state borders. Partly in response to this, many manufacturers have their own branches, or outsourced agents (called Carrying and Forwarding Agents - CFAs) that operate in various locations. The material at these locations is still owned by the manufacturing company. This has legal implications for liability, as well as accounting implications in inventory accounting. From a supply chain point of view, this introduces another stage in the physical supply chain, since material is physically stocked at the CFA location.

Furthermore, it is not economical to supply directly in full truck loads or equivalents, to final retail locations, in many cases. This has led to another level, called the distributor, who maintains stock and does frequent supplies to the final retail points, using milk runs (combinations of locations using a large vehicle) or other modes of supply. Traditionally in India, distributors are quite large and commercially powerful and have long term equations with the manufacturing company. They play a key role in contact with the retailers, successful introduction of new products and relationship with the final market as such. Again, from a supply chain point of view, this adds another stage in the physical flow of goods.

7.2.2 Depth and Reach of Distribution

An important decision to do with distribution management is the design of primary and secondary stages of distribution in terms of depth and reach. The extreme options are (a) a hub and spoke arrangement with one intermediate node and where all movements are routed through this node, and (b) a direct shipment model. Intermediate models with a small number of primary stocking points are also possible. Formal decisions of this type are based on mixed integer programming models of network design.

Pure location models are important in this context while deciding on warehousing options, similar to those while deciding on where to position manufacturing facilities. With options of sub-contracting on the one hand, and leasing space or capacity on the other, there are both long and medium term decisions to be made regarding facility decisions in the distribution part of the supply chain. Apart from factors that identify feasible options, the pure location costs (such as land cost or rent or utility costs) need to be incorporated into multi-criteria decision analysis in these location models. In case subsequent decisions are also planned, such as resulting transportation and supply to multiple locations, the models become more complex (involving both long run and medium run costs) and the class of location-allocation models becomes useful. These have been successfully applied in various sectors such as the food industry, electronic goods and these days, in retail supply chains.

7.2.3 Options in Logistics Management—In-House versus Third Party

A key decision facing firms is whether to take on the role of logistics (including warehousing and storage) and transport themselves or leave it to their customers or suppliers, or to enter into contracts with service providers and manage that interface. Each option has its pros and cons and in Indian industry today, all of them have successful (and unsuccessful) examples.

The option of leaving transport and logistics to a customer or a buyer is adopted either by smaller players, where a large player is controlling movement of goods, or some very large players whose core competence is the static value addition or trading benefits (especially price) that they provide. It is more common for supplier to make arrangements for transport than for buyers to make arrangements for transport, partly because of commercial considerations and the point of change of title.

Managing In-House Logistics

Managing own logistics has become a strong business strategy for major players in many different segments. It allows them to control an end-to-end process, and for large players, turns out to be cost effective since the internal business volumes are sufficiently large to justify asset investments. Mahindra, Tata Steel and Godrej Appliances are three players who have taken this route in India. In fact, what starts out as an internal service function soon turns to offering these services (logistics management) to other group companies and even outside companies and in some cases even competitor companies. Logistics organisations in the three examples quoted above have evolved into strategic business units.

Procuring Third Party Logistics Services

The intermediate option of using a third party provider is an attractive option for fast-growing firms who lack the managerial resources or the volumes of business to own and operate logistics relevant to their needs, but who still need a professionally managed operation to meet current standards of competition. The notion of service measures discussed above, plus the cost economics of transport and storage are relevant to be able to successfully manage this interface. Viewed as a procurement activity (of logistics services), the discussion on contracts in the previous chapter is relevant here.

Firms sometimes make a strategic decision not to enter into logistics related activities and prefer to procure these services even when volumes are potentially large. Maruti and some of the big players in electronics, computers and white goods are examples of such firms. Multinational firms in emerging markets often adopt this strategy to ramp up business in a phased way without committing assets up-front. With the emergence of high value outsourcing by such firms, there has been a growth in the third-party logistics sector, which is the subject of the next chapter.

Broadly, decisions to do with procurement of third party logistics services is intricately tied up with the design of the channels of distribution, discussed earlier in this chapter. A specific factor that may be relevant is the mode of transport that is used. The onus of choice of mode is shifting from the shipper to the third party logistics provider, who often has multiple modes of transport and will use an appropriate one. For example, a shipper may negotiate port to factory shipment delivery of containers, with a third party logistics provider. The rates may be attractive because the carrier has access to rail movement of containers. But if rail services are not available (occasionally), the carrier may have the option of switching to the more expensive road mode and still deliver as per the desired schedule. The occasional use of such options can be factored into cost computations by the carrier. Such options may become increasingly common in a world where different transport modes are increasingly available, containerisation is making the use of multiple modes possible and where service norms are becoming tighter. For this analysis, size of vessel (e.g. light commercial vehicle versus large truck) can also be considered to be different modes of transport, as far as cost and service computations go.

7.3 OPERATIONAL MANAGEMENT OF DISTRIBUTION

Some key elements of the operational management function in distribution are material accounting and control, allocation, inventory control and routing and scheduling. These are briefly discussed, in turn.

7.3.1 Material Accounting

The basic logic of inventory balances and accounting of material at multiple locations forms the heart of Distribution Resource Planning (DRP) systems in many different versions in the industry. The main features of DRP account for stocks of items at different locations, and allow for different stocking units (SKUs at the retail level, and containers, pallets and packages at upstream levels). An issue of growing importance is accuracy in inventory records (due to losses, perishability, pilferage etc.).

Bar coded material storage and transfer units are the first step towards electronic records and quick retrieval of information in a form compatible with computer enabled management of activities. A subsequent step is to have radio frequency enabled communication between bar code readers and a database for planning applications (e.g. where a local handheld device communicates with a central computer). A further step is an RFID enabled system, where there are readers that automatically pick up information through tags on items. As of now, tags are economical and being used at the level of containers or pallets and it is anticipated that they will penetrate to the individual SKU level as costs come down. These systems will make material accounting timely and accurate. RFID is discussed in Section 9.5.

7.3.2 Allocation

In a supply-constrained environment where there are a few manufacturing locations and many demand locations, a basic distribution decision is the allocation problem. This, while theoretically of some fundamental interest, gets resolved, often forcibly, by linkages developed over time, and regional regulations, which do not permit too many shipment choices (e.g. tax implications of inter state or inter country sales) and simply the availability of reliable transportation between various pairs of locations. The resulting scenario is then often simplified to an extent where a heuristic or a manual solution is good enough.

In situations where a formal model is required, the transportation (or trans-shipment or allocation) model from linear optimisation encapsulates the basic single period decision. This well-studied model, while sometimes not directly useful, is nevertheless quite widespread in its applicability and forms the basis for more complex decisions and even some heuristic techniques. An example is that of locomotive assignment for railway operations on a large network, as part of the internal supply chain of a transportation service provider. Another situation is a consortium of oil companies trying to co-ordinate supplies from refineries to stocking points. A more traditional example is that of a multi-plant manufacturer supplying to several wholesalers in a state.

The basic version of this decision involves a single, homogeneous commodity; the multi-commodity version of this has some complications, referred to briefly in Chapter 10.

7.3.3 Inventory Planning and Control

In what are called pure push systems, inventories are dispatched downstream as per a central plan based on committed demands or forecasts. These are useful where there are large economies of transport, and up to the level where demand is steady or known well in advance. As we get closer to the downstream part of a supply chain, the demands (of individual customers) becomes uncertain, mainly because of choices available to customers (variants as well as competition) and getting close to the individual value establishment by the customer, which is difficult to predict very accurately. Conversely speaking, in upstream parts of a supply chain, uncertainty is less because of aggregation or pooling of multiple random influences, which does tend to make for more stable behaviour. In this setting, inventory planning is done, which includes what are called lot sizing rules, to take advantage of scale economies. The well-known EOQ (Economic Order Quantity) model is a repetitive, periodic version. These are further simplified to take into account transport batch sizes and are often implemented in some periodic manner, for ease of planning and implementation (e.g. shipments to some location once a week, some other locations twice a week). This gives predictability and regularity to the entire system and allows downstream players to place orders according to an announced plan.

In contrast to push systems, we have pull systems that are characterised either by re-order levels (and orders placed at varying times) or re-order times (with varying order quantities). The main consideration here is that demand is random (not entirely predictable) and the term used here is that of inventory control. Assuming there is some knowledge of this random demand, in the best case, a demand distribution, there are well developed theoretical bases for both types of systems. Broadly speaking, the logic for order quantity is a modification of the EOQ to account for unplanned stockouts or holding, but whose consequences can be estimated in the long run. They result in (R, Q) policies, where R refers to a re-order point and Q the fixed order quantity. The policy is to place an order of quantity Q whenever the inventory level drops down to level R. This analysis depends quite crucially on the lead-time of supply, because it is really the uncertainty of demand during the lead time that one has to plan for, in a probabilistic manner.

The periodic review version of this results in a very well-known class of policies called (S, s) policies, which have an ordering trigger(s)—where an order is placed provided the inventory level is below s, and an order-up-to level (S). Note that the extent of the order is variable, but is at least (S-s), which captures economy of scale of order fulfillment. An easily implementable approximation of such policies are two bin policies, where an order (equal to the bin size) is placed when one bin is empty and the other bin is used till the replenishment arrives. The one time (single period) version of this problem is also referred to as the newsvendor problem, which determines the base stock. This analysis has an elegant and intuitively appealing structure to the optimum quantity which captures the demand characteristics and cost characteristics in a neat way.

See Chapter 10 for more discussion in these models.

7.3.4 Scheduling and Routing

In distribution logistics, scheduling of shipments is tied up with inventory planning, since the frequency of ordering is determined by inventory and ordering economics. As one goes up the supply chain, demand becomes more stable, and transport and logistics costs are a bigger fraction of total costs. Scheduling at the strategic level helps in planning for requirements of transport assets and contracting with logistics providers. At the next level, it allows for planning horizons to be shared between supply chain players and makes for streamlined activities. Finally, at the lowest level, it is tied up with the allocation decision of what goes where in a given time period (like a day or a week).

Routing decisions are considered in Chapter 10, and they form part of the core set of decisions a transporter or a logistics service provider takes.

7.3.5 Service Measures and Performance Measures in Distribution Systems

Performance measures have already been discussed in Chapter 4 in the general setting of supply chain management. We discuss some specific issues arising in the design of performance measures in the context of distribution systems.

In the design of any distribution system, the criteria for deciding on a good system would mean cost considerations on the one hand, and others that reflect the service goals of the system. In the area of distribution, service measures such as the proportion of orders fulfilled on time (formalised by different types of fill rates) are important, as also discussed in Chapter 6. To keep a check on inventory costs, measures such as amounts of inventory that become obsolete are used. These indirectly indicate accuracy of forecasting—and therefore an understanding of the market, and the design of a good order fulfillment system that supplies the right items to the right location at the right time.

Warehouse managers would need to develop and use specific measures such as the retrieval time, or turn around times of stock, in addition to cost measures (such as turnover per unit of space).

Like all performance measures that attempt to capture the behaviour of complex systems such as supply chains, the measures are useful up to a point, to draw attention to various elements of cost and service. Very soon, systems adjust themselves to satisfy one measure (which is viewed as important by management), often at the expense of other measures that actually contribute to the overall effectiveness. In that sense, measures themselves are used quite dynamically, thereby causing some distress to the system in consideration. Despite these limitations, performance measures and their understanding form a crucial role in modern supply chain management.

7.4 ITEMS OF DISTRIBUTION AND DELIVERY

In a manner symmetric to the upstream interface, we look at various possibilities of distributing and delivering goods and services.

7.4.1 Semi-Finished Goods

In a supply chain, a firm can supply semi-finished goods to its customer. This means that there is further processing to be done before the end customer is able to derive value from the product. An important issue here is the synchronisation of deliveries with the process requirement of the customer. Semi-finished goods are the supply chain equivalent of WIP in the manufacturing activity. There are powerful reasons to streamline the flow of such goods in the supply chain, in keeping with the lean principles of Chapter 5.

Another important issue is quality and warranty liability on the part of the upstream player. For example, an OEM would provide service quality through the warranty or service guarantee provided by its customer to the final user.

7.4.2 Finished Goods

If a firm is supplying finished goods to a market, it means that there is no subsequent value addition through conversion of the product. There may still be a locational transfer, stocking and final supply through further stages (all of which continue to be inportant to customers in terms of utility derived from place, time and availability).

The issues here are more to do with information tracking and information sharing among supply chain partners. Initiatives such as VMI (Vendor managed inventory) at retailers have been tried to provide for directness of response. The retailer in this case provides shelf space and it is the supplier who has to monitor availability, decide on frequency of shipments to back-end store locations and replenish stocks.

Bar coding and scanning (for robust and quick data capture), radio enabled and later full-fledged RFID technologies (which enable real time and automatic data capture) are beginning to show potential for increased visibility in the supply chain. One advantage of such technologies is that they provide a direct interfacing with other planning tools such as an ERP system.

7.4.3 Services

Service delivery is an important part of supply chain management, and although we do not discuss it fully here, we point out some key features. Unlike tangible products, service is difficult to provide ahead of time and store, so time synchronised supply is very important. We do point out that anticipation of the type of service that may be required can ease supply chain transactions considerably, and perhaps cut costs significantly. But generally, capacity utilisation is not as much of a goal here. Rather, idle resources are often justified if they can be used to achieve acceptable levels of service in peak periods.

A service provided by logistics players is customer side tracking of goods, which allows for considerable reliability of planning on the downstream side. As much as compensation for late delivery and claim settlement, it is information visibility that customers seek in supply chains.

7.5 TRANSPORTATION, STORAGE AND WAREHOUSING

The distribution function tries to match the requirements of the customer in time and in space. Transportation, including choice of mode, is discussed in greater detail in the next chapter. While transportation would take care of the physical bridging regarding this match, it is storage and warehousing that will allow for the time match to be made.

7.5.1 Transportation Mode Choice and Multi-Modal Transport

A supply chain perspective to transportation mode choice is the following. The end to end requirement of movement is what needs to be considered. Most modes of transport, except road, would not directly fulfil mine-to-factory or factory-to-factory or factory-to-store needs. In that sense, except in a few cases where the economics would permit pure road based movements, it is a combination of modes that is used.

Example 7.1

Iron ore that moves from Karnataka to Japan and Korea moves by truck to rail loading points, then by rail to unloading points, then by truck to barge loading points, then by barge on the Mandovi-Zuari canal system in Goa to loading points for ocean going ships at Marmagao or Panaji port (sometimes with staging of the material at the port). So even in the movement prior to the ocean movement (the only realistic mode for that segment of movement), there are a variety of modes (conveyors, trucks, rail, barges), each with its own role to play in the supply chain.

In this example, which in itself admits several variants in the flows, the bulk of material is such that road (using trucks) is too inefficient in terms of managing such units of movements (10–12 tons per standard truck) over long distances. Rail is used to bridge part of the gap, but because of port side infrastructure and also line capacity considerations in the last lap, barges on the inland waterway system have emerged as cost effective, environmentally acceptable (in comparison with hundreds of trucks carrying iron ore through hebetated areas) and fuel efficient mode for that leg. But since barge movement is not end to end, there are a number of bridging technologies to handle the movements at interfaces. This example is analysed in detail in Example 8.4 in Chapter 8.

India has seen several shifts of transport mode in recent times. Cement from Gujarat to South India has moved from rail to coastal shipping, often with manufacturer stakes in jetties and port infrastructure. Iron and steel products from steel plants have moved from rail to road because of smaller batches and more value addition and innovations in handling products by road. The flexibility in batch size, destination and timing of supply offered by road proved to be too much to ignore. Petroleum has moved to pipeline in a number of instances. With multi-modal transport, there has been an emergence of third party logistics service providers who sometimes take on the task of co-ordinating across modes.

7.5.2 Developments in Storage Technologies

From a practical point of view, storage during transport and at various stocking locations is quite important, given the quality standards that customers expect of final products. The most important of these developments is in cold-storage facilities and refrigerated movement for agro products and food products. These have led to the development of cold chains, which allow for such products to be shipped across the world.

In India, professional warehousing infrastructure is now emerging. For example, container freight stations and inland container depots for handling of containers are coming up near all major ports.

7.5.3 Warehouse Management

A host of design and operational issues arise in warehouse management. Some design issues are to do with choice of material handling equipment, cross docking arrangements and information system design for data capture and communication. Some of the operational issues are deciding on stacking locations, order picking strategies and grouping of orders. A major area of development is to do with information system integration with retailers who place orders with an increasing frequency (and smaller batches) and manufacturers. Consolidation of orders for delivery to a given location and sometimes combining locations for a transport shipment (the milk-run) are made possible by systematic warehouse management practices where order locations are known, where there is some automation in material handling, where commercial documents can be quickly and accurately prepared and where inspection and reception procedures are in place.

7.6 THE ROLE OF CONTRACTS IN DISTRIBUTION AND MARKETING

If we accept the role of multiple supply chain players who will stock products at various levels (called echelons in the technical literature), and take active ordering decisions, the following issues emerge. They are all a consequence of each player having its own objective vis-à-vis the supply chain goal.

Economists have long recognised that the introduction of multiple players each with its own margin of profit would force decisions that are sub-optimal from the supply chain's point of view. A concrete example of this is the following. In the presence of uncertain demand, a retailer would balance the costs of overstocking (typically inventory holding costs) with the costs of under-stocking (the typically to do with opportunity costs, including profit margins that are foregone). If this is done by each player sequentially, the supply chain as a whole would order less than the optimal quantity. This phenomenon is an example of what is called double marginalisation. This is discussed in Chapter 10, in Section 10.5.2.

7.6.1 Quantity Based Contracts

Practically speaking, if supply chain players remain distinct entities, a way out of this dilemma of double marginalisation would be for the supplier (upstream player) to provide the retailer (downstream player) with some incentives. This can be done in different ways, through quantity based contracts, as discussed below.

Buy Back Contracts

Here, the manufacturer agrees to buy back unsold items at or close to cost. The retailer still has an incentive to sell what he can, because the margin is attractive, but the risks of unsold items are wholly or partly borne by the manufacturer.

Revenue Sharing Contracts

In this type of contract, rather than an outright sale and defining a margin at the interface, the manufacturer shares a fraction of all sales that the retailer makes, in return for a lowered price of sale. This again increases the retailer's ability to take risks on the amount ordered/stocked and comes closer to the 'optimal' balance point.

Quantity Flexibility Contracts

In such contracts, there is an option for the retailer to change the final quantity ordered after observing some of the demand. This is prevalent in the apparel industry, based on early signals of fashionable trends.

In all these type of contracts, while they try to spread risks and assuage the problem of double marginalisation, they do lead to certain information distortions with regard to the 'true' demand at various stages. Often in such contractual settings, there is a leader who would take certain decisions (e.g. announce a revenue sharing mechanism) and a follower who would then act accordingly (e.g. decide on an order quantity). To some extent, this behaviour can be anticipated and analysed in an appropriate multi-level optimisation setting. In game theoretic terms, these would lead to leader-follower or Stackelberg games. Some aspects of pricing decisions are taken up in Section 10.5.

7.6.2 Time Based Contracts

An example of a time based contract in a supply chain context is a performance based contract, such as 'pizzas in 30 minutes or money back'. The 'optimal' design of such schemes may be a very subjective issue, dealing with many considerations of brand positioning and marketing effectiveness, but one thing that is certainly 'objective' and useful is an estimate of the costs arising from such a scheme. Given a demand pattern, whose knowledge is anyway essential for any serious business, it may be possible to compute such costs (at least on average) through analytical or simulation techniques.

More complex contracts can be envisaged, which take into account the time based performance. JIT contracts, where there are penalties for late supply (because that has implications on safety stocks and downstream activity delays of the customer) ***as well as*** for early supply (which has implications on storage, perishability and double handling, for the customer). Such contracts then have implications on the optimum time of order placement, among other decisions.

Supply chain managers would have to be responsible for questions of the following kind. Customer *X* wants a service guarantee of delivery within 3 days of placing an order (subject to a maximum of K units a week). Customer *X* is willing to pay a premium of Rs Y for this, but on the other side, demands a penalty P for every unit that fails to meet this target. Should we agree to this proposal? We note that the answer to this question has firm-wide implications on capacity management, because of capacity that is already committed and sub-contracting options, apart from marketing considerations. While a general answer to this question is not possible, specific analysis of a given situation is perhaps achievable.

Reference

Bowersox, D. J., D. J. Closs, O. K. Helferich, (1986), *Logistical Management: A Systems Integration of Physical Distribution, Manufacturing Support, and Materials Procurement,* New York: Macmillan.

Exercises

Questions 1–6 refer to the description below. Familiarity with the material in Section 10.3 may permit enhanced analysis of these issues.

Distribution of Fertilizer

Rashtriya Chemical Fertilizers (RCF) is considering the rationalisation of the distribution of urea in Karnataka. Urea has to be moved from the factory in Bombay to five potential Rake Point Warehouses (RPWs) where it is required. The demand for urea in a particular season at the nine Feeder Point Warehouses (FPWs) is given in the Table 1. The capacity at Bombay is adequate to satisfy the total demand. The cost (in Rs/ton) of distribution from Bombay to the five RPWs is given in Table 3 and the cost of distribution from each RPW to each FPW is given in Table 2.

Note: Usually the rail mode is used for distance above 300 km and the road movement is used for distance less than 300 km. Hence, the costs between Bombay and the RPWs are potential ones that the management is considering for the primary warehouses.

Management wants minimise the total cost of distribution from the factory to RPWs and then on to the FPWs but at the same time have only a few RPWs in order to have better control.

(1) Provide the management with a trade-off between the number of RPWs and minimum total distribution costs.

(2) If the fixed costs of opening a warehouse are not the same, then provide the management with a model to make the decision. How might fixed cost be estimated/calculated?

(3) The management would also like to keep a percentage of the demand to provide for fluctuations (from forecast) of demand at the FPWs. Develop the logic to allow management to decide the additional stocking quantities. Show how this quantity will decrease as the number of warehouses increases.

(4) The transport link between the following pairs of locations is not established and has a cost associated with them: Gulbarga—Belgaum, Bellary—Raichur and Hospet—Hassan. The company may not want to incur this cost at this time and would like to do so only if some immediate benefits flow. Before contracting with transporters, the company would like to know what sort of cost savings would accrue.

(5) Demand is placed once a month to the FPWs around the 25th of every month. In the peak season (March to September), they are placed once in 15 days. They are placed at the RPWs after a gap three to four days and to the factory after another two to three days. The lead times for supply are typically one week from RPWs to FPW and three weeks from factory to RPW. FPWs are in more direct touch with dealers and final demand and are apt to react vigorously to fluctuations. They placed orders extrapolating both increases and decreases in demand for the month ahead as well i.e. if the demand is 10 per cent above the forecasted value, the assumptions is that next month too, the demand will be that much more than the forecasted value. Estimate how long it takes for such a system to settle down (in terms of steady state pipeline inventories).

(6) RCF is also considering direct supplies to some FPWs (bypassing the RPWs). They were warned that this would lead to much larger management of pipeline stocks. Therefore, RCF would also like to estimate the impact of its location policy on pipeline stocks. Given the typical lead times, make assumptions about the fixed and variable part of lead times (fixed part is the order processing loading of the rakes, etc. and the variable part depends on the distance and location), estimate the pipeline inventories in your distribution network solution.

Table 1: Forecasted Requirements at Marketing Districts in Tons

Marketing Dist.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Gulbarga	32	26	24	35	57	69	75	52
Belgaum	18	13	15	20	32	38	50	31
Bangalore	35	33	23	35	41	46	54	32
Mysore	18	17	18	20	23	27	32	19
Dharwar	12	13	8	11	15	20	26	16
Raichur	13	16	23	26	31	48	53	34
Bellary	10	10	4	7	10	16	14	10
Hassan	12	11	4	8	11	17	23	12
Chitradurga	8	7	2	4	9	15	15	9

Table 2: Cost Matrix (Rs/Ton)

	Bangalore	Hospet	Raichur	Gulbarga	Bellary
Bangalore	Nil	156	185	386	157
Raichur	113	103	Nil	156	108
Gulbarga	133	139	124	Nil	156
Bellary	102	42	105	204	Nil
Hubli	130	83	145	176	108
Belgaum	139	120	162	180	138
Mysore	83	161	227	283	182
Hassan	102	139	201	270	191
Chitradurga	115	Not known	Not known		

Table 3: Cost Matrix (Rs/Ton)

Bombay to	
Bangalore	320
Hospet	203
Raichur	203
Gulbarga	145
Bellary	230

(7) What are the pros and cons of managing one's own logistics vis-à-vis going in for third Party Services? Further, India now has examples of organisations that offer logistic services to other organisations, including their customers and sometimes even competitors, apart from meeting their internal requiements. What is the benefit of this?

(8) Design an appropriate service measure for a warehouse storing multiple products. How would you judge whether a storage policy in a warehouse is effective based on some quantitative measure of performance?

CHAPTER

8

Transportation, Storage and Warehousing

CHAPTER OUTLINE

Introduction
8.1 Transportation Mode Choice
8.2 Transport Operator Decisions
8.2.1 Fleet Management
8.2.2 Size of Vehicle
8.3 Trucking Sector in India
8.4 Rail Transport
8.5 Container Operations
8.6 Air Transport
8.7 Water Transport
8.8 Transport Networks
8.8.1 Hub and Spoke Networks
8.9 Storage and Warehousing
8.10 Concluding Examples and Remarks
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Exercises

INTRODUCTION

Many activities in the logistical sphere can be improved if viewed from a supply chain viewpoint. We look at some such sectors; in particular, transportation, storage and warehousing. Of course, each of these sectors has specific technological and managerial complexities per se, which are beyond the scope of this chapter. But we point out many advantages of looking at these operations through a supply chain lens.

INTRODUCTION TO TRANSPORTATION

Traditionally transport operations were initiated and managed by either a seller who wished to access new markets for sale, or a buyer looking for new sources of supply to fulfill a certain need. The former was a predominant driver of freight transport activity, once technologies developed that facilitated larger volumes of production than could be locally consumed. Over some period of time, specialist transport firms, for example, trucking companies, emerged, which were hired for achieving this spatial transfer of commodities. With international trade becoming more pervasive, the commercial maritime sector developed into a complex multi-stage operation because of the specialised technology involved, the need to transfer material across modes of transport (at the land sea interface) and the commercial requirements of inter-country trade. Ancillary players such as freight forwarders, port terminal operators, customs agents, insurers and others formed part of a complex chain of entities that moved cargo across oceans.

With this complexity in operation, specialised firms that manage a range of activities around transport have emerged, called Third Party Logistics (TPL) service providers. These have further evolved in functions, to include IT integration with partner firms, to be labelled fourth party logistics firms, but we concentrate on describing the main transport activity and the major decisions involved in this sector, in the first part of this chapter.

8.1 TRANSPORTATION MODE CHOICE

We now discuss transport mode choice detail from two points of view. We have already seen it from a shipper's point of view in the supply chain context in Section 6.4.4. We will see this from the point of view of asset management of the transporter, in this chapter.

In many parts of the world, transport (especially road transport) is by dedicated vehicles, which would typically return empty to the original point. This has got some advantages,

1. The increased reliability of the transport service, since the vehicle does not have to wait for a potentially uncertain return load,
2. The reliability to customise the transport mode for the commodity and thereby reduce handling losses and quality defects during transport.

In some cases, the choice of type of vehicles and mode of operation is forced because of dedicated vehicle owned by the shipper. Another driving factor is when a commodity requires special handling (e.g. petroleum) or makes it difficult for the vehicles to be used for other commodities (e.g. coal using bottom discharge wagons).

In India, the option of using transport in a one-way mode is available in various ways

1. Road, because of the presence of well-developed, decentralised transport markets in which independent truckers participate.
2. Rail, where Indian Railways allow point to point booking of wagons or rakes and manages the overall flow of empty wagons on a system-wide basis.

This system is also available in international sea or air, especially container movement.

This is possible only with standardised vehicles. This has certain advantages

1. Lower cost of operation because of better vehicle utilisation
2. Bigger pool of vehicles available and better contingency planning in case of disruptions.

In supply oriented or supply constrained markets, standardisation of vehicles (or in general, any product or service) is very important for interchangeability and effective offering.

Example 8.1

The case of Rajshree Cement in the book looks at this issue in an integrated manner. Here, asset management of the railways (in this case locomotive) is examined from the utilisation as well as the service effectiveness point of view. A similar set of arguments applies in the case of dedicated rolling stock for certain closed circuit movements in coal mine and iron ore shifting.

8.2 TRANSPORT OPERATOR DECISIONS

The following form a set of (these are stated roughly in the order they are made, in practice) decisions that a transport operator needs to make.

- ➢ Locations to serve (markets in which to operate)
- ➢ Network design (that is, which pairs or sets of locations to serve, and route structure)

- Route capacity planning (often has a large infrastructural element, with public, or public-private financing)
- Vehicle capacity and number (fleet planning)
- Vehicle schedules (timetabled services and provisions for on-demand or charter services)
- Crew planning (in keeping with vehicle schedules)
- Terminal facilities planning (can be infrastructural, and increasingly in private control for dedicated needs)
- Maintenance plans (for vehicles and terminal facilities)
- Day to day management of operations (includes pricing of services)

8.2.1 Fleet Management

We discuss an issue that is uniquely relevant in India where cost considerations in transport are very important. Consider general purpose trucks or railway wagons. These can be used to transport a number of commodities. There is a natural tendency to maximise their utilisation across these possibilities in order to cut costs. This leads to empty trucks or wagons being made a part of an open system where they are either assigned to, or find their way to nearby locations where they are demanded. This is in contrast to the model of operations where dedicated vehicles would return empty to the origination location.

In trucking, we would have two options of fleet management; (a) dedicated fleet for one customer, and movement to and from pre-decided locations, on an agreed upon frequency with minor variations through the year or (b) on-demand services to a large number of customers and meeting of multiple types of demands to several locations.

In barge services and ocean sea transport, we have two types of operations (a) liner services which run to a specified schedule among many ports of call and (b) tramp services that are as per the demand of customers.

In air cargo services, most traffic is by scheduled services, but charter services could be used, for occasional or high value cargo.

In almost all modes, the dominant mode of long distance *passenger* transport is the scheduled or liner mode of operation. Charter services for small groups of specialised customers (high end business and location specific tourism) are the only exceptions to this. The only comparable mode to the tramp mode is the taxi cab operation in most cities. Long distance passenger operations have an inherent symmetry of demand in the medium run and it makes sense to concentrate on scheduled services.

Fleet management for scheduled services is easier to plan. Some issues relate to route structuring (choosing originations, destinations and points en-route for different routes) and frequency of services. This last one is a competitive element in transport strategy as choices are often made based on the service offered.

8.2.2 Size of Vehicle

The unit of movement in transport has a significant impact on supply chain effectiveness. To some extent, this is parallel to batch size in manufacturing. Like in manufacturing, there is a movement towards small batch movement, in keeping with greater flexibility, responsiveness and just-in-time logic. Small vehicles, especially in road (for example, the light commercial vehicle on Indian roads), and regional aircraft for feeder services are examples in this direction. Mini rakes in railway operations are an example, since they are often viable in sections where line capacity is not a constraint. One of the factors pushing systems towards larger batches (apart from lower unit cost) is the reduced set up or capacity consumption per unit of movement.

There is an opposing pressure towards scale efficient technologies in transport. Examples of these are the super-tankers carrying more than 50,000 tonnes of cargo on ocean going routes and large commercial jet aircraft. In such cases, the unit costs are considerably lower and provide a significant competitive advantage. A limiting factor could be the facilities in the entire network that can accept large vehicles (e.g. runways that accommodate large bodied aircraft).

The pros and cons of these options are well known, but need to be detailed in each environment. A solution is to combine the benefits of many vehicle types (but using efficient material transfer technologies!), such as using large vehicles for primary transport to warehouses and using smaller vehicles for secondary transport. If a warehousing stage is beneficial from commercial reasons, this is a good compromise. Combining large ships with barge movements into ports or into canal shore locations is another example of this.

8.3 TRUCKING SECTOR IN INDIA

Since there are well-developed, decentralised transport markets in India, the option exists of general purpose vehicles being hired for one way travel. This does increase vehicle utilisation and brings down costs. However, reliability of vehicle supply is affected as the requirement is now met by a return flow of loaded commodities (which may not be synchronised in time) or by a market driven flow of empty vehicles (which could occasionally have mismatches because of information delays or competitive forces).

A challenge in India is to facilitate the growth of large scale national truckers, given the regulatory regime and the business environment. The cost structure favours small operators, self driven vehicles or small fleet owners. As of now, large operators in turn sub-contract operations to smaller operators, which is cost effective, but has reached its limits in terms of tracking, flexibility, service provisioning and overall effectiveness.

8.4 RAIL TRANSPORT

Freight movement by rail is through wagons or containers (which are discussed more generally in the next section). Wagons are generally formed into movement units called rakes, which have a standard size depending on the terrain and the type of locomotive used. Each unit movement of a rake is a train that has to be scheduled and handled through the railway system. For the last many years, Indian Railways operates mainly rake loads, thereby catering to movement of bulk commodities. The advent of containerisation has made it possible to carry mixed traffic through aggregation into rake loads of containers by operation such as Container Corporation of India and others.

As discussed in Section 8.2, wagons could be general purpose or special purpose in nature. Rail wagons for specialised commodities generally move in specified circuits of operation. Special purpose wagons are usually justified when there are significant volumes of traffic over a period of time. Such demands sometimes justify closed-circuit operations of wagons.

The other mode of movement of commodities is through general purpose wagons. This is justified when commodities have seasonal demand and vary from location to location at different times. Food grain is a good example of this type of movement.

Indian Railways made a strategic decision to move the large fraction of its traffic in unit loads called rakes (collection of wagons formed as a train used over large circuits of movement in between train inspection and other safe running formalities). This led to considerable gains in wagon turnaround and asset utilisation. Today, wagon loads are accepted in principle, but almost all traffic that is meaningful is offered in rake loads. Containers form a convenient way of allowing the carrier (railways) to carry rake loads and traffic to be conveniently built up, e.g. by Container Corporation of India and other operators who consolidate loads and form trains.

The overall asset management from the railways point of view is in terms of track and terminal capacity, locomotive management and wagon management. The overall management of these resources assumes that subsequent resources like crew are essentially available on demand, and need not be planned at this level.

8.5 CONTAINER OPERATIONS

The container box has had a revolutionary impact in the freight transport sector and today, it is impossible to think of movement of value-added commodities across countries, without containerisation. This technology, now standardised in design (especially in dimensions), has made it possible for safe carriage of goods across modes [land (road or rail), water (inland, coastal or ocean going) and even air] in a seamless manner.

For both domestic and international operations, container movement is an increasingly viable option. In India, traditional rail containers like Concor, also operate road container services, to improve flexibility. Other players have been allowed to offer container based rail traffic to the Indian Railways and this has thrown up some interesting issues in asset planning for these operations. In particular, new players have had to face difficulties in procuring flat railway wagons for carriage and also attain access to the rail network through appropriately situated container freight station with railway sidings. The latter issue is partly resolved through leasing and partnership arrangements with Concor.

Road based container operators need a fleet of trucks that can carry containers (in 20 TEU or 40 TEU sizes—which are the standard ones). The major operational problem then is to plan the return flow of containers. The dynamic positioning of containers is a complex problem in the face of uncertain demand. A basic choice to be made is whether to wait at a location to meet a known or anticipated demand at a later date or to move empty to a location where there is already committed demand. Technically, dynamic programming is a technique for such decisions.

8.6 AIR TRANSPORT

Cargo moved by air is time sensitive, high value and needs tracking and careful handling. A number of operational decisions have to be made in addition to the above-mentioned transport planning decisions. We mention only two: (a) dynamic pricing and capacity management to exploit elasticity of demand with respect to price and service levels and (b) stacking and storage decisions on the aircraft and at the terminal for load balancing as well as quick retrieval when required.

In (a), capacity is allotted to different segments of the traffic, so as to maximise expected revenue and in (b), prices adjust themselves dynamically to perceived demand and what bookings are already done and what sort of cancellation pattern there is. These are technical problems that are quite challenging, and form an important part of ongoing research.

A supply chain issue of direct relevance to air transport decisions is that economies of scale preclude the regional dispersal of air services to the extent normally required and therefore, it is inevitable to have other modes to complement air transport, to finally achieve door to door service. Providing for this supply chain requirement is a major concern of new airports, new hubs and regions that plan to have air transport infrastructure.

8.7 WATER TRANSPORT

Water transport is cheap when it can be done, since the cost of movement is generally in a natural channel (low capital cost of acquisition of right of way and construction), and fuel efficiency is very high. From a supply chain point of view, the major disadvantage is that water transport can rarely meet end-to-end needs of customers and there is a need for a change of mode of transport at either end of the water movement. Also, water movement tends to be slower than competing modes. But the cost advantages of handling large volumes are quite significant.

Large ocean liners are transport supply chain drivers as their schedules at major ports determine the timings of all the other legs of movement. They have restricted access to ports and need supporting infrastructure to load and evacuate material, such as barge movement, port terminals and hinterland connectivity.

A small sector in India, but a significant one in some other countries, is inland water transport, on rivers and canals. This sector can merge with ocean going sea traffic in a few cases, such as operations on the Great Lakes in the U.S./Canada. Otherwise, barge operations in inland waterways are too small to be cost effective in long distance ocean movements. See example 3 at the end of this chapter to understand how inland waterways can form an important part of a logistics supply chain.

8.8 TRANSPORT NETWORKS

A conceptual design issue that arises in transport is the possibility of aggregation and dis-aggregation of traffic over the end-to-end demand satisfaction. Two extreme structures that are used worldwide are the hub and spoke system and the direct connectivity network options. These extremes and variants in between, can be found in rail, air, water and all forms of road transport.

8.8.1 Hub and Spoke Networks

The network design problem is of specific importance in the air freight sector since the cost of assets and operations are huge and any inefficiency in planning gets magnified greatly. The operational economics are as follows: larger aircraft are cheaper to fly (per seat mile at full load) but are costlier to purchase as compared to smaller aircraft. The demand dynamics are as follows: direct flights are faster and more reliable as compared to connecting flights and hence more in demand.

Consider a demand distribution for a typical network (in tons of cargo)

From/To	Mumbai	Pune	Goa	Delhi	Lucknow	Chandigarh
Mumbai	0	20	30	100	10	15
Pune	20	0	15	15	0	10
Goa	30	15	0	20	5	10
Delhi	100	15	20	0	20	30
Lucknow	10	0	5	20	0	10
Chandigarh	15	10	10	30	10	0

Aircraft of the hold capacities of 40 ton and 100 ton are available.

Two contrasting network designs are:

The highly aggregated **hub and spoke** network

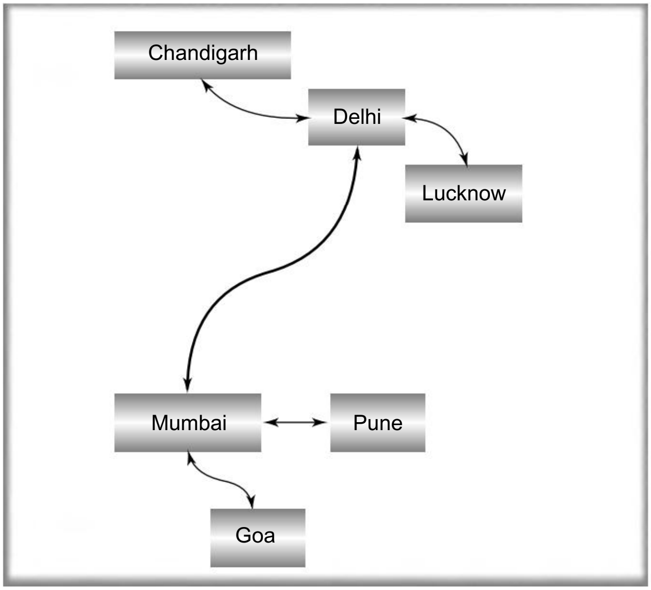
- A few airports are chosen as hub airports. Demand originating from nearby airports is aggregated at these hub airports.
- This demand is then transported to their final destination (if it is a spoke of the same hub) by small aircraft or to another hub by large aircraft.
- Fewer flights are required totally. For a network of n nodes only n–1 flights are required (assuming single frequency is enough to satisfy the demand).

- On the hub-hub routes a large amount of traffic is generated due to aggregation and the economies of scale offered by the larger aircraft can be utilised.

For the transport of most forms of packaged goods this approach is adopted since it provides wider network connectivity using fewer trips. Moreover, unlike passengers, with packages it does not matter what routing they take provided they arrive on time. The downside is that since the smooth functioning of such a network requires that many connections be made, in case of contingencies such as delays, etc., the entire operation is affected badly.

In the freight context, the hub and spoke model is characterised by the cross-docking methodology adopted successfully by big retailers like Wal-Mart. There are multiple suppliers (for different commodities) and multiple demand points (individual stores). Instead of each supplier supplying separately to each store, they supply the goods meant for all the stores to a centralised location, much like the hub explained earlier. Here all the goods destined for one store (from various suppliers) are loaded on to one truck directly from the suppliers' trucks without storage. The timing of arrival of the suppliers' trucks and the departure of the stores' trucks must be well synchronised. If there are n suppliers and m stores (n+m+1 node network, including cross-docking station), n+m truck trips are required to the central location.

A possible hub and spoke network for our example is shown below



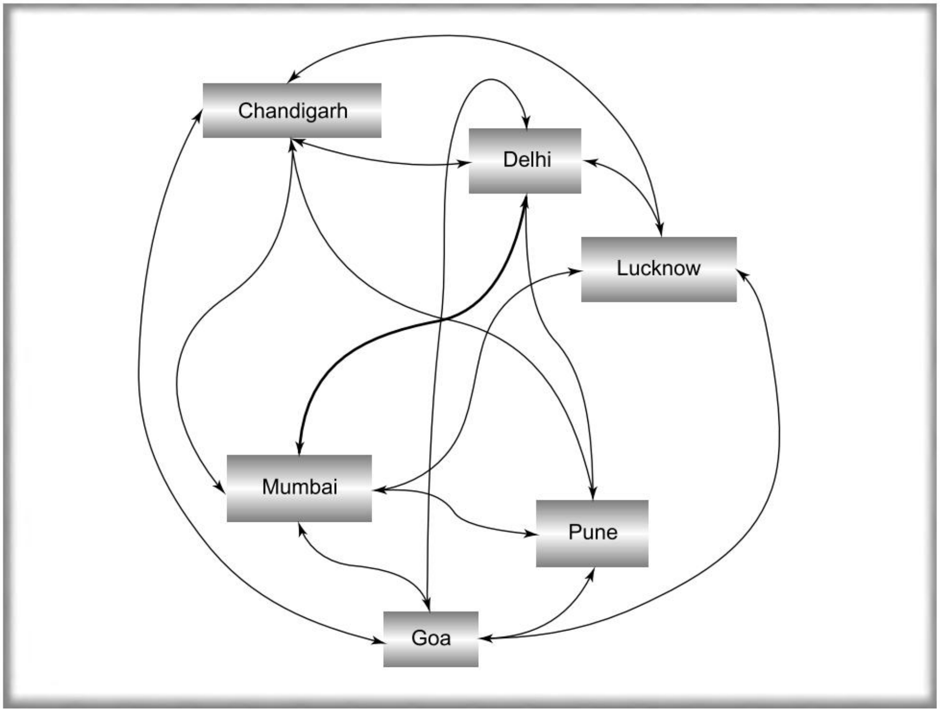
From/To	Mumbai	Pune	Goa	Delhi	Lucknow	Chandigarh
Mumbai	0	1*100	1*100	2*100	0	0
Pune	1*100	0	0	0	0	0
Goa	1*100	0	0	0	0	0
Delhi	2*100	0	0	0	1*100	1*100
Lucknow	0	0	5	1*100	0	0
Chandigarh	0	10	10	1*100	0	0

The dispersed **point-to-point** network

- ➢ Each demand is met by a separate service.
- ➢ A larger number of flights have to be operated, for an n node network typically n^2 flights need to be operated.

Point-to-point networks are more suited to specialised services such as delivery of perishable goods where time is of the essence. Direct connections offer the fastest way to get from A to B. Also the reliability of these networks is better since the operations on various sectors are more isolated and hence problems in one sector do not transform into network wide problems. Regular high volume traffic between specific nodes may also warrant the use of direct connections.

A point-to-point network for our example is shown below



The point-to-point solution to the sample demands shown above is as follows

From/To	Mumbai	Pune	Goa	Delhi	Lucknow	Chandigarh
Mumbai	0	1*40	1*40	1*100	1*40	1*40
Pune	1*40	0	1*40	1*40	0	1*40
Goa	1*40	1*40	0	1*40	1*40	1*40
Delhi	1*100	1*40	1*40	0	1*40	1*40
Lucknow	1*40	0	1*40	1*40	0	1*40
Chandigarh	1*40	1*40	1*40	1*40	1*40	0

Most operators settle for a combination of the two solutions where they have hubs that aggregate traffic and several focus cities that get a lot of point-to-point connections to hubs and other focus cities.

8.9 STORAGE AND WAREHOUSING

The last decade has seen many developments in storage and warehousing technologies. One area is in information technology, to allow quick tracking of locations, SKUs or even specific items. Another area is in the technology of storage in special conditions, such as temperature control. These allow an increased time frame of product life and therefore access to markets that could not otherwise be serviced. The impact of this is significant in outbound agri-logistics (sea-food, fruits and vegetables, flowers, meat, etc.).

An example of storage technologies synergising supply chain operations is a typical warehouse attached to an air-cargo hub, where unit loads are stored before and after the flight segment of movement. Complete synchronisation of arrivals/departure of loads and flight movements is neither possible nor even desirable, one needs locations to de-couple these activities when required. An efficient storage system, such as a fully automated or partly automated storage facility with quick storage and retrieval is essential. Such facilities require design of a two or even three dimensional storage space, order picking procedures (which have a host of options ranging from completely dedicated storage areas to randomly assigned areas as two extremes) and technologies for item movement. The trend in these technologies is towards traceability and responsiveness, rather than cost minimisation, per se, since the costs of cargo not meeting demands in time, or not making transport connections would often justify one time investments in the technology for storage and retrieval.

8.10 CONCLUDING EXAMPLES AND REMARKS

We conclude with some illustrations of how transport, storage and processing can all be viewed as part of a common framework of value addition in a supply chain that ultimately tries to provide location and time value of products and services to customers.

Example 8.2

Ready Mix Cement

In the last few years, we see the emergence of cement concrete being moved in vehicles that also perform the function of mixing in the required proportions. Such technologies allow for flexibility of operation, since the timing of the activity can be synchronised with the requirement, without having (a) facilities at the construction site and (b) stacks of material on the construction site, instead having a common facility to serve many sites over a period of time.

Example 8.3

Railway Mail Service on Indian Railways

In earlier days, overnight trains used to carry mail in mail vans, coaches equipped with sorting facilities so that mail could be accepted till the time of train departure and then sorted en route and ready for dis-aggregated dispatch at the destination (e.g. sorted into locality wise bundles at the destination city/district). Over time, demand has grown such that a large number of buckets (destinations) are required. Automated sorting technologies have emerged which are used in large cities with a large volume of traffic. Finally, the opportunity cost of space on trains has become so high, that sorting facilities on trains are now not provided and mail bags are carried as such. This represents a change in the mix of operations, storage and transport in the mail supply chain.

The relationship between transport and supply chain management is two way. On the one hand, transport is a significant value addition activity in the supply chain, leading to place utility for the customer (providing products and services at the locations where they want them) and on the other hand, principles of supply chain management can be applied to the transportation activity itself. A striking example is the application of the principles of lean manufacturing (including standardisation, waste minimisation, streamlined flow etc.) in airline operations, such as those for Southwest airlines (one of the longest running profitable airlines in the world, consistently).

Example **8.4**

Inland Water Transport in Goa

The tidal riverine system in Goa, comprising the Mandovi and Zuari rivers, the Cumberjua canal and the linkage with Mormugao and Panaji ports forms more than 90 per cent of the commercially viable freight inland water movement in the country. Almost all of this traffic is exported and inland waterways in Goa form an integral part of the competitiveness of the mineral ore export industry. In recent years, higher grade iron ore from mines in Karnataka is also brought to Goa, blended with the lower grade Goa ore and moved by barge to ocean going vessels for export destinations. Hundred per cent of this export traffic is handled by barges on the Mandovi and Zuari and although the distances involved are small, the inland water mode of transport is vital to the functioning of the whole activity. This is from two points of view: overall logistics costs and environmental acceptability.

The point to note is that the entire movement of iron ore by export is by barge in the Goa sector, even though historically there was rail movement of iron ore right upto the port on the earlier metre gauge railway system. When this was dismantled, barge movement emerged as the primary mode. Apart from the lack of a proper unloading interface at the port, a bottleneck was the line capacity on the broad guage rail line section leading to Goa. This has led to the emergence of a dedicated set of barges and loading/unloading infrastructure at several loading points on the Mandovi and Zuari and at Mormugao port.

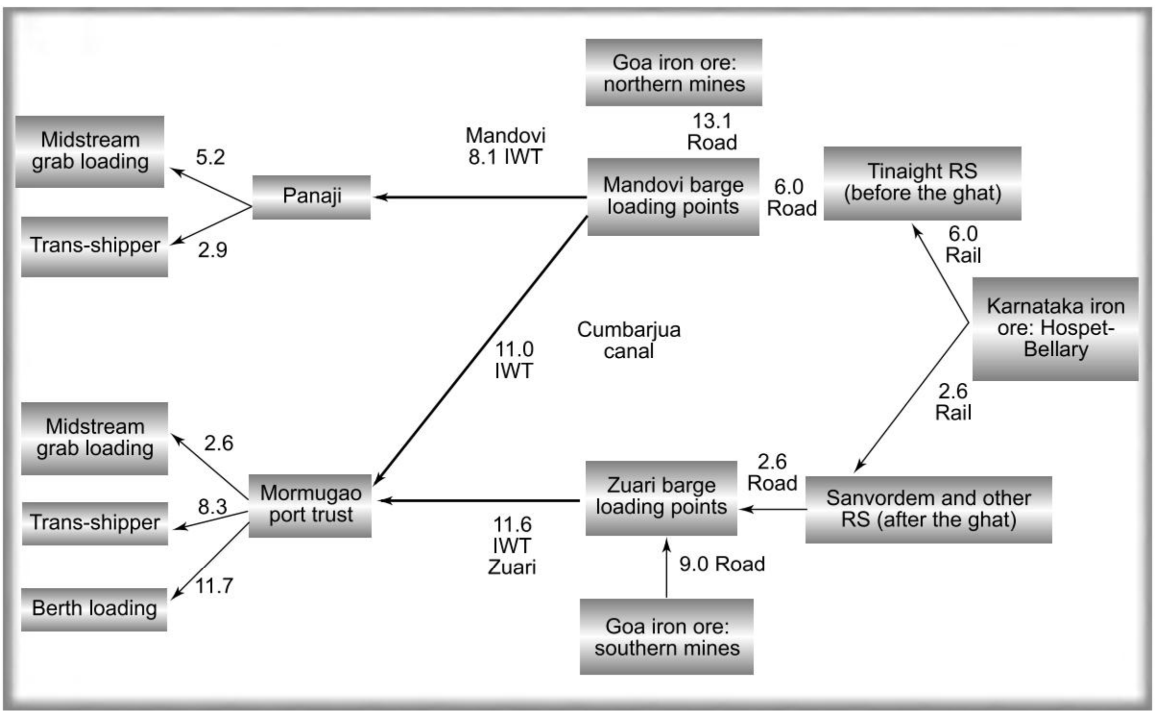
The analysis also illustrates and emphasises the supply chain element in transport planning. The interfaces with other modes and an origin-destination view of the flow are essential for a mode to be an effective part of the movement of a commodity. In this case, the inland water mode, together with its interfacing costs, offers a cost competitive way of moving material to the next step in the supply chain (the ocean going vessel that carries bulk cargo for export).

Mormugao port is specifically designed to handle iron ore for export through barge shipments in three different ways: by stacking on the ground and loading on to ships via conveyors, by transferring ore from barges to ships anchored at points called mooring dolphins at the port and finally, by trans-shippers or own fleet of ships docked at anchorage in deep water locations at Panaji port or Mormugao port limits.

Lack of loads on the return trips for the barges is an area of concern since the lead times are short and there is considerable cleaning, etc required before different commodities can be handled by the barges.

Figure 8.1 gives a flow chart of the iron ore movement by IWT in Goa for 2003–04.

Figure 8.1

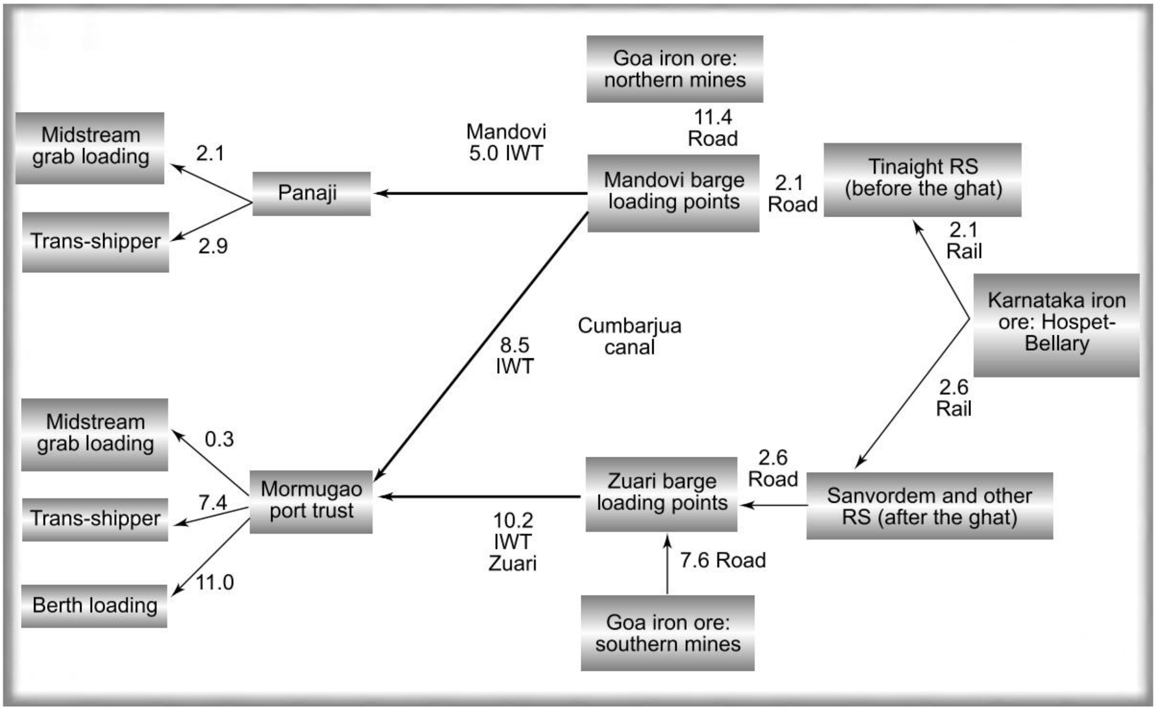


- All figures are in million tons (mt)
- Exports at Mormugao Port Trust (MPT) were 22.6 mt, at Panaji were 8.1 mt
- Total Goa iron ore production was 22.1 mt. All were exported. 60 per cent were from the northern mines and 40 per cent from the southern mines

- About 1 mt of Karnataka ore was blended with Goan ore for exports. The remaining 7.6 mt were exported directly, mostly through Panaji
- Ore from Mandovi loading points moved to MPT, both via the sea route from the Mandovi mouth and the midway Cumbarjua canal route

Figure 8.2 gives a flow chart of the iron ore movement by IWT in Goa for 2002-03.

Figure 8.2



- All figures are in million tons (mt)
- Exports at Mormugao Port Trust (MPT) were 18.7 mt, at Panaji were 5.0 mt
- Total Goa iron ore production was 19.0 mt. All were exported. 60 per cent were from the northern mines and 40 per cent from the southern mines
- About 1.7 mt of Karnataka ore was blended with Goan ore for exports. The remaining 3.0 mt were exported directly, mostly through Panaji
- Ore from Mandovi loading points moved to MPT, both via the sea route from the Mandovi mouth and the midway Cumbarjua canal route

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Case references : Transportation issues are dealt with in the cases Western Oil Limited (A), Laxmi Transformers and Rajshree Cement. Third party logistics issues are the main concern in the cases Air Freight Limited and Seth Dhaniram (C & FA). Vehicle utilisation and fleet planning issues are relevant in Concor and Rajshree Cement. Containerisation is dealt with explicitly in Concor.

Exercises

1. Provide details for a typical (a) air cargo operator, (b) barge operator on inland waterways (on a river/canal system), and (c) operator who is planning container services by rail (refers to Section 8.2 in chapter).
2. Determine the trucking requirements for iron ore to rail siding movements of ore, given the following parameters: average distance (pit head to rail depot): 20 km, average speed of trucks, 10 kmph, loading time: 12 minutes per truck, unloading time on to wagons 10 minutes, to ground stack locations, 3 minutes. Amount carried per truck, 12 tons. Hours of operation, 10 hours a day. Requirement: two million tons a year.
3. In India, truck rates are published and available through local transport exchanges. Consider a simplified two node network (Mumbai-Delhi). The demands for loaded movement for a particular carrier specialising in industrial products is 35 trucks a week from Mumbai to Delhi and 30 trucks a week from Delhi to Mumbai. In a given season, these demands can be taken as representative of the overall demand. (a) Since transport rates are competitive, would you expect Mumbai-Delhi rates to be higher than Delhi Mumbai rates? (b) What is the overall fleet requirement for this transporter (you can assume four days of travel time each way, but you would have to make additional assumption of variability of demand over time and also vehicle maintenance requirements)?

4. From secondary sources, identify directions of movement of (a) coal from producing regions to thermal power plants, (b) petroleum products, and (c) cement, in India. Estimate the time taken for loading, movement and unloading for any one such cycle and thereby estimate the pipeline inventory of the commodity and its value.
5. A Concor terminal in a city has three loading lines (sidings) and has estimated that its internal requirements vary between 30 and 90 rakes a month, uniformly over a month. If loading/unloading can be done during daytime hours and take anywhere from four to six hours, does it have enough capacity to offer other players? Design the terms of a reasonable contract, in terms of service levels to a shipper interested in utilising this terminal.
6. A container company wants to qualitatively understand cost trade-offs in its operations. Assume a container costs Rs K per day to hold at some location. Extend the Delhi-Mumbai trucking problem with the same data and assumptions. Compare the options of owning a fleet of L1 versus a fleet of L2 (L2 > L1), but with less empty running. What are minimum/maximum values of L1 or L2 for viable running?
7. Gather data about the economics of such an operation and compare it with the option of static facilities for storage and mixing of cement and the transport of the material required for this.

CHAPTER 9

Role of Information Technology in SCM

CHAPTER OUTLINE

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9.1 Basic Requirements of Supply Chain Management
9.2 Elements of a Modern IT System
9.3 A Typical Architecture of an IT System
9.4 Elements of the Application Layer
9.4.1 Transaction Engine (Core Applications)
9.4.2 Extended Application Layer
9.4.3 Integration Layer
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9.5.1 Design of Information Technology for Supply Chain
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INTRODUCTION*

From its early beginnings as a set of automated electronic procedures for recording transactions and managing data, Information Technology has become pervasive in all walks of an enterprise today. The term 'Information technology' is of a recent origin. In its basic form, it gives the users the ability to record business transactions, to review or change them later, to save the data related to the transactions, to review or change it later, and transmit the information in form of printed reports or online enquiries. In addition to these basic tasks, it does many more things for an enterprise:

1. Connect internal and external people for transaction collaboration, effectively giving the people an ability to see the same data and take decisions through online communication. For example, the Engineering Department may collaborate with the suppliers for new designs by sharing information on materials, drawings, materials, processes etc.
2. Enable automated workflows for business processes across departments and locations. For example, automated process can be initiated for the materials to move from the factories to the warehouses and to the distributors.
3. Watch for vital events and trigger alerts to appropriate people. For example, a non-receipt or a likely delayed receipt of an important scheduled shipment can be notified to the factory manager.
4. Provide an up-to-date status of key operational parameters, for example daily sales figures for an in-launch product, or machine utilisation figures.
5. Analyse the data to extract commercially useful trends or patterns that are otherwise hard to detect. For example, customer interactions, product co-influence factors in buyer behaviour, transport efficiency etc.
6. Predict the trends for decision support, for example the movement of the stock or forward build-up of inventory at a particular location.

The key function of 'Information' technology will always be to *manufacture and distribute 'information'* to be used by *the businesses*. The exact role of Information Technology in the Supply Chain management is determined by its usability; i.e. it depends on how the supply chain managers *want to use it*, and how *usable* they find it.

* The authors thank Milind S. Padalkar for his extensive contribution to this chapter.

9.1 BASIC REQUIREMENTS OF SUPPLY CHAIN MANAGEMENT

To support supply chains, an IT system must perform certain basic tasks.

Two fundamental tasks supporting supply chain management are: (a) Information exchange and reporting and (b) information alerts. At a more advanced level Supply Chain Management will require: (c) data and trends analysis, (d) forecasting (e) scenario modelling, planning, decision-making.

Basic Requirements of a Supply Chain

(a) Information Exchange and Reporting

An organisation may have several requirements of reporting. Apart from providing information of different types to different people, it will be necessary to exchange information and data with entities outside the organisation in a timely and an effective manner. Examples include information flows between logistics service providers, transporters, distributors, warehouses, and related third party operators. When integrating the information from the outside agencies, the issues of data homogenisation and integrity need to be kept in mind.

(b) Information Alerts

Information alerts need to be specially designed and implemented. The alerts are implemented on the computer systems through a set of memory-resident programmes—called resident tasks—that act as watchdogs for the transactions taking place and the data streaming in and out of the system. For example, specific high-value transactions can be detected as soon as they occur, and the alerts can be sent out to the defined receivers.

To enable information alerts, the IT systems need to be equipped with an online data capture facility at various points of the enterprise supply chain. In many cases, the alerts are based on data aggregations. For example, the total capacity of the trucks reporting to a warehouse may fall short of the planned shipments. For such alerts, the IT systems require data aggregation/consolidation programmes to be running frequently or constantly.

Advanced Requirements of a Supply Chain

Analysis of Supply Chain Data

This includes the development of appropriate algorithms and analytical products to analyse the supply chain data. These products are called 'Analytics'. Several leading software companies such as SAP, Oracle, Cognos, SAS, Informatica etc. supply specialised analytics products.

Analysing supply chain data often involves a process whereby supply chain managers formulate hypotheses and test them on the data. Hence, the analytics products have a superior capability to flexibly manipulate and view the data in different ways. We note that choices of management in many areas would have significant impact on the way data is managed and what analysis is done. For example, an organisation changing its overhead cost allocation scheme from standard costing to an activity based costing would require major changes to data handling and analysis.

Forecasting

Based on the analysis of the data and its aggregates, it is possible to extract transaction patterns. These can be used to forecast key supply chain trends to support the decisions and forward planning of supply chains. The forecasts can also be represented in various forms such as tables, charts, simulated transitions from current to future state etc. The graphical presentation can generally enhance the usability of the forecasts by integrating a comparative analysis of the forecasts versus present or against other estimates.

Supply chain forecasts must assume a continuation of the present policies. If the supply chain design or the policies change, the forecasts will be affected.

Scenario Modelling, Planning and Decision-Making

The supply chain involves a large number of coordinated or un-coordinated actions by many players. Any proposed changes in the supply chain policies cannot be pre-tested in real life, because such tests would necessarily be expensive, time consuming, geographically impractical and disruptive. Information Technology can create a powerful scenario modelling capability to enable the supply chain managers to understand the component behaviours and to evaluate the systemic impacts arising from proposed policy changes. A good understanding of the interactions between supply chain stages and the behaviour of the data allows organisations to model the different scenarios.

Scenario modelling goes a step beyond forecasting by conducting a 'what-if' simulation by changing one or more of the design rules. For example, inventory forecasts can be created after an analysis of the demand patterns, assuming no changes to the replenishment strategies. But the organisation may want to introduce different replenishment strategies for different demand patterns.

Because changes in the supply chain design cannot be studied through physical means, a scenario modelling capability is a powerful platform for analysing changes. Such a platform can also evaluate how the various applications at various levels will work with each other.

A scenario modelling platform can also assist in planning the supply chain variables from time to time, thereby acting as a key decision support system.

9.2 ELEMENTS OF A MODERN IT SYSTEM

Modern IT systems include many components such as the data, programmes, printed reports, screen images, network connections etc. 'IT architecture' describes how these components are tied together. The objective of an architectural design for a given application is to ensure optimal levels of Usability, Scalability, Interoperability, and Flexibility.

Most IT systems are generally designed around client-server architectures, in which multiple users can use an application simultaneously. The applications and the data reside on separate computers called 'servers'. The servers are connected in a network with the user computers. The user accesses the system through a local PC (also known as a desktop, or a workstation)—called as a 'client'. The client places specified requests on the 'server' which fulfills them. In their physical forms, the clients and the servers are computers running programmes, and having a designated function.

In practice many users will access different applications simultaneously. Hence the IT architectural designs keep four factors in mind. These are: (1) efficiency (2) security (3) error-free operation, and (4) load balancing.

To ensure these objectives, the IT architecture as separate layers which communicate with each other. Each layer communicates with the next layer in the architecture and not with the others. The 3-Tier (also 3-layer) architectures are most common in designing the client-server systems. For scalability, the three layers are generally kept on separate server machines. The three tiers are described as below:

1. **Presentation Layer**: Also called User Interface layer. This layer includes all programmes, display formats, objects and techniques to present the information to the users. The information may be presented as screen images, printed reports, messages on personal devices, etc. For example, the display of inventory status on a desktop will be handled within the presentation layer.
2. **Application Layer:** Also called Logic layer, or Rules layer. This layer includes all programmes which perform the business processing. The extraction of the data, the logic to manipulate it, and the selection of the data sub-set for the purpose of presentation will be handled in this layer. Continuing with the preceding example, the Application layer will access the inventory data, process it according to defined rules, and forward the sub-set of the data to the presentation layer.
3. **Data Layer**: This layer includes the physical and logical data stores along with the logic to receive requests and send data to the Application layer.

The middle layer may be further divided into multiple tiers—resulting into n-tier architectures. To prevent unauthorised accesses between the layers, the architectures may include firewalls—essentially computers to allow or prevent network traffic between the two layers.

Supply chain managers may need to access and analyse data coming from several different sources. Web technologies allow many players in the supply chain to collaborate and exchange data over the internet. The operating conditions of web applications differ widely. A range of technologies, standards, protocols and software object libraries are available to support the variability in designing the web-based IT systems. These are briefly described below:

Web browsers (such as Microsoft Internet Explorer©) belong to the presentation layer. Web browsers decode and present the data sent by the application layer. Other presentation technologies include Java Server pages (JSP) or Active Server Pages (ASP). The data is usually exchanged by using standards such as XML (eXtensible Markup Language).

The Application Layer uses several technologies and standards. J2EE or .NET are frameworks for connectivity to various systems. Servelets or Java Beans refer to the programme objects to perform functions within the Application layer. The entire set of such programmes is called Application Server.

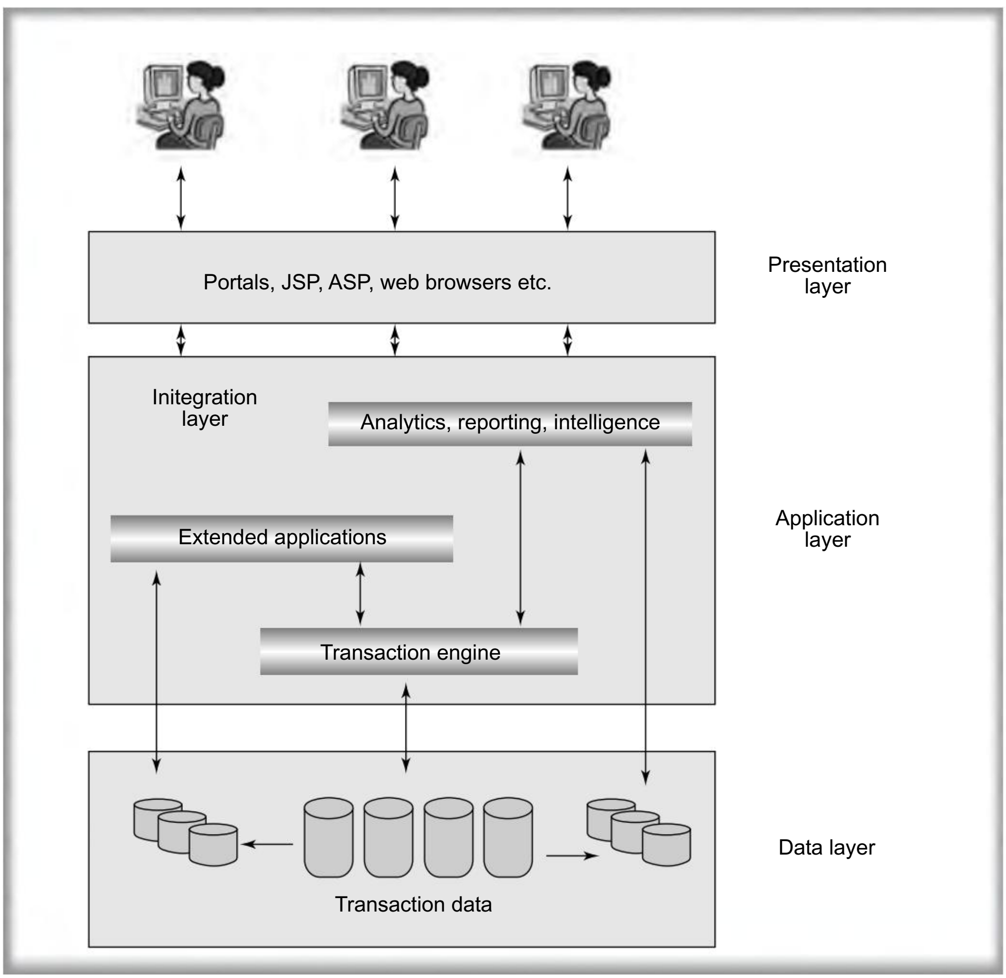
Database server keeps the data. The Application Server exchanges data with the database server by using standards such as JDBC or ODBC.

Depending on the application size, the application server and database servers may be hosted on the same computer or on separate computers.

A careful mix of the technologies and standards can result into an optimal performance of the IT system.

9.3 A TYPICAL ARCHITECTURE OF AN IT SYSTEM

An IT system is described through a collection of its components. A pictorial representation of the various IT system elements and how they interact is given below.



9.4 ELEMENTS OF THE APPLICATION LAYER

The application layer encompasses the core transaction engine, i.e. the rules, programmes, algorithm logic, workflow decision triggers etc. It is the heart of any IT system. Hence a further understanding of its elements is necessary. These are described below:

9.4.1 Transaction Engine (Core Applications)

Any IT system will need a transaction engine, i.e. a set of core applications to process transactions and capture data. The transaction engine provides complete support for all operations in the different business processes such as order-to-cash cycles, design-to-manufacture processes, other supporting business processes etc. The users interact with these applications in course of the regular business operations.

Depending on the type of the IT infrastructure, these applications could be of two types:

9.4.1.1 Integrated Enterprise Resource Planning (ERP) Applications

Applications such as SAP or Oracle provide an integrated set of applications to enterprises for all or most of the operations. Within an ERP package, there are several smaller applications performing specific sets of functionality (such as materials management, accounts receivables, plant maintenance etc.). However they are tightly coupled, and share the same database, user interfaces and reporting standards. By 'Integrated', we mean that the various business processes are connected, automated and work in tandem. For example, a new sales order can automatically trigger a shop order if the finished product inventory is not sufficient to fulfill the order. 'Integrated' also means that these applications come in as one package that cannot be dissembled into its component applications or the data. They also cannot be used for stand-alone functionalities.

9.4.1.2 Loosely Coupled Applications

Companies often have many discrete applications that are essentially designed as stand-alone. These applications operate on their own data bases/structures, and interact with each other only for defined transactions. For example, a new sales order will not automatically create a shop order or a purchase order on the suppliers, but it will leave an indication, usually a data flag that can be read by the shop order application when it is run. In that sense, the applications are said to be loosely coupled. A transaction engine built on such loosely coupled applications will generally not enable some of the features talked above, i.e. scenario modelling, trend analysis, forecasting etc. It will also not support an on-line, real-time analysis, information alerts and other features dependent on the quick availability of data.

9.4.2 Extended Application Layer

The Transaction Engine serves the basic users, i.e. the people directly engaged in transactions such as purchase orders, sales orders, payments etc. These transactions create records in form of data which accumulates over a period of time. Such historical data is useful for analysing the trends and understanding how the different entities in the supply chain perform. For example

1. A history of material receipts from a particular supplier will indicate the quality of shipments, and price/delivery performance.
2. Corporate finance may require an application for treasury management i.e. management of free cash.
3. Sales department may want a set of ad-hoc reports to link the salesman's performance with his incentive calculations.

Such applications are not core to the business. They are required for extended business purposes and operate on the derived forms of the basic transaction data. Such applications collectively form the Extended Application Layer.

Generally, the Transaction Engine alone cannot meet the requirements of supply chain managers. These are met by the Extended Applications Layer. When this layer is integrated with the Transaction Engine, it becomes effective in managing the supply chain. It is easy to see that a loosely-coupled application structure will create difficulties in the integration with the Extended Applications and will lead to a loss of effectiveness.

9.4.3 Integration Layer

Since the extended layer is actually a set of independent applications, another set of applications is required to connect the Extended Applications to the Transaction Engine. Collectively, such applications are called 'Integration Layer'. The integration layer employs several different methods for integration. These include: (a) integration at a data level (b) integration at a message level, and (c) integration at an application level. A detailed description of these models is out of scope of this chapter, however for a supply chain practitioner, they can be understood as follows:

(a) Under data integration, the applications exchange only data with each other. Generally this type of integration is simple and the quickest to set up and maintain. However, it is the slowest form of integration, and does not support fast collaboration between the applications.

(b) Under message-based integration, the applications communicate with each other via coded messages, typically through short data packets. The participating applications have an in-built logic to decode the messages and take appropriate actions. The messages are managed by programmes called Message Brokers and Message-Oriented-Middlewares (MOM). IBM, SAP, Oracle and Microsoft are some of the companies supplying these products. Generally this type of integration is more expensive, and most effective in supporting pair-wise application integration. They are less effective when an application needs to communicate with several other applications using broadcast or publish-and-notify schemes.

(c) Under process integration, the participating applications enter into a common protocol to collaborate in executing a business process. This type of integration is supported by softwares called web servers. This is the most expensive form of integration to set up and manage. Process integration becomes necessary to support the complex, real-time analytical requirements in the supply chain.

Apart from providing integration within an organisation, this layer also provides an ability to exchange data from third party sources. For example, retail trade data supplied by market research agencies.

9.4.4 Business Intelligence Layer

Key decision makers often need specially prepared data to take complex decisions. For example, a marketing manager may want to decide the price of a product after looking at the cost of production, the relative brand appeal of the product, the purchasing power of the consumer, the prices of competing products, the distributor commissions etc. or a supply chain manager may decide the warehouse inventory and the re-order variables based on the demand pattern, cost and time taken to transport the product, the service levels etc.

For such decisions, the decision maker typically cannot use the basic transaction data. He needs data computed or derived from the transaction data. He also needs to view this data in conjunction with the other data that may come from outside the enterprise. For conducting any analysis, he typically needs a large volume of various kinds of data to support his decision-making needs.

Further, the Transaction Engine and the Extended Applications layer may not be able to fulfill some of the supports needed for decision making. To illustrate, consider the following example:

A company makes shaving blades in various styles, and sells it in different markets at different prices. It may run promotion campaigns from time to time and may respond to competitor moves by price cuts or other strategies. Further, it may believe that its products are preferred by a certain kind of a customer. The decision-makers want to know whether the price set for this product is optimal for the company, and whether it is able to fulfill the demand in the various markets.

Such a situation cannot be handled by the Transaction Engine. The Extended Application layer is often insufficient to address requirements stated above.

Business Intelligence layer includes technologies to set up data warehouses containing large amounts of data extracted and transformed to support special needs as above. Business Intelligence also includes special programmes to analyse and view the data in a flexible manner. Data warehouses are designed by using the concept of a 'multi-dimensional cube' which can support fast online analysis. A multi-dimensional cube is a collection of data around a few central key elements (dimensions) such as product, customer, account, or supplier. For the above example, consider the following data 'cube':

Pcube: {Product, geography, customer demographics, competition price and market share, market size estimates, sales history, price realised, promotional campaigns}

The way to read this: For each product, its sales volume and price history, in each geography, split by the customer types, against the market size estimates from time-to-time, against the competitor prices and volumes, under the promotional campaigns launched by the company. This becomes a 9-dimensional data warehouse.

The basic transaction data is processed by Extract-Transform-Load (ETL) programmes to shape it for fitting into the data warehouse design.

Once the warehouse is populated with all the data classified under these dimensions, it becomes possible to analyse the product behaviour on the various dimensions. This is called 'slicing and dicing of the data'. The analysis is conducted by a class of fast softwares called 'Analytics'. Analytics use a methodology called On-line Analytical Programming, or OLAP in short. Using these tools, it is possible to address the 'what-if' questions (what will be the incremental sales, if a promotional campaign is launched in a specific geography?). These techniques also allow setting up and testing hypotheses.

Data warehouse can be used to carry out trend analysis and scenario modelling usually required in operating a supply chain. Hence it becomes a useful part of the infrastructure to validate the health of the supply chain from time to time.

Third-party data (such as retail and consumer spending data or demographics data supplied by market research firms like AC Nielsen) is available at a price—however, most companies will not be able to use it unless they have an ability to integrate it into their systems and data architecture. Data warehouse can be a place to accommodate and harmonise such third party data.

Data warehouses are expensive to set up and operate. Hence most mid-sized firms do not have them. For such firms, object-oriented technologies could provide an answer. These technologies are able to encapsulate the third-party data in its native form with an agent software that can answer specific pre-defined queries to the querying application.

9.4.5 Portal Technologies

An enterprise will have many users, decision-makers or trading partners who will be marginal in their IT usage. These marginal users do not need all parts of data or the IT system functionality. For example, the Corporate Treasury Manager may only access the system to compute the cash flows and surpluses. A supplier may only want to know the status of his deliveries and payments.

Enterprise information portals are frameworks for integrating information from multiple sources and personalising it for the specific user. Portals give the users a single point of entry into the IT systems—usually through a web-based user interface. The user accesses information from various systems through specific 'portlets' (programmes to extract and display the data). The main purpose of the portals is to access and view the information, hence the processing ability is limited. IBM, Oracle, SAP, Vignette, BEA are some of the companies providing portal technologies.

With portals, the marginal users get a controlled but limited and secure access to the IT system. The marginal users can be within the same organisation or outside the organisation. They can be located anywhere, and will be able to access the system simply via internet. Portal technologies also massage the information, so that different people are able to look at it differently. For example, a materials manager and a distribution manager may look at the same data in different ways, as per their needs.

9.4.6 Dashboarding Technologies

Analytics is often used to compare two or more sets of data to understand underlying phenomena or trends. Presentation of such comparisons in graphical form is useful. Dashboarding technologies allow painting, charting and frequent refreshing of the vital information and making it visible to the various users.

9.5 CURRENT PRACTICE

9.5.1 Design of Information Technology for Supply Chain

The key function of Information technology is to *manufacture and distribute information* to be used by *the businesses*. Many companies are unable to use Information Technology effectively for managing their supply chains. There are several hurdles to be overcome before IT can be made effective. Leading global corporations such as Hewlett Packard, Procter and Gamble or Alpha Laval have implemented several strategies to address this area. For using IT effectively, the enterprises need to take a strategic view of supply chain management, and go beyond the technology into several organisational areas. Such a view will include four factors given below:

(a) The Role of Supply Chain Managers—From Operators to Change Managers

Supply Chain managers must play a principal role in determining exactly what 'information' is to be 'manufactured' for their use. The pace of change in the product innovation and its supply chain environment has accelerated considerably over the last two decades. Accordingly, today's supply chain managers are required to be change-oriented (experimental) in the way they manage the supply chain. While being experimental, they must be careful that each new initiative creates an incremental value for the enterprise. All such initiatives will require accurate and timely data from the supply chain operations and an ability to perform data analysis.

The Information Technology today has the capacity to provide such data and its analysis. If the supply chain managers have an insufficient understanding of what IT can provide, it becomes difficult for them to visualise how they can—given the right information—improve the supply chain processes and their control over them. Hence, in addition to being change-oriented, they need to be familiar with what the Information Technology can do.

(b) The Role of IT Organisation—From Service Providers to Partners/Consultants

IT organisation accordingly must accept the burden of educating the supply chain managers about how and where the information technology can create an advantage. Business users have traditionally viewed the IT organisation as slow and change-resistant. This is partly due to the fact that the IT has been historically structured as a corporate department providing information to the corporate users.

As the supply chain managers get experimentally active, the IT organisation will need to get more business-oriented, consultative and initiatives-driven. They will need to view themselves as engaged in a proactive partnership with the businesses rather than providing a service-on-demand. They should develop an improved level of understanding of the business environment faced by the functional users such as supply chain managers. They should also seek to obtain a greater access and leverage to the business users, many of whom will be situated away from the corporate headquarters. Leading global companies like General Electric or Procter and Gamble have implemented the role of a full-time IT representative to the business, to support the IT:Business partnership.

(c) Investments in IT Infrastructure

Need for Building IT Assets

A robust IT infrastructure is necessary to take advantage of the features commented in the beginning of this section. Corporate executives may not completely understand that such investment can be rather large. The case for such capital investment needs to be made by the supply chain managers working in partnership with the IT organisation. However, once in place, the advantages of such an IT infrastructure are significant and not easily obtainable by any other means. For example, a capability to perform trend analysis will require the following features in IT systems:

(a) Well designed data model with multiple relevant dimensions (**Enterprise Data Dictionary**)

(b) Capability to synchronise and harmonise data from outside the enterprise (**Data Management and Synchronisation**)

(c) A single enterprise-wide business rules engine having an ability to capture and store transactions and store high quality data in large volumes (**Transaction System, Application or ERP**)

(d) An organisation of such data into a form that supports powerful analysis (**Data Warehouse or Data Mart**)

(e) A capability for rapid search, pattern recognition, analysis and visual presentation of findings (**Search Algorithms, OLAP procedures, Dashboarding/charting tools**)

(f) Ability by decision makers who may be located anywhere, to have an integrated view of selected data and conduct ad-hoc comparative analysis based on their functional responsibilities (**web-based Portals**)

Enterprises not having such a backbone will be unable to analyse or predict the trends in their businesses in any scientific manner.

Such an investment is perhaps not needed for smaller manufacturing businesses, since they may find equal utility in ad-hoc spreadsheet-based analyses of data. However, as these enterprises grow, the need for a well-designed infrastructure will grow rapidly.

Limitations of Existing IT Systems

The design of the existing IT systems may impose restrictions on the ability to meet the demands of the supply chain managers. Extra investment will be required to remove such limitations. These restrictions principally arise from the departmental design of the IT systems. This is explained below:

Departmental Nature of Application Design

The core applications are generally structured in departmental terms, i.e. each application supports business processes used within a department. For example, the warehouse applications will only process all transactions for a warehouse; inventory applications will be concerned only with the movement and storage of the materials in the inventory, etc.

In this architecture, any single business process that spans multiple departments will be supported by a sequence of transactions occurring in multiple discrete applications responsible for the departments involved. Such a sequence cannot be coordinated or automated unless the applications are integrated.

A departmental design creates three major hurdles in designing the IT systems for supply chain.

(i) Lack of Orchestration Ability

By definition, supply chain must span multiple departments acting in concert for the various business processes. When the applications are loosely coupled, the supply chain process orchestration will be disjoint and poorly controlled. For example, a goods receipt note in a warehouse receiving application will not automatically be considered for a picklist operation, unless the receiving, the order matching, and the cargo planning functionalities are orchestrated across the various applications. Careful attention needs to be given to ensure that such applications are able to work in a coordinated manner, if they are to play a role in the supply chain management.

(ii) Lack of a Uniform Data Model

Since a supply chain spans multiple departments, it is necessary to have a standardised data nomenclature across the applications. If the data model differs across the applications, it becomes hard to manage the supply chain. A heterogeneous data model reduces the manager's ability to compare, control and validate the health of the supply chain. For example, the Engineering Bill of Materials (BOM) may differ from Production BOM in many companies. It is not a problem for the respective department to manage their work—but it becomes difficult to manage the extended supply chain. To address this problem, IT organisation needs to employ methodologies and tools such as Master Data Management to harmonise the data model and ensure a uniform treatment of the data.

The supply chain management requires a fair amount of third-party data, i.e. data which is neither owned nor controlled by the enterprise. Getting this data from outside trading partners is difficult because the partner will generally resist sharing this information. This problem is out of scope for IT, and requires negotiations and trust-building initiatives. However, even where such data is available (through Vendor-managed-inventory initiatives with retail stores; or EDI-based collaboration with suppliers), such data is not in a form or definition consistent with the enterprise data model. Before such data can be added to the enterprise database—for further analysis by the supply chain manager—it needs to be harmonised and synchronised with the enterprise data model. Portal technologies or object-oriented technologies could partially address the latter problem. However, doing this requires special technology skills not easily available to the IT organisation in a manufacturing company.

(iii) Problem of Absent Data

Under the departmental structure of applications, the data controlled by each application is the one directly required by the specific transactions in that department. Supply chain managers are often concerned with the data relating to the overall process. Such data does not fall within any single departmental boundary. This creates an important limitation for managing supply chains. The data required to manage the supply chain does not exist in any application, and must be computed from multiple data points that may be controlled/owned by different applications. Thus, a new set of programmes and data structures become necessary to address the needs of supply chain managers. Such programmes generally do not exist in the Transaction Engine—especially the loosely coupled core applications. The following example will illustrate this problem.

A perishable product is made in a factory, dispatched to a warehouse, and from there it is dispatched to the retail store. In this movement, the finished goods inventory application will create a dispatch note listing the item code, quantity dispatched and the date (optionally, time) of dispatch. The warehouse receiving application will record the receipt of the item, the quantity and the date (optionally, time) of receipt and will allocate the shelf location. The logistics application will match the inventory to a sales order, and generate a pick list noting the item code, quantity, date (time), carton/crate number and the truck details. On arrival the retail store will accept the shipment, sign the warehouse dispatch note and proceed to make appropriate entries into its own store applications.

Suppose, because of the deteriorating road conditions, the supply chain manager of the product is now concerned with the time-to-dispatch and wants to keep it to a minimum. It will be clear that such time-to-dispatch has not been captured by any application in this sequence. It is not known when the item was actually loaded on the truck and when the truck actually reached the customer. The time of customer receipt may be captured in the retail store application, but that data is no longer available to the supply chain manager, since the store is not controlled by the company. It could have been captured by the transporter who delivered the item to the store, but many transporters have no access to online IT applications, and instead use manual, paper-based transactions. Hence they may simply not have this data. There is no requirement that the transporters return the paper logs to the company. In summary, the supply chain manager has no way of knowing the actual time it has taken to dispatch the material, and its variability. Depending on the exact design of the systems, it may not even be possible to compute this value.

The example given above is not hypothetical. Similar limitations exist if the supply chain manager wants to study other control variables that span multiple supply chain stages such as transport cost/unit.

To overcome this limitation, an extended supply chain application with a separate data structure must be designed on the top of the Transaction Engine.

(d) Organisation Culture and Structure—Enabling New Ideas, Methods and Technologies

The power of IT depends on the hands in which it is placed. Many manufacturing companies may persist with their view of IT as merely a record-keeping system. This may have worked well when they were smaller. But with continuing growth, the operations cannot be managed without increasing sophistication of the IT systems. As the enterprises implement a strong and active supply chain function, they need to create an IT organisation working in consultative partnership, and invest into a robust IT infrastructure. The organisational culture becomes important to sustain these initiatives and to continue to create an advantage. The top management could implement several initiatives to ensure that the supply chain management becomes a powerful instrument of competitive advantage.

- Supply chain organisation structure in which strategy formulation/ implementation is recognised as a key responsibility, different from operations responsibility.
- IT organisation structure should recognise architecture strategy and design as a key responsibility, different from IT operations
- Selecting and staffing right individuals for the roles
- Implement the Key Result Areas (KRAs) and the review processes for the key individuals
- Ensure accurate information for the performance management of the key individuals

➢ Key supply chain leaders and individuals should report to higher levels of organisation to ensure visibility and support for the supply chain initiatives from the top management.

9.5.2 Adoption of Information Technology

In general, for any IT system to succeed, it must be seen as an organisation-wide change programme and not merely as a technology implementation project. IT system is a replica of the various organisational processes, operations and behaviours. In the context of supply chain management, such processes are orchestrated across the departmental boundaries. A mature enterprise experiences many levels of disagreements and non-standard processes between its departments. Such lack of standardisation leads to value destruction for the company. Information Technology provides a platform for the executives to obtain consensus towards a standardised set of processes. Defining and implementing such processes becomes the core of a change management programme, with Information Technology providing a backdrop.

The key elements of a successful implementation are: (a) educated users, (b) proactive IT organisation acting as change facilitators, (c) robust IT assets, and (d) top executives playing a positive role as change managers. The leadership of the respective functions needs to engage in positive negotiations, and employ initiatives to promote a consensus-building environment.

Choice of technology is crucial for the implementability. Technology comes in different forms/features at widely varying costs. The difference in cost to support a feature can be staggeringly high. For example, online, real-time reporting can cost as much as 20X–50X more than if the same reports are acceptable with a 24-hour delay. With constant evolution of the computing technology, newer technologies may be very expensive to implement, even if the cost of acquisition is low. When choosing a technology, due attention must be paid to the features, utility, usability, implementability, maintainability and cost. It is useful to evaluate the technologies as to their life cycle costs rather than one-time purchase costs.

Due to lack of in-house skills, it often becomes necessary to engage third-party service providers to implement the information technology. Such engagements need to be managed carefully especially if their work involves technology or architecture decisions.

9.5.3 Deployment and Usage

New release of Information Technology generally changes the operating environment for the users, and is therefore disruptive. The training (or re-training) needs of the users are almost always underestimated and under-budgeted. Whenever a version of IT is released for use, it causes a spike in demand for support for which the IT organisation needs to prepare itself. Increasingly, such releases affect a large number of users who are spread out geographically—sometimes internationally. Web-based training programmes can ease the cost and effort of preparing the users for a new release.

Once the users become familiar with the new operating features, the initial spike for support dies down. However, with growing familiarity, the users start expecting more features and functionality. Continued effective usage is possible if the IT organisation provides support for such demands.

9.5.4 Costs

Information Technology is not cheap. Whether used well or not, it costs about the same to set up and operate. Since its usability is largely governed by factors outside the immediate technology domain, the high-costs-poor-usability syndrome often gets it low marks in user popularity. IT costs come from (a) design effort (b) technology acquisition, (c) maintenance of the IT infrastructure and (d) training costs. IT organisations must share the responsibility to educate the company executives about the costs and to manage the user expectations.

In the context of supply chains, the benefits of IT will come from an overall improvement in the supply chain efficiency. However, most enterprises lack the mechanism of computing the cost benefits and linking them to the improved Information Technology. Without such benefit estimates, the investment costs may appear large and the proposals may be turned down by the corporate executives. A project costing approach with inclusion of long-term benefits from improvements in supply chain may be a solution to address this issue.

9.6 THE PROMISE OF INFORMATION TECHNOLOGY

The Information Technology continues to evolve by adding more powerful technologies, and applications. These can have a significant impact on the design and the operation of the supply chains. We will discuss three such trends:

9.6.1 Radio Frequency Identification Technology (RFID)

A material in the supply chain must have a unique identification to ensure control over its custody and movement. A common way to do this is to fix a barcode label on the material listing its item code or SKU code. Barcodes are black-and-white vertical strips printed on label, which represent the item code using some industry-standard format. Barcodes can be read by hand-held optical scanners which convert the scanned image into the alphanumeric digital item code. The scanning operation eliminates the need to enter data manually and speeds up the operation significantly. Barcode labels are very cheap and can be printed on a standard printer.

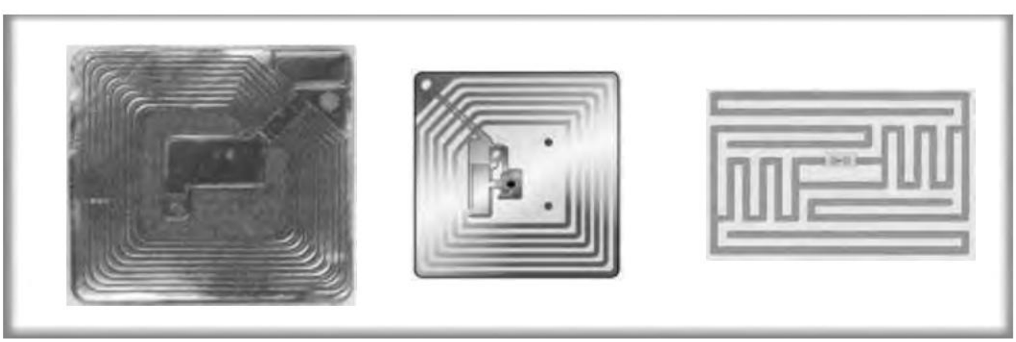
Figure 9.1: Example of a Barcode Label

0 123456 789005

However, the scanning of the barcodes needs human operators. Hence it cannot be speeded up beyond a certain limit. The number of human operators is directly proportional to the material volumes to be handled. Hence it is difficult to handle sudden fluctuations in material volumes.

Radio Frequency Identification (RFID) is a new technology to scan the materials without any human intervention. The technology is built around a small, paper-thin electronic microchip and antenna circuit called RFID tag. When exposed to specific

Figure 9.2: Example of RFID Tags Showing the Microchip at the Centre



radio frequencies, the circuit in the tag transmits a unique digital code identifying its presence. This code is read by radio receivers which transmit it digitally to a computer system. RFID overcomes the limitations of barcode technology listed above.

RFID can have a material impact on the supply chain, since it can record the movement of materials without any human intervention. The data enters the systems automatically as soon as the material movement occurs. This has many advantages:

1. Information about the movement of materials is available real-time, and not delayed as is the case with most IT systems.
2. Theft of sensitive/expensive materials is controlled, thereby reducing the shrinkage cost.
3. Improved inventory accuracy leads to more efficient supply chain policies.

RFID tags come in three types:

1. Passive RFID tags do not have own power source, but use the induced power from the scanning radio wave to transmit the identification code. Passive tags have the shortest transmission range and need to be close to the scanning reader. Depending on the radio frequency used, the effective range varies from 10 cm to a few metres. Passive tags may cost in the range of US$0.07–US$0.15.
2. Active tags have an in-built battery source that powers the microchip and also the transmitter. This allows them to transmit over much longer ranges–up to 500 metres. Active tags can cost US$2.00 or more.
3. Semi-passive (battery-assisted) tags use in-built power for the microchip, but do not have a transmitter. The signal transmission works like a passive tag. Semi-passive tags are faster and give higher reader accuracy. Semi-passive tags cost around US$1.00 to US$1.50.

Barcode costs are negligible—around US$0.002. In contrast, RFID tags cost considerably more than the barcodes. The tag costs are expected to decline as the technology matures. Even so, the industry analysts do not expect the costs to fall below US$0.05. Supply chain managers should conduct a careful cost-benefit analysis of the technology before they consider its adoption.

9.6.2 Service-Oriented Architectures

Service Oriented Architecture – SOA in short, is a way of designing the IT systems so that they operate as a collection of services. Each service consists of its own programmes, code, data, workflows and presentation layers and performs a specific set of tasks upon request. The requestor can be a person or another service. The services can exchange data amongst themselves, or execute a common process in a coordinated manner.

By its definition, SOA is independent of the underlying technologies. Hence, IT systems designed under different technologies can work with each other (interoperability) as long as they are designed using the SOA principles.

This feature is most useful from the supply chain manager's point of view. There will be several independent or loosely-coupled players in any given supply chain. Each of these players may be using its own IT systems and data. For a supply chain manager, many initiatives may span the supply chain and may require a coordination of the different IT systems for exchanging data or for process execution. If these IT systems are architected as silo-designs, then coordinating them becomes an extraordinarily complex task. A re-design of the IT systems using SOA framework can greatly assist the supply chain management.

9.6.3 Service Providers, Outsourced IT Services

Over the past five to six years, a set of independent service providers have emerged in the field of IT. These providers are increasingly providing several types of services which can be used for addressing the supply chain management requirements that cannot be met by the internal IT departments. Examples of such services include:

1. Data Collection, Cleaning, Archiving
2. Data Preparation, Analytics, Presentation
3. Application Service providers offering specialty applications on a pay-per-use basis
4. Turn-key IT systems installation and operation—typically for 3PLs.

Summary

In summary, Information Technology offers compelling application in the field of supply chain management. In the hands of a thinking and experimental supply chain manager, it can become an instrument of unique competitive advantage for the enterprise. IT enables many functional features that cannot be obtained by any other means. However, there are several considerations before IT can play an effective role in supply chain management.

As organisations start focusing their attention on managing extended supply chains, and as the Information Technology continues to evolve, the scope for using IT in supply chain will continue to widen.

Case references : An example of IT issues in the context of the retailing end of supply chains is found in the analysis of the case of Food World (B).

Exercises

1. What are the basic information requirements of Supply Chain Management? Give examples for a maker of consumer products.
2. What are the advanced information requirements of Supply Chain Management? Why are these called advanced requirements? How is the supply chain requiring advanced requirements different from the one that is satisfied with the basic requirements? Discuss in the context of the consumer products maker.
3. What are the elements of a modern IT system? How does the 3-tier system design contribute to a more effective operation of the supply chain? Which goals of the supply chain management will be harder to achieve without such a design?
4. What is the utility of the Business Intelligence Layer and Portal Technologies? Discuss giving concrete examples in the context of the maker of consumer products.
5. How should the supply chain manager augment his role to make the most effective use of IT? Contrast the goals and methods employed by a traditional operations manager vs. the supply chain manager. What changes may be required in terms of complementary support from IT organisations and the top management?
6. What would be the elements and features of an IT backbone that is 'ready-for-supply-chain'? What limitations may be expected in implementing such a backbone?
7. What hurdles may be expected in deploying and using a 'ready-for-Supply-Chain' IT backbone? What methods would you suggest in addressing such hurdles?
8. How would you estimate the total cost of implementing the changes to an IT backbone? What cost elements would you include? How would you estimate them? How would you assess the benefits flowing from such an improved IT backbone?
9. What are some of the new technologies and developments in Information Technology? How would you assess their utility in the context of the goals of supply chain?

CHAPTER 10

Quantitative Tools for Supply Chain Management

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References

Exercises

INTRODUCTION

Is Supply Chain Management (SCM) an art or a science? Arguably, since it is still an evolving field, SCM can be viewed as more of an art than a science. However, a number of tools are available to help the manager arrive at a more scientific basis for decision-making, many of them drawn from the Operations Research/Management Science (OR/MS) discipline. In this chapter we present some quantitative tools that find ready application in SCM.

Consider first the issue of matching supply with demand. In the ideal world, there would be no variation in customer demand, the production processes would be extremely reliable, and products could be delivered as soon as they are demanded. Since this is a situation that will almost never be realised in practice, organisations in the supply chain will have to estimate what their customers are demanding and determine how this demand can be met. A related decision is concerned with where to source the raw material or components required so as to meet demand and how to arrive at fair pricing contracts. The manager of the supply chain will also have to determine how much inventory to carry in the supply chain, and where this inventory should be strategically located.

In this chapter, we present tools for helping managers (a) match demand with supply (Forecasting), (b) determine where to hold inventory and the quantity to be held (Management of Inventories in the Supply Chain), (c) determine production quantities and how to transport them (Linear Programming and Network Models), (d) evaluate pricing decisions.

These tools are well studied in the academic world and professional practice, and can be used effectively in many situations. This chapter cannot do justice to all of them in detail, but we do provide an orientation to classify models and decide on the scope of their applicability. To use them to full effect would require further study of the associated technique. In all cases, software support is available in a variety of combinations, and part of the supply chain manager's function may be to judiciously plan and use such software solutions. We provide a number of small exercises which will help in appreciating the scope of the modelling techniques that we present and the likely data requirements and level of detail that the model would require.

10.1 FORECASTING

As noted earlier, if lead times in operations were zero, then there would be no need to forecast demand. This points to a very important direction in supply chain improvement, that of reducing the lead time. Apart from obvious benefits like reducing pipeline inventory (lower lead times mean shorter pipelines and so less inventory and working capital to attain the same throughput), there are less apparent, but equally important benefits in the area of reducing uncertainties. In other words, the smaller the lead time, the smaller is the need for safety stock to achieve given service levels. One way of explaining this would be that smaller lead times lead to smaller forecasting errors and so less safety stock requirements. That said, since supply chain operations will certainly involve some lead time, it is necessary to forecast various quantities, especially demand. Forecasting also plays a key role in the sales and operations planning process.

We consider the forecasting process for a single product, although we will subsequently point to some issues in forecasting simultaneously for multiple, related products. For a single item, the standard forecasting framework represents time in discrete periods (e.g. week 1, week 2, etc.) and a time-indexed series of demands is maintained. This allows us to extrapolate demands in future time periods as per the requirement. The model is as follows:

Let X_1, X_2, ..., X_t be the past demands up to time period t, which is the current time. We shall use these values to generate forecasts for time periods t+1,..., t+k. There are two standard ways of estimating the base value, given past data that is subject to some randomness. These are (a) the moving average model and (b) the exponential smoothing model. With these, the trend, if any, and seasonality, if any, is superimposed, to get a point forecast for future time periods. The intention is to generate a forecast, Z, for the next time period, given the X_i values.

10.1.1 Method of Moving Averages

In the moving average model, a parameter m is chosen and the base value is estimated as $Z' = (1/m)\,[X_t + X_{t-1} + \ldots\ldots + X_{t-m+1}]$. The value is thus taken to be the average of the previous m values. The set of values considered therefore is a moving bunch of m values over which the average is taken, hence the name. We see that fluctuations in the data in the distant past are eventually immaterial. The less the value of m, the more weightage we give to recent data, i.e. we believe that the demand data is more volatile.

10.1.2 Method of Exponential Smoothing

In this method, a parameter α is chosen between zero and 1 and the updated forecast for the base value is a weighted mean of the previous forecast and the most recent value. i.e. $Z_{t+1} = \alpha Z_t + (1-\alpha) X_t$. Applying this recursively, we get $Z_{t+1} = \alpha Z_t + (1-\alpha) Z_{t-1} + (1-\alpha)^2 X_{t-1}$ … so each term in the time series is weighted by an exponent of the term α (the smoothing constant). This explains the term exponential smoothing.

10.1.3 Trend

The consideration of trend in the demand data is easily incorporated. For example, a linear grown rate is accounted for by making the forecasts $Z_{t+k} = Z_t + ka$, where a is the growth rate. This growth rate itself is estimated from the past data (e.g. the most recent estimate of the growth rate is $X_t - X_{t-1}$ or we may wish to take the smoothed value of this growth rate over the past several time periods), by using the moving average logic or the exponential smoothing logic. The latter method, using double exponential smoothing, to estimate the trend as well as the base value, is called Holt's method.

10.1.4 Seasonality

If we believe that the demand data exhibits seasonality (e.g. daily data exhibits seasonality with respect to day of the week, or monthly data exhibits seasonality over the year), we can bring in seasonality factors quite easily. The full blown version of this, where exponential smoothing is used to estimate seasonality factors as well, is called Winter's method. For this, we require at least three full seasons' worth of data.

10.1.5 Regression

Another approach to forecasting is to use regression, a tool commonly used in economics and statistics. To apply regression in a forecasting context, time is assumed to be an independent variable, and demand is assumed to be the dependent variable. The dependence of demand over time is typically presented as a linear equation:

$$D_t = \alpha + \beta t,$$

where α and β are constants to be determined from the given data. The usual way is to use the least squares criterion for determining the parameters α and β.

Regression models are applicable if we have other data that can be assumed to (largely) influence what we are interested in. For example, we may believe that tractor sales are influenced by agricultural prices in the previous season. A regression model with prices in the previous season as the independent variable and tractor sales as the dependent variable can be calibrated and used.

The R^2 measure of fit of a regression model tells us how accurate the model is likely to be.

Although the terms dependent and independent variables are used, actually there is no restriction of causality and it could just be that the two sets of data are related in some way that is accurate enough for our purpose. The model is easily extended where the quantity of interest 'depends' on not one, but several independent variables. With an assumption on the nature of influence (e.g. linear), the appropriate co-efficients can be calibrated using previously gathered data.

Returning to time series models, we note that if the data is inherently volatile, then forecast error is bound to be high. All we can ensure through our techniques is that the forecast error is in some way not too far from the 'true' error.

If data are auto-correlated (i.e. depend on previous values in the series), apart from depending on time, there are additional methods that can be used. Box and Jenkins ARIMA (Autoregressive Integrated Moving Average) model is an example of such a model. We note that the term Moving Average here refers to a more subtle notion than in Section 10.1.1 and the reader is referred to a text in Statistics or Time series analysis.

10.1.6 Forecast Error

Measures for determining forecast errors (such as Mean Absolute Deviation) are useful to estimate the efficacy of forecasts and the resulting contingency plans. A truism is that forecasts are always wrong, but it is then important to estimate how wrong they have been in the past (when using a given technique) and perhaps refine the forecast technique. It is also true that at least some inventories in supply chains are a consequence of not having information (as a 'substitute' for inventories) and to that extent, forecast errors capture the inventory related costs of inaccurate information.

We remark that by and large, forecast errors are about as much as the inherent volatility in demand (they can certainly be no better than the demand variability and a good forecasting method will see to it that they are not much worse than that). So the only good way to reduce forecast errors is to manage demand variability itself. This can be done, to some extent by customer relations, information sharing, product design, and other marketing initiatives, some of which are beyond the scope of this chapter. From a supply chain point of view, information sharing upstream can reduce variability to some extent. If customers are aware of the accurate position of dispatches and production quantities, they can plan purchases and will not react in a volatile manner (resorting to contingency buying, for example). This can actually be a valuable smoothing impact on supply chains.

10.1.7 Forecasting of Multiple Products

We briefly look at some issues in forecasting of multiple products. Consider, for example, an automobile dealer, who deals with several different variants of a certain model. Forecasting the demand of each of these variants may make very little sense except for a few of the models of the bread and butter variety. Many models may sell in ones and twos over several time periods, depending on the tastes of customers. Rather than forecasting such demand, a demand sensing procedure based on a behavioural model of the customer's preference may be more useful.

An example of a behavioural model is the multinomial logit model.

10.1.8 Point Estimates and Distributions

A single estimate of demand may be enough for aggregate planning of quantities ahead of time, or for capacity planning. But for inventory planning, we need an estimate of the variability in demand as well. This is most usually done in the stationary case, using data over a period where the underlying distribution of the demand is the same. Stationarity actually means more than this, but this is enough for our purpose. We emphasise that stationary demand does not mean constant demand, but rather that the demand distribution (probabilistic behaviour) remains the same from one time period to the next. In this case, we can use statistical techniques of fitting distributions to map the past data to derive a demand distribution. The simplest way is to de-seasonalise and remove the effects of trend and then plot a histogram of the demand data. This will give a variability which we can capture using a discrete (or sometimes continuous) distribution.

Sometimes, we have reason to believe that the demand data is normally distributed (e.g. when it arises as the sum of several independent and identically distributed choices of various individuals, when by the Central Limit Theorem, the resulting sum has the well known bell shaped distribution). In this case, all we need to do is to estimate the mean and variance of this distribution and the entire probabilistic behaviour is then available for further decision making (e.g. safety stocks). This is because the normal distribution is fully characterised by two parameters (usually the mean and variance, which is nothing but the square of the standard deviation).

We remark that the mean and variance exist for all meaningful distributions. For example, a Poisson distribution (capturing completely random occurrences drawn from a large pool) is characterised by a single parameter λ and the mean and standard deviation are both equal to λ.

10.1.9 Qualitative Aspects of Forecasts

In business, the qualitative understanding of the market is as important as the formal techniques for analysing demand. Competitive elements are important, qualitative shifts in customer preferences can be estimated well before a model can detect it and finally, a firm's own initiatives can influence the demand (e.g. through advertising or promotions). These aspects should obviously be taken into account when moderating forecasts that are generated by a model.

10.1.10 Collaborative Planning, Forecasting and Replenishment (CPFR)

In supply chains, information sharing is a critical issue. Forecasting is an activity that generates crucial information on the basis of which plans are made, orders placed, dispatches made, stocking decisions taken etc. It makes sense to try to see if this can be done collaboratively with supply chain partners. CPFR is an attempt to achieve this.

We remark that each supply chain player can very well forecast independently, but several decisions made by one player as part of a plan can affect the resulting flow of information (e.g. orders) and this is what should be shared where appropriate. An example is the following. A manufacturer decides to move to rail based container movement to cut transport costs. This involves batching of dispatches to some locations.

This creates a lumpy demand for the supplier, which if seen in isolation at one time, seems like a big swing in the demand. This is really a policy driven decision, and not a real uncertainty in demand. With this, we observe that a lot of 'randomness' in demand vanishes and what remains to be estimated is the true fluctuation in the primary demand (and supply) which the supply chain has to really grapple with.

CPFR is now part of a business level set of standards in forecasting, in which major retailers and suppliers are participating, so as to improve the state of the art.

10.2 MANAGEMENT OF INVENTORIES IN SUPPLY CHAINS

The management of inventories in supply chains has two broad aspects. One is the planning of quantities at different stages based on aggregate demands, capacities and overall economies of production—this is the inventory planning decision. The second is the inventory control issue of responding in the short run to demand and supply uncertainties and the operation of safety stocks. We discuss both of them in turn.

10.2.1 Inventory Planning

The single stage inventory planning problem to minimise costs of production and stocking is exemplified in the well-known Economic Order Quantity (EOQ) or Economic Batch Size (EBS) concept. Even this fundamental concept captures some ideas central to supply chain management, where the attempt is to meet a given (steady) demand at minimum cost considering the basic technology on hand—which considers either the batch production cost or the batch ordering cost. It is interesting to note that both these elements of cost are coming down due to technological advances.

1. Batching constraints are coming down in manufacturing because of flexible, quick change technologies in many processes.
2. Batch ordering costs are coming down because of developments in IT.

For example, a shipment of goods may be consumed uniformly over time at a certain rate, for which we charge an average inventory holding cost, but equally true is that it takes a uniform production rate a certain time to build up that shipment. In a traditional system, since it was another person (the supplier) who was bearing that cost, it did not factor in the EOQ computation, but the supply chain view is that the cost is anyhow borne and reducing it is of the first order of importance, with the next task being that of splitting the accrued gains.

10.2.2 Inventory Control

Inventory control refers to the management of inventory under uncertainties in supply or in demand, or both. Two commonly used ideas in inventory control are the following:

1. Fix the size of an order or a shipment, but allow some flexibility in the timing of the order. This is often called a reorder point system with a fixed reorder quantity or (R, Q) policy. Here R is the inventory level which triggers off a reorder, which is always a certain fixed amount Q. These parameters R and Q can be chosen 'optimally' based on cost consideration in an expected sense. See the next section for an illustration of a commonly used variant of this policy, the two bin policy.
2. Another commonly used idea is that of the reorder level, order up to level. This works as follows. The ordering cycle is fixed such that orders can be placed only at certain fixed intervals. The amount of the order, however, can vary. A general form of this is the (S, s) policy, where an order is placed to get the inventory level back up to S whenever the inventory in the review period (those intervals when orders can actually be placed) falls below s. Note that since we survey the system only at certain periods, the inventory at that time could be below s. In fact, in most such systems, a certain percentage of stock out is anticipated and accepted as a via media solution from a cost perspective. The value of s is chosen so as to guard against stock out in the lead time and the value S is chosen keeping in mind the economies of ordering and holding inventory.

10.2.2.1 Cost Models

The basic idea in planning for inventory under uncertainties is the following. First, analyse the consequences of falling short by one unit of inventory (this includes the cost of express shipments in the case of committed demand, the cost of losing customer goodwill, the opportunity loss of the margin of sale assuming that the customer will not return for that particular sale), etc. Call this cost C_u (the cost of under-stocking). Next, analyse the consequences of having one unit of excess inventory (this includes inventory holding costs, the cost of capital, the cost of storage, and perhaps even the possibility of spoilage, obsolescence, losses etc.). Call this cost C_o (the cost of overstocking). We emphasise at this point that there could be some subjectivity in both these costs, but it is still useful to estimate them and use them as guidelines for making the decision of how much to stock.

We can now see that the amount to stock will go up as C_u increases (it is more attractive to stock as the cost of falling short is high) and will go down as C_o increases (it is expensive to wind up with excess stock). The precise trade-off requires an estimate of the demand, which is uncertain. The standard approach is to capture this uncertainty through a demand distribution (using the histogram derived from past data, for example) and position the inventory at a level $Q^* = F^{-1}(C_u / (C_u + C_o))$. This formula is of considerable theoretical importance and is the basis for cost optimal inventory control in an uncertain environment. It seeks to minimise the expected (or average) costs of operating in this environment. This Model is referred to as the "news vendor" model in the inventory control literature. Note that in such a policy, one expects to fall short some of the time and have excess some of the time (as per the random demand), but the optimal thing to do (with all the assumptions of cost and demand behaviour) in the long run is to stick to this quantity of stock at the beginning of the period under consideration.

The same argument can be used to derive an 'optimal' policy for some similar situations. See example below.

Example 10.1

What is the optimal time of ordering under uncertain lead time conditions, where there is a cost of material arriving early and a cost of arriving late?

Suppose trucks arrive at a loading point after t days and with probabilities as given below in Table 10.1 below. This summarises the uncertain supply condition of trucks that arrive between two and 10 days after placing an order.

Table10. 1

Days (t)	2	3	4	5	6	7	8	9	10
p(t)	.01	.02	.3	.25	.2	.15	.05	.01	.01
Cumulative probability F(t)	.01	.03	.33	.58	.78	.93	.98	.99	1.0

If the desired time of shipment is time t* and if the truck arrives before t*, then a cost Rs per day (cost due to early arrival of trucks) is incurred. This cost is basically waiting charges which are incurred due to keeping the trucks idle and could correspond to demurrage charges by the vehicle supplier (commonly charged for ships or railway rakes) or one's own fleet utilisation charge.

This cost can be calculated in many ways as below.

(1) From depreciation cost: Suppose truck cost is Rs 10,00,000 and life of truck is 18 years, then $C_1 = 10{,}00{,}000/18 \times 365$ = Rs 152 per day.

(2) From the profit earned: Suppose profit earned from a truck per year is Rs 6,00,000 then, $C_2 = 6{,}00{,}000/365$ = Rs 1,644 per day.

If truck arrives after time t* then some cost Rs C_2 per day (cost due to late arrival of trucks) is incurred. This cost depends upon the type of commodity, inventory holding cost, penalty charged due to late delivery and future market loss due to poor customer relationship etc.

The intention is to place an order at the optimum time before one needs it so as to minimise the total expected cost, which in this case is given below as

$$\text{Total expected cost} = C_1 \sum_{t=2}^{t^*} (t^* - t)p(t) + C_2 \sum_{t=t^*}^{10} (t - t^*)p(t)$$

For finding optimal t*

$$F(t^*) = \frac{C_1}{C_1 + C_2}, \text{ let } C_1 = 60 \text{ and } C_2 = 50,\ F(t^*) = .05455$$

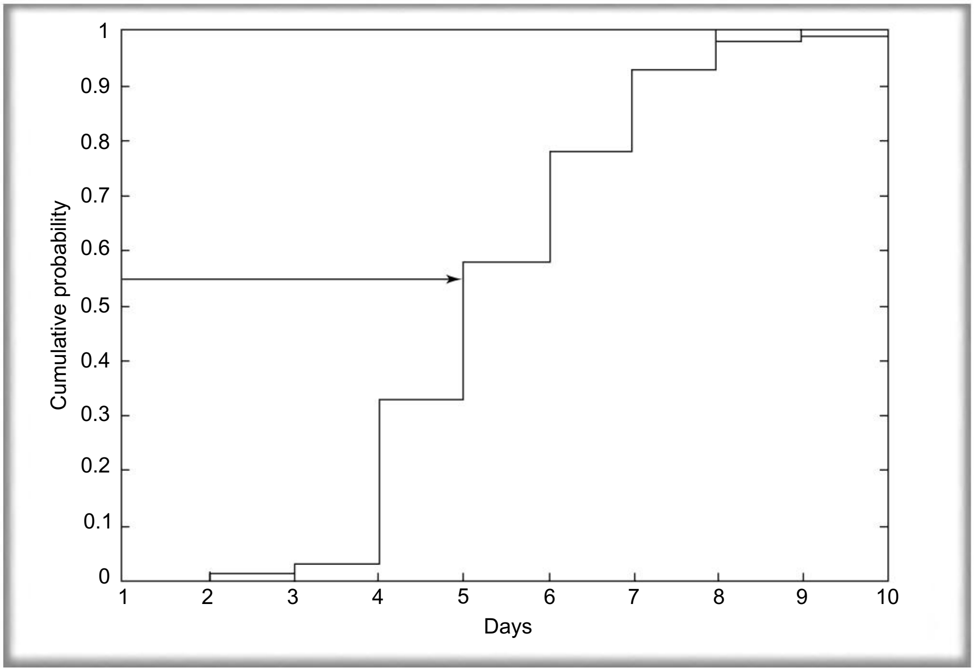
Expected cost for $t^* = 5$ is $E.C_5 = 62.9$ rupees per day

Check that the expected cost for $t^* = 4$, $C_4 = 86.6$ rupees per day and the expected cost for $t^* = 6$, $E.C_6 = 66.7$ rupees per day, and that $t^* = 5$ is optimal. A schematic view in Fig. 10.3 plots the critical ratio $\frac{C_1}{C_1 + C_2}$ against the cumulative distribution function and derives the optimal time. The solution in this case is to place an order five days before one needs the vehicle.

This idea leads to several natural and useful extensions. One is the inventory control of a non-perishable item over multiple periods, where this quantity Q* is then viewed as an order-up-to level. In the absence of any fixed costs for ordering, this leads to a simple, implementable policy: in every period, examine the inventory and order enough to push the level back up to Q*. Note that this could lead to some instances of small sized orders.

How would one approach this question when there is a fixed cost C for every order that you place? This can be viewed as an extension of the EOQ idea, but in the presence of uncertain demand. If we assume a demand rate, akin to the EOQ situation, we can derive a reorder point, re-order quantity policy, which says that when the inventory level hits a level R, place an order for a quantity Q. This will

Figure 10.1



prevent the placement of very frequent, small orders (keeping in mind the ordering cost C). The exact formula for this optimum policy is a bit involved. The key point is that it is the uncertainty of demand during the lead time that is of importance.

A simpler version is the *two bin policy*, where R = Q, where there are two bins each of capacity Q, and the policy is simply to place an order of one bin-worth when the bin number 1 becomes empty. Intuitively, bin number 2 contains the stock that will be used till the ordered material actually arrives.

Finally, the multi-period, discrete time-bucket version of this is the (s, S) policy, mentioned in Sec. 10.2.2.1. Note that this periodic review and replenishment policy is non-trivial even for the zero fixed cost case.

10.2.2.2 Service-Level Models

Cost minimisation provides one rationale for inventory control. Another transparent and customer oriented method in the presence of uncertain demand is service level based inventory planning. Here, if the demand pattern is known, say as a histogram, we peg an inventory level so that we fall short of meeting the demand at most α per cent of the time. Then, $1-\alpha$ is the service level. If the demand is normally distributed, say with mean μ and standard deviation σ, then holding an inventory of $\mu + 2\sigma$, for example, will ensure that we are short no more than 5 per cent of the time, which may be acceptable.

10.2.3 Positioning of Inventory

In a multi-stage system, should one have inventory at upstream stages or downstream stages? If the same item is stocked (without any major material transformation but involving operations like repacking and local customisation), there is a case for holding it as close as possible to the customer points. Especially if the customers are willing to wait a little (some of the time) and trans-shipment across locations is possible at a cost, this is an attractive option.

When some value addition is in fact done at a certain stage, then retaining the inventory at that stage allows for flexibility in meeting final demands precisely. In this case, a centralised stock of inventory becomes attractive.

10.2.4 Management of Perishable Inventory

Almost all inventories are actually perishable, truly speaking, either because of physical deterioration of products or because of product obsolescence. Some models of inventory management do need to be significantly enhanced to handle this aspect. In particular, the costs associated with holding inventory at the end of a planning period may need to be modified and this results in smaller ordering quantities. Paradoxically, organisations would like to penalise themselves for not meeting demand as well, pushing the system towards larger inventories. So it turns out that all costs are higher, and to that extent, operating policies may not be too different. But there is sometimes an impact on optimal stocking strategies.

10.2.5 Management of Obsolescence

Planned obsolescence is now a business strategy in many firms. Such initiatives are taken in conjunction with the planned introduction of new products. This is done to continuously respond to changing customer needs and to compete based on new features. The complication here is to take into account the end of horizon of the product life cycle in inventory terms. Since customers are unlikely to be satisfied with older variants when newer ones are available in the market, the attempt is to minimise the presence of multiple variants at the same time.

In inventory terms, this leads to a tapered ordering policy, where the order up to levels (and thereby the average inventory held at any time) is gradually brought down as the time of product withdrawal nears. Two possible complicating impacts of this are as follows:

- ➢ Service levels may suffer since the firm is operating with less inventory for some time. This would be harmful at a time when the firm is relying on an increased market presence through a new product in the near future.
- ➢ However, customers may postpone purchases in anticipation of new products that are already announced.

This phenomenon is quite prevalent in white goods, electronics and related products. It is increasingly relevant in the software industry as well.

Simulation: Models such as the one above, can become analytically very complicated, and for a one time understanding of the impact of various factors, simulation is a useful technique. Broadly speaking, this would need the following steps (for the scenario above).

(a) Demand patterns are captured from past data and using an appropriate histogram, we should be able to generate a series of appropriate random demands.

(b) The cost criterion and other service measures of interest need to be fixed.

(c) Equations relating the inventories and other parameters of interest need to be developed. For example: Inventory in the beginning of period (n) = Inventory in the beginning of period (n –1) + Orders received in period (n – 1) – Demand in period (n –1).

(d) These quantities are related to the costs, e.g. positive inventories at the beginning of a period indicate holding cost and negative inventories would indicate shortage or penalties.

(e) The simulation is done over a large number of time intervals to get a statistically valid picture of behaviour.

The advantage of such an approach is that a number of practical considerations (ordering costs, capacity constraints etc.) can be easily incorporated into the analysis. Correspondingly, various performance measures of interest, including service levels, can be quantified and assessed. Careful planning of numerical experiments can then give a good idea of the impact of different parameters as well as the effect of different policies.

Tools like Pro-model, Arena, Quest and several general-purpose simulation tools can be employed for such an analysis, apart from building one's own simulation numerical procedures. Simulation is useful in assessing facility investments, complex operating policies and many other decisions, before they are actually implemented.

A related technique is that of system dynamics, which emphasises certain quantitative features of system stability, asymptotic behaviour and the time lags that may occur in a system because of implementing some policies. Tools like iThink can be used for this purpose.

10.3 LINEAR PROGRAMMING OR LINEAR OPTIMISATION

The framework of linear optimisation, popularly called Linear Programming (LP) when dealing with a finite set of variables and constraints, is a powerful and appealing one. We do not attempt a comprehensive review of this topic, but illustrate its use with a number of examples.

Even if 'nature' is inherently non-linear, many practical conditions can indeed be modelled as linear relationship between entities. One example is the inventory balance over time mentioned elsewhere in the context of multi-period inventory management. A similar condition arises in the inventory balance across locations. For example, for a given product, the amount received at a warehouse in a week plus the initial inventory equals the departures to various stocking points in a week plus the inventory on hand at the end of week. A particularly simple form of this is the so-called transportation problem–perhaps more accurately called the trans-shipment problem.

Exercise: Empty containers emerge in a nation wide logistic operator's network at the end of every day and they have to be re-balanced as per the requirements on hand at various locations. How is this to be done in a cost optimal manner if the following are the locations and quantities?

Requirement Matrix

	A	B	C	D	E	F	G	H
A	—	25	24	40	29	35	27	12
B	18	—	50	30	12	45	5	10
C	35	18	—	28	35	15	10	36
D	13	25	30	—	10	15	13	15
E	14	33	15	41	—	17	16	15
F	26	10	28	17	30	—	43	15
G	11	14	5	21	10	21	—	40
H	15	10	15	14	8	12	20	—

Cost Matrix

	A	B	C	D	E	F	G	H
A	0	200	450	450	150	250	300	600
B	200	0	300	180	500	450	230	480
C	450	300	0	320	350	150	150	300
D	450	180	320	0	250	250	300	600
E	150	500	350	250	0	350	430	200
F	250	450	150	250	350	0	280	160
G	300	230	250	300	430	280	0	400
H	600	480	300	600	200	160	400	0

For example, the entry 45 in the cell BF indicates that 45 wagons per week are required to be moved from B to F and the entry 450 in the BF cell of the cost matrix indicates the transportation cost of moving a empty wagon from B to F.

First identify the locations where there is a surplus of wagons every week and locations where there is a deficit and then a plan to balance these requirements at minimum cost.

From a mathematical point of view, a special case that is well-studied by students is the assignment problem where there are an equal number of supply and demand points and each shipment or assignment is of one unit. Although this may have some applications, in practice the standard formulation of this problem is not that useful. The transportation problem on the other hand, is quite widely applicable, and in fact, occurs as an underlying structure in more strategic decisions such as plant/ warehouse locations.

10.3.1 Network Flow Models

A really useful analytical class of LP formulations, which is applicable in very many contexts, is that of network flows. This class of formulation is exemplified by the minimum cost flow problem, which is as follows:

Transportation network consists of n nodes. There are three types of nodes. T is the trans-shipment node. S is the source node and D is the demand node. ij is a link between node i and node j.

c_{ij} is the Cost of unit flow in link ij

F_{ij} Flow on link ij

C_{ij} Capacity of link ij

S_i Supply from the source node i

D_i Demand at the destination node i

$c_{ij} * F_{ij}$ Cost of net flow on link ij

Thus total cost of flow over all nodes $\sum_i \sum_j c_{ij} * F_{ij}$

Objective is to minimise this cost

$$Min \sum_i \sum_j c_{ij} * F_{ij}$$

Net flow at each node is zero if it is a trans-shipment node

$$\sum_i F_{ij} - \sum_j F_{ji} = 0 \quad \forall \text{i} \;\; \text{if} \;\; \text{i} \in T$$

Net flow at each node is equal to supply if it is a source node

$$\sum_i F_{ji} - \sum_j F_{ij} = D_i \quad \forall \text{i} \;\; \text{if} \;\; \text{i} \in D$$

Net flow at each node is equal to demand if a destination node

$$\sum_i F_{ij} - \sum_j F_{ji} = S_i \quad \forall \text{i} \;\; \text{if} \;\; \text{i} \in S$$

Flow on each link should satisfy the capacity constraint

$$0 \le F_{ij} \le C_{ij}$$

This formulation permits, among other things, the modelling of

- The shortest path decision in directed networks
- The trans-shipment/assignment problem
- The longest path (critical path) determination in activity networks in project management
- The max flow problem
- The tanker scheduling problem (a simple version of the fleet utilisation problem in a transport network)

and many others.

If more than one commodity is flowing is the network, the problem is conceptually similar, but generally much harder to solve, computationally speaking. This multi-commodity version of this problem requires some specialised tools.

Example: A Network Flow Model of Iron Ore Movement (From Section 8.10)

The multiple paths of iron ore in the example in Section 8.10 (Example 3) allow a network flow characterisation. The nodes of the basic network are (a) supply nodes where iron ore is produced, (b) trans-shipment nodes, where ore is loaded to a mode of transport or transferred from one node to another and (c) terminus nodes, where ore is finally put on to ocean going vessels. More than one node could correspond to a single physical location if there are multiple ways of handling material. In particular, the unloading node representing Mormugao port is in four parts depending on how the material is handled; by the land based mechanised bulk ore handling system, by mooring dolphins and trans-shippers, by manual unloading or by rail.

The flows (yearly movement of iron ore) on various arcs of the network in two successive years are shown schematically in Figures 1 and 2 in Section 8.10, Example 3. To derive more detailed schedule related information, the flow network can be replicated to include time by considering either a month or a fortnight as a time bucket. The capacities at certain nodes are significantly different in different time buckets, e.g. Panaji port during monsoon. A single instance of the network flow model would include the capacity and cost constraints on different arcs and would answer questions like:

(a) What are the expected flows through Panaji port and Mormugao port, given the constraints on loading, unloading and movement (including the movement through the Cumberjao canal)?

(b) What is the impact of increasing capacity of the facilities at Mormugao port?

(c) What will be the impact of increased facilities of iron ore handling through rail at Mormugao port, through the tippler unloading system?

Modelling Capacities

Capacities on different segments of the supply chain translate naturally to capacities on arcs of the network shown in Figures 1 and 2 in Section 8.10, Example 3. Depending on the granularity of the model (e.g. weekly flows or yearly flows), the capacity is calculated based on specific operating conditions. It is convenient to take a standard barge operating size for looking at the throughput in tonnes through different segments and modes. Interestingly, with an increase in traffic in

2003–2004, barge owners are considering investing in barges of larger capacity (upto 2,000 tons), as it is economically viable, the draft permits it and the traffic can sustain it.

For example, maximum yearly flows at the Panaji port are calculated based on the availability of the port for eight months of the year and some maximum number of barges per week, considering the loading options available. The capacity of the river arc segments is approximately governed by the draft available and the tide conditions. Actually there is a complex relationship between the size of the barges that are operated and the achievable throughput, because for larger barges, there are monsoon related restrictions as well as restrictions on moving in the Cumbarjao canal.

Modelling Costs

Operating costs (in our case, costs of moving one ton over the relevant link) are approximated in by a linear function of overall flow (assuming a certain barge fleet adopted by the group of operators). Individual flows on the network clearly incur different costs, depending on the size of the barge, but at the large levels of traffic, we can assume that the operating ranges of costs on any segment will vary linearly with the total traffic on that segment. Costs are then mainly a function of barge size (already accounted for in the vessel mix) and time cost (including paying for crew time). Other costs, such as diesel and vessel maintenance costs are assumed to be same, no matter what mode of operation is chosen.

Cost of Expanding Capacity

From an infrastructure point of view, capacities on many links are flexible. More capacity can be added to some links by actions such as increasing the number of trans-shippers, dredging of the canal, night navigation aids, etc. One way to handle these options in a simplified model is to model costs as non-linear functions of the flow (simple polynomial functions which represent convex, increasing costs with respect to flow). This is particularly simple to do when examining incremental scenarios where traffic in some arcs is guaranteed to be in a certain range.

Analysis: The formal model yields a network of modest size (the base network is 14 nodes and 14 arcs and can be extended to include more detailed options), and one which is flexible in its use. For example, the model can quickly estimate the flows on different parts of the river canal system at different times of the year and can also identify bottlenecks over a longer time frame. Observing the changes in traffic from 2002–2003 to 2003–2004, we see that the bulk of the increased movement has been by the following two paths:

(1) Karnataka mines to Tinaighat and other stations before the ghat—road to the Mandovi loading points—Panaji port (mid stream grab loading)

(2) Karnataka mines to Tinaighat and other stations before the ghat—Road to the Mandovi loading points—Cumbarjua canal—Mormugao port (mid stream grab loading and trans-shipper).

Current bottlenecks in the network (correspond to saturated arcs in our flow model) are (a) grab loading at Panaji (b) trans-shipper at Panaji (c) berth loading at Mormugao, (d) rail movement from Karnataka through the ghats to Sanvordem and (e) movement on the Cumberjao canal. With these as capacitated arcs, it can be seen that the only increased flow of material that can be handled is from the southern Goa mines through the Zuari river and through Mormugao port.

The model shows that increased traffic from the Karnataka mines can be achieved by a variety of options, depending on the costs of increasing capacity on various links. The capacity expansion options corresponding to the five bottleneck arcs correspond to (a) and (b) : Increasing accessibility of Panaji port during the monsoon—this is quite an expensive option as it involves an analysis and feasibility study to mitigate the effect of a long standing oceanographic phenomenon, viz. the Aguada sand bar, which makes navigation difficult in the monsoon months; (c) increasing mechanised handling facilities at Mormugao, which is possible although there are some space constraints; (d) doubling of the railway line between Londa-Castle Rock-Sanvordem, which is quite an expensive option and (e) dredging and improving navigability of the Cumbarjao canal, which is possible up to a small increase. These options can be modelled by appropriate cost functions on arcs, still yielding a tractable and insightful flow model.

If the network is extended to include (a) the road options from Tinaighat to Zuari loading points and (b) direct rail from Karnataka (Hospet/Bellary) to Mormugao Port and (c) a tippler unloader node at the port that can handle rail traffic, then other expansion options can be explored. This is easily done in the model.

These options can be explored using linear and non-linear (convex) minimum cost flow models on the appropriate network. The base network has 14 nodes and arcs (a more compact formulation is possible, but the model that we use leaves open the possibility of selectively increasing the capacity of different parts of the physical network) and the extended network has three more arcs in the network. As usual in a minimum cost flow model, there are several options of including the costs and capacity constraints and we have chosen a simple variant where capacity constraints are imposed only on arcs and not on nodes. The optimal-flow model (solved in

LINGO) has flow balance constraints and capacity constraints on individual arcs and a linear or non-linear objective function.

10.3.2 General Linear Programming

The framework of LP is used in many other decisions as well. We discuss two of them here, from the manufacturing environment.

1. The production planning problem: This problem balances the cost of production in various periods (allowing for variable production costs) vis-á-vis the costs of inventory holding, capacity sub-contracting and cost of backlogging (or cost of delayed satisfaction of demand).

We can see a few qualitative ways in which the overall cost function would behave. If we follow the requirement every month (subject to capacity constraints), we incur the lowest possible inventory costs. This is called the lot-for-lot solution in MRP/ERP systems. But this may incur a larger production cost, if costs are different in different time periods (e.g. because of sub-contracting costs or seasonal production costs, including procurement of raw materials). The alternative of advance production to take advantage of lower costs in some periods leads to higher inventory costs. The balance between these factors is the one captured by the linear programme.

Example 10.2

Assume that there is a production capacity of B units available each month. If the cost of inventory is Rs h per unit per month, production costs are c_i in month i, and quantities required are d_i in month i, then we look for the lowest cost, feasible production plan. This is obtained by solving the LP on the variables x_i (the amounts produced in period i), as below.

Min S_i $[hI_i + c_i x_i]$ (total cost of inventory and production)

where I_0 = initial inventory,

$I_i = I_{i-1} + x_i - d_i$, for all i = 1, …, n (the inventory balance condition)

$I_i >= 0$ all i (this captures the no backlogging condition)

and $B >= x_i >= 0$ all i.

2. The product mix problem: This is a very important and useful formulation in aggregate planning where a facility manufactures multiple products. It has been successfully implemented in petroleum refineries, to name one specific sector. Here, particular care needs to be paid to material balance equations which could involve conversion co-efficients, including yield of processes.

Such formulations typically involve a certain number of constraints (say m) and a much larger number of activity variables (say n). The LP formulation makes it quite explicit that there are many potential bottleneck resources in a system and a small set of them could be operative bottleneck resources at any cost optimal operating point. An interesting fact is that, generally speaking, very few of the activities would be at a non-zero value at the optimal operating policy. In the above instance, only m of the activity variables would be non-zero.

Also, only some of the resources would be binding or bottleneck resources. These would have non-zero impact on the objective function, if relaxed. The section below points to the fact that further useful information is available through the techniques of duality and sensitivity analysis.

10.3.3 Solution Techniques for LP and the Role of Sensitivity Analysis and Duality

Linear programming is a popular and well established tool for analysis and decision-making. The solver utility in Microsoft Excel allows reasonable sized formulations and solution. Several modelling languages and solver engines provide more detailed formulations. This includes Lindo/Lingo, Gams (popular in the process industry and for formulating macro-economic models) and Cplex, a most powerful general purpose LP solver which is also used in Ilog and other resource planning tools.

Intimately related with the effective solution of LPs is the fact that there is a well established sensitivity analysis that is possible. This arises from duality theory, which provides an elegant, economic analysis to the issue of certifying optimality, identification of bottleneck (binding) constraints and the impact of perturbation of certain parameters (especially resource availability or demand requirements) on the final solution to an LP. This analysis provides a rich basis and motivation for problem solving using formal tools such as LP.

Solution of LPs

There are two main techniques for solving LPs, extreme point iterative methods (referred to as the simplex method, because a simplex is a full dimensional polyhedron) and interior point methods (which are now getting to be part of commercial LP software). Both have comparable practical performance but differ widely in the underlying mathematics and also some theoretical properties (especially regarding convergence to the optimal solution).

10.3.4 Integer Constrained LP (Also Called Integer Programming – IP)

These are optimisation problems where there is a linear relationship between variables in the constraint and objective function with the added condition that the variables are constrained to be integer. The most common use of this is in modelling Yes/No decisions using {1, 0} variables. This is of use in several practical problems, for example facility location, scheduling problems and the production planning problem with fixed costs or batch constraints. A formulation in which some variables are restricted to be integer and some are from a continuous domain is called a Mixed Integer Linear Programme (MIP).

Example 10.3

Distribution Network Design

A firm has to decide on the location of plants to meet their customers demand located in m cities. There are n potential sites for the plants. Let F_i be the annual fixed cost of opening a plant at location i, K_i be the capacity of the plant at at location i, D_j be the customer demand at city j and c_{ij} the unit transportation cost from location i to city j. The aim is to design the network to meet all the demand. This is obtained by solving the MIP on the variables x_{ij} (shipped quantity from plant located at i to city j) and y_i (1 if plant is open at site i, 0 otherwise)

$$\text{Min } S_i F_i y_i + S_{i,j} c_{ij} x_{ij}$$

s.t. $S_i x_{ij} >= D_j$ for all j   Constraint set 1

$S_j x_{ij} <= y_i K_i$ for all i   Constraint set 2

$x_{ij} >= 0, y_i \text{ in } \{0,1\}$

Here, the objective function captures the total cost over an operating horizon, including the fixed cost of operation and the variable cost of transport. There are choices here, one being the consideration of costs over a finite horizon (say five years) over which the plant is assumed to operate and therefore the expected transport costs over that time. The other option is to annualise the fixed cost using some method of capital cost depreciation, and consider annual costs. The data regarding costs and the demand estimates affect the model outcome significantly and estimating these satisfactorily is a big part of successful modelling.

Constraint set 1 in the above formulation indicates that all demand is met by supply from various locations and constraint set 2 indicates that supply is not made from a facility unless it is declared as open. Check that values of y_i being zero or one does give the required meaning in each case. Here again, there are multiple ways of modelling such a constraint. This is a formulation which is adequate for moderate sized decisions.

Example 10.4

Consider an example where customers are located in four cities and there are four potential sites for the plants. The model inputs are given in the following table.

Plant	Customer location				Capacity	Fixed cost
location	C1	C2	C3	C4		
P1	16	12	13	17	40	200
P2	14	19	15	13	50	300
P3	18	11	13	16	70	450
P4	15	8	10	12	80	550
Demand	29	37	40	24		

The cost optimal solution in this case is to select locations P2 and P4. In the same example, if the fixed cost of facility P2 is 1000 units, the model selects locations P3 and P4 as the best solution.

In general, the more the fixed cost of facilities, the fewer of them are declared open in the optimal cost solution.

We only note that IP, in its most generic form, is difficult to solve, but there are some classes of IPs (arising from network flow formulations, mainly) that are quite tractable. Most LP solvers also include the option of including integer restriction on variables, but these may not be useful for large unstructured problems. Such problems would require specially customised and constructed algorithms.

10.4 ROUTING MODELS

Routing is a concept that is useful in operations planning of transport. A term used in this context is that of a milk-run, derived from the regular (daily) multi-point delivery of largely standardised products—such as milk from a dairy to several retail dispersing points. This concept is in fact very widely applicable in many settings such as courier operations, delivery of soft drinks, collection of crates/bottles of soft drinks, newspaper deliveries and several retailing applications. The advantages are:

- Cost minimisation of meeting the demands of a large set of demands, where each individual demand may not meet a full vehicle load (called FTL—Full Truck Load, in retail and short haul transport by road).
- Frequent delivery cycles because of the above consolidation and as a result of which retailers do not have to stock too much—since they are assured of supplies ever so often.

A decision that has to be made in a milk run is the order (sequence) of destination visited. A single vehicle version of this decision is referred to in the Operations Research literature as the Travelling Salesman Problem (TSP) whereas the multi-vehicle version is known as the Vehicle Routing Problem (VRP). The TSP is a classical combinatorial optimisation problem (of selecting the least cost option among n options when visiting n cities). This problem is not difficult to solve for small n and has a number of heuristics (rule-of-thumb) procedure for medium and large n, but is known to be difficult to solve to optimality. Note that it is possible to get a solution by examining all options, which would involve a finite (but could be very large) number of computations. Of more importance in SCM is that both the TSP and the VRP admit reasonably good solutions that are approximately optimal.

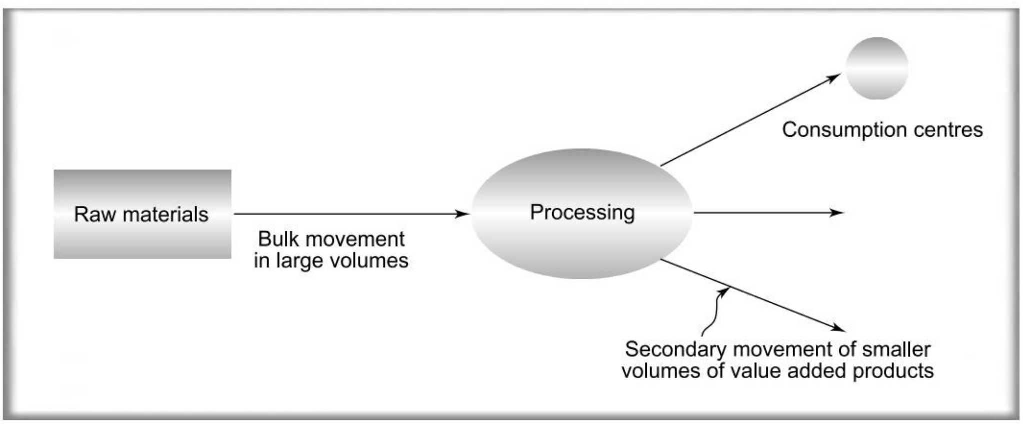
There are several variants of this that arise in practice which can make the problem difficult. Of particular interest in express delivery services and courier operations is that there are time windows for collection and delivery. In personnel scheduling, factors like detours incurred by each entity could be of interest. Heuristic procedures need to be designed to take care of such concerns in a reasonable way.

An argument working against the milk run idea is the following. When commodities are not time sensitive and are needed in large quantities (e.g. bulk commodities), dedicated location shipments maximise vehicle utilisations and reduce costs (remember that a milk truck gets progressively empty as its van progresses, so the average utilisation of the vehicle may be close to half its capacity).

Clarke Wright Heuristic:

- Calculate the savings resulting from combining location i and j into a single route for every location pair (i, j) and rank the savings in decreasing order.
- Pick the link with largest saving and include in a route if it satisfies the constraints. If the constraints are violated, move to next link in the list.
- Repeat till the list gets exhausted.

Schematic View:



Most multi-stage facility planning problems start with this basic design issue. Extend this schematic diagram realistically to a real supply chain [e.g. cement] and evaluate different options.

10.5 PRICING DECISIONS

Pricing of products and services is clearly an important business decision driven by marketing considerations in a firm, and the prevailing economic scenario. We discuss a few aspects that provide a supply chain focus to this rather complex issue.

10.5.1 Transfer Prices and Supply Chain Entities

If we view a supply chain as an entity, then what determines its competitiveness is the value generated in its entirety vis-á-vis what the end customer is really willing to pay for consumption of the product or service. In this view, all transactions between supply chain partners, including selling prices and purchasing prices between these entities, are all internal to the supply chain and do not affect the final profitability. However, these internal prices do affect some key decisions of the various supply chain players and to that extent, they do affect competitiveness.

A highly vertically integrated organisation would use a mechanism of transfer prices between its constituent managerial units to judge the financial performance of these units. It is quite difficult to know if these prices are 'fair' measures that can be used for this purpose. They are sometimes quite artificial and to that extent, may foster some inefficiencies in the system.

Example 10.5

Indian Railways is a highly integrated organisation which manufactures coaches and locomotives, runs catering units, hospitals and schools, as well as its 'core' business of train operations. The internal pricing of locomotives is somewhat open to debate. It is based on a cost oriented system of accounting. There are no regular competing suppliers of locomotives of similar types, nor any regular customers, other than internal one, for the products. Therefore, there is no good market signal as to prevailing norms in this sector. Prices are therefore not subjected to proper signals that push the system to efficiency.

On the other hand, some services like catering are now undergoing a change in two ways. One is the creation of a separate entity with its own managerial control. This brings in an element of transparency in the costs of services and may in itself lead to some improvements. The second is the introduction of competitors, if not in the same route, at least on similar routes elsewhere. Because of this, there are some pressures to improve and/or standardise the offering of products/services.

10.5.2 Double Marginalisation

In the presence of uncertainty, a firm takes a position on quantities to be transacted or stocked depending on the margin of profit made for every unit sold. Against this, there is the cost of holding and/or the cost of salvage/disposal. Therefore the prices transacted between supply chain entities, although internal to the chain, do affect stocking quantities and therefore the actual availability to final customers.

Economists have alerted us to this phenomenon of *double marginalisation*, which is now interpreted in supply chain terms. The basic impact is that whenever the overall margin in a supply chain is split into two because of two supply chain entities controlling two parts of the supply chain activity, the chain as a whole understocks products relative to the 'optimum' value.

10.5.3 Elasticity

It is well-known that demand for a product depends on the price at which it is offered. If this aspect is to be formally captured in decision-making, a useful concept is that of price elasticity of demand. A practical way of capturing this impact is through price-demand curves, where demand Q is expressed as a (decreasing) function of price P such as $Q = a - bP$ (for some positive constants a and b).

Economists define elasticity in terms of relative changes in demand with respect to prices. Such ratios are useful for computing or predicting equilibrium outcomes, but for decision making related to pricing, equations such as the above, are used more often.

In practice, the demand for a product is also determined by the value proposition it offers. If we consider S as a quality parameter (e.g. the hours of life of a light-bulb), we can write demand Q as a function of P and S as $Q = a - bP + cS$, for some positive constant values a, b and c.

Finally, if we include cross-elasticities, which reflect the impact of competing products, we can write $Q = a - bP + cS + dP' - eS'$, where P' and S' are the price and quality parameters of the competing product(s). The values of these constants are to be estimated by statistical methods such as regression or other means. Such data is difficult to obtain and such models are more useful conceptually, to understand how pricing and product/service quality levels affect demand, revenues and overall supply chain performance.

10.5.4 Pricing Contracts in SCM

Contracts provide one mechanism for conveying price and other signals to different entities in the supply chain, as we have seen in Chapters 6 and 7. In simple transactions, we can consider quantity discounts and other pricing initiatives as part of a single cost minimisation objective. When we look at longer term transactions spanning more than one period, other types of contracts and pricing mechanisms can be designed. We look at two possibilities.

1. Buy-back arrangements to counter the effects of double marginalisation. Here a manufacturer agrees to take back unsold items at the end of a period. This should encourage a retailer to order the 'optimal' value since part of the risk is now covered.
2. Service level based contracts: Supply chain analysis inherently bring focus to the interface between two decision making units in a linked series of activities. The timing of deliveries is one aspect of this. *Late* deliveries are known to cause shortage and penalties to the system. The JIT concept highlights the pitfalls of *early* delivery and 'Just-in-case' safety stocks. In a similar vein, the Taguchi methodology in quality management highlights the costs in any deviations from a given target. When this is formalised for a logistic service provider, what emerges is a service level contract.

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Case references : Models and techniques can be profitably used in almost all cases in the book. Specifically, Linear Programming and mixed integer variants can be used in Farm Aid Tractors Limited, Inventory theory in Bayer Crop Science, Fleet planning models in Laxmi Transformers, Simulation in Western Oil Limited (A) and many others.

Exercises

1. If there is a qualitative shift in the market, and the data shifts from a base value K to a base value K+G, how long will the moving average method take to discover this? Remember that the data you would typically have is of the form [base value + e], where e is some fluctuating term representing the randomness (usually assumed to be a zero mean normal random variable with some variance).

2. For a concrete example, consider the series 4, 4, 5, 4, 5, 3, 4, 5, 5, 4, 6, 5, 5, 4, 5 ... and make a guess as to when the market shifted from a base value of 4 to a base value of 5. Assume some reasonable value of m, such as 3 or 4.
3. For a look at how the method works on extreme cases (e.g. without randomness), consider how the moving average method works with the time series 4, 4, 4, 4, 5, 5, 5, 5, 5, 5 ... (we note that the human will discern that the market has shifted to a base value 5 in the fifth period, but only past fact!). How long will the moving average method take to discover this (as a function of m)?
4. Apply the exponential smoothing method to the same sample data as in the moving average case, for different parameters α = 0.7, 0.8, 0.9. Here, the larger α is, the more weightage is given to the most recent data (similar to the case of small value of m in the moving average method). In this sense, the two methods are quite similar. The exponential smoothing method requires you to maintain the time series method in a compact form, only the most recent data and the previous forecasted value. The moving average method requires you to maintain the m most recent values. When dealing with forecasts for hundreds or thousands of items, this may be an issue.
5. Look at data given below and try to generate forecasts for each quarter in year 5. Assume constant seasonality factors.

Year	Quarter	Sales	Year	Quarter	Sales
1	I	98	3	I	138
	II	106		II	130
	III	109		III	147
	IV	133		IV	141
2	I	130	4	I	144
	II	116		II	142
	III	133		III	165
	IV	116		IV	173

6. Daily demand for an item is observed to be as in the table below, for the last 30 days. This includes items actually sold as well as unfulfilled demand.

25	38	26	31	21	46	29	19	35	39	24	21
17	42	46	19	50	40	43	34	31	51	36	32
18	29	22	21	24	39						

For this data, plot the histogram. What is your estimate for the probability that the demand in week 31 is less than 40? Using a normal approximation (for which you would have to compute the mean and standard deviation of this sample), compute this probability and compare with the empirical distribution. The empirical distribution is a tabulation of thr values of Prob{X <= t} for different values of t, from the observed data and their histogram. The normal distribution is also tabulated in references as a table for observed value of t.

7. The traditional EOQ model considers inventory costs on the consumption side (the saw tooth curve of inventory versus time). Extend this idea to include the inventory costs on the supply side as well.
8. All other things being the same, what is the relationship between the lead time of supply L (days) and the order quantity Q (units)? Do you expect it to be increasing, decreasing or neither? Linear or non-linear?
9. When ordering costs are zero, show that it is economical to order in every period (this amounts to s=S)—even if it is a small size order. Such a system is called an order-up-to system.
10. As before, convince yourself that if review is continuous, and replenishment was instantaneous (lead time is zero), then a simple, trivial policy is adequate. Now assess what would be the effect on R and/or Q if the lead time increases. Try to see if you can deduce the nature of the cost curve with respect to R (for a fixed Q), which could arise because of transport constraints (say a truck load). Separately, argue what would happen if the fixed cost for ordering is zero.
11. If the demand at a warehouse is the aggregated demand from several retailers and is observed to be as given in Section 1, over 30 weeks. How much inventory should you hold at the warehouse to ensure that you (almost) never fall short?
12. A stockist of a food item orders daily. Items ordered today can last three days before they have to be scrapped or returned. The demand is somewhat uncertain and follows the histogram as derived from Exercise 6 above. Profit in selling an item is Rs 5 and cost of the product is Rs 12.

    1. What is an approximate optimal stock level at the beginning of each day?
    2. If there is a salvage value of Rs 2 for each unsold item, what is the stocking policy?
    3. If the perishability of the item is now considered as two days (because of customer perceived attitude to 'fresh' products), how would the ordering strategy change?

    These are difficult issues to analyse, especially if ordering cannot be done too often.
13. A retailer faces a weekly demand for a food item with the given data histogram capturing the demand distribution for 16 weeks. What should the ordering strategy be if the retailer has the knowledge that the product is to be withdrawn in four weeks time? You can assume a nominal salvage value for returned, unsold items.

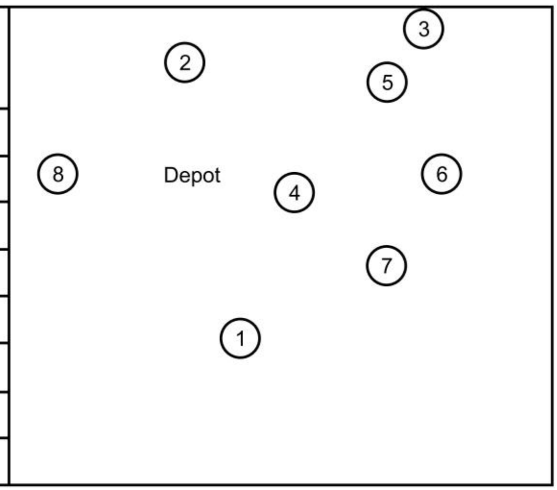
108	116	118	124	96	119	96	102	112	102	92
91	117	111	94	98						
14. If capacities are not constant throughout of the year then the quantity of B is replaced by the relevant capacity B_i in each month. This could be because of planned plant

maintenance or vendor capacity fluctuations that are known in advance. Try modelling the constraint that the inventory at the end of each month cannot exceed some quantity K (because of storage requirements).

Try applying this logic to the situation in the case of Farm Aid Tractors Limited. We note that if there are batching constraints or fixed costs (which again push one towards batches), the problem is more complex and is in the realm of integer programming. There are also multi-product versions of this production planning problem where some group of products share resources.

15. Design a set of routes for collection of goods from the following eight locations where the daily demands are given and the distance of each location from the other (including the central depot) are as given below. Capacity of the vehicle is 10 tons.

Depot Location	Quantity-per-day (tons)
1	1
2	6
3	9
4	3
5	4
6	2
7	2
8	2



Try to design a general purpose procedure yourself and then compare it with the following well-known procedure called the Clarke Wright heuristic for VRP.

16. Any manufacturing supply chain with (say) one stage of value addition or processing can be located close to the source of raw materials or close to the demand centres, or something in between. For example, cement plants can be located close to limestone deposit (raw material source) or consumption centres (e.g. urban agglomerations). What are the pros and cons of each option? The same issue arises in the location of power plants close to coal mines (pit head generation of electricity) versus location close to consumption centres (urban areas).

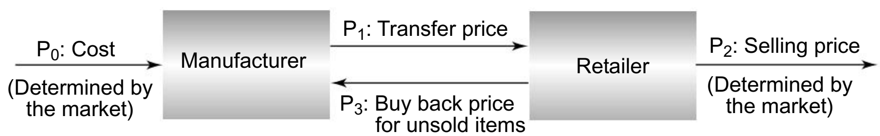
17. Discuss whether the setting up of a supply chain in such an environment (e.g. corporatisation of some part of the activities or privatisation and the introduction of competition), actually helps the end customer effectiveness.

18. For the end demand that is random with demand distribution as in the histogram as derived from Exercise 6 above, compare the cases of:

    1. An integrated supply chain that has a raw material purchase price of Rs 4 and an overall selling price of Rs 10.

    2. A two stage supply chain that has an intermediate transfer selling price of Rs 6.

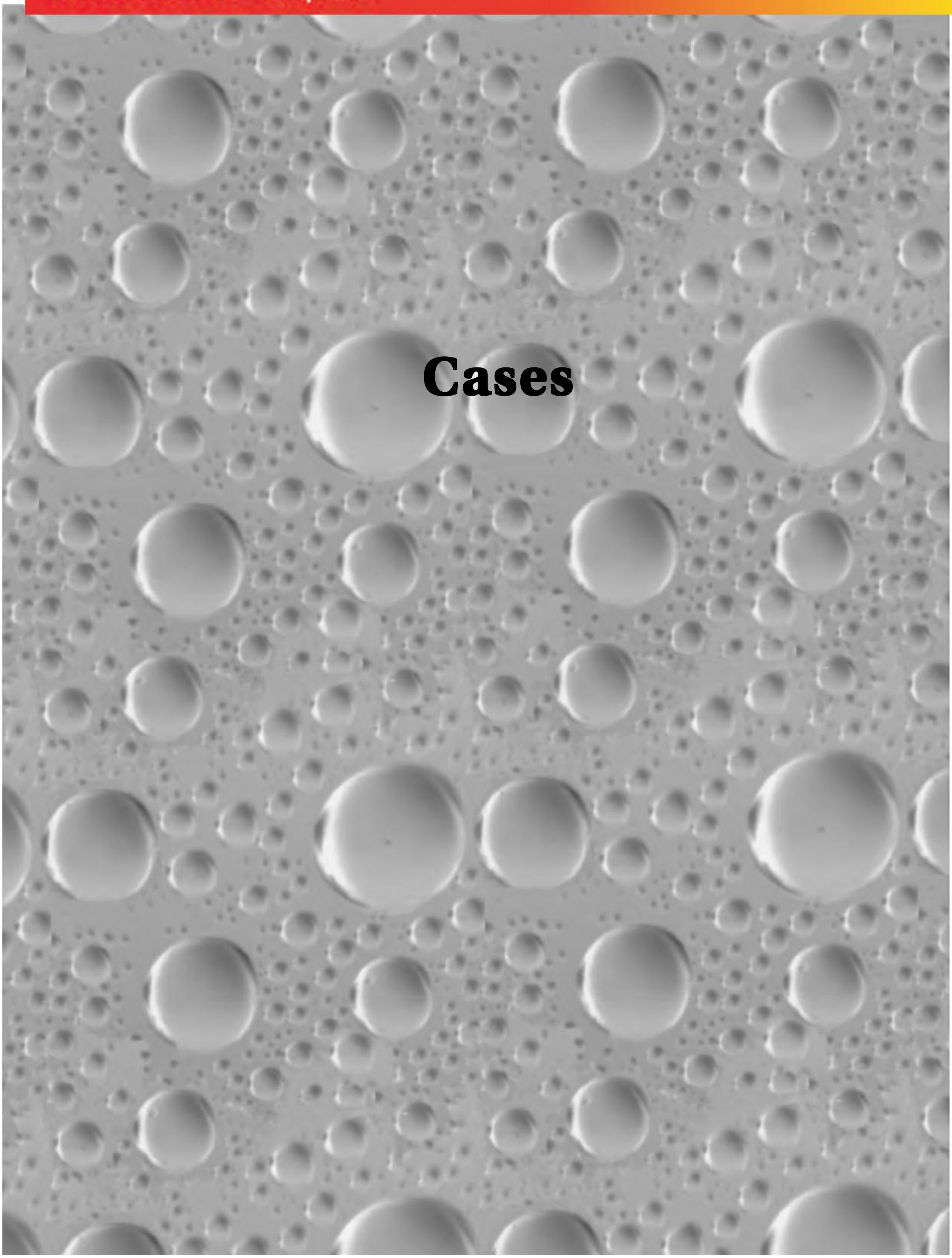
19. Analyse a two period decision of a retailer with the following data.



Demand characteristic:		
	10 (low)	Probability = 0.25
	12 (medium)	Probability = 0.5
	15 (high)	Probability = 0.25

Here, we make the assumption that the manufacturer announces the transfer price P_1 and the buy back price P_3 first, and then the retailer makes the ordering/stocking decision.

20. An iron ore transporter needs to move ore from a mine site to a barge location 50 km away. The requirement is a steady ore of 500 tons a day. The material is moved in 10 trucks moving at an average speed of 20 km/hr and allowing 30 minutes each for loading and unloading. If the transit time is not fixed but varies between 2.5 to 4 hrs with some distribution, estimate the number or trucks that the transporter should deploy. For this, you would first have to determine a suitable objective of the supply chain (inventory cost, contingency cost of storage of ore in case of transport delays at either end, etc.). You may need additional data, which you can assume for the purpose of this exercise. After that, formalise this arrangement as a contract between shipper and carrier.



Cases

Case 1

CASE CONTEXT

The issue of mode choice for movement of both raw materials and finished products is the focus in this case. The location of the plant has already been decided based on various considerations, such as the availability of natural gas as a fuel and access to new sponge iron plants in Western India. However, the market for the final product of Laxmi Transformers, DRI (sponge iron) was a growing one in India and there was scope for focusing on some selected final markets. Logistics costs could form a significant factor in this consideration. Apart from mode choice, distribution network design, investments for railway siding, barge rentals and scheduling of ships could be explored for a complete logistics plan.

LAXMI TRANSFORMERS

Direct reduced iron (DRI), commonly called sponge iron, was to be produced by Laxmi Transformers (LT) at its new Rs 500 crore Alibag (Maharashtra) plant starting in February 1991. DRI was an intermediate product in the steel making process and essentially served as a substitute for scrap iron. DRI was used by both mini steel plants and large integrated steel plants. It could also be used by ferrous foundries. Maharashtra and Gujarat were the two most industrialised states in India and had a number of mini steel plants and ferrous foundries which were potential sponge iron buyers. All the integrated steel plants were located in the eastern part of the country except the SAIL plant which was at Bhadravati in Karnataka.

The advantages of using sponge iron were as follows:

1. It was a substitute for ferrous scrap which was currently imported in large quantities, costing the nation a large amount of foreign currency.
2. Undesirable elements which may be found in scrap such as chromium, tin, nickel etc. were absent. This gave a more consistent and reliable end-product quality.

Prepared by G. Raghuram and Dilip Mathew. Case material of the Indian Institute of Management, Ahmedabad, is prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems.

3. It was easier to handle than scrap.

Location

The two primary reasons for locating the project at Alibag were the availability of natural gas and nearness to sponge iron markets. Natural gas from the Bombay High offshore field was brought to Uran by a pipeline, about 25 km due south of Bombay. Industries located in areas near Uran would get gas at what was called "landfall prices" which were substantially less than what inland customers would pay. The landfall price of gas was about Rs 2500 per 1000 cubic meters. About 300 cubic meters of gas were needed per tonne of sponge iron. The project site was on the seashore, with a view to having access to sea transport, both during construction and operations.

There were a number of different processes that could be used for sponge iron production, some being coal based and some being gas based. In consultation with the engineering advisers of the project, Technocrats India Ltd., LT decided to adopt the HyL III process for sponge iron production, under license from the Mexican firm HyLsa which had patented it. This process used reformed natural gas to convert iron ore to sponge iron.

The plant which had a rated capacity of 500,000 tonnes per annum, would require about 1.24 tonnes of pellets per tonne of DRI and 0.31 tonnes of lump ore per tonne of DRI, making for a feed mix proportion of approximately 80 : 20. A problem with the Alibag plant was that the iron ore and pellets required were not available locally.

Transportation

LT's newly appointed Manager, Logistics decided that his first task would be to review the proposed transportation strategies of his company for the inward movement of raw materials and the outward movement of his company's product.

Raw Materials

He first met the Manager, Raw Material Procurement (RMP) and then the Manager (Marketing) to get their views. Manager (RMP) was responsible for identifying potential reliable suppliers of the principal raw materials, namely, lump iron ore and iron pellets. He found that the Manager (RMP) had already made a thorough examination of the production situation and entered into contracts with three mines that would supply lump ore. The Manager (RMP) had also entered into a long term contract with Kudremukh Iron Ore Company Limited (KIOCL), Mangalore, for supply of iron pellets which were essentially produced by agglomerating fine particles of iron ore. Even though this was an export-oriented unit whose rupee prices should ordinarily fluctuate according to the value of the rupee with respect to the US dollar, LT was able to negotiate a special arrangement guaranteeing its requirements at the rate of Rs 600 per tonne FOB. This rate would be reviewed annually. The Manager (RMP) was able to clinch this deal because he negotiated at a time when KIOCL was going through a very troublesome period financially.

Based on considerations such as quality of ore and possible supply and handling constraints, LT had decided to procure lump ore in the following proportions from the mines mentioned below:

	Percentage	Price (Rs/tonne)
Daitari (Orissa)	40	250
Banspani (Orissa)	40	250
Goa	20	330

These sources were not substitutable, since they had been identified according to certain required chemical properties.

Finished Goods

The Manager (Marketing) was in the process of trying to line up customers for LT's DRI. While he had not yet been able to get any firm commitments, he had been able to make some estimates of the size of the market. A major difficulty he faced in this task was that while there were a few sponge iron producers in the country already, none of them could be called major producers, because, for various reasons, they were producing at only a fraction of their capacity. The Manager, Marketing's estimates of the market potential is shown in Exhibit 1.

Inbound Mode Choice

LT was now faced with the problem of deciding the best way of transporting raw materials to the Alibag plant and DRI from the plant to market centres. There were three possible modes that could be used – rail road and sea – or combinations of these.

Rail

The nearest railhead to Alibag was at Pen about 15 km away. The Railway Board in Delhi had categorically stated that there was no prospect of building a line to Alibag, but suggested that LT would be able to get a line constructed at its own expense at an approximate cost of about Rs 1 crore per km (including handling and storage infrastructure). If other industries which were coming up in the area (a cement bagging plant, a gas based fertiliser plant, and a few others in the drawing board stage) wanted to use the track, LT would be able to share the construction cost.

In the case of rail transport, freight rates were determined by the Indian Railway Conference Association (IRCA) which published a book of tariffs. Exhibit 2 gives relevant tariffs. While iron ore was classified as Category 110 for purposes of tariff determination, there was some confusion on the classification of DRI. While IRCA stated that sponge iron came under Category 150, Central Railway's commercial staff maintained that DRI was a different product and would be charged under Category 210.

Sea

A jetty capable of handling four barges simultaneously with an unloading rate of 2000 tonnes per hour was to be built at the plant site in Alibag. Giant Western Shipping had said that it would be able to provide two ships, one of 65000 deadweight tonnes (dwt) and the other of 35000 dwt. LT would be expected to pay market rates whichever ship it decided to employ, as the shipping industry was riding on the crest of a wave. Going rates and details of ship operating costs and times are given in Exhibit 3.

High-tonnage ocean-going ships like the ones being considered, could not enter Alibag's minor port due to draft restrictions. Hence, cargo had to be loaded/unloaded in deep water into/from barges which could use the jetty. Each barge could be used for one round trip in a day, due to the tidal variations. The current plan was to charter five barges of 1,000 tonnes payload capacity for this task. (The limits for unloading were determined by the operating rate of the cranes on the ship. A total of 10000 tonnes per day was possible, but then 10 barges would be required. Five would be at the ship side when the other five were at the jetty.) The charter rates for these barges were Rs 300 per tonne per month. Deep water operations at Alibag were not possible for 120 days of the year due to the monsoon.

Road

Road transport rates were expected to be 50 paise per tonne for a kilometre, though, due to the new Motor Vehicles Act and consequent strict imposition of no overloading, the rates could possibly go as high as 70 paise per tonne kilometre.

Exhibit 4 gives a distance matrix between the various mines, Pen station, ports and market centres.

Considerations for Outbound Movement

In examining the options LT had regarding outbound movement, the following were some of the key issues that had to be borne in mind:

1. Since the ships that bring iron ore would be returning empty (being on a time charter), sponge iron to markets in the eastern parts of India could be transported by ship. This would involve additional time due to loading and unloading, but not due to travel time.
2. Scheduling the ships for various trips could become an issue.
3. If LT opened a stockyard for redistribution, it would cost about Rs 1 lakh per month to maintain the stockyard.
4. Inventory carrying costs would be significant.
5. If trucks were to be used for outbound movement, two issues would dominate. Would it be possible to get enough 10 tonne trucks to carry the quantities demanded? Would the plant be able to handle such a large number of trucks?
6. If a rail-siding were to be laid from Alibag to Pen, inbound rail transport would also be facilitated. Regarding outbound movement, only the major consumers could

handle direct rail movement. If a siding was not considered, and rail movement was still planned from/to Pen, then road movement between Pen and Alibag would take place at a cost of Rs 30 per tonne, including handling.

7. Each additional handling of DRI resulted in a loss of 1%. The average selling price of DRI was expected to be Rs 4000 per tonne.
8. The above considerations could even influence the market choice for LT, since demand was expected to exceed supply.

The Manager (Logistics) was keen on developing a transportation plan keeping all these considerations in mind.

Exhibit 1: Market Centre wise Demand Estimate for Sponge Iron (10,000 tpa)

No.	Market Centre	1990/91	1995/96	2000/01
1	Delhi	8.8025	17.605	35.21
2	Hissar	1.0375	2.075	4.15
3	Ambala	0.885	1.77	3.54
4	Ludhiana	3.8475	7.695	15.39
5	Jaipur	2.475	4.95	9.9
6	Lucknow	3.4325	6.865	13.73
7	Muzzafarnagar	1.7375	3.475	6.95
8	Tatanagar	2.0275	4.055	8.11
9	Ranchi	1.175	2.35	4.7
10	Barajamda	0.0525	0.105	0.21
11	Calcutta	10.705	21.41	42.82
12	Rajkot	0.0525	0.105	0.21
13	Ahmedabad	0.845	1.69	3.38
14	Baroda	1.3075	2.615	5.23
15	Raipur	1.7775	3.555	7.11
16	Gwalior	0.565	1.13	2.26
17	Indore	1.9125	3.825	7.65
18	Jabalpur	0.1825	0.365	0.73
19	Bombay	9.37	18.74	37.48
20	Nagpur	2.485	4.97	9.94
21	Aurangabad	0.35	0.7	1.4

(Continued)

(*Continued*)

No.	Market Centre	1990/91	1995/96	2000/01
22	Kolhapur	0.6775	1.355	2.71
23	Waltair	0.8075	1.615	3.23
24	Secunderabad	1.16	2.32	4.64
25	Kothagudam	2.44	4.88	9.76
26	Bangalore	2.65	5.3	10.6
27	Hospet	0.5575	1.115	2.23
28	Bhadravati	1.48	2.96	5.92
29	Calicut	1.275	2.55	5.1
30	Madras	2.1175	4.235	8.47
31	Tiruchirapalli	0.245	0.49	0.98
		68.435	**136.87**	**273.74**
32	Bhilai	20	25	30
33	Bokaro	20	30	35
34	Rourkela	9	11	15
35	Durgapur	8	9	11
36	Burnpur	5	5	6
37	TISCO, Jamshedpur	10	15	20
38	VISL, Bhadravati	2.5	3.5	5
	Total	**142.935**	**235.37**	**395.74**

Exhibit 2: IRCA Tariff (Rupees per Quintal)

Category	110	150	210		110	150	210
Km	Rs Ps	Rs Ps	Rs Ps	Km	Rs Ps	Rs Ps	Rs Ps
1-100	4.25	5.44	7.24	341-350	10.74	14.27	19.58
101-105	4.54	5.82	7.77	351-360	10.98	14.59	20.03
106-110	4.66	5.99	7.99	361-370	11.21	14.91	20.46
111-115	4.79	6.17	8.21	371-380	11.46	15.23	20.91
116-120	4.91	6.32	8.45	381-390	11.67	15.55	21.36
121-125	5.02	6.48	8.68	391-400	11.91	15.87	21.80
126-130	5.14	6.65	8.91	401-410	12.59	16.78	23.06
131-135	5.26	6.81	9.14	411-420	12.84	17.12	23.52

(*Continued*)

(*Continued*)

Category	110	150	210		110	150	210
Km	Rs Ps	Rs Ps	Rs Ps	Km	Rs Ps	Rs Ps	Rs Ps
136-140	5.38	6.98	9.37	421-430	13.08	17.45	23.99
141-145	5.49	7.14	9.59	431-440	13.33	17.78	24.46
146-150	5.61	7.29	9.84	441-450	13.55	18.11	24.92
151-155	5.74	7.47	10.06	451-460	13,80	18.44	25.38
156-160	5.86	7.64	10.28	461-170	14.05	18.77	25.84
161-165	5.98	7.79	10.52	471-480	14.30	19.10	26.30
166-170	6.11	7.97	10.74	481-490	14.54	19.44	26.76
171-175	6.22	8.12	10.97	491-500	14.78	19.77	27.24
176-180	6.34	8.30	11.20	501-510	15.66	20.96	28.87
181-185	6.47	8.45	11.44	511-120	15.91	21.28	29.33
186-190	6.59	8.61	11.66	521-530	16.13	21.59	29.77
191-195	6.71	8.79	11.90	531-540	16.38	21.91	30.22
196-200	6.82	8.94	12.12	541-550	16.59	22.23	30.67
201-205	7.15	9.39	12.73	551-560	16.84	22.53	31.11
206-210	7.28	9.57	12.98	561-570	10.07	22.86	31.56
211-215	7.40	9.73	13.21	571-580	17.31	23.18	31.99
216-220	7.53	9.91	13.45	581-590	17.53	23.50	32.45
221-225	7.65	10.07	13.68	591-600	17.77	23.81	32.90
226-230	7.78	10.24	13.92	601-610	18.59	24.93	34.44
231-235	7.91	10.41	14.15	611-620	18.84	25.26	34.90
236-240	8.04	10.58	14.40	621-630	19.07	25.58	35.36
241-245	8.15	10.74	14.64	631-640	19.32	25.91	35.82
246-250	8.28	10.92	14.86	641-650	19.56	26.25	36.29
251-260	8.51	11.22	15.30	651-660	19.81	26.57	36.73
261-270	8.73	11.54	15.75	661-670	20.04	26.90	37.20
271-280	8.97	11.86	16.19	671-680	20.28	27.23	37.64
281-290	9.19	12.18	16.63	681-690	20.52	27.54	38.11
291-300	9.42	12.48	17.06	691-700	20.77	27.90	38.57
301-310	9.81	12.99	17.79	701-710	21.08	28.34	39.19
311-320	10.05	13.32	18.23	711-720	21.34	28.67	39.65
321-330	10.27	13.64	18.67	721-730	21.57	28.99	40.12
331-340	10.51	13.95	19.12	731-740	21.81	29.32	40.58

(*Continued*)

(*Continued*)

Category	110	150	210		110	150	210
Km	Rs Ps	Rs Ps	Rs Ps	Km	Rs Ps	Rs Ps	Rs Ps
741-750	22.05	29.65	41.04	1651-1675	43.60	59.02	82.13
751-760	22.30	29.97	41.50	1676-1700	44.04	59.61	82.95
761-770	22.54	30.31	41.97	1701-1725	44.65	60.43	84.13
771-780	22.78	30.65	42.44	1726-1750	45.10	61.04	84.96
781-790	23.03	30.98	42.89	1751-1775	45.52	61.62	85.76
791-800	23.26	31.31	43.36	1776-1800	45.95	62.21	86.57
801-825	23.98	32.26	44.69	1801-1825	46.35	62.74	87.34
826-850	24.57	33.09	45.85	1826-1850	46.77	63.34	88.16
851-875	25.18	33.92	47.01	1851-1875	47.21	63.91	88.97
876-900	25.80	34.76	48.18	1876-1900	47.65	64.50	89.81
901-925	26.52	35.71	49.53	1901-1925	47.95	64.92	90.42
926-950	27.11	36.55	50.69	1926-1950	48.38	65.54	91.23
951-975	27.72	37.38	51.86	1951-1975	48.81	66.12	92.07
976-1000	28.33	38.22	53.02	1976-2000	49.24	66.69	92.88
1001- 1025	28.96	39.06	54.22	2001-2025	49.38	66.90	93.15
1026- 1050	29.49	39.78	55.21	2026-2050	49.52	67.10	93.42
1051- 1075	29.99	40.46	56.18	2051-2075	49.91	67.60	94.14
1076- 1100	30.51	41.17	57.16	2076-2100	50.28	68.10	94.85
1101-1125	31.13	42.03	58.37	2101-2125	50.64	68.61	95.55
1126-1150	31.66	42.75	59.36	2126-2150	51.01	69.13	96.27
1151-1175	32.17	43.44	60.35	2151-2175	51.39	69.62	96.98
1176-1200	32.69	44.13	61.32	2176-2200	51.75	70.13	97.67
1201-1225	33.83	45.70	63.50	2201-2225	52.12	70.64	98.39
1226-1250	34.38	46.42	64.50	2226-2250	52.50	71.15	99.11
1251-1275	34.89	47.15	65.49	2251-2275	52.88	71.64	99.81
1276-1300	35.40	47.84	66.50	2276-2300	53.24	72.15	100.53
1301-1325	36.06	48.73	67.75	2301-2325	53.61	72.66	101.22
1326-1350	36.59	49.46	68.75	2326-2350	53.98	73.16	101.93
1351-1375	37.12	50.17	69.75	2351-2375	54.35	73.66	102.63
1376-1400	37.64	50.89	70.75	2376-2400	54.72	74.16	103.35
1401-1425	38.64	52.23	72.64	2401-2450	55.45	75.18	104.75
1426-1450	39.17	52.97	73.66	2451-2500	56.21	76.20	106.18

(*Continued*)

(*Continued*)

Category	110	150	210		110	150	210
Km	Rs Ps	Rs Ps	Rs Ps	Km	Rs Ps	Rs Ps	Rs Ps
1451-1475	39.71	53.69	74.68	2501-2550	56.84	77.07	107.40
1476-1500	40.23	54.42	75.69	2551-2600	57.49	77.95	108.62
1501-1525	40.88	55.28	76.90	2601-2650	58.14	78.83	109.85
1526-1558	41.30	55.88	77.73	2651-2700	58.77	79.69	111.07
1551-1575	41.73	56.45	78.54	2701-2750	59.41	80.56	112.31
1576-1600	42.13	57.04	79.34	2751-2800	60.04	81.46	113.53
1601-1625	42.75	57.84	80.50	2801-2850	60.69	82.33	114.75
1626-1650	43.18	58.44	81.31	2851-2900	61.32	83.19	115.98

Exhibit 3: Shipping Charges and Times

Ship size (dwt) Payload (tonnes)	35000 34000	65000 64000
Standing charges		
(US $ per day) (Rs per day)	9000 153000	15000 255000
One way voyage fuel costs to/from Alibag (Rs)		
Mormugao – Loaded – Ballast	 120000 105000	 125000 110000
Mangalore – Loaded – Ballast	 180000 157500	 187500 165000
Paradip – Loaded – Ballast	 840000 735000	 875000 770000
Calcutta – Loaded – Ballast	 960000 840000	 1000000 880000
Fuel costs at anchor (Rs per day)	**15000**	**17000**

(*Continued*)

(*Continued*)

Port dues (Rs per entry)		
Alibag	300000	412500
Mormugao	336000	462000
Mangalore	330000	453750
Paradip	380000	522500
Calcutta	420000	577500
Unloading/loading charges (Rs per tonne)		
Alibag	15	
Mormugao	50	
Mangalore	FOBT	
Paradip	40	
Calcutta	45	
One way average travel times to/from Alibag (days)		
Mormugao	1.0	1.0
Mangalore	1.5	1.5
Paradip	7.0	7.5
Calcutta	8.0	8.5
Average waiting/loading period at ports (days)		
Alibag (unloading)	8.0	11.0
Mormugao	4.5	5.5
Mangalore	3.0	3.5
Paradip	5.0	6.0
Calcutta	6.0	7.0

Exhibit 4: Distance Matrix (kilometres)

Inbound road and rail distances between mines, ports and the plant

		Goa	Mangalore	Daitari	Banspani
Alibag	(Road)	520	800	1780	1650
Pen	(Rail)	500*	700*	2200	1800
Mormugao	(Rail)	50	—	—	—
Paradip	(Rail)	—	—	170	700 400 (post '95)

* After the completion of Konkan Railway (1996)

(*Continued*)

(*Continued*)

Outbound distances to market centres

Town	Pen (Rail)	Alibag (Road)	Town	Pen (Rail)	Alibag (Road)
Delhi	1420	1490	Baroda	440	510
Hissar	1520	1590	Raipur	1140	1200
Ambala	1610	1680	Gwalior	1225	1170
Ludhiana	1695	1765	Indore	880	680
Jaipur*	1150	1250	Jabalpur	1000	1130
Lucknow	1400	1450	Bombay	70	85
Muzaffarnagar	1550	1620	Nagpur	830	940
Tatanagar	1700	2040	Aurangabad*	340	350
Bhilai	1280	1450	Kolhapur	540	350
Rourkela	1540	1900	Waltair	1520	1320
Durgapur	2000	2300	Secunderabad	810	680
Burnpur	1850	2250	Kothagudam	1060	980
Bokaro	1820	2200	Bangalore	1140	970
Ranchi	1650	2000	Hospet	870	670
Barajamda	1600	1800	Bhadravati*	1390	780
Calcutta	1970	2160	Calicut	1840	1170
Rajkot	780	850	Madras	1290	1310
Ahmedabad	540	630	Tiruchirapalli	1710	1300

Towns marked * have metre gauge only

QUESTIONS FOR DISCUSSION

1. What is the best mode for inbound logistic supply of raw material?
2. What final markets should Laxmi Transformers choose to serve based on logistical considerations? What is the best mode for the finished goods despatch to key markets?
3. Contingent on a particular choice for inbound movement, can the same mode be used for servicing some final markets?
4. Is a rail siding from Pen to Alibag worth the investment?
5. If ships are to be used for inbound logistics, how many barges would be required for the lighterage operations from the mother vessel to the jetty at Alibag?
6. Would the scheduling of carriers in any mode affect the economics of the mode choice?

APPROACH FOR ANALYSIS

In such a situation, attention must be paid to the value chain of the product, which could have a significant impact on inventory related costs. In particular, the inventory costs have to be calculated keeping in mind the stage at which the material is in, since raw material and finished goods have quite different values of holding and handling. The main quantities to be considered in inventory calculations for each mode are pipeline (or transit) inventories, batching inventories and buffer stock inventories.

Each mode choice scenario has to be worked out with the relevant detail of all the associated costs. The sea mode, in particular has a number of cost factors, since the volume of movement is high enough that inventory costs while building up the loading quantity and, while consuming the unloaded quantities have to be estimated. Also, barge costs have to be accounted for, with a suitable level of detail.

Since the spatial spread of final markets for the firm is still uncertain, the logistics costs due to a mode choice decision may affect the choice of locations for marketing efforts, to some extent. In other words, while considering each mode of movement, the "optimal" choice of markets to serve (with appropriate assumptions about market share) can be assumed. For this purpose, a segmentation of the final market can be done either on the basis of location of the customer, or on the basis of size of the customer's demand, in order to decide which markets to focus on. Recall that one of the motivations of locating the plant at Alibag was to serve new mini-steel plants and ferrous foundries in Western India.

CASE 2

CASE CONTEXT

The market share for cement transportation by rail had declined from 56% to 43% over the past decade. In an attempt to arrest the sliding market share, the Indian Railways (IR) wished to focus more on customer service by expanding the scope of its offer to a third party logistics service provider. The client system was in the private sector (unlike the other major commodities carried by IR) and hence was more demanding and representative of the future orientation of industrial activity in India. Cement had to reach the retail customer, due to which the distribution side had reasonable scope for a third party logistics service provider.

This case examines what the IR can do in the context of a large scale modern cement plant, called Rajashree Cement (RC), in terms of operations at a specific client site. This had implications for infrastructure, services, organization and information systems. A new concept called Engine on Load (EOL) was being experimented by RC and the IR to improve the throughput of bulk cement from the Malkhaid plant of RC to the Bangalore market. After three months of EOL, executives from RC and IR were reviewing-(i) whether to continue with the EOL system or not and (ii) if, to continue, what should be the terms of the contract between RC and IR. This would have implications for IR's service levels to their clients.

RAJASHREE CEMENT Engine On Load

In January 2004, Mr Rawat, General Manager, Malkhaid Plant; Mr Mehta, Vice President – Logistics, Grasim Industries Limited (GIL); and Mr Chaddha, Logistics Manager, Malkhaid Plant, of Rajashree Cement (RC) and, Mr Gupta, Chief Operations Manager; and Mr Murthy, Divisional Railway Manager, Secunderabad (SC) Division of South Central Railway (SCR) of the Indian Railways (IR) were discussing (i) whether to continue with the Engine on Load (EOL) system or not and (ii) if to continue, what should be the

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terms of the contract between RC and SCR. They felt that the recommendations would have wider implications and should be considered by the Railway Board of the IR.

Background

Indian Railways

IR was a critical transport provider to the Indian economy, carrying about 40% freight ton kilometers and 20% of the country's passenger kilometers. Over two-thirds of the revenue came from freight operations. While freight was crucial to IR, and has been growing in an absolute sense, it had steadily been losing market share to the road sector and more recently to coastal transportation. The service offer from the IR had traditionally been station to station transportation, and even in that, with a more explicit focus on the originating station. In an attempt to arrest the sliding market share, the IR wished to focus more on customer service by expanding the scope of its offer to a third party logistics service provider. Cement was considered as one of the focus areas for this.

Significance of Cement to IR

In 2001-02, seven commodities accounted for over 90% of the freight revenue. Coal was the dominant commodity, followed by food grains, iron and steel, iron ore, cement, petroleum, oil and lubricants, and fertilizers [Indian Railways, 2003]. Salient aspects of cement transportation by rail were—(i) the market share for cement transportation by rail had declined from 59% in 1991-92 to 40% in 2002-03, (ii) the client system was in the private sector (unlike the other major commodities carried by IR) and hence, was more demanding and representative of the future orientation of industrial activity in India, and (iii) cement had to reach the retail customer, due to which the distribution side had reasonable scope for a third party logistics service provider.

In 2002-03, cement accounted for about 9% (46 million tons (mt)) of the originating traffic of IR. Nearly 24% (11 mt) of IR's cement was loaded in SCR, 75% (8 mt) of which was in the SC division. Cement accounted for 18% of freight loading in SCR and 25% in the SC division. Exhibit 1 gives the cement and total freight loading statistics for SC division, SCR and IR.

Some of the concerns raised by the cement industry were non-availability of appropriate wagons, lack of proper loading and unloading systems, seamless intermodal connectivity for further movement in the supply chain, non uniform methods across railway zones in indents and claims processing, and the inflexibility of IR to deal with smaller parcel sizes and insufficient information on wagon availabilities and movements.

Structure of the Cement Industry

The installed capacity in large plants (above 0.2 mt per annum) was 140 mt, spread across 125 plants and 54 companies. Out of the 54 companies, the top 11 accounted for nearly 64% of the production in 2002-03. There were four companies having a market share of over 10% each. These were ACC, GACL, GIL, and L&T. The industry structure had been undergoing a change in terms of consolidation, and fewer players were expected to control a larger share of the market. The most recent acquisition had been that of L&T by GIL towards the end of 2003. This would make the merged entity the largest cement player in the country, with a market share of more than 20%. ACC and GACL had started working as an alliance and were expected to merge soon.

There had been changes in the production structure of cement in a variety of ways. One of them involved making cement in two stages; first as clinker as an intermediate product close to the raw material source and then transporting it to grinding plants where it was ground, blended and bagged into value added cement for further distribution to the market. Another change was to transport cement in bulk form for bagging near market centers. The bulk cement could also be processed to a value added product as ready mix concrete for the customer. The product variety was also increasing with the manufacture of blended cements.

Bulk movement of cement required special loading, unloading, and handling relative to bagged cement, while offering advantages of lower transportation costs. The cement industry was keen to look at integrated solutions for distribution logistics wherein a single player could offer all the services for distribution from the plant to the customer.

GRASIM INDUSTRIES AND RAJASHREE CEMENT

GIL was a flagship company of the Aditya Birla Group. It ranked among India's largest private sector companies, (with a gross sales of Rs. 54.12 billion in 2002-03). Starting as a textiles manufacturer in 1948, GIL's businesses comprised Viscose Staple Fiber, cement, sponge iron, chemicals and textiles in 2004. The company held a dominant position in several of its businesses. GIL was the world's eighth largest cement producer, and the largest in a single location. Exhibit 2 provides the locations and capacities of the GIL cement units.

RC, established in 1983, was the largest, single location grey cement manufacturer in the Grasim Cement Division under GIL. It had a capacity of 4.2 metric tons per annum production with a total manpower of 844. The RC plant was located at Malkhaid, Karnataka. Exhibit 3 provides the details on the expansion in capacity from 1984 to 2003 at RC.

CEMENT CLUSTERS

Cement was manufactured in India in regional clusters due to the availability of limestone, which constituted over 80% of the raw material by weight. Limestone, however, constituted about 5-7% of the cost of sales. The RC plant was located in the Gulbarga cluster of limestone mines.

The Gulbarga cluster spanned the states of Andhra Pradesh and Karnataka. Exhibit 4 provides the cluster-wise map showing the large plants, the state-wise installed capacities and plants in the Gulbarga cluster. As of June 2003, the total installed capacity was 13 mt, forming over 8% of the national installed capacity. ACC and RC were the major plants in the cluster. RC had a 1.4 mt grinding unit at Hotgi in Maharashtra, about 150 kms from its plant at Malkhaid. ACC had a grinding unit near Mumbai. Exhibit 5 provides the details of rail connectivity for the Gulbarga cluster.

LOGISTICS AND DISTRIBUTION

RC served the Maharashtra dealers from their grinding unit at Hotgi. It served Karnataka dealers from Malkhaid, both in bagged and bulk forms. About 0.6 mt (52,000 tons per month) was sent in bulk by rail to service the Bangalore market to a bagging plant at Dodballapur, near Bangalore. For Andhra Pradesh, it had four depots spread across the state for stock transfer and secondary distribution to the dealers. Some bulk cement was also sent by road for further value addition to a ready mix concrete plant near Hyderabad.

For the bulk movement, since specialized handling was a requirement, special purpose wagons were necessary. IR encouraged customers having such requirements to invest in their own wagons and offered a 22.5% freight subsidy under the Own Your Wagon (OYW) scheme. Depending on the utilization, the returns on investment could be attractive to customers like RC. RC had invested Rs 600 million on the wagons (amounting to three rakes a rake is a set of wagons constituting a train) and five wagons and the loading and unloading facilities. The freight subsidy for the current level of cement movement was Rs 73 million, providing a return of about 12%. Exhibit 6 provides the details of economics of the OYW scheme.

BULK CEMENT CLOSED CIRCUIT MOVEMENT

For supplying bulk cement to Dodballapur, there was a closed circuit movement of rakes from Malkhaid to Dodballapur and back. The three rakes, averaging a turnaround of 100 hours, led to about seven trips per month per rake. This resulted in a total of over 21 trips per month. Since each rake could carry 2,400 tons, the supply at Dodballapur was as required. A graphical view of the closed circuit movement, layout at Malkhaid and Dodballapur, and operating details of the crew change, fuelling, engine change and wagon maintenance are given in Exhibit 7.

Since IR viewed the engine as a critical resource, after the engine pulled in the rake at RC's premises, it was allocated to other tasks, while the incoming rake was loaded at RC. Consequently, there was a wait for engine after the loading was completed at RC, since the SC division had to organize for it. Exhibit 8 gives the waiting time for engine at Malkhaid.

GROWING MARKET

The market for bulk cement in and around Bangalore was growing. RC felt that there was an opportunity to meet this demand. RC wanted to improve the supply to Dodballapur to 70,000 tons per month. In consultation with SCR, the following alternatives were considered:

- Increase throughput with the same number of trips by increasing load per wagon and/or wagons per rake. Both these would require redesign of the wagon (due to the topology over which the journey had to be made) and acquisition of fresh stock.
- Increase the number of trips with additional rakes. This would require acquisition of fresh stock, for which one possibility was modifying and using oil tankers that had been rendered surplus due to increased pipeline transportation)
- Increase the number of trips with the same rakes by improving the turnaround time.

The first two alternatives required additional investments by RC. Recognising the rather significant waiting time for engine at Malkhaid, RC proposed that the third alternative be considered. SCR agreed to take this up.

ENGINE ON LOAD EXPERIMENT

IR had introduced an Engine on Load (EOL) scheme, wherein the engine would be kept attached with a rake during loading and unloading operations, thus minimising the delays caused due to loaded/unloaded rakes waiting for it. Such delays led to loss of throughput and consequent loss of revenues to IR. The relevant Railway Board Circular is given in Exhibit 9.

RC and SCR decided to experiment with improving the turnaround time by adopting the EOL scheme. The economics of the EOL for the closed circuit movement, as perceived by RC, are given in Exhibit 10. The approval by SCR for this scheme is given in Exhibit 11. The EOL was inaugurated on 15th September, 2003 (Exhibit 12).

For the EOL, it had been mutually agreed that three hours would be the total time in which RC would complete the loading of the incoming rake. (The three hours was the lower bound of the time taken for an engine to pick up a task subsequent to the one just completed, during the normal assignment process). An hourly penalty of Rs 3,800 would accrue if this was exceeded. This can be viewed in the context of the two types of engines that were used. The indigenous engines in a twin set cost Rs 80 million and a recent import cost Rs 140 million. At a 10 per cent cost of capital, the engine cost per hour was about Rs 900 and Rs 1,600 respectively.

In December 2003, RC and SCR wanted to review the EOL experiment. When a team from the Indian Institute of Management, Ahmedabad and Railway Staff College, Vadodara visited RC as a part of the study on the role of IR as a third party logistics service provider for the cement industry, RC proposed that the team be involved in the review. The team members agreed and gathered data on the closed circuit movement performance till the end of December, 2003. 78 trips had been undertaken from Malkhaid after the introduction of EOL, of which only 45 actually availed of EOL. Exhibits 13 and 14 give the rake-wise detention details gathered by the team at Malkhaid and Dodballapur respectively. It was now essential to calculate and analyse the components of the closed circuit movement, both for the rakes which availed EOL and those that did not, to facilitate the review. The components of the turnaround time before the EOL introduction is given in Exhibit 15.

Based on the experience of the EOL scheme, the team suggested that RC and SCR consider the following issues:

- Should RC and SCR have the option of declaring a trip as not for EOL? Can this be unilaterally decided or should it be a joint decision? What should be the required advance notice?
- From the time the rake reaches the terminal, what should be the guaranteed time for engine availability? What should the penalty be on RC if load is not available? *What should the penalty be on SCR if engine is not available?* (Currently, there was no penalty on SCR).
- What steps should RC take to ensure timely loading at the terminal?
- What steps should SCR take to ensure EOL, and by implication powering the incoming train with an appropriate engine?
- Is the issue EOL or timely availability of engine (incoming and outgoing engines need not be the same, should SCR want the flexibility)?
- To improve customer service towards becoming a third party logistics service provider, should not SCR (and thus, IR) focus on guaranteed total (a) delivery time from Malkhaid (origin) to Dodballapur (destination) and (b) turnaround time for the whole circuit?

Exhibit 1: Cement and Total Originating Loading Statistics

Year	Secunderabad Division						South Central Railway				Indian Railways	
	Cement		Total		% Variation Over Previous Year		Cement		Total		Cement	Total
	Mt per annum	Average Wagons per day	mt per annum	Average Wagons per day	mt per annum	Average Wagons per day	mt per annum	Average Wagons per day	mt per annum	Average Wagons per day	mt per annum	mt per annum
1990-91	5.76	703	17.32	2175	4.4	4.9	8.19	912	31.78	3503		
1991-92	5.38	661	18.88	2325	9.0	6.9	8.60	929	34.78	3723		
1992-93	5.92	723	20.67	2593	9.5	11.5	8.63	931	35.83	3937		
1993-94	6.78	801	24.23	3073	17.2	18.5	9.60	1027	40.30	4570		
1994-95	5.55	786	20.51	2970	–15.3	–3.4	8.18	1042	35.73	4766		
1995-96	6.28	757	21.51	2521	4.9	–15.1	9.33	1059	36.68	4267		
1996-97	7.00	767	24.09	2849	12.0	13.0	9.89	1069	40.30	4581		
1997-98	7.90	772	26.17	3056	8.6	7.3	10.42	1053	44.11	5021	37.36	429.38
1998-99	6.70	664	24.25	2824	–7.3	–7.6	9.65	989	42.45	4920	36.75	420.92
1999-00	7.22	705	28.73	3298	18.5	16.8	11.37	1184	51.25	5917	43.62	456.42
2000-01	7.05	827	30.41	3517	5.8	6.6	10.76	1093	56.84	6604	42.90	473.50
2001-02	6.56	770	31.31	3619	3.0	2.9	9.70	1137	60.41	7010	44.04	492.50
2002-03	8.34	975	33.41	3843	6.7	6.2	11.18	1305	62.29	7222	46.25	518.74

Source: [South Central Railway, 2004 and Indian Railways, 2003a]

Exhibit 2: Grasim Industries (AV Birla Group): Cement Units

Plant	Location	State	Capacity (mt)
Rajashree Cement	Malkhaid	Karnataka	4.20
Birla Super Grinding Unit	Hotgi	Maharashtra	1.40
Aditya Cement	Shambupura	Rajasthan	1.75
Vikram Cement	Khor	M.P.	3.00
Grasim Cement	Rawan	Chhattisgarh	2.06
Grasim Cement South	Reddypalayam	Tamil Nadu	1.03
Bhatinda Grinding Unit	Bhatinda	Punjab	1.20
SDCC	Sikka	Jamnagar	1.08

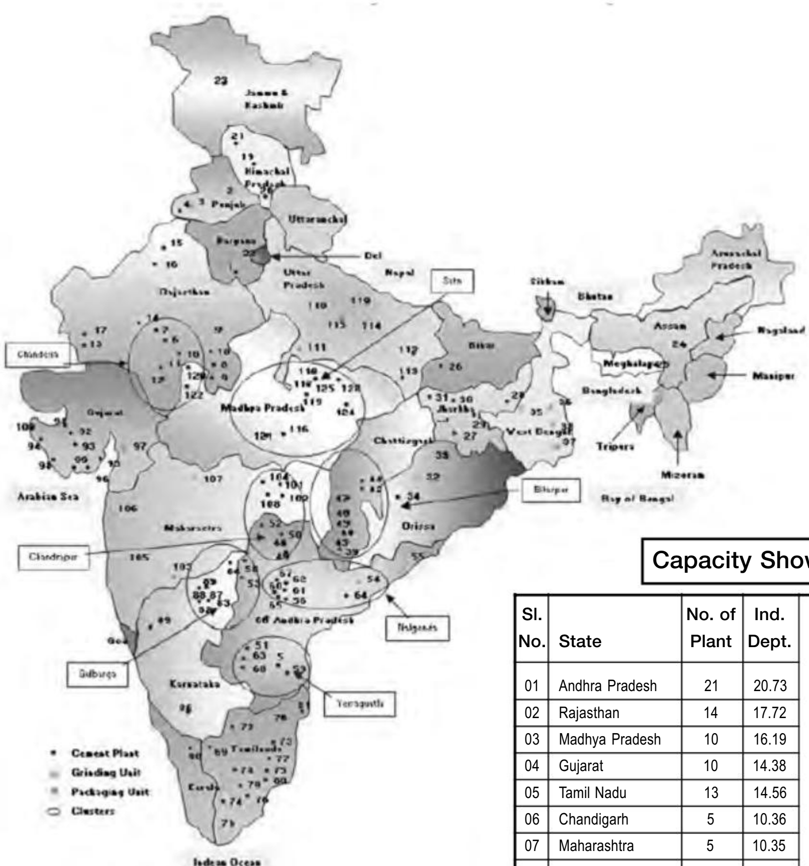
Source: [RC, 2003]

Exhibit 3: Rajashree Cement – Malkhaid Plant Capacity

Plant	Year of Commissioning	Capacity (mt)	Cumulative Capacity (mt)
Unit-I	1984	0.50	0.50
Unit-I Expansion	1989	0.30	0.80
Unit-II	1990	1.00	1.80
Unit-III	1995	1.20	3.00
Unit-II Internal Optimization	2000	0.20	3.20
Capacity Enhancement By Debottlenecking	June 2003	1.00	4.20

Source: [RC, 2003]

Exhibit 4: Clusterwise Cement Map of India (Large Plants) (*as on 31.3.2003*)



Capacity Shown Million Tonnes

Sl. No.	State	No. of Plant	Ind. Dept.		Sl. No.	State	No. of Plant	Ind. Dept.
01	Andhra Pradesh	21	20.73		12	West-Bengal	4	43.13
02	Rajasthan	14	17.72		13	Panjab	3	42.04
03	Madhya Pradesh	10	16.19		14	Urissa	3	43.04
04	Gujarat	10	14.38		15	Bihar	1	41.10
05	Tamil Nadu	13	14.56		16	Delhi	1	40.50
06	Chandigarh	5	10.36		17	Kerala	1	40.42
07	Maharashtra	5	10.35		18	Jammu & Kashmir	1	40.20
08	Karnataka	5	19.79		19	Assam	1	40.20
09	Uttar Pradesh	7	15.06		20	Meghalaya	1	40.20
10	Jharkhand	5	14.57		21	Hariyana	1	40.17
11	Himanchal Pradesh	3	14.06			**Total**	**124**	**43.13**

Gulbarga Cluster

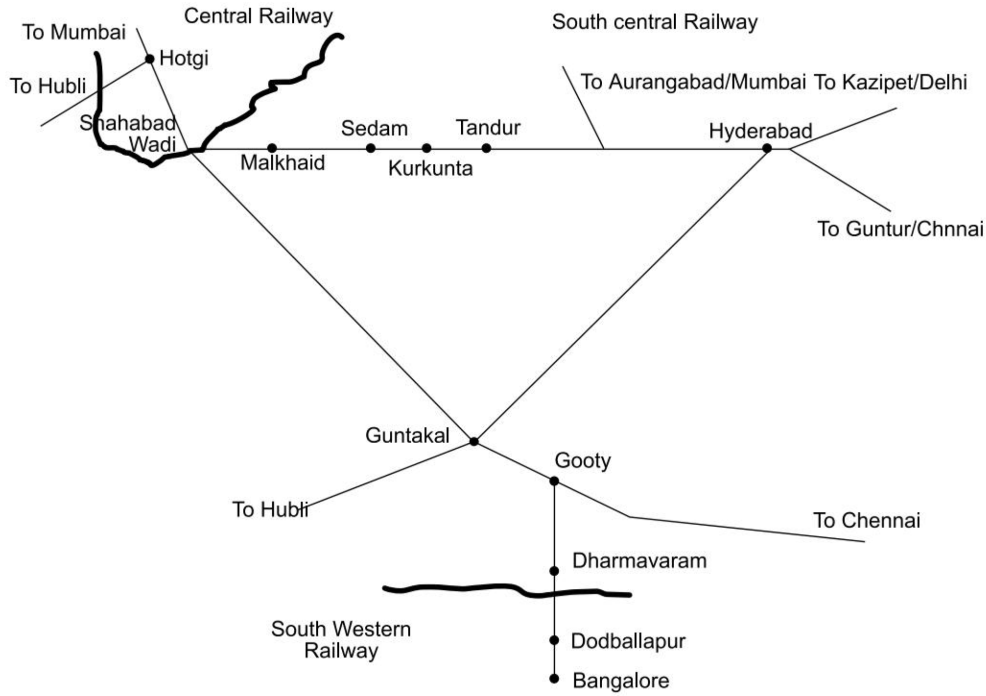
Sl. No.	Region/State	Location	Installed Capacity (mt)	
Andhra Pradesh				
53.	CCI Ltd.	Tandur	1.00	
58	India Cement-Visaka	Tandur	1.12	
				2.12

(*Continued*)

(*Continued*)

Sl. No.	Region/State	Location	Installed Capacity (mt)	
Karnataka				
82	ACC Ltd.	Wadi	2.11	
83	ACC Ltd.- New	Wadi	2.60	
84	Vasavadatta Cement	Sedam	1.20	
85	Rajashree Cement	Malkhaid	4.20	
87	CCI Ltd.	Kurkunta	0.20	
88	HMP Cements Ltd.	Shahabad	0.48	
				10.79
Source: [CMA, 2003]				

Exhibit 5: Rail Connectivity for the Gulbarga Cluster

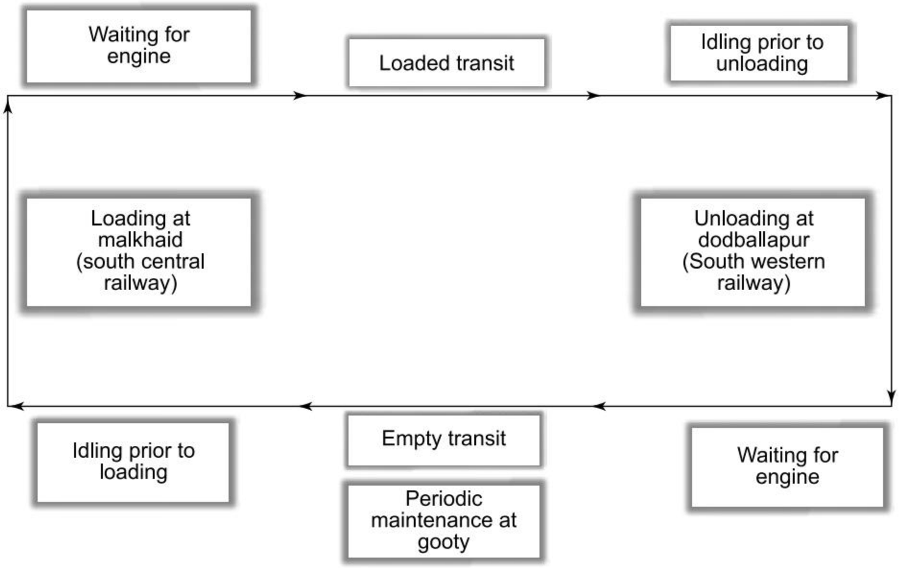


Source: [Indian Railways, 2003b]

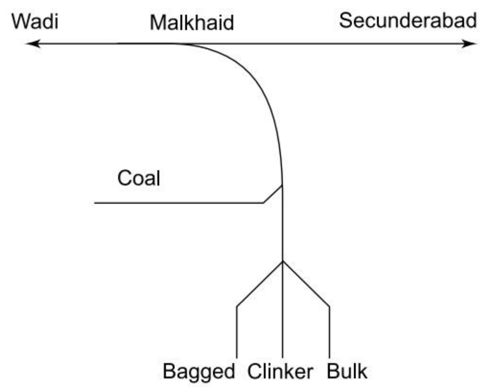
Exhibit 6: Economics of Own Your Wagon Scheme for Rajashree Cement

Investments	
Wagons (40 *3 Rakes plus 5 for contingency = 125 Boxes)	Rs 200 million
Malkhaid (Loading) Silo	Rs 10 million
Dodballapur Unloading	Rs 390 million
Total Investment	Rs 600 million
Benefits	
Freight Subsidy	22.5% for 10 years (Rs 116 on a total of Rs 516)
7 trips per rake per month @2400 mt per rake	52,000 tons per month = 624,000 tons per annum
Savings	624,000*116 = Rs 73 million
ROI	73/600 = 12 %
Alternatives	
Net savings: Rs 116 or Rs 150 per ton?	- Rail OYW – Rs 460: Rs 400 (Malkhaid to Dodballapur) + Rs 60 (Dodballapur to dealers) - Rail regular wagon – Rs 610: Rs 550 (Malkhaid to Bangalore in bags) + Rs 60 (Bangalore handling at goods shed and then to dealers)
Source: [RC, 2003 and Author's Analysis]	

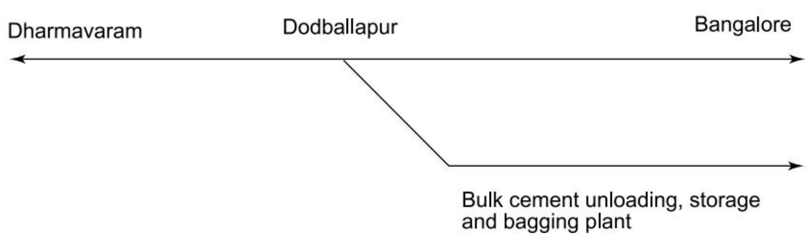
Exhibit 7: RC Bulk Cement Closed Circuit Movement

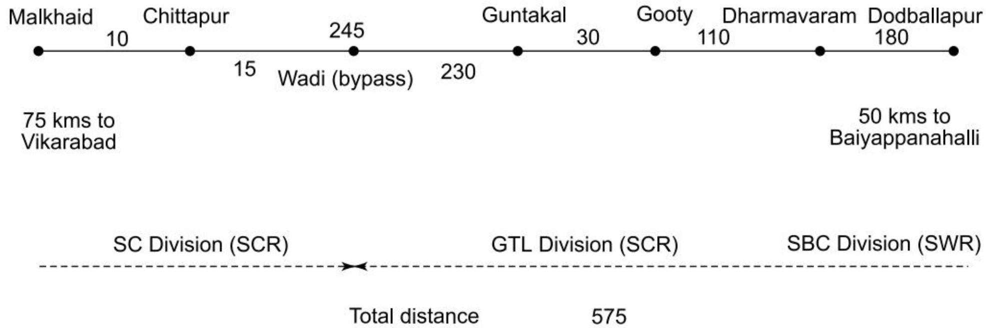


Malkhaid Layout



Dodballapur Layout





Crew Change	:	Chittapur, Guntakal, Dharmavaram and Baiyappanahalli
Engine Change	:	Guntakal and Gooty (for maintenance, if required) and Dharmavaram (for engine compatibility, if required). Three types of engines were used from Malkhaid: WDM2 Multi (about 5000 horse power, 16, 17 and 18 series), WDG3A Shaktiman (3100 horse power, 13 and 14 series) and WDG4 GM (4000 horse power, 12 series). The WDG3A had difficulty in managing the gradient in a few sections in GTL division. It could stall if it was slowed down. A banker/double head/multi would be preferred. The WDG3A required a banker on the ghats in the Dharmavaram – Dodballapur section for one block section. The WDG4 were not safety certified for the ghat sections.
Fuelling	:	Vikarabad, Guntakal, Gooty and Baiyappanahalli, as required. A top up to 5000 litres (for WDM2) and 6000 litres (for WDGs) at Gooty would enable a trip to either Malkhaid or Dodballapur and back
Wagon Maintenance	:	Gooty (The maintenance provided a break power certificate for 4000 kms, implying that the next maintenance would be required before this distance was covered. This implied a maintenance once in three trips.)
SCR – SWR Issues	:	SCR suggested that SWR should conduct trials using WDG3A without a banker on the ghat section. Alternately, SCR was ready to provide a banker to operate only in the ghat section, if SWR agreed. This would avoid the need for engine change at Dharmavaram.
	:	SWR suggested that if the engine from Dharmavaram came with enough fuel, the same can be turned around at Dodballapur. However, the crew would need rest during the unloading operations, for which a running room was being constructed by RC at Dodballapur

Source: [RC, 2003 and Authors' Analysis]

Exhibit 8: Average Waiting Time for Engine to Pull Out Loaded Rakes

(Hours:Minutes)

Apr'02 - Mar'02			
Month	**Average Time Taken for Arrival of Engine**		
	Cement Rake		Clinker Rake
	Bagged	Loose	
Apr'02	12:45	8:00	5:50
May'02	20:30	13:50	7:50
Jun'02	31:40	13:00	8:50
Jul'02	17:20	9:20	6:30
Aug'02	7:00	29:30	5:40
Sep'02	10:50	13:30	6:00
Oct'02	21:00	11:00	10:20
Nov'02	13:45	14:10	9:50
Dec'02	24:10	10:50	9:30
Jan'03	19:15	13:30	11:15
Feb'03	18:45	12:23	9:40
Mar'03	16:06	9:42	8:31
Total	**213:06**	**158:46**	**99:46**
Average 02-03	**17:45**	**13:13**	**8:18**
Minimum time	**7:00**	**8:00**	**5:40**
Maximum time	**31:40**	**29:30**	**11:15**

Apr'03 - Nov'03			
Month	**Average Time Taken for Arrival of Engine**		
	Cement Rake		Clinker Rake
	Bagged	Loose	
Apr'03	30:38	6:48	11:27
May'03	29:10	9:52	21:41
Jun'03	15:06	12:20	19:03
Jul'03	28:56	12:53	9:15
Aug'03	23:49	12:38	11:43

(*Continued*)

(*Continued*)

Sep'03	14:39	6:24	12:02
Oct'03	17:07	3:06	12:06
Nov'03	15:15	6:00	14:00
Total	**174:43**	**70:04**	**111:19**
Average 03-04	**21:50**	**8:45**	**13:54**
Minimum time	**14:39**	**3:06**	**9:15**
Maximum time	**30:38**	**12:53**	**21:41**
Source: [RC, 2003]			

Exhibit 9: Railway Board Circular

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

(RAILWAY BOARD)

N0: TC-I/94/214/9 New Delhi, dt 26-6-1997

The General Manager,

All Indian Railways

Sub: Provision of Engine on Load Scheme at selected terminals and sidings.

1. For quite some time the question of reducing the detention caused to the wagons at the terminals/siding because of their waiting for Power has been engaging the attention of the Board. It has also been observed that such detentions to wagons caused heavy loss of loading capacity as also loss of revenue to the Railways.
2. On the basis of extensive review, it has been observed that detention to rakes could be minimised substantially if the locomotive is kept attached with a rake during loading and unloading operations. The moment the loading/unloading is completed, the rake could be moved out without much loss of time; thereby improving the turn round of wagons resulting in generation of additional carrying capacity. This system, also known as Engine on Load is already operational on Eastern Railway (Khalari-Unchahar Circuit), South-Eastern Railway (Bacheli Yard on Kirandul-Kottavalasa Line) and Northern Railway (NTPC siding at Dadri). The studies conducted on operation of existing Engine on Load system, which is based on the debit/credit hours for calculation of free time have shown remarkable results in that it has led to a substantial reduction in detentions and better turn round of wagons. This scheme, however, did not make much headway at other places because the terminal/siding owner did not show much interest in improving the handling facilities and infrastructure as they were not getting any

direct monetary advantage and perceived that this scheme benefited only the Railways.

3. Keeping this in view, the basic features of the scheme are being outlined in a Draft Memorandum of Understanding, which is under finalisation in Board's office. The proposed features are enumerated as under:

   (i) This scheme is open to selected terminals/sidings, handling atleast one rake per day, who are desirous of making investments for improvement of siding infrastructure and handling facilities for reduction in time taken for rake loading/unloading operations.

   (ii) The investments in sidings will precede the grant of monetary incentive i.e. the installation and commissioning of improved terminal handling facilities and resultant saving in detention of rakes is a must for payment of these incentives.

   (iii) The terminal/siding user will submit technical plans with capital cost, method of financing and period during which the facilities will be installed, to the Railways for vetting and ascertaining the adequacy of the scheme etc.

   (iv) The revised free time for loading/unloading would be four hours or less depending on the facilities and the special features of the siding.

   (v) The monetary incentive will be 50% of the notional earnings accruing to the Railways on account of reduction in the loading/unloading time of the rake. These notional earnings would be calculated after deducting the cost of detention of locomotives as a result of the implementation of the scheme.

   (vi) The incentive will be paid for a limited period of upto 3 years, commensurate with the investments made.

   (vii) After the period of recovery of investment, the rebate would be replaced by a nominal concession to the extent of the expenses on maintenance of the facilities plus a token 5% thereof as long term incentive, subject to a ceiling of 2-3% of the annual freight charges.

   (viii) In case the party defaults and savings do not accrue, then normal demurrage charges on rakes as also loco detention charges would be recoverable from the party.

   (ix) Monetary incentive will be paid on half-yearly basis.

   (x) The monetary incentive is towards investments made only for infrastructure improvements and provision of other facilities in the sidings, leading to reduction in time taken for loading/unloading.

   (xi) The scheme will take effect from a prospective date only.

4. The draft MoU is under finalisation.

5. In the meantime, Zonal Railways may address prospective rail-users who can opt for the scheme and explain the provisions to them so that it is appreciated in the correct perspective.

6. Any suggestions from Zonal Railways to further improve and strengthen the scheme, may be sent alongwith comments of associate Finance.
7. This issues with the concurrence of the Finance Department in the Ministry of Railways.

(Hindi version will follow)

(K.K. Sharma)
Jt. Director, Traffic Comml. (Rates) I
Railway Board.

Copy to: (1) General Manager (Commercial) and General Manager (Optg.), All Indian Railways including Konkan Railway.
(2) EDTT (M), EDCE (G), EDF(C), DDTC(R), Railway Board.

Exhibit 10: Economics of EOL

Preamble

The following table gives an activity wise breakup of the time taken in the turnaround cycle for bulk rakes (Inclusive of both historical data and Proposed Time for each activity with EOL system)

Time in Hours

Particulars	2002-03	2003-04	Proposed with EOL
	Apr 02-Mar 03	Apr 03-Jul 03	
Loading Time	3.36	3.27	3.3
Placement/Shunting/Formation(*) Time	7.36	3.11	1.3
Total Time for loading and placement	11.12	6.38	5
Time taken for engine arrival to pullout loaded rake	13.14	16.42	2 (***)
Transit time – Malkhaid to Dodballapur	34.42	53.4(**)	34
Unloading time at Dodballapur	9.46	25.54(**)	9
Transit time – Dodballapur to Malkhaid	30.09	29.13(**)	30
Total Bulk Rake turnaround time	**99.03**	**132.07 (**)**	**80**
Average no. of trips per month	**22.11**	**16.58**	**27.38**
Actual average number of trips	**22**	**20**	-
(*) Also inclusive of detention of empty rake for want of stock in silos			
(**) The high values are due to detention of loaded rakes due to Transport Strike in April and maintenance at Dodballapur in June			
(***) Time taken as 2 hours for any contingency , ideally should be zero			

(Continued)

(*Continued*)

Expected Benefits			
Effective increase in number of trips per month	5		
Incremental quantity moved per month (tons)	11900		
Incremental quantity moved per annum (tons)	142800		
Freight rebate @ 22.5 % (Rs/ton)	105.52		
Logistics Gain per month (Rs million)	1.26		
Cost envisaged towards engine detention of two hours @ Rs 3900 per hour (Rs million) per month	0.21		
Net Logistic Gain per month (Rs million)	1.05		
Net Annual Logistic Gain (Rs million)	**12.5**		
Gain to Railways			
Additional revenue per month due to incremental quantity (Rs million)	4.33		
Additional revenue annually due to incremental quantity (Rs million)	**51.9**		
Detention Charges per month (Rs million)	0.21		
Detention Charges annually (Rs million)	2.5		
Total Gain to Railways (Rs in million)	**54.4**		
Source: [RC, 2003]			

Exhibit 11: Approval by South Central Railway

South Central Railway

Office of the Divisional Railway Manager,
Commercial Branch,
Sanchalan Bhavan – II floor,
Secunderabad.

C/C/490/Shunting Charges/96
Date: 18-9-03

Vice President,
M/s Rajashree Cements,
May Fair Complex, S.P.Road,
Secunderabad.

Dear Sir,

Sub: Your request for detaining engine on load for loading BCCW rake.

Ref: Your Ir No. RC/MQR/CEM/EOL dated 06-8-03

Your request for loading BCCW wagons with engine on load, keeping with Railway engine is agreed. Necessary instructions have been issued to station staff to permit to keep the engine on request for loading BCCW wagons.

It may be noted that detention charges have to be paid at prescribed rate for detention of engine beyond three hours, from the time of arrival of engine with empty rake into the siding, till the departure of engine with load from siding.

Yours Sincerely,

For Divisional Railway Manager,

Secunderabad

Copy to:

CCM for kind information

COM for kind information

Sr. DOM/SC for information and necessary action.

CCI/TDU for necessary action

SM/MQR & Siding clerks for recording and levying engine detention charges beyond three hours as stated above.

Exhibit 12: Inauguration of EOL (15.09.2003)

Source: [RC, 2003]

Exhibit 13: Rakewise Detention Details at Malkhaid

September 2003

S No	Rake	Date	Stock	Arriving at Siding Date	Arriving at Siding Time	Engine No.	Placement Time Date	Placement Time Time	Release Time Date	Release Time Time	Departure from Siding Date	Departure from Siding Time	Total Detention Hrs	Free Time Hrs	Time Charge Hrs	Rate per Hour Rs	Amount Rs	Remarks
1	A	15.09.03	40 Bccw	15.09.03	2:00	14615	15.09.03	2:30	15.09.03	7:30	15.09.03	8:00	6:00	3:00	3:00	3870	11610	
2	B	15.09.03	40 Bccw	15.09.03	16:30	14630/14577	15.09.03	17:00	15.09.03	23:00	15.09.03	23:30						Engine withdrawn no EO L Cleared with 12019
3	C	15.09.03	40 Bccw	15.09.03	22:30	18513/18897	16.09.03	12:00	16.09.03	17:00	16.09.03	19:30						Party requested since no time gap
4	A	17.09.03	40 Bccw	17.09.03	17:00	14559	17.09.03	18:00	17.09.03	23:30	18.09.03	0:00						Enginewithdrawn anot-her power 14818 cleared
5	B	18.09.03	40 Bccw	18.09.03	20:30	12006	19.09.03	5:00	19.09.03	8:00	19.09.03	12:00						Engine withdrawn at party requestsince no materia
6	C	19.09.03	40 Bccw	19.09.03	16:00	14678	19.09.03	20:00	19.09.03	23:00	20.09.03	7:00						No EOL
7	A	20.09.03	40 Bccw	20.09.03	8:00	14818	21.09.03	3:00	21.09.03	7:00	21.09.03	11:00						No EOL
8	B	23.09.03	40 Bccw	23.09.03	22:00	12020	23.09.03	22:30	24.09.03	4:30	24.09.03	7:00						Withdrawn engine cleared with 14693
9	C	24.09.03	40 Bccw	24.09.03	1:00	14639	25.09.03	4:00	25.09.03	8:00	25.09.03	8:30						Cleared with 14819
10	A	25.09.03	40 Bccw	25.09.03	8:15	14819	25.09.03	13:00	25.09.03	17:00	25.09.03	18:00						Cleared with 12030
11	B	26.09.03	40 Bccw	26.09.03	19:30	14639	26.09.03	20:00	27.09.03	1:00	27.09.03	2:00	6:30	3:00	3:30	3870	15480	
12	C	27.09.03	40 Bccw	27.09.03	20:00	14819	28.09.03	3:00	28.09.03	7:00	28.09.03	11:00						Cleared with 14678
13	A	28.09.03	40 Bccw	28.09.03	20:00	12039	29.09.03	2:00	29.09.03	7:00	29.09.03	11:00						Cleared with 14917/ 14938
14	B	30.09.03	40 Bccw	30.09.03	3:00	17110	30.09.03	4:00	30.09.03	9:00	30.09.03	10:00						Cleared with 12029
	Total																27090	

October 2003

S No	Ra-ke	Date	Stock	Arriving at Siding		Engine No.	Placement Time		Release Time		Departure from Siding		Total Dete-ntion	Free Time	Time Charge	Rate per Hour	Amo-unt	Remarks
				Date	Time		Date	Time	Date	Time	Date	Time	Hrs	Hrs	Hrs	Rs	Rs	
1	C	30.09.03	40 Bccw	30.09.03	23:30	14678	01.10.03	1:00	01.10.03	4:00	01.10.03	4:3	5:00	3:00	2:00	3870	7740	E O L
2	A	02.10.03	40 Bccw	02.10.03	11:30	12006	02.10.03	12:00	02.10.03	16:00	02.10.03	16:30	5:00	3:00	2:00	3870	7740	E O L
3	B	03.10.03	40 Bccw	03.10.03	19:30	14813	03.10.03	20:00	04.10.03	4:00	04.10.03	4:30	9:00	3:00	6:00	3870	23220	E O L
4	C	04.10.03	40 Bccw	04.10.03	13:30	14678	04.10.03	14:30	04.10.03	18:30	04.10.03	19:30	6:00	3:00	3:00	3870	11610	E O L
5	A	06.10.03	40 Bccw	06.10.03	1:30	12015	06.10.03	2:00	06.10.03	7:30	06.10.03	8:00	7:00	3:00	4:00	3870	15480	E O L Power Interception with 18897/16499
6	B	06.10.03	40 Bccw	06.10.03	17:00	14813	06.10.03	17:30	07.10.03	1:30	07.10.03	2:00	9:00	3:00	6:00	3870	23220	E O L
7	C	09.10.03	40 Bccw	09.10.03	8:30	14818	09.10.03	9:00	09.10.03	15:00	09.10.03	15:30	7:00	3:00	4:00	3870	15480	E O L
8	A	10.10.03	40 Bccw	10.10.03	7:30	12025	10.10.03	8:00	10.10.03	12:00	10.10.03	12:30	5:00	3:00	2:00	3870	7740	E O L
Subtotal													53:00	24:00	29:00	3870	112230	
9	B	11.10.03	40 Bccw	11.10.03	4:30	12004	11.10.03	5:00	11.10.03	10:30	11.10.03	13:00						12004 with drawn cleared with 13039
10	C	12.10.03	40 Bccw	12.10.03	19:00	16696/702	12.10.03	19:30	13.10.03	1:30	13.10.03	2:00	7:00	3:00	4:00	3870	15480	E O L
11	A	15.10.03	40 Bccw	15.10.03	2:30	16705/703	15.10.03	3:00	15.10.03	7:00	15.10.03	10:10						16705/703 with drawn cleared with 13039
12	B	16.10.03	40 Bccw	16.10.03	4:00	12026	16.10.03	4:30	16.10.03	9:30	16.10.03	10:00	6:00	3:00	3:00	3870	11610	E O L
13	C	16.10.03	40 Bccw	16.10.03	15:00	12026	16.10.03	21:00	17.10.03	0:00	17.10.03	6:45						Party's request since no time gap cleared with 14691
14	A	18.10.03	40 Bccw	18.10.03	13:30	14092	18.10.03	14:00	18.10.03	19:00	18.10.03	19:30	6:00	3:00	3:00	3870	11610	E O L
15	B	19.10.03	40 Bccw	19.10.03	7:00	14999	19.10.03	7:30	19.10.03	10:30	19.10.03	11:00	4:00	3:00	1:00	3870	3870	E O L
16	C	19.10.03	40 Bccw	19.10.03	20:30	14660	19.10.03	21:00	20.10.03	2:00	20.10.03	2:30	6:00	3:00	3:00	3870	11610	E O L
Subtotal													29:00	15:00	14:00	3870	54180	

(*Continued*)

(*Continued*)

S No	Rake	Date	Stock	Arriving at Siding		Engine No.	Placement Time		Release Time		Departure from Siding		Total Detention	Free Time	Time Charge	Rate per Hour	Amount	Remarks
				Date	Time		Date	Time	Date	Time	Date	Time	Hrs	Hrs	Hrs	Rs	Rs	
17	A	21.10.03	40 Bccw	21.10.03	14:30	13037	21.10.03	15:00	21.10.03	21:00	21.10.03	21:30	7:00	3:00	4:00	3870	15480	E O L
18	B	22.10.03	40 Bccw	22.10.03	20:30	14813	22.10.03	21:00	23.10.03	2:00	23.10.03	2:30	6:00	3:00	3:00	3870	11610	E O L
19	C	25.10.03	40 Bccw	25.10.03	1:30	13044	25.10.03	3:00	25.10.03	8:00	25.10.03	13:30						No E O L cleared with 14667, Loco no. 13044 not permitted due to loco trouble
20	A	26.10.03	40 Bccw	26.10.03	5:30	17228/16474	26.10.03	6:00	26.10.03	11:00	26.10.03	11:30	6:00	3:00	3:00	3870	11610	E O L
21	B	28.10.03	40 Bccw	28.10.03	5:30	14589/14689	28.10.03	6:00	28.10.03	13:00	28.10.03	13:30	8:00	3:00	5:00	3870	19350	E O L
22	C	29.10.03	40 Bccw	29.10.03	16:00	13037	29.10.03	16:30	29.10.03	23:00	30.10.03	0:50						As per T N No. 1/41 with drawn went for fueling
23	A	30.10.03	40 Bccw	30.10.03	18:30	16017	30.10.03	19:00	30.10.03	0:00	31.10.03	1:15						No E O L cleared with 14613
24	B	31.10.03	40 Bccw	31.10.03	15:30	12023	31.10.03	16:00	31.10.03	20:00	31.10.03	20:30	5:00	3:00	2:00	3870	7740	E O L
Subtotal													32:00	15:00	17:00	3870	65790	

November 2003

S No	Ra-ke	Date	Stock	Arriving at Siding		Engine No.	Placement Time		Release Time		Departure from Siding		Total Dete-ntion	Free Time	Time Charge	Rate per Hour	Amo-unt	Remarks
				Date	Time		Date	Time	Date	Time	Date	Time	Hrs	Hrs	Hrs	Rs	Rs	
1	C	01.11.03	40 Bccw	01.11.03	13:30	13039	01.1103	14:00	01.11.03	18:00	01.11.03	18:30	5:00	3:00	2:00	3870	7740	EOL
2	A	02.11.03	40 Bccw	02.11.03	7:00	14613	02.11.03	7:30	0211.03	11:30	02.11.03	12:00	5:00	3:00	2:00	3870	7740	EOL
3	B	04.11.03	40 Bccw	04.11.03	23:00	14613	04.11.03	23:30	05.11.03	5:30	05.11.03	6:00	7:00	3:00	4:00	3870	15480	EOL
4	C	06.11.03	40 Bccw	06.11.03	12:00	12029	06.11.03	12:30	06.11.03	16:30	06.11.03	17:00	5:00	3:00	2:00	3870	7740	EOL
5	A	07.11.03	40 Bccw	07.11.03	23:00	12030	07.11.03	23:3	08.11.03	3:30	08.11.03	4:00	5:00	3:00	2:00	3870	7740	EOL
6	B	08.11.03	40 Bccw	08.11.03	23:30	12001	09.11.03	0:00	0911.03	4:00	09.11.03	4:30	5:00	3:00	2:00	3870	7740	EOL
7	C	09.11.03	40 Bccw	09.11.03	23:30	14943/572	10.11.03	0:00	10.11.03	8:00	10.11.03	8:30	9:00	3:00	6:00	3870	23220	EOL
Subtotal													41:00	21:00	20:00	3870	77400	
8	A	10.11.03	40 Bccw	10.11.03	23:30	14927/13007	11.11.03	0:00	11.11.03	5:00	11.11.03	5:30	6:00	3:00	3:00	3870	11610	EOL
9	B	12.11.03	40 Bccw	12.11.03	19:00	12024	20.11.03	16:00	20.11.03	20:00	21.11.03	16:05						On party's request No EOL Since Mech break down at doballapur w/indent
Subtotal													6:00	3:00	3:00	3870	11610	

(*Continued*)

(*Continued*)

S No	Rake	Date	Stock	Arriving at Siding		Engine No.	Placement Time		Release Time		Departure from Siding		Total Detention	Free Time	Time Charge	Rate per Hour	Amount	Remarks
				Date	Time		Date	Time	Date	Time	Date	Time	Hrs	Hrs	Hrs	Rs	Rs	
10	C	14.11.03	40 Bccw	14.11.03	7:00	14572/943	21.11.03	8:00	21.11.03	12:00	22.11.03	0:30						On party's request No EOL Since Mech break down at doballapur w/Indent
11	A	21.11.03	40 Bccw	21.1103	23:30		22.11.03	9:00	22.11.03	12:00	22.11.03	21:30						No EOL cleared with 14902/17178
12	B	24.1103	40 Bccw	24.11.03	18:45	17673	24.11.03	22:00	25.11.03	2:00	25.11.03	5:40						No EOL cleared with 14813
13	C	25.11.03	40 Bccw	25.11.03	12:00	16602/17744	25.11.03	19:00	25.11.03	24:00	26.11.03	3:00						No EOL cleared with 14816
14	A	26.11.03	40 Bccw	26.11.03	1:00	14904	26.11.03	9:00	26.11.03	12:00	26.11.03	18:00						No EOL cleared with 14684/697
15	B	27.11.03	40 Bccw	27.11.03	14:00	14813	2711.03	14:30	27.11.03	19:30	27.11.03	20:00	6:00	3:00	3:00	3870	11610	EOL
16	C	28.11.03	40 Bccw	28.11.03	21 :30	14093	28.11.03	22:00	29.11.03	6:00	29.11.03	6:30	9:00	3:00	6:00	3870	23220	EOL
17	A	30.11.03	40 Bccw	30.11.03	0:00	14891	30.11.03	0:30	30.11.03	4:30	01.12.03	7:30						As per TN no 1/41 power 4891 Withdrawn cleared with 14588/888
Subtotal													15:00	6:00	9:00	3870	34830	

December 2003

S No	Rake	Date	Stock	Arriving at Siding		Engine No.	Placement Time		Release Time		Departure from Siding		Total Detention	Free Time	Time Charge	Rate per Hour	Amount	Remarks
				Date	Time		Date	Time	Date	Time	Date	Time	Hrs	Hrs	Hrs	Rs	Rs	
1	B	01.12.03	40 Bccw	01.12.03	8:00	17336	01.12.03	10:00	01.12.03	13:00	01.12.03	19:00					12025	No E O L cleared with
2	C	02.12.03	40 Bccw	02.12.03	16:00	14697	02.12.03	16:30	02.12.03	19:30	03.12.03	11:30						No E O L cleared with 12002
3	A	04.12.03	40 Bccw	04.12.03	6:30	16683	04.12.03	8:00	04.12.03	11:00	04.12.03	21:50						No E O L cleared with 13037
4	B	04.12.03	40 Bccw	05.12.03	23:30	14585	05.12.03	0:00	05.12.03	4:00	05.12.03	11:10						No E O L withdrawn for fueling
5	C	05.12.03	38 BCCW	05.12.03	23:30	14660	06.12.03	0:00	06.12.03	3:00	08.11.03	3:30	4:00	3:00	1:00	3870	3870	E O L
6	A	07.12.03	40 Bccw	07.12.03	12:30	14999	07.12.03	13:00	07.12.03	16:00	07.12.03	16:30	4:00	3:00	1:00	3870	3870	E O L
7	B	07.12.03	40 Bccw	07.12.03	21:30	16705	07.12.03	0:00	08.12.03	4:00	09.12.03	3:00						No E O L cleared with 14639
8	C	10.12.03	38 Bccw	10.12.03	2:30	13038	10.12.03	3:00	10.12.03	8:00	10.12.03	8:30	6:00	3:00	3:00	3870	11610	E O L
Subtotal													14:00	9:00	5:00	3870	19350	
9	A	11.12.03	40 Bccw	11.12.03	10:30	14613	11.12.03	11:00	11.12.03	14:00	11.12.03	14:30	4:00	3:00	1:00	3870	3870	E O L
10	B	12.12.03	40 Bccw	12.12.03	16:30	14045/35	12.12.03	17:00	12.12.03	20:00	12.12.03	20:30	4:00	3:00	1:00	3870	3870	E O L
11	C	14.12.03	40 Bccw	14.12.03	11:30	12004	14.12.03	12:00	14.12.03	16:00	14.12.03	16:30	5:00	3:00	2:00	3870	7740	E O L
12	A	15.12.03	40 Bccw	15.12.03	22:30	14613	15.12.03	23:00	16.12.03	4:00	16.12.03	4:30	6:00	3:00	3:00	3870	11610	E O L
13	B	17.12.03	40 Bccw	17.12.03	18:30	12010	17.12.03	19:00	17.12.03	23:00	17.12.03	23:30	5:00	3:00	2:00	3870	7740	E O L
14	C	18.12.03	40 Bccw	18.12.03	21:00	14613	18.12.03	21:30	19.12.03	0:30	19.12.03	1:00	4:00	3:00	1:00	3870	3870	E O L
15	A	19.12.03	40 Bccw	19.12.03	17:00	17744/	19.12.03	17:30	19.12.03	20:30	19.12.03	21:00	4:00	3:00	1:00	3870	3870	E O L
					17462													
Subtotal													32:00	21:00	11:00	3870	42570	

(*Continued*)

(*Continued*)

S No	Rake	Date	Stock	Arriving at Siding		Engine No.	Placement Time		Release Time		Departure from Siding		Total Detention	Free Time	Time Charge	Rate per Hour	Amount	Remarks
				Date	Time		Date	Time	Date	Time	Date	Time	Hrs	Hrs	Hrs	Rs	Rs	
16	B	21.12.03	40 Bccw	21.12.03	10:30	12015	21.12.03	11:00	21.12.03	14:00	21.12.03	14:30	4:00	3:00	1:00	3870	3870	E O L
17	C	22.12.03	40 Bccw	22.12.03	8:30	14660	22.12.03	9:00	22.12.03	12:00	22.12.03	12:30	4:00	3:00	1:00	3870	3870	E O L
18	A	23.12.03	40 Bccw	23.12.03	14:30	14816	23.12.03	15:00	23.12.03	19:00	24.12.03	16:55						No E O L cleared with 14779
19	B	25.12.03	40 Bccw	25.12.03	14:30	12045	25.12.03	15:00	25.12.03	19:00	25.12.03	19:30	5:00	3:00	2:00	3870	7740	E O L
20	C	26.12.03	40 Bccw	26.12.03	23:00	14637	26.12.03	23:30	26.12.03	4:30	27.12.03	5:00	6:00	3:00	3:00	3870	11610	E O L
21	A	27.12.03	40 Bccw	27.12.03	20:00	12002	27.12.03	20:30	27.12.03	0:30	28.12.03	1:00	5:00	3:00	2:00	3870	7740	E O L
22	B	29.12.03	40 Bccw	29.12.03	8:00	14999	29.12.03	9:00	29.12.03	12:00	30.12.03	17:40						No E O L cleared with 13049
23	C	30.12.03	40 Bccw	30.12.03	19:30	14786/87	30.12.03	20:00	30.12.03	23:30	31.12.03	13:55						No E O L cleared with 13054
Subtotal													24:00	15:00	9:00	3870	34830	

Summary (as per L.NO.C/C/490/SHUNTING CHARGES/96/DT. 18.09.2003)

Period	No of Rakes Loaded	No of EOL Rakes	Total Detention Hrs	Free Time Hrs	Time Charged Hrs	Rate per Hour Hrs	Amount Rs
Ist Period (Sep 15th to 30th)	14	2	12:30	6:00:00	6:30:00	3870	25155
Total	14	2	12:30	6:00:00	6:30:00	3870	25155
Ist Period (Oct 1st to 10th)	8	8	53:00	24:00	29:00	3870	112230
Iind Period (Oct 11th to 20th)	8	5	29:00	15:00	14:00	3870	54180
IIIrd Period (Oct 21st to 31st)	8	5	32:00	15:00	17:00	3870	65790
Total	24	18	114:00	54:00	60:00	3870	232200
Ist Period (Nov 1st to 10th)	7	7	41:00	21:00	20:00	3870	77400
IInd Period (Nov 11th to 20th)	2	1	6:00	3:00	3:00	3870	11610
IIIrd Period (Nov 21st to 30th)	8	2	15:00	6:00	9:00	3870	34830
Total	17	10	62:00	30:00	32:00	3870	123840
Ist Period (Dec 1st to 10th)	8	3	14:00	9:00	5:00	3870	19350
IInd Period (Dec 11th to 20th)	7	7	32:00	21:00	11:00	3870	42570
IIIrd Period (Dec 21st to 31st)	8	5	24:00	15:00	9:00	3870	34830
Total	23	15	70:00	45:00	25:00	3870	96750

Exhibit 14: Rakewise Detention Details at Dodballapur

September 2003

S No	Rake	Rake Arrival		Unloading					Rake Releasing Time (Shunting+ unloading) at BSBT (Hrs)	Rake Removal by Rlys.		Rake Waiting Time for Engine (Hrs)	Total Time (Shunting Unloading and Rake Waiting) (Hrs)
		Date	Time	Date	Starting Time	Completion Time	Time for Unloading (Hrs)	No. of Wagons		Date	Time		
1		02.09.2003	3:25	02.09.2003	3:25	7:44	4:19	40	4:19	02.09.2003	8:40	0:56	5:15
2		03.09.2003	23:15	03.09.2003	23:33	3:40	4:07	40	4:25	04.09.2003	7:15	3:35	8:00
3		04.09.2003	17:45	04.09.2003	17:55	22:00	4:05	40	4:15	05.09.2003	7:40	9:40	13:55
4		05.09.2003	18:00	05.09.2003	18:30	22:37	4:07	40	4:37	05.09.2003	22:50	0:13	4:50
5		07.09.2003	4:30	07.09.2003	4:45	8:49	4:04	40	4:19	07.09.2003	9:45	0:56	5:15
6		09.09.2003	0:05	09.09.2003	0:20	4:26	4:06	40	4:21	09.09.2003	10:15	5:49	10:10
7		09.09.2003	18:05	09.09.2003	18:30	22:37	4:07	40	4:32	10.09.2003	1:05	2:28	7:00
8		11.09.2003	1:15	11.09.2003	1:30	5:45	4:15	40	4:30	11.09.2003	7:00	1:15	5:45
9		12.09.2003	23:00	12.09.2003	23:35	3:41	4:06	40	4:41	13.09.2003	8:20	4:39	9:20
10		14.09.2003	5:00	14.09.2003	5:25	9:38	4:13	40	4:38	14.09.2003	10:30	0:52	5:30
11		14.09.2003	14:30	14.09.2003	15:35	19:40	4:05	40	5:10	14.09.2003	20:30	0:50	6:00
12	A	16.09.2003	15:30	16.09.2003	16:05	20:15	4:10	40	4:45	16.09.2003	20:35	0:20	5:05
13	B	17.09.2003	3:00	17.09.2003	3:25	7:32	4:07	40	4:32	17.09.2003	9:45	2:13	6:45
14	C	18.09.2003	4:35	18.09.2003	5:00	9:25	4:25	40	4:50	18.09.2003	10:00	0:35	5:25
15	A	19.09.2003	2:35	19.09.2003	2:55	7:12	4:17	40	4:37	19.09.2003	8:20	1:08	5:45
16	B	20.09.2003	23:00	20.09.2003	23:25	3:32	4:07	40	4:32	21.09.2003	11:45	8:13	12:45
17	C	21.09.2003	19:00	21.09.2003	19:18	23:24	4:06	40	4:24	22.09.2003	2:15	2:51	7:15
18	A	22.09.2003	16:15	22.09.2003	16:29	20:59	4:30	40	4:44	22.09.2003	21:15	0:16	5:00
19	B	25.09.2003	17:30	25.09.2003	17:50	22:05	4:15	40	4:35	25.09.2003	23:10	1:05	5:40
20	C	26.09.2003	7:40	26.09.2003	8:08	12:14	4:06	40	4:34	26.09.2003	14:15	2:01	6:35
21	A	27.09.2003	9:55	27.09.2003	10:08	14:15	4:07	40	4:20	27.09.2003	15:45	1:30	5:50
22	B	28.09.2003	15:55	28.09.2003	16:10	20:26	4:16	40	4:31	29.09.2003	2:25	5:59	10:30
23	C	29.09.2003	16:20	29.09.2003	16:30	20:35	4:05	40	4:15	29.09.2003	21:05	0:30	4:45
24	A	30.09.2003	19:50	30.09.2003	20:02	0:10	4:08	40	4:20	01.10.2003	2:50	2:40	7:00
Average							4:10		4:31			2:31	7:00

October 2003

S No	Rake	Rake Arrival		Unloading					Rake Releasing Time (Shunting+ unloading) at BSBT (Hrs)	Rake Removal by Rlys.		Rake Waiting Time for Engine (Hrs)	Total Time (Shunting Unloading and Rake Waiting) (Hrs)	Remarks
		Date	Time	Date	Star-ting Time	Com-pletion Time	Time for Unloa-ding (Hrs)	No. of Wagons		Date	Time			
1	B	01.10.2003	15:30	01.10.2003	16:04	20:07	4:03	40	4:37	02.10.2003	16:45	20:38	25:15	
2	C	02.10.2003	22:50	02.10.2003	23:07	3:12	4:05	40	4:22	03.10.2003	10:20	7:08	11:03	
3	A	04.10.2003	16:30	04.10.2003	16:50	20:55	4:05	40	4:25	04.10.2003	21:00	0:05	4:30	
4	B	05.10.2003	4:45	05.10.2003	5:13	9:26	4:13	40	4:41	05.10.2003	10:55	1:29	6:10	
5	C	06.10.2003	4:20	06.10.2003	15:35	19:40	4:05	40	15:20	08.10.2003	1:00	29:20	44:40	37.15 Hrs-Insufficient silo space
6	A	08.10.2003	2:15	08.10.2003	21:30	1:35	4:05	40	23:20	09.10.2003	2:20	0:45	24:05	19.15 Hrs-Insufficient silo space
7	B	09.10.2003	3:25	09.10.2003	23:40	4:06	4:26	40	24:41	10.10.2003	7:45	3:39	28:20	20.15 Hrs-Insufficient silo space
8	C	10.10.2003	16:50	11.10.2003	13:10	17:21	4:11	40	24:31	11.10.2003	17:50	0:29	25:00	20.20 Hrs-Insufficient silo space
9	A	11.10.2003	18:55	12.10.2003	17:00	21:42	4:42	40	26:47	13.10.2003	5:35	7:53	34:40	22.05 Hrs-Insufficient silo space
10	B	13.10.2003	7:00	14.10.2003	0:40	4:56	4:16	40	21:56	14.10.2003	12:20	7:24	29:20	17.40 Hrs-Insufficient silo space
11	C	14.10.2003	23:35	15.10.2003	0:10	4:16	4:06	40	4:41	15.10.2003	10:15	5:59	10:40	
12	A	17.10.2003	1:00	17.10.2003	1:27	5:39	4:12	40	4:39	17.10.2003	11:35	5:56	10:35	
13	B	17.10.2003	22:35	17.10.2003	23:08	3:22	4:14	40	4:47	18.10.2003	6:40	3:18	8:05	
14	C	18.10.2003	10:20	18.10.2003	11:15	16:26	5:11	40	6:06	18.10.2003	19:00	2:34	8:40	
15	A	20.10.2003	3:15	20.10.2003	3:33	7:42	4:09	40	4:27	20.10.2003	10:10	2:28	6:55	
16	B	21.10.2003	4:20	21.10.2003	4:55	9:01	4:06	40	4:41	21.10.2003	11:45	2:44	7:25	
17	C	22.10.2003	3:05	22.10.2003	18:45	22:54	4:09	40	19:49	23.10.2003	4:10	5:16	25:05	15.40 Hrs-Insufficient silo space
18	A	23.10.2003	9:45	24.10.2003	0:54	5:15	4:21	40	19:30	24.10.2003	11:20	6:05	25:35	15.09 Hrs-Insufficient silo space
19	B	24.10.2003	19:30	26.10.2003	17:45	22:15	4:30	40	50:45	26.10.2003	22:55	0:40	51:25	46.15 Hrs-Insufficient silo space
20	C	27.10.2003	2:30	28.10.2003	6:20	10:37	4:17	40	32:07	28.10.2003	13:15	2:38	34:45	27.50 Hrs-Insufficient silo space
21	A	28.10.2003	14:50	29.10.2003	4:18	8:24	4:06	40	17:34	29.10.2003	13:20	4:56	22:30	13.28 Hrs-Insufficient silo space
22	B	30.10.2003	1:20	30.10.2003	1:55	6:05	4:10	40	4:45	30.10.2003	9:55	3:50	8:35	
23	C	31.10.2003	6:35	31.10.2003	7:00	11:20	4:20	40	4:45	31.10.2003	14:15	2:55	7:40	
Average							4:15		14:29			5:34	20:03	

November 2003

S No	Rake	Rake Arrival		Unloading					Rake Releasing Time (Shunting+ unloading) at BSBT (Hrs)	Rake Removal by Rlys.		Rake Waiting Time for Engine (Hrs)	Total Time (Shunting Unloading and Rake Waiting) (Hrs)	Remarks
		Date	Time	Date	Star-ting Time	Com-pletion Time	Time for Unloa-ding (Hrs)	No. of Wagons		Date	Time			
1	A	01.11.2003	1:55	01.11.2003	2:21	6:25	4:04	40	4:30	01.11.2003	7:20	0:55	5:25	
2	B	02.11.2003	4:15	03.11.2003	15:43	19:57	4:14	40	39:42	03.11.2003	20:48	0:51	40:33	35:28 Hrs Insufficient silo space
3	C	03.11.2003	22:20	04.11.2003	20:45	0:55	4:10	40	26:35	05.11.2003	5:45	4:50	31:25	22:25 Hrs Insufficient silo space
4	A	05.11.2003	6:35	06.11.2003	2:00	6:07	4:07	40	23:32	06.11.2003	10:00	3:53	27:25	19:25 Hrs Insufficient silo space
5	B	07.11.2003	9:50	07.11.2003	10:10	14:40	4:30	40	4:50	07.11.2003	18:50	4:10	9:00	
6	C	08.11.2003	3:10	08.11.2003	11:15	15:20	4:05	40	12:10	08.11.2003	18:10	2:50	15:00	8:05 Hrs Insufficient silo space
7	A	09.11.2003	14:20	09.11.2003	16:15	20:17	4:02	40	5:57	09.11.2003	22:20	2:03	8:00	1:55 Hrs Insufficient silo space
8	B	09.11.2003	22:35	10.11.2003	3:15	7:16	4:01	40	8:41	11.11.2003	12:15	4:59	13:40	4:40 Hrs Insufficient silo space
9	C	12.11.2003	1:40	12.11.2003	18:10	22:24	4:14	40	20:44	13.11.2003	6:35	8:11	23:55	16:30 Hrs Insufficient silo space
10	A	13.11.2003	8:00	20.11.2003	18:00	22:08	4:08	40	182:08	20.11.2003	23:15	1:07	183:15	178:00 Hrs Insufficient silo space
11	B	23.11.2003	1:30	23.11.2003	1:55	6:35	4:40	40	5:05	23.11.2003	11:40	5:05	10:10	
12	C	24.11.2003	0:10	24.11.2003	0:30	4:35	4:05	40	4:25	24.11.2003	5:40	1:05	5:30	
13	A	24.11.2003	10:35	24.11.2003	10:55	15:00	4:05	40	4:25	24.11.2003	19:05	4:05	8:30	
14	B	26.11.2003	5:10	26.11.2003	5:30	10:26	4:56	40	5:16	26.11.2003	10:50	0:24	5:40	52 min PLC control voltage prob.
15	C	27.11.2003	5:35	27.11.2003	6:05	10:10	4:05	40	4:35	27.11.2003	13:00	2:50	7:25	
16	A	28.11.2003	4:30	28.11.2003	5:05	9:10	4:05	40	4:40	28.11.2003	11:35	2:25	7:05	
17	B	29.11.2003	15:30	29.11.2003	15:35	19:38	4:03	40	4:08	29.11.2003	20:10	0:32	4:40	
18	C	30.11.2003	13:30	30.11.2003	13:40	17:45	4:05	40	4:15	30.11.2003	19:05	1:20	5:35	
Average							4:12		20:18			2:51	23:10	

December 2003

S No	Rake	Rake Arrival		Unloading					Rake Releasing Time (Shunting+ unloading) at BSBT (Hrs)	Rake Removal by Rlys.		Rake Waiting Time for Engine (Hrs)	Total Time (Shunting Unloading and Rake Waiting) (Hrs)	Remarks
		Date	Time	Date	Star-ting Time	Com-pletion Time	Time for Unloa-ding (Hrs)	No. of Wagons		Date	Time			
1	A	02.12.2003	18:35	02.12.2003	19:08	23:14	4:06	40	4:39	02.12.2003	23:40	0:26	5:05	
2	B	03.12.2003	10:50	03.12.2003	11:04	15:08	4:04	40	4:18	03.12.2003	17:20	2:12	6:30	
3	C	04.12.2003	20:15	04.12.2003	20:25	0:25	4:00	38	4:10	05.12.2003	4:15	3:50	8:00	
4	A	06.12.2003	4:35	06.12.2003	4:51	8:45	3:54	40	4:10	06.12.2003	11:35	2:50	7:00	
5	B	06.12.2003	17:05	06.12.2003	17:25	21:19	3:54	40	4:14	06.12.2003	23:59	2:40	6:54	
6	C	08.12.2003	1:20	08.12.2003	14:20	18:33	4:13	38	17:13	08.12.2003	22:25	3:52	21:05	13:00 Hrs Insufficient silo space
7	A	09.12.2003	3:40	09.12.2003	19:25	23:35	4:10	40	19:55	10.12.2003	2:50	3:15	23:10	15:45 Hrs Insufficient silo space
8	B	10.12.2003	6:45	11.12.2003	7:40	12:15	4:35	40	29:30	11.12.2003	12:40	0:25	29:55	23:55 Hrs Insufficient silo space
9	C	11.12.2003	15:50	12.12.2003	15:45	19:25	3:40	39	27:35	13.12.2003	6:25	11:00	38:35	25:55 Hrs Insufficient silo space
10	A	13.12.2003	7:20	13.12.2003	21:50	1:44	3:54	40	18:34	14.12.2003	10:30	8:46	27:10	14:30 Hrs Insufficient silo space
11	B	14.12.2003	22:35	15.12.2003	15:42	19:28	3:46	40	20:53	16.12.2003	3:20	7:52	28:45	17:07 Hrs Insufficient silo space
12	C	16.12.2003	4:15	16.12.2003	19:09	23:27	4:18	40	19:12	17.12.2003	3:30	4:03	23:15	14:54 Hrs Insufficient silo space
13	A	18.12.2003	1:55	18.12.2003	2:08	5:55	3:47	40	4:00	18.12.2003	10:20	4:25	8:25	
14	B	19.12.2003	20:05	19.12.2003	20:15	23:59	3:44	40	3:54	20.12.2003	3:00	3:01	6:55	
15	C	20.12.2003	17:40	20.12.2003	17:58	23:35	5:37	40	5:55	21.12.2003	3:45	4:10	10:05	01:15 Hrs Boot positioner problem
16	A	21.12.2003	13:40	21.12.2003	15:44	20:12	4:28	40	6:32	22.12.2003	1:45	5:33	12:05	02:04 Hrs Insufficient silo space
17	B	23.12.2003	15:20	23.12.2003	15:58	19:55	3:57	40	4:35	24.12.2003	7:20	11:25	16:00	
18	C	25.12.2003	5:05	25.12.2003	5:38	9:32	3:54	40	4:27	25.12.2003	12:05	2:33	7:00	
19	A	26.12.2003	4:55	26.12.2003	5:24	14:48	9:24	40	9:53	26.12.2003	18:10	3:22	13:15	05:17 Hrs Insufficient silo space
20	B	27.12.2003	7:10	27.12.2003	15:32	19:18	3:46	40	12:08	28.12.2003	6:45	11:27	23:35	08:22 Hrs Insufficient silo space
21	C	29.12.2003	12:50	29.12.2003	13:12	17:12	4:00	40	4:22	29.12.2003	18:00	0:48	5:10	
22	A	30.12.2003	4:25	30.12.2003	15:21	19:19	3:58	40	14:54	30.12.2003	20:40	1:21	16:15	10:56 Hrs Insufficient silo space
Average							4:19		11:08			4:30	15:38	

Exhibit 15: Statement of Turn Around Time

Turn around status	No of Rakes Loaded	Idle Time Prior to Loading	Time taken For Loading	Time Taken for Engine Arrival After Loading completed	Transit Time: Malkhaid to Dodba-llapur	Transit Time: Dodba-llapur to Malkhaid	Time Taken for Unloading at Dodba-llapur	Total Turn Around Time
		Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs
Turn around status prior to 15.09.03 (01.04.03 to 12.09.03)	109	5:14	4:37	12:52	34:23	29:48	10:13	97:10
Turn around status from 15.09.03 to 31.12.03	–	–	–	–	–	–	–	–
Of rakes on which EOL availed	45	–	–	–	–	–	–	–
Of rakes on which EOL not availed	33	–	–	–	–	–	–	–
Weighted average for the year 03-04 (01.04.03 to 31.12.03)	21 (monthly average)	5:09	4:34	6:18	34:05	29:40	8:13	88:02
Weighted average for the year 02-03	22 (monthly average)	7:36	3:35	13:13	34:42	30:09	9:46	99:03

Idle time at Dodballapur/Malkhaid in lieu of any extreme disruption is discounted

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QUESTIONS FOR DISCUSSION

1. Should RC and SCR have the option of declaring a trip as 'not-for-EOL'? Can this be unilaterally decided or should it be a joint decision? What should be the required advance notice?

2. From the time the rake reaches the terminal, what should be the guaranteed time for engine availability? What should the penalty be on RC if load is not available? What should the penalty be on SCR if engine is not available? (Currently there is no penalty on SCR).
3. What steps should RC take to ensure timely loading at the terminal?
4. What steps should SCR take to ensure EOL, and by implication, powering the incoming train with an appropriate engine?
5. Is the issue EOL or timely availability of engine? Incoming and outgoing engines need not be the same, should SCR want the flexibility.
6. What performance measures should be used for IR to improve customer service and position itself as a third party logistics solution provider?

APPROACH FOR ANALYSIS

Possible performance measures of interest to RC and SCR are-(a) the turnaround time at the terminals (b) the delivery time between Malkhaid and Dodballapur, and (c) the total turnaround time for the whole circuit. These should be analysed from the point of view of RC and SCR.

The questions are largely related to establishing a sustainable contract between RC and IR. While RC's objective is to increase the throughput of bulk cement, using the same asset base, IR's objective is to ensure that the EOL concept takes off. The EOL concept would essentially provide turnaround time improvements at the terminal, while for RC, the turnaround of the entire fleet between the origin and the destination would be of significance.

Based on the three-month data, an analysis can be attempted to see how the EOL and the non-EOL movements have performed. It would be important to break the data set from Exhibits 13 and 14, into three separable sets, since there are three rakes doing the round trip movement between the origin and the destination. Summary statistics can then be generated to fill up the format in Exhibit 15.

This analysis would bring out an approach to answering the questions, if not providing specific recommendations. The terminal turnaround versus total turnaround time would also get highlighted, since, while satisfying the EOL requirements, IR often passed the problems on to the transit segment. The consequence was that while the terminal performance looked good, the transit and total turnaround time performance really did not improve.

Simulation of the performance of this supply chain is also possible with the data that is provided. This may be useful for looking at the impact of policy variables such as EOL at the destination end, type of engine being assigned and different rake maintenance strategies of the railways, and impact of randomness in transit times and occurences of accidents.

Case 3

CASE CONTEXT

An important decision in petroleum supply chains that operate through port-based refineries is to determine optimal jetty capacity for handling crude and refined products. Western Oil Limited, a refinery in Western India was set for an expansion that would more than quadruple its capacity over the coming three years.

This case examines how to expand the captive jetty capacity to match the projected refinery output in terms of volume and variety. An appropriate trade off between the cost of jetty expansion and demurrage due to ship delays had to be considered.

WESTERN OIL LIMITED (A)

Western Oil Limited (A)The following letter was received by Professor Prashanth in October 2007. Please help him in the proposed study.

4th October 2007

Mr. K Sitaram
Head – Shipping Operations, and Member, Investment Committee
Western Oil Limited
Makers house,
Mumbai - 400020

Prof. R. Prashanth
Well-known Institute of Management in Western India (WIMWI)
Karnavati

Dear Prof. Prashanth,

I hope you would recall me as a participant in the Strategic Port Management Programme held at WIMWI in May 2006.

Prepared by Chetan Soman and G. Raghuram. We acknowledge the research support by Shivani Shukla. Teaching material of the Indian Institute of Management, Ahemdabad, is prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems.

As you are probably aware, our company has sailed through troubled waters right from its inception, but now that should be a thing of the past. When speaking of the Western Oil Limited (WOL) in its 'new-avatar', we are thinking of a truly world class refinery and equally good infrastructure facilities to support it in its current and expanded capacity. But we have to take into account the diverse and changing product-process-market characteristics.

In particular, WOL's management is reviewing the jetty capacity requirements, and alternate methods of providing the additional capacity to match the three-fold expansion (due in the next couple of years) in its Sikkanar refinery output.

Knowing your interest and expertise in this area, we would like you to develop a model based on operations management/research tools or such other tools as you may deem fit to use and advise us on jetty capacity requirements at various refinery throughput levels. You can assume that there is sufficient number of product tanks available. You may also want to suggest some suitable software to enable us to examine such decisions in the future.

I am enclosing a few pages introducing our company, projected marine movements, the jetty operations and the relevant cost estimates.

Thanking you

(sd) Sitaram

INTRODUCTION

The Western Oil Limited (WOL) is a part of the large corporate house - Western - which has presence in various sectors: Telecommunication, Textile, Steel, BPO, Oil and Gas etc. The Oil and Gas Group is further organized into three separate divisions, each focusing on one link in the petroleum value chain:

1. Exploration and Production

Western Oil and Gas was one of the first private companies to bid for exploration blocks in early 1990s, under the New Exploration Licensing Policy of Government of India, along with the other major private players (Reliance and Essar). It has acquired rights for oil and gas explorations blocks in Assam and Gujarat in India.

2. Refinery (WOL)

WOL's oil refinery is located on India's west coast in close proximity to the crude rich Gulf States. Sikkanar is an all weather deep draft natural port. More than 60% of India's crude imports land in and around this region. Besides, the refinery's location enables access to the fast growing markets in the north and western region of India through product pipelines. The eastern and southern parts of India are generally serviced through the coastal route circling the country.

WOL's refinery has a capacity of 7.5 million tons per annum (mtpa) with an investment of close to Rs 10 billion. The refinery is built with the state of the art technology with technical and project assistance from the world's leading consultants and equipment suppliers in the field. It is designed to handle a diverse range of crude mixes. The refinery is configured to produce Euro II and Euro III grades of petrol (MS - motor spirit) and diesel (HSD—high speed diesel). With mid-stream upgradation of processes and technologies, the refinery has the capability to process the most sour, acidic and heavy crude.

The refinery is fully integrated with its own dedicated 120 mega watt co-generation power plant, port and terminal facilities. It includes a single point mooring (SPM) capable of handling vessels up to 350,000 deadweight tons (DWT) capacity, marine product dispatch capacity of 14 mtpa, and railcar and truck loading facilities.

The refinery has built-in environment-friendly technologies for pollution management and has also planted over one million trees to ensure a green corridor around the entire refinery complex.

The refinery is set for an expansion in the next couple of years. Exhibit 1 shows the planned refinery throughput milestones. The key idea behind the expansion is to produce higher value-added products and to have economies of scale. Exhibit 2 gives the national production, import and refining capacity of crude, and production, import and export of products.

3. Marketing

WOL took rapid marketing strides by setting up its retail network all across India. The company has set up more than 800 retail outlets. (Effective 1st April 2002, marketing of transportation fuel, including MS and HSD was de-regulated and all companies meeting the eligibility criteria laid down by the Ministry of Petroleum & Natural Gas, Government of India, were permitted to market these products, and also to set up a retail network after receiving formal authorization from the Government). In addition to this, there are another 900 retail outlets under various stages of construction, and 1100 franchisees and sites identified. Currently, the company has 17 depots to ensure timely supplies to all its retail outlets. In addition to the above, more such depots are identified.

Following the industry trend, a host of other products and services are planned to compliment MS and HSD at the retail outlets. Some of these are restaurants, dhabas, truckers stop, car wash, service stations, ATMs, convenience stores, cafés, etc. Some of the companies with which WOL has an association for supplies of other products and services are Castrol (for lubricants), Pepsi, Coca Cola, Frito-Lay, and State Bank of India.

The company had planned to set up over 5000 retail outlets across the country by 2008. However, given the higher crude prices in the recent years and the Government not hiking the fuel prices fearing a political backlash, it doesn't make economic sense for private players to sell the products in India. Hence, WOL has decided to focus more on the exports.

Projected Marine Movements

Given the new focus on the export markets, it is but natural to have more marine movements. Exhibit 3 shows the projected marine movements and various expected parcel sizes to be sold for the various products. This is provided for various throughput levels. It is evident that WOL expects larger parcel sizes for larger marine movements. This brings in economies of scale in jetty operations and transportation.

Jetty Operations

The jetty located at Sikkanar is owned and operated by WOL itself. Currently, WOL has to get pilots on board from the Kandla port, but soon this dependence is likely to vanish. There is only one berth at the moment. The depth of water alongside the berth is about 20 meters. The length of the berth is 310 meters. It can accommodate vessels ranging from 10,000 to 100,000 DWT.

The petroleum product tankers arrive and anchor at the anchorage and await their turn for berthing alongside the jetty for high waters. Although the WOL jetty is located in a non-tidal port, for ease of navigation, the current practice is to berth and de-berth activities only when tide is moving from low to high. Exhibit 4 gives the tide calendar as a sample for the month of September 2007. Exhibit 5 brings out the implication of the current practice due to tide variations on the waiting time of the ships.

At the jetty, WOL has two dedicated pipelines of 16" each for loading white oil and one dedicated pipeline of 12" for loading black oil. Typically, these ships are designed to load the petroleum products as per flow rate depending on their DWT and certain ship board conditions like ballast discharge rate. From the shore side, the company can pump the petroleum products into the ships at the maximum rate of 2000 m^3/hr per pipeline for white oil. The pumping rate for black oil is a maximum 1400 m^3/hr. However, historical data suggests that, generally, only 85% of the above flow rates are achievable. Exhibit 6 shows the schematic representation of the pipelines present.

Currently, only one of the pipelines is used for pipeline loading. This is because, in the case of multiple products loading, waste called 'slop' is generated as we transition from one product to another. This slop is pumped back to the refinery using the second pipeline. Very soon, it is planned to set up a slop tank near the jetty, from where the slop would be transported by road. This would allow double line loading of white oil with a rate of upto 4000 m^3/hr. The slop is generated even though a required operation called 'pigging' is done between the two different products. This takes upto three hrs. In future, WOL plans to have dedicated product pipelines. With dedicated pipelines, the pigging time loss won't happen. This will also reduce the need for the slop tanks. Instead, warping (alignment of the pipelines' loading arm with the ship) will have to be done which takes upto two hrs. Around 10% of the ships will have loading of multiple products.

In addition, there could be delays because of pump and/or tankage problems at the jetty. Last year, 2% of the vessels were delayed by two to three hours on account of this. Upon completion of loading operations, the product tankers are deberthed during high waters after inspection, documentation, etc.

Presently, there are restrictions in terms of non-availability of night navigation. It means that the ships can neither be berthed nor can they be deberthed after daylight hours. However, with work underway, it is expected that this restriction of non-availability of night navigation will be overcome latest by the end of 2007.

Exhibit 7 shows the ship arrival times and the quantity loaded during the period December 2006 to July 2007. It is suspected that although most arrivals were scheduled or based on the product stock levels, the actual arrival times were random. (As is usual in such arrival patterns, the inter arrival times are expected to follow a negative exponential distribution).

Relevant Costs

Due to the various operating conditions governing the berthing and loading, delays could occur to the ships. A demurrage is payable if the actual operation time exceeds agreed laytime which is typically 36 hours for loading and documentation. The clock for the actual operation time starts six hours after the first available favourable daylight tide or actual berthing time, whichever is earlier. The clock stops when all documentation is on board. There are agreed deductions available on the actual operation time for documentation and shifting of the vessel. Delays on account of vessel and/or weather would not be part of actual operation time.

Once night navigation is in place, the first available favourable tide will no longer be restricted to the daylight hours for short vessels i.e. upto 40,000 DWT. For very large vessels, the 36 hours are typically extended to 48 or 60 hours. If the ship does not arrive during the agreed laycan (arrival period), then the actual operation time clock starts only after berthing which can now happen at the jetty's convenience.

The demurrage rates are typically in the range of USD 20,000 to 30,000 per day. One would expect larger rates for the larger vessels but this need not be the case. The rates are often supply and demand driven. Exhibits 8a, 8b and 8c show typical 'Statement of Facts' for the vessels and the demurrage calculations. These statements capture, in detail, the vessel movement, the related activities and their duration. Exhibit 8a relates to a vessel which arrived in the night with the first available favourable tide being at 6.00 am. Exhibit 8b relates to a vessel whose first available daylight tide was available on arrival, with berthing done rightaway. Exhibit 8c relates to a vessel which just missed the tide. This vessel also had two product loading involving pigging operation.

Acknowledging the high demurrage rates, the general industry philosophy is that "a berth should wait for the vessels and not the other way around". The WOL management feels that they should not have more than 65% berth occupancy. The cost of constructing a new jetty, that can accommodate practically all the vessel sizes, is about Rs 100 crores (approximately USD 25 million). The jetty operating expenses are about USD 0.25 million per year.

Exhibit 1: Refinery Throughput Milestones

Time	Capacity	Remarks
As of now	7.5 mtpa	
December, 2007	10.5 mtpa	Integration of secondary process including cracker, hydrotreatment, sulphur production and value added products.
September, 2009	16 mtpa	Addition of coker, fuel oil handling and heavy crude oil diesel production.
December, 2009	32 mtpa	Duplication of 16 mtpa facilities.

Exhibit 2: National Petroleum Imports, Production and Exports

(000' t)

	Crude			Products				
	Production	Import	Refining Capacity	Production	Import		Export	
*								
2002-03	33044	81989	116968	104140	7228		10289	
2003-04	33373	90434	127368	113463	8001		14620	
2004-05	33981	95861	127368	118579	8828		18211	
2005-06	32190	99409	132468	119750	11677		21507	
2006-07	33988	110858	148968	135260	16966		32394	
**					Base case	Upper case	Base case	Upper case
2007-08	41230	107270	158700		4070	4110	30950	29870
2008-09	42330	120370	194700		3320	3400	40640	37860
2009-10	42490	150510	210210		4280	4400	67880	62200
2010-11	41190	170410	225880		5490	6600	79560	71060
2011-12	39510	195490	240960		6130	7460	92680	83980

Base case: Low Demand projections

Upper case: High Demand projections

Source:* http://petroleum.nic.in/petstat.pdf

** http://planningcommission.nic.in/aboutus/committee/wrkgrp11/wg11_petro.pdf

Exhibit 3: Projected Marine Movements and Parcel Sizes

Products	Density	Grade	10.5 mtpa		16 mtpa		32 mtpa	
			Total marine movement	Parcel size	Total marine movement	Parcel size	Total marine movement	Parcel size
	ton/m³		(kt/year)	(kt)	(kt/year)	(kt)	(kt/year)	(kt)
LPG	0.53	Domestic			858	13	1661	13
Gasoline[1]	0.74	Grade 1			2386	60	990	30
	0.74	Grade 2	2336	40	627	40	4924	60
	0.74	Grade 3					4115	90
ATF[1]	0.79	Jet export	950	29	2419	60	3441	60
HSD[1]	0.84	Grade 1			3600	90	1485	40
	0.84	Grade 2	3689	60	1485	60	2696	80
	0.84	Grade 3					5629	100
PCN[1]	0.66	Domestic	122	20	1198	50	713	80
SKO[1]	0.79	Domestic					396	30
VGO[2]	0.86	Domestic/ Export			584	60		
FO[2]	0.87	Domestic	1914	40				
Total Marine Movement (kt/year)			**9011**		**13157**		**26050**	

[1] white oil

[2] black oil.

For LPG, the maximum loading rate is 800 m^3/hr.

kt = 000 tons

Exhibit 4: Tide Calendar for Sikkanar for September 2007

Units are meters, timezine is IST
September 2007 low is 0.4 m, high is 7.0 m, range is 6 6 m

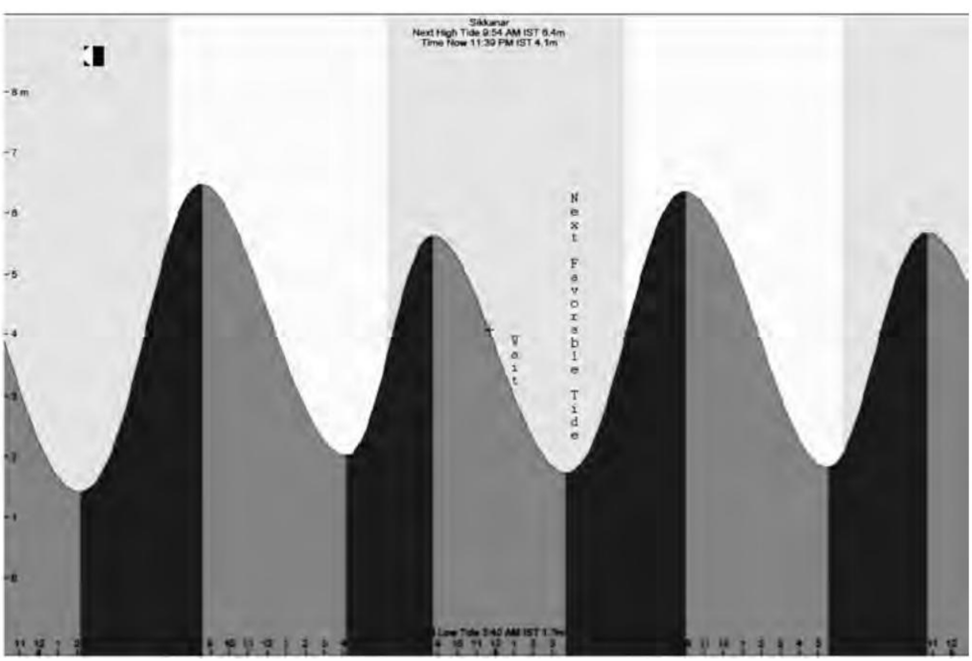
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
08–26 H0012 5.4 L0657 1.0 H1321 6.3 L1959 1.7	08–27 H0105 5.8 L0743 0.8 H1354 6.6 L2032 1.4	Full 08–28 H0150 6.1 L0824 0.6 H1427 6.8 L2105 1.0	08–29 H0233 6.4 L0905 0.5 H1500 6.9 L2139 0.7	08–30 H0316 6.6 L0944 0.6 H1533 7.0 L2214 0.5	08–31 H0358 6.7 L1025 0.8 H1608 6.9 L2251 0.4	09–01 H0443 6.7 L1106 1.0 H1644 6.7 L2331 0.4
09–02 H0529 6.6 L1151 1.4 H1722 6.4	09–03 L0016 0.5 H0621 6.3 L1241 1.8 H1804 6.1	LQtr 09–04 L0108 0.8 H0723 6.0 L1348 2.1 H1853 5.7	09–05 L0216 1.0 H0847 5.8 L1533 2.4 H2004 5.4	09–06 L0345 1.2 H1035 6.8 L1730 2.3 H2157 5.2	09–07 L0518 1.3 H1157 6.0 L1850 2.0 112339 5.4	09–08 L0631 1.2 H1249 6.2 11940 1.7

(Continued)

(Continued)

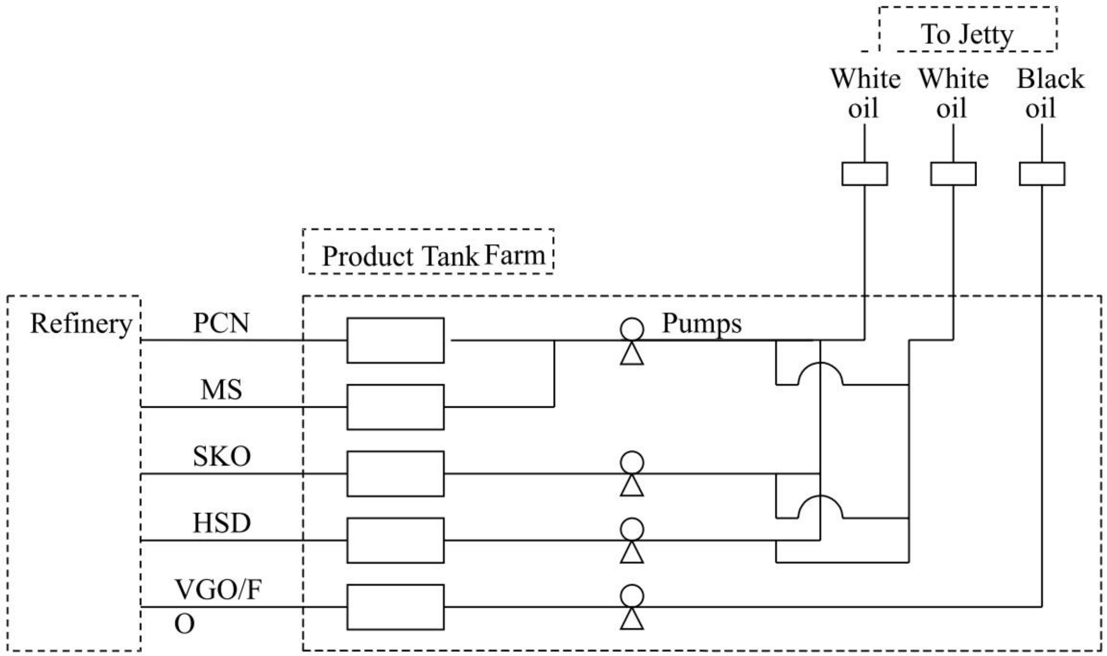
09–09	09–10	New 09–11	09–12	09–13	09–14	09–15
H0043 5.6	H0129 5.9	H0208 6.1	H0242 6.3	H0314 6.4	110345 6.4	H0416 6.4
L0725 1.0	L0807 1.0	L0843 0.9	L0913 1.0	L0941 1.0	L1009 1.2	L1035 1.3
H1327 6.4	H1400 6.5	H1428 6.6	H1455 6.6	H1521 6.5	H1546 6.4	H1611 6.2
L2018 1.4	L2048 1.2	L2114 1.0	12138 0.9	12201 0.8	12224 0.8	L2247 0.8
09–16	09–17	09–18	FQtr 09–19	09–20	09–21	09–22
H0447 6.3	H0520 6.1	H0557 5.9	L0015 1.2	L0102 1.4	L0223 1.6	L0412 1.6
L1102 1.5	L1130 1.8	L1202 2.0	H0643 5.7	H0749 5.5	H0932 5.5	H1107 5.7
H1635 6.1	H1659 5.9	H1725 5.6	L1245 2.3	L1413 2.5	L1644 2.5	L1802 2.2
L2312 0.9	L2341 1.0		H1757 5.4	H1846 5.2	H2032 5.0	H2244 5.1
09–23	09–24	09–25	09–26	Full 09–27	09–28	09–29
L0534 1.4	L0633 1.2	H0050 6.0	H0135 6.4	H0217 6.8	H0259 7.0	H0342 7.1
H1200 6.0	H1239 6.3	L0721 0.9	L0805 0.8	L0846 0.7	L0928 0.8	L1009 0.9
L1846 1.8	L1922 1.3	H1315 6.5	H1350 6.7	H1426 6.8	H1502 6.8	H1539 6.7
H2358 6.5		H965 0.9	L2030 0.5	L2106 0.2	L2142 0.0	L2220 0.0
09–30	10–01	10–02	LQtr 10–03	10–04	10–05	10–06
H0426 7.0	H0513 6.8	H0604 6.4	L0040 0.8	L0152 1.2	L0333 1.5	L0509 1.5
L1052 1.2	L1138 1.5	L1233 1.9	H0705 6.1	H0827 5.8	H1011 5.8	H1129 5.9
H1617 6.5	H1657 6.2	H1743 5.9	L1352 2.1	L1547 2.2	L1728 2.0	L1831 1.7
L2302 0.2	L2346 0.4		H1839 5.5	H2006 5.2	H2216 5.1	H2346 54

Exhibit 5: Tides and Implications for Ship Movements



At Sikkanar, currently all the ship movements are only during the low-to-high tide periods. In the above figure, the ship has arrived at 11:39 PM marked by + (at the center of the figure). It cannot berth straight away, since the tide is not favorable. Further ship movement is possible at around 4 AM if night navigation facilities are present and only after 6 AM in their absence. Before the movement, the ship also has to get customs clearance, medical clearance, shore readiness signal, and the pilot on board. Also, a maximum of three shipping movements are possible through the channel during any favourable tide.

Exhibit 6: Pipeline Layout



Refinery to Product Tank Farm: 2 kms

Product Tank Farm to Jetty: 22 kms

Exhibit 7: Ship Arrival Times and Quantity Loaded for Different Products

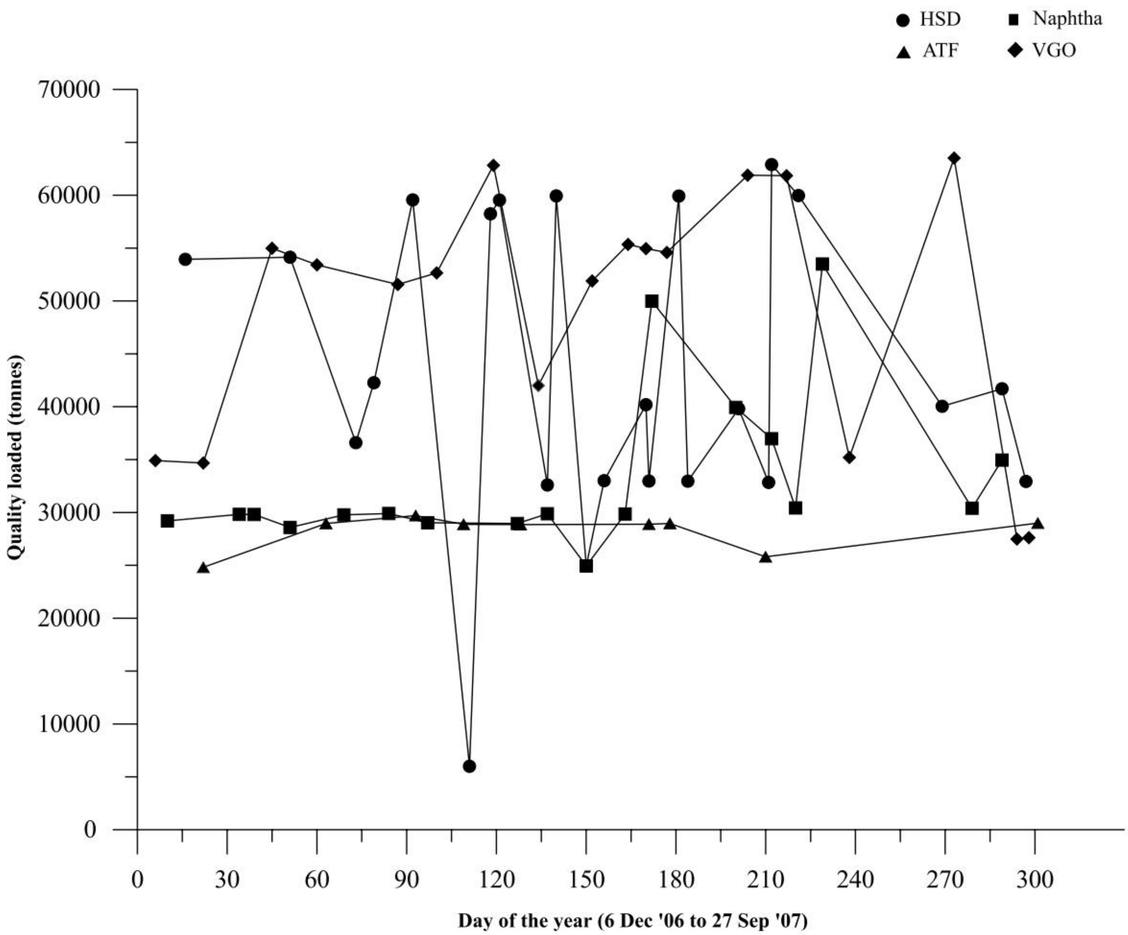


Exhibit 8a

I. Statement of Facts

Vessel: Ship 20 Cargo: HSD

Laytime allowed:

Minimum of (First available daylight tide + 6 hrs, Berthed and all-fast time) + 36 Hrs. Delays because of weather, problems on vessel side not to be counted. Shifting time from Anchorage to berth should not be counted.

Demurrage rate: $25000/day

Last port: Fujairah Next Port: West Africa

Activity	From		To	
	Date	Time	Date	Time
End of sea passage	02.03.07	2130	–	–
NOR Tendered	02.03.07	2200	–	–
Anchored	02.03.07	2225	–	–
Custom on Board	02.03.07	2300	–	–
Free Pratique	02.03.07	2325	–	–
Custom clearance granted	03.03.07	0125	–	–
Anchor aweigh	06.03.07	1054	–	–
Pilot on board	06.03.07	1127	06.03.07	1350
Berthing tug used	06.03.07	1130	06.03.07	
Mooring	06.03.07	1236	06.03.07	1335
NOR Received	06.03.07	1350	–	–
Gangway down	06.03.07	1350	–	–
Pre Operation meeting	06.03.07	1350	06.03.07	1410
Tank inspection	06.03.07	1410	06.03.07	1510
L/A connection	06.03.07	1445	06.03.07	1500
Safety check list	06.03.07	1440	06.03.07	1515
Ship Line up	06.03.07	1515	06.03.07	1525
Shore Line up	06.03.07	1525	06.03.07	1954
Loading HSD	06.03.07	1954	08.03.07	0900
Stoppage by shore	08.03.07	0400	08.03.07	0530
Re-ullaging/Cargo calculation	08.03.07	1100	08.03.07	1200
Anchored awaiting cargo documents	08.03.07	1348	–	–
Tank inspection/Ullaging	08.03.07	0900	08.03.07	1000
Cargo Calculations	08.03.07	1000	08.03.07	1030
Draining/Disconnection of L/A	08.03.07	0930	08.03.07	1048
Documents on board	08.03.07	1630	–	–
Documentation completed	08.03.07	1645	–	–
POB for unmooring	08.03.07	1120	08.03.07	1310
Unberthing tug used	08.03.07	1230	08.03.07	1300
Unmooring	08.03.07	1230	08.03.07	1248
Vessel sailed	08.03.07	1730	–	–
Quantity loaded (tons)		**59,560**		

II. Demurrage Calculation for Ship 20

Activities	Date	Time
Vessel anchored	02.03.07	2225
NOR tendered	02.03.07	2200
Time to count as of	03.03.07	1200
Anchor aweigh	06.03.07	1054
Berthed	06.03.07	1335
Hose connected	06.03.07	1500
Commenced loading	06.03.07	1954
Completed loading	08.03.07	0900
Hoses off	08.03.07	1048
Documents on board	08.03.07	1630
Time to count till	08.03.07	1630
Gross time taken		**124:30:00**
Time allowed for documentation		4:00:00
Shifting		2:30:00
Net time at loadport		**118:00:00**
Time allowed as per charterparty		36:00:00
Time on demurrage		82:00:00
Demurrage rate (per day)		**$25,000**
Amount payable		**$85,417**
Amount paid		**$85,347**

Exhibit 8b

I. Statement of Facts

Vessel: Ship 20 Cargo: HSD
I. Statement of Facts
Vessel: Ship 42 Cargo: Naphtha
Laytime allowed:

Minimum of (First available daylight tide + 6 hrs, Berthed and all-fast time) + 36 Hrs. Delays because of weather, problems on vessel side not to be counted. Shifting time from Anchorage to berth should not be counted. Demurrage rate: $27000/day Last port: Fujairah Next Port: Fujairah

Activity	From		To	
	Date	Time	Date	Time
End of sea passage	12.05.07	1500	–	–
NOR Tendered	12.05.07	1605	–	–
Anchored	12.05.07	1605	–	–
Free Pratique	12.05.07	1620	–	–
Custom clearance granted	12.05.07	1730	–	–
Anchor aweigh	12.05.07	1730	–	–
Pilot on board	12.05.07	1605	12.05.07	1800
Berthing tug used	12.05.07	1620	12.05.07	1810
Mooring	12.05.07	1730	12.05.07	1815
NOR Received	12.05.07	1845	–	–
Gangway down	12.05.07	1845	–	–
Pre Operation meeting	12.05.07	1845	12.05.07	1900
Tank inspection	12.05.07	1900	12.05.07	2015
L/A connection	12.05.07	1900	12.05.07	1915
Safety check list	12.05.07	1930	12.05.07	1950
Ship/Shore Line up	12.05.07	2015	12.05.07	2036
Loading Naphtha	12.05.07	2036	14.05.07	0135
Stoppage by shore	13.05.07	0620	13.05.07	0650
Stoppage by ship	13.05.07	1435	13.05.07	1615
Stoppage by shore	13.05.07	2000	13.05.07	2154
Tank inspection/Ullaging	14.05.07	0135	14.05.07	0235
Cargo Calculations	14.05.07	0235	14.05.07	0305
Draining/Disconnection of L/A	14.05.07	0215	14.05.07	0236
Documents on board	14.05.07	0445	–	–
Documentation completed	08.03.07	0515	–	–
POB for unmooring	14.05.07	0538	–	–
Unberthing tug used	14.05.07	0540	–	–
Unmooring	14.05.07	0600	–	–
Vessel sailed	14.05.07	0700	–	–
Quantity loaded (tons)	**29,853**			

II. Demurrage Calculation for Ship 42

Activities	Date	Time
Vessel anchored	12.05.07	1600
NOR tendered	12.05.07	1600
Anchor aweigh	12.05.07	1730
Berthed	12.05.07	1830
Time to count as of	12.05.07	1830
Hose connected	12.05.07	1915
Commenced loading	12.05.07	2036
Completed loading	14.05.07	0135
Hoses off	14.05.07	0200
Documents on board	14.05.07	0500
Time to count till	14.05.07	0500
Gross time taken		**34:30:00**
Time allowed for documentation		3:00:00
Shifting		1:00:00
Net time at loadport		**30:30:00**
Time allowed as per charterparty		36:00:00
Time on demurrage		**00:00:00**
Demurrage rate (per day)		$27,000
Amount payable		**$0**
Amount paid		**$0**

Exhibit 8c

I. Statement of Facts

Vessel: Ship 58 Cargo: HSD and ATF

Laytime allowed:

Minimum of (First available daylight tide + 6 hrs, Berthed and all-fast time) + 36 Hrs. Delays because of weather, problems on vessel side not to be counted. Shifting time from Anchorage to berth should not be counted. Demurrage rate: $26000/day. Last port: Singapore Next Port: Djibouti

Activity	From		To	
	Date	Time	Date	Time
End of sea passage	18.06.07	1300	–	–
NOR Tendered	18.06.07	1300	–	–
Anchored	18.06.07	1415	–	–
Free Pratique	18.06.07	1520	–	
Custom clearance granted	18.06.07	1630	–	–
Anchor aweigh	20.06.07	1125	–	
Pilot on board	20.06.07	1130	–	–
Berthing tug used	–	–	–	–
Mooring	20.06.07	1255	20.06.07	1400
Gangway down	20.06.07	1442	–	–
NOR received	20.06.07	1442	–	–
Pre Operation meeting	20.06.07	1442	20.06.07	1500
L/A connection for ATF loading	20.06.07	1442	20.06.07	1450
Tank inspection	20.06.07	1500	20.06.07	1536
Safety check list	20.06.07	1536	20.06.07	1600
Ship/Shore line up	20.06.07	1600	20.06.07	1612
Loading ATF	20.06.07	1612	21.06.07	1154
Rate reached to max 2100 cu.m	20.06.07	1625	–	–
Stoppage by shore (for pig launching)	21.06.07	0730	21.06.07	0842
Resume Loading ATF	21.06.07	0842	–	–
Ref. ullaging for ATF	21.06.07	1154	21.06.07	1254
L/A disconnection ATF	21.06.07	1214	21.06.07	1218
L/A connection for HSD loading	21.06.07	1218	21.06.07	1224
Ship/Shore line up	21.06.07	1254	21.06.07	1754
Loading HSD	21.06.07	1754	21.06.07	2218
Rate reached to max 1600 cu.m	21.06.07	1810	–	–
L/A disconnection HSD	21.06.07	2324	21.06.07	2330
Ullaging & calculation for ATF & HSD	21.06.07	2218	21.06.07	2324
Documents on board	22.06.07	0040	–	–
Documentation completed	22.06.07	0115	–	–
POB for unmooring	22.06.07	0130	22.06.07	
Unberthing	22.06.07	0130	22.06.07	0205
Vessel sailed	22.06.07	0330	–	–
ATF: Quantity loaded (tons)		**28,496**		
HSD: Quantity loaded (tons)		**5048**		

II. Demurrage Calculation for Ship 58

Activities	Date	Time
Vessel anchored	18.06.07	1415
NOR tendered	18.06.07	1300
Time to count as of	19.06.07	1800
Anchor aweigh	20.06.07	1130
Berthed	20.06.07	1400
Hose connected	20.06.07	1450
Commenced loading	20.06.07	1612
Completed loading	21.06.07	2218
Hoses off	21.06.07	2330
Documents on board	22.06.07	0100
Time to count till	22.06.07	0100
Gross time taken		**55:00:00**
Time allowed for documentation		2:30:00
Shifting		2:30:00
Net time at loadport		**50:00:00**
Time allowed as per charterparty		36:00:00
Time on demurrage		**14:00:00**
Demurrage rate (per day)		$26,000
Amount payable		**$15,167**
Amount paid		**$14,722**

GLOSSARY OF TERMS

(Compiled from various sources)

Term	Definition
Anchor	A device which is attached to anchor chain at one end and lowered into the sea bed to hold a ship in position; it is designed to grip the bottom when it is dragged by the ship trying to float away under the influence of wind and current; usually made of heavy casting or casting
Anchorage	A place suitable for ships to anchor
Arrived Ship	A ship is considered arrived and the laytime can commence when certain conditions specified in the charterparty are fulfilled, e.g. reach the designated position for loading or discharging, vessel is ready in all respects for cargo operation and notice of readiness properly given

Aweigh	Describes an anchor which has been lifted off the sea bottom and has its weight fully taken by the anchor chains
Berth	1. Cabin or place to sleep in a ship; 2. Place for mooring a ship in port or anchoring
Cargo	Goods carried in a ship
Charterer	A person or firm who enters into a contract with a ship-owner for the transportation of cargo or passengers for a stipulated period of time, i.e. a ship owner's customer
Charterparty	A written contract between ship-owner and charterer whereby a ship is hired; all terms, conditions and exceptions are stated in the contract
Deadweight Tons (DWT)	Total weight of cargo, stores, fuel and water needed to submerge a ship from her light draught to her maximum permitted draught; it is given by the difference between the load displacement and light displacement (also known as lightweight)
Demurrage	Fee paid by the charterer to the ship-owner when the latter's ship is detained beyond the specified date agreed in the charterparty
Draught	The vertical distance measured from the lowest point of a ship's hull to the waterline or the water surface
Free Pratique	Official permission from the port health authorities that the ship is without infectious disease or plague and the crew is allowed to make physical contact with shore; otherwise the ship may be required to wait at quarantine anchorage for clearance
Laytime	Time allowed by the ship-owner to the voyage charterer to carry out the cargo loading and/or discharging operations; laytime may be expressed as a certain number of days or number of tons of cargo loaded/unloaded per day
Mooring	Securing a vessel to a buoy or strong point ashore e.g. bitt by ropes; at anchorage, by dropping anchor
Notice Of Readiness (NOR)	Notice presented to shipper or his agent by masters or ships' agent stating the readiness of the arrived ship to load; it determines when the time starts to count
Pigging	Passing a solid plug through a pipeline. The plug is small enough to pass through the pipeline but large enough to touch the inside wall. They have many uses - separating product, cleaning the pipeline, measuring the pipeline's wall thickness, etc.
Pilot	A qualified person having local knowledge of navigation hazards, is authorised to guide ships in and out of a port or channel
Ullage	1. Quantity represented by the unoccupied space in a tank or compartment;

2. Depth of space from the tank top to the free surface of the liquid;
3. Natural loss in weight or quantity e.g. due to evaporation

ABBREVIATIONS

ATF	Aviation Turbine Fuel
ATM	Automatic Teller Machine
BPO	Business Process Outsourcing
DWT	Deadweight Tons
EOSP	End Of Sea Passage
FO	Fuel Oil
HSD	High Speed Diesel
KT	Kiloton
LPG	Liquified Petroleum Gas
L/A	Loading Arm
MTPA	Million Ton Per Annum
MS	Motor Spirit
NOR	Notice Of Readiness
PCN	Polychlorinated Naptha
POB	Pilot On Board
SKO	Superior Kerosene Oil
SPM	Single Point Mooring
VGO	Vacuum Gas Oil

QUESTIONS FOR DISCUSSION

1. What are the criteria that should be considered during the determination of jetty capacity?
2. What is the number of berths required to take care of marine movements at various throughput levels? Do the sensitivity analysis for your recommendation.
3. Do you agree with the WOL's idea of not to have more than 65% berth occupancy?
4. What kind of software is required to analyse the situation described in the case? What would be the functionality of such a software?
5. Suggest an approach, if the number of product tanks is also a decision variable.

APPROACH FOR ANALYSIS

Ports and jetty operators use a thumb-rule of a desirable jetty utilization (e.g. 65%) before further expansion is considered desirable. This, often is the case when the costs of additional ship waiting time are not borne directly by the jetty operator. In the case of WOL, the investments in the jetty capacity and the demurrage consequences are both borne by the same entity. Hence, it is useful to develop a trade-off between the investment levels and the demurrage costs for various throughput levels.

At a first level, a process flow chart needs to be constructed, based on the data in exhibits 8A, B & C. An aggregate analysis can now be attempted using deterministic figures to get a broad relationship between the throughput and the number of jetties. This approach would be largely based on average times. Some average times are not so obvious, for example, the average waiting times for a favourable tide.

For the next level of analysis, the actual distribution of the different time parameters would be essential. A simulation model that considers these inputs along with different investment levels (e.g. navigation during a wider tidal window, more pilots on call, piping and pumping capacities and allocation) and evaluates the relevant performance measures can be used. From this, the various costs incurred such as demurrage, can be estimated.

Case 4

CASE CONTEXT

FarmAid Tractors Limited (FTL) is a tractor company with a 20% market share and aiming to be the market leader within five years. The tractor industry in India has become very competitive, with growth in capacity outstripping the growth in demand. Customer preferences and demands have changed in the context of the competitive environment. The role of the dealer and servicing the dealer by the company are recognised by FTL as key success variables in this business. The key issues of concern is to develop a partnership with the dealers by bringing in a service focus, through improvements in supply chain management and outbound logistics. Two critical areas for analysis are to be taken up, namely (i) order processing and inventory planning and (ii) distribution structure including stockyard location. The issue that is taken up specifically is of determining optimal stockyard location for states in India. The state of Gujarat has been given as an example for analysis.

FARMAID TRACTORS LIMITED

1. Introduction

The tractor industry in India had become very competitive, with growth in capacity outstripping the growth in demand. The industry production capacity was in response to a healthy growth in demand during the nineties. (A brief description of the Indian tractor industry is given in Exhibit 1). There were seven major players targeting both the domestic and international markets (Exhibit 2). FarmAid Tractors Limited (FTL), situated near Thane in Mumbai was the third largest player in FY99 with a 20% market share. FTL was aiming to be the market leader within 5 years.

FTL had one factory, 15 models (4 accounting for 90% sales), 18 regional offices (each with a stockyard - one in a given state), 300 dealers and sold 60,000 tractors per year for

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Prepared by G Raghuram. Assistance provided by Ms Sushma Chaudhary is acknowledged. Names and some of the data have been modified. Teaching material of the Indian Institute of Management, Ahmedabad, is prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems. *Revised December 2004.*

the past two years (Exhibit 3). FTL was relatively a new entrant in the industry, having started in the early nineties. The promoters were familiar with the automobile industry, and had competencies in the auto components business.

Customer preferences and demands had changed in the context of the competitive environment. The role of the dealer and servicing the dealer by the company were recognised by FTL as key success variables in this business. The key issues of concern were to develop a partnership with the dealers by bringing in a service focus, through improvements in supply chain management and outbound logistics.

In summer 1999, as a part of a major effort in organisational restructuring and business process reengineering, FTL decided to engage the services of Prof Prashanth from a reputed institute of management in Western India for a consultancy assignment. The assignment was on supply chain management, focused on outbound logistics. After an in-depth study of FTL (the manufacturing, production planning and despatch processes), and some of the regional offices, stockyards and dealers, various issues and decision areas were identified by Prof. Prashanth. Exhibit 4 gives a list of the issues, and decision and action areas which were planned to be analysed and for which data was sought from FTL. An in-company logistics team of four young executives, coordinated by Mr Rajesh Bhatt, supported Prof. Prashanth in this exercise.

Two critical areas for analysis were first taken up, namely:

(i) Order processing and inventory planning
(ii) Distribution structure including stockyard location

2. Order Processing and Inventory Planning

Orders were placed by regional offices for delivery to stockyards, model-wise on a monthly basis. Orders had to be consolidated, based on dealers' requirements by the 20th of a month for receipts during the following month. Over the next five days, there could be discussion between the plant (production planning) and the regional offices to modify the order, keeping in view any possible production constraints. Even though the production (and the dispatches) were planned and scheduled for a whole month, there were always end of month pressures for modifications and additions. FTL marketing executives and the top management were sensitive to the monthly market share points that industry analysts watched and reported.

Inventory planning at the stockyards to enable high service levels to the dealers, and at the plant to respond to seasonality were key concerns. The forecasts that would drive this planning also needed to be examined. Exhibit 5 gives the framework proposed by Prof. Prashanth to address these.

3. Distribution Structure Including Stockyard Location

There were two concerns here, namely, the need for a central despatch yard and location (and number) of stockyards. Exhibit 6 gives relevant issues as part of the consultant's framework of addressing these concerns.

Currently, all despatches were made from the factory to the stockyards through a daily allocation process which took into account the unmet demand at stockyards, ready for despatch inventory and availability of trucks based on the transporters' inputs. Once assigned to a transporter, the tractors were moved by the transporters to their godowns, since there was no space in the factory for holding finished stocks. It was often noticed that the transporters actually moved the tractors out of their godowns after an average of two days, primarily due to the non-availability of the intended trucks for despatch. FTL was concerned about this since the period of "lack of control" over the tractors was enhanced due to this. A central despatch yard at a suitable highway location, 20 kms away from the plant was being considered to address this. (There was no space nearer or adjacent to the existing plant for such expansion).

For better servicing of dealers, location of stockyards was another issue. The primary transportation mode was decided as road, using long platform trucks that could carry up to five tractors. The secondary transportation from the stockyards to the dealers would now begin to use trucks that could carry two tractors rather than move on own power. This was expected to reduce transit damages and also offer the tractor in a mint condition to the dealer. One of the debates was whether a stockyard should be close to the entry point in a state or close to the marketing office, which was usually in a large commercial centre near the centre of the state. For an in-depth analysis, Exhibit 7 gives the potential stockyard locations for Gujarat, with the monthly operating costs and distances. The current stockyard location was Ahmedabad. Exhibit 8 gives the location of the 19 FTL dealers in Gujarat, along with the expected monthly demand and distances. The total Gujarat demand was expected to be 500 tractors per month. Exhibit 9 gives a map of Gujarat showing all locations.

The primary transportation cost was expected to vary from Rs 2.5 to Rs 3.0 /tractor/km, depending on the truck technology. The secondary transportation cost was expected to vary from Rs 3.0 to Rs 3.5 /tractor/km depending on the service level offered. It was also a matter of concern that a dealer should not have to be more than 500 kms from a stockyard. Some of the more aggressive marketing executives felt that this should not exceed even 350 kms, which would be a one day transportation lead time. Another issue was a possible minimum on what a stockyard should handle per month, especially if stockyard management were to be outsourced. The company executives felt that a number of 200 tractors per month was a reasonable figure, to enable it to be attractive to the outsourcee.

Exhibit 10 gives the results (optimal stockyard locations with total costs) of the analysis based on a math programming model for various scenarios of parameters affecting the stockyard location. The top management was interested in the actual allocation of dealers to stockyards for these scenarios and their implications in terms of the criteria considered. The final recommendations for stockyard locations of the major states are given in Exhibit 11.

4. Supply Chain Organisation

To ensure better supply chain coordination for higher service levels to the dealers and customers, it was also decided that the distribution unit right upto stockyards would be under a new supply chain organisation which would include the production units (Exhibit 12).

The overall spirit of the service orientation sought to be achieved by better supply chain management was communicated in a letter (Exhibit 13) to the logistics team members in response to certain queries.

Exhibit 1: The Indian Tractor Industry

In 1999, the Indian economy was still highly dependent on agricultural growth and not surprisingly, it was the largest tractor market in the world. However, in terms of total tractors in use in the country, it was eighth in the world. The country had a tractor density of 10.5 tractors per thousand hectares of Gross Cropped Area (GCA) compared to the international average of about 28 tractors per thousand GCA.

Demand and Supply

The tractor industry was segmented based on the power of the tractor engine expressed in terms of horse power (HP). Among the segments, 31-40 HP segment led with 54.7% of total tractors sales in FY2000. Among the regions, North India constituting UP, Punjab and Haryana led with a contribution of 44% of tractor sales for FY99. The demand for tractors has increased from 121,106 tractors in FY90 to 260,762 tractors in FY2000 at a CAGR of 8%, but the annual growth in demand varied substantially. For example, in FY99 and FY2000, the rise in sales was reducing with growth rates of 3% and 2.9% respectively.

During the last 20 years from FY78 to FY98, the tractor industry had performed substantially better in comparison to the growth in Indian agriculture production and GDP. As given in Table 1 below, the CAGR of tractor sales was almost four times the growth of agriculture production.

Table 1: Tractor Sales v/s GDP Growth

Particulars	CAGR (FY78 to FY98)
Agriculture production	2.2%
GDP	5.15%
Tractor sales	8.31%

The major factors influencing demand of tractors were monsoon, land-holding pattern, availability of credit, growth in income of farmers and implementation of scientific farming practices. The industry was not cyclical, as many would presume about the automotive industry in general. Demand contraction occurred in 1982 and again in 1993, the two years of severe credit squeeze.

The optimal land-holding required for different HP tractors was approximately 8 to 10 hectares for 1800 cc or 25 HP tractors, 25 to 30 hectares for 35 HP and beyond that, it was higher HP tractors. But, the actual relationship between different land-holdings and the power of tractors was dependent on earning stability, type of soil, type of operation and affordability by farmers.

As per FY91 data, nearly 78.2% of India's agriculture land was held by small and marginal farmers having less than the prescribed land holding. This had gone up from 76.2% in FY86. The all-India average land-holding figure stood at 1.55 hectares in FY91, down from 1.69 hectares in FY86. For these small and marginal farmers, there was very little potential for economic use of tractors by outright purchases.

Industry Structure

The HP-wise composition of tractor industry sales as shown in Table 2, reveals that 31-40 HP tractors constituted the largest segment with 54.7% of the total tractor sales in FY2000. It can also be seen that demand for the less than 30 HP segment, which used to be the largest in FY94, had been pushed back by the 31-40 HP segment.

Table 2: Segment-Wise Market Shares

Segment	FY94	FY99	FY2000
< 30 HP	36%	22.5%	26.1%
31-40 HP	46%	57.8%	54.7%
41-50 HP	15%	15.9%	14.7%
> 51 HP	3%	3.8%	4.4%

This graduation to a higher HP segment can be explained if one considers the fact that region-wise share of tractor sales had also shifted from the northern states to other parts of the country. Initially, the population of tractors was concentrated in states like Punjab and Haryana which received the benefits of the so-called 'Green Revolution'. The soil in these states were alluvial in nature and thus required a low powered tractor for tilling it. However, over the years, with an increase in irrigated cropped area, the population of tractors began to increase in other states as well. These included states located in the western and southern parts of the country where the soil - laterite soil, black soil etc - was harder and needed higher powered tractors.

From the table above, we see that in FY2000 the share of the less than 30 HP segment improved by around 3.5% while that of the next higher segment fell by 3%. This could be attributed to the fact that in the 1999-2000 budget, the excise duty for the plus 1800cc tractors (above 30 HP) was increased from 13% to 16% while that of the less than 1800cc segment remained at 8%.

Region-Wise Share of Tractor Sales

North India constituting UP, Punjab and Haryana led among the regions, by contributing 44% of tractor sales in FY99, the data for which is presently available. But, its contribution had come down in the last five years from a peak level of 53.5% in FY94. Among the states, UP stood first with a contribution of 23% of the country's tractor sales. MP and Punjab stood next with around 12-13% contribution each.

The state-wise sales figures over the years show some important changes (Table 3). Sales from agriculturally developed states like Punjab, Haryana and Uttar Pradesh as a part of total tractor sales had come down from 53.5% in FY94 to 44% in FY99. This contrasts with the increase in share for the central and western regions of the country (Rajasthan, Madhya Pradesh, Maharashtra and Gujarat). This region's share rose from 20.4% to 27.8% in the same period. Sales in the northern regions had been below the all India CAGR of 8.6% in the last ten years. On the other hand, the central and western regions of the country had recorded double-digit growth rates.

Table 3: State-Wise Market Shares

States	FY90	FY94	FY98	FY99	CAGR (FY90 to FY99)
Punjab	22,026	26,636	31,644	31,047	3.9%
Haryana	15,307	16,579	22,711	21,877	4.0%
UP	31,233	30,656	50,433	59,211	7.4%
Bihar	4,891	2,900	10,282	12,875	11.4%
Rajasthan	9,315	11,129	25,152	24,054	11.1%
MP	10,018	11,418	32,250	32,711	14.1%
Andhra Pradesh	5,395	5,881	11,171	9,862	6.9%
Gujarat	6,508	10,033	21,501	22,208	14.6%
Maharashtra	5,737	6,730	15,059	16,011	12.1%
Karnataka	3,665	5,179	10,176	6,501	6.6%
Tamil Nadu	3,864	7,030	10,392	7,369	7.4%
Others	3,147	3,887	9,608	11,145	15.1%
All-India	121,106	138,058	250,379	254,871	8.6%

As seen in Table 4, the increased growth from central and south Indian states had led to growth in the medium and high powered tractor sales, as they had harder soil compared with the alluvial soil in the northern states. In the future, new tractor sales were expected to take place mainly in the western and southern regions of the country while the mature markets of the north would see higher replacement sales.

Table 4: Major Markets for Tractors

Tractor power (HP)	Major markets
Less than 30 HP	UP, MP, Rajasthan, Haryana and Bihar
31-40 HP	MP, Rajasthan, Punjab, UP, Haryana, Gujarat and Bihar.
41-50 HP	Punjab, MP and Rajasthan.
More than 51 HP	Punjab and also some volumes in Kerala and Maharashtra

Source: SIAM/TMA

Exhibit 2: The Key Market Players

As of 1999, the industry was controlled by seven major players, namely, Mahindra & Mahindra (M&M), Escorts, FarmAid Tractors Limited (FTL), Punjab Tractors Limited (PTL), TAFE, Eicher and HMT. All except FTL had been in the tractor market for more than 20 years. M&M continued its leadership position for the sixteenth successive year with a market share of 25% in FY2000. Escorts had taken the second position from PTL with a market share of around 20%. Escorts was followed by FTL (20%), PTL (15%) and TAFE (12%). While M&M had a balanced presence in all the HP segments, except that of less than 20 HP, others like PTL were stronger in the low and medium powered segments.

In recent years, the tractor industry had seen some new entrants introducing their products in the higher HP range. These included Ford New Holland and L&T John Deere. This had added around 65,000 units to existing capacities. In FY99, capacity stood at approximately 350,000 units. This meant a capacity utilisation of around 72%, down from around 87% in FY98. This pointed to a growing problem of overcapacity in the industry.

Many of the players had strong linkages with the automobile industry. Recently, one of the largest and the oldest players in the tractor industry, Escorts Ltd merged itself with Escorts Tractors Ltd after buying out the stake of its foreign collaborator Ford New Holland.

Mahindra and Mahindra Limited (M&M)

M&M was the world's largest tractor manufacturer. It was the largest jeep and tractor manufacturer in India with a tractor market share of 27%. Achieved economies of scale due to these associated operations in LCV and Utility Vehicles. Strong distribution network and brand equity. Recently embarked on a Business Process Reengineering Programme to achieve reduction in the production time, costs and improvements in product quality. One of the core competencies of M&M lay in the engineering skills and its R&D which had helped the company develop a diversified product range. They had acquired a majority stake in Gujarat Tractors Limited.

Escorts

With the recent merger, Escorts has emerged as the second largest player in the Indian tractor market with a market share of 20%. (Escorts may not have substantial economies of scale due to differences in the products of the two companies). It was also poised to takeover the tractors division of public sector HMT Ltd. Engaged in a restructuring exercise, resulting in the integration of the entire tractor business in one company and the other businesses like two-wheeler, auto components, telecom etc in separate companies. The distribution network, though widespread in the North, was weak in the emerging markets of South and West. The highly successful brand name FORD had been withdrawn due to the divestment of the stake of Ford New Holland in favour of Escorts. Now, the tractors were being marketed in the name FARMTRAC and the change had been well advertised among the customers. Escorts had seen declining sales, had lower margins than the industry and had a very high debt/equity ratio.

FarmAid Tractors Limited (FTL)

Had a presence in all market segments. Had a 20% market share and was aiming to be the number one player in another five years, achieving a market share of 30%, either by expansion or by acquisition.

Punjab Tractors Limited (PTL)

Strong distribution network and brand equity. Had adapted its tractors to suit specific state/crop conditions. Had been growing at a faster rate than the industry. Had one of the highest operating margins in the industry. Sales were against advances. It had a working capital surplus. Well positioned in the > 40 HP segment to exploit future growth opportunities.

TAFE

Closely held company of the Amalgamation Group. It had the strongest presence in the 30-40 HP market segment, but had no presence in either < 30 HP or > 40 HP segments. The company had substantial presence in all the major markets, though, its earlier focus was Southern India where the competition was weak. Setting up new facilities to manufacture 13,000 tractors per year. Most of the vendors were well known automobile ancillary group companies like Bimetal Bearings, India Pistons etc.

Eicher

All the sales were limited to < 30 HP category which had seen declining market share, though the absolute sales may be increasing. Distribution was limited to Haryana, Punjab and Western UP. There was a proposed merger with Royal Enfield, which could provide access to Enfield's network in South. Had one of the lowest net profit margins in the industry.

HMT

Had a presence in all the market segments. Despite very good product quality, had not been a very strong marketing company. Had been experiencing a declining market share, although volumes were increasing. Had not been strong in the Green Revolution states of Punjab, Haryana and Western UP. It had not been competitive on prices. Proposed takeover by Escorts Ltd though the final approval was pending with CCEA.

As seen in the table below, production capacities in the tractor industry had increased with the coming in of John Deere and Ford New Holland last year. However, this increase had not kept pace with a corresponding increase in production. Capacity utilisation in FY99 stood at around 72%, clearly indicating a growing problem of overcapacity in the industry. In FY2000, the utilisation was expected to drop to 64%. In FY01, an additional

17,000 units is likely to be added to New Holland's capacity while another 20,000 units was expected to be added to John Deere's capacity in the next two years. FTL was also planning to expand either by adding capacity or through acquisition.

Production Capacities

Company	FY99	FY2000 (Expected)
Bajaj Tempo	6,000	6,000
Eicher	45,500	45,500
Escorts	56,250	56,250
FTL	60,000	65,000
HMT	18,000	18,000
M & M	77,000	89,500
Punjab Tractors	50,000	72,000
TAFE	37,800	37,800
L&T John Deere	0	10,000
Ford New Holland	0	18,000
Total	350,550	418,050
Total production	253,904	267,356

Source: TMA/Annual reports

Exhibit 3: FTL Tractor Production

FY	Numbers
1996	45000
1997	53000
1998	60000
1999	60000
2000	65000 (Expected)

Source: Company Records

Exhibit 4: Logistics Issues and Decision Areas

1. Objectives of FTL's logistics: To maximise market share and profitability in a competitive environment, by enabling availability of the right model in best quality at the right place at the right time.
2. Symptoms/issues
   a) Stockouts

   i) Inability to supply the specific models indented by the dealers (end-user impact: lost sale/forced conversion to another model)
   ii) Delayed supply of the specific model indented by the dealers (end-user impact: loss of goodwill)
   iii) Stockout cost considered anywhere from 50% of contribution to 200% of contribution.

b) Excess stocks
   i) Inventory carrying cost: working capital cost of Rs. 100 per tractor per day (@ 0.05% per day on a tractor worth Rs. 200,000)
   ii) Scope for damages
   iii) An average of 20 days stock before sale to dealer costs Rs. 2000 per tractor (Rs 12 crores per annum)
   iv) An average of 20 days stock and a further 15 days credit by the dealer costs the dealer Rs. 3500 per tractor (Rs 21 crores per annum) (a dealer typically earns Rs. 8000 per tractor as commission, and possibly Rs. 1500 as 15 days credit, apart from margins on accessories)

c) Inter-stockyard transfers
   i) Extent during 1997/98
   ii) Reasons, costs

d) Losses: transit/storage resulting in repair/replacement/replenishment (70% of tractors received a 'yellow' card on receipt at dealers - implying not ready for sale. 75% of these were set right in the first week. The remaining sometimes got complicated in 'investigations', resulting in non-settlement of claims/dues even upto four years)
   i) Losses chargeable to transporter
   ii) Losses chargeable to insurance
   iii) Other losses, including opportunity cost of sale
   iv) Modewise losses

e) End-of-month pressures
   i) Inventory carrying cost associated with skewed sales to dealers
   ii) Cost of communication

f) Need to revise production schedules

i) Extent during 1997/98

ii) Scope for improvement through better forecasting and planning

g) Transportation costs
   i) Average primary (Rs 2500 per tractor, Rs 15 crores per annum)
   ii) Average secondary (Rs 1500 per tractor, Rs 9 crores per annum)

3. Decision and action areas
   a) Central despatch yard
      i) Allocation based on truck availability: savings in inventory
      ii) Increased flexibility due to later allocation across destinations: savings in inventory
      iii) Loading and storage under supervision: reduced losses
      iv) Infrastructure cost
      v) Availability of trucks/movement to railsiding
   b) Stockyard locations
      i) Stockyard in every state due to tax savings
      ii) Since secondary transportation cost is not significantly higher than primary transportation cost, entry point in the state is often the best
      iii) Multiple stockyards will be justified based on total transportation cost (primary and secondary), limitations on secondary movements (if on own power) and stockyard infrastructure and management cost (each stockyard costs about Rs 25,000 per month)
      iv) Stockyard to have minimum throughput volume (say 200 tractors per month)
      v) Stockyards to be managed by C&FA
   c) Mode choice
      i) Transportation Cost
      ii) Inventory cost at unloading end
      iii) Inventory cost at loading end
      iv) Inventory cost due to pipeline
      v) Cost due to losses
      vi) Buffer inventory cost at unloading end due to reliability in transit
      vii) Availability of transport/lead time for availability
   d) Inventory norms
   e) Forecasting and planning systems
      i) Current system
      ii) Revised system with rolling horizon
   f) MIS for stockyard management
      i) Selection of C&FA
         a) Experience/familiarity with tractor business
         b) Professional outlook of management and employees
         c) Understanding of transport business
         d) Skills for inspection and documentation on receipt and before delivery

e) Security infrastructure, preparedness for contingency
f) Infrastructural support: land for ordered storage and retrieval, fax, telephone, loading/unloading ramp
g) Professional charges
h) Time-frame for contract

ii) Monitoring of C&FA
a) Proper record keeping
b) Proper execution of instructions
c) Orderly storage and retrieval (in full communication with area office)
d) Damages during unloading/storage/despatch

g) MIS for transporter assessment
i) Selection of transporter
a) Quality in delivery (accidents, thefts)
b) Reliability in transit time (average, variance)
c) Price
d) Number of trucks owned
e) Nature of financing
f) Type of drivers employed
g) Permits invested in

ii) Monitoring of transporter
a) Date of despatch, date of delivery, variance analysis,
b) Transshipments onroute
c) Report daily movement
d) Spot contingency due to accident (role of central despatch/nearest C&FA/ destination C&FA)
e) Stock allocation during contingency by central despatch
f) Despatchwise
g) Transporterwise
h) Modewise

h) Need for transport development
i) Loading and unloading practices
ii) Truck design
iii) Financing of transporters
iv) Coordination with other tractor manufacturers for return loads

i) Inputs for product development
i) Avoid protruding parts for better packing efficiency and reduction of damages
ii) Kitting of loose parts

Exhibit 5: Order Processing and Inventory Planning

Regional Office to Factory (Stockyard-wise, Model-wise)

- Monthly inventory plan with safety stock for stockyards. Safety stock to provide 98% service level, model-wise
- Order quantity = expected demand during protection interval + safety stock - current stock (including stock in transit)
- Protection interval = Order interval (monthly) + lead time (0.8-1.3 months)
- Attempt to reduce end of month skew and move to weekly ordering, with two weeks lead time

Seasonality

- Annual inventory plan for seasonality (uniform production versus demand driven, if required by using overtime and/or subcontracting).

Month	Demand	Production	Inventory due to uniform production
January	5,000	5,000	1,100
February	4,000	5,000	2,100
March	4,500	5,000	2,600
April	6,000	5,000	1,600
May	5,900	5,000	700
June	5,700	5,000	0
July	4,500	5,000	500
August	4,000	5,000	1,500
September	4,500	5,000	2,000
October	5,500	5,000	1,500
November	5,400	5,000	1,100
December	5,000	5,000	1,100
Total	60,000	60,000	

Forecasting

- Company level (for aggregate and seasonality planning)
- Regional office level (consolidation of dealer forecasts and cross checking the same, for placing orders from the factory)
- Dealer level (customer tracking)

Exhibit 6: Distribution Structure

Central Despatch Yard

- Investment cost: Rs 15 million
- Operating cost: Rs 2 million per year
- Flexibility in allocation after physical verification of truck availability
- Inventory saving over current practice: 2 days (1,20,000 tractor days per year) i.e. Rs 12 million per year

Some Drivers for Secondary Logistics

- Change from own power to truck based movement
- Stockyard near dealer
- B/C category inventory to be held by stockyard only

Stockyard Location Analysis

- Due to 4% Central Sales Tax considerations, by and large each state had to have atleast one stockyard
- Current policy for stockyard locations was proximity to regional marketing office, which was usually in a major city in the centre of the state
- Both the number and location of stockyards were questioned and relaxed where logistical servicing of dealer gained importance
- A math programming model could be used for analysis

Exhibit 7: Stockyard Location, Cost and Distance

Sr No	Stockyard Location	Operating Cost per Month (Rs)	Distance from Thane (Kms)
1	Valsad	25,000	136
2	Surat	20,000	263
3	Vadodara	30,000	448
4	Ahmedabad	30,000	545
5	Rajkot	25,000	761

Exhibit 8: Dealer Location, Demand and Distance

Dealer Location	1 Amreli	2 Anand	3 Bardoli	4 Bharuch	5 Bhavnagar	6 Dharampur	7 Dholka	8 Godhara	9 Himmatnagar	10 Jamnagar	11 Junagadh	12 Nadiad	13 Mehsana	14 Morbi	15 Palanpur	16 Patan	17 Porbandar	18 Rajpipla	19 Surendranagar
No of Tractors/ *Month*	35	30	25	40	25	20	20	20	35	20	30	45	20	20	20	30	20	25	20
1 Valsad	633	272	62	163	514	32	385	315	424	616	630	293	419	647	491	456	715	204	431
2 Surat	566	205	31	96	447	109	318	248	357	549	563	226	352	570	424	389	648	141	364
3 Vadodara	399	38	125	71	280	266	151	81	190	382	396	59	185	403	257	238	481	82	200
4 Ahmedabad	258	73	225	182	200	377	40	136	79	313	327	52	74	292	146	125	412	195	116
5 Rajkot	105	255	492	365	175	560	162	321	304	88	102	234	299	67	371	255	187	255	111

* All distances are in Kilometers.

Exhibit 9: Stockyard and Dealer Locations

Exhibit 10: Scenario Analysis for Gujarat

(Rs)

Cost/tractor/km	Current	Secondary distance limit: None	Secondary distance limit: 350 kms	Secondary distance limit: 500 kms	Secondary distance limit none Minimum no of tractors to be serviced by a stockyard: 200/month	Secondary distance limit: 500 kms Minimum no of tractors to be serviced by a stockyard: 200/month
Primary: 2.5 Secondary: 3.5	10,28,999 Ahmedabad	8,73,533 Valsad Rajkot	8,78,209 Valsad Ahmedabad Rajkot	8,75,454 Valsad Ahmedabad	8,75,484 Valsad Ahmedabad	875,484 Valsad Ahmedabad
Primary: 3.0 Secondary: 3.0	11,19,855 Ahmedabad	8,22,880 Valsad	9,43,085 Valsad Ahmedabad Rajkot	8,87,380 Valsad Vadodara	8,22,800 Valsad	8,99,080 Valsad Vadodara

Exhibit 11: Recommendations for Stockyard Locations

State	Existing Yard(s)	Optimal Locations	State	Existing Yard(s)	Optimal Locations
Andhra Pradesh	Hyderabad	Hyderabad Vijaywada	Madhya Pradesh	Bhopal	Indore Raipur
Tamil Nadu	Chennai	Hosur Trichy	Rajasthan	Jaipur SriGanganagar	Kota Jodhpur SriGanganagar
Karnataka	Bangalore	Belgaum Davangere	Punjab	Jalandhar	Patiala
Gujarat	Ahmedabad	Valsad Ahmedabad	Haryana	Karnal	Gurgaon

Exhibit 12: Organisation Structure

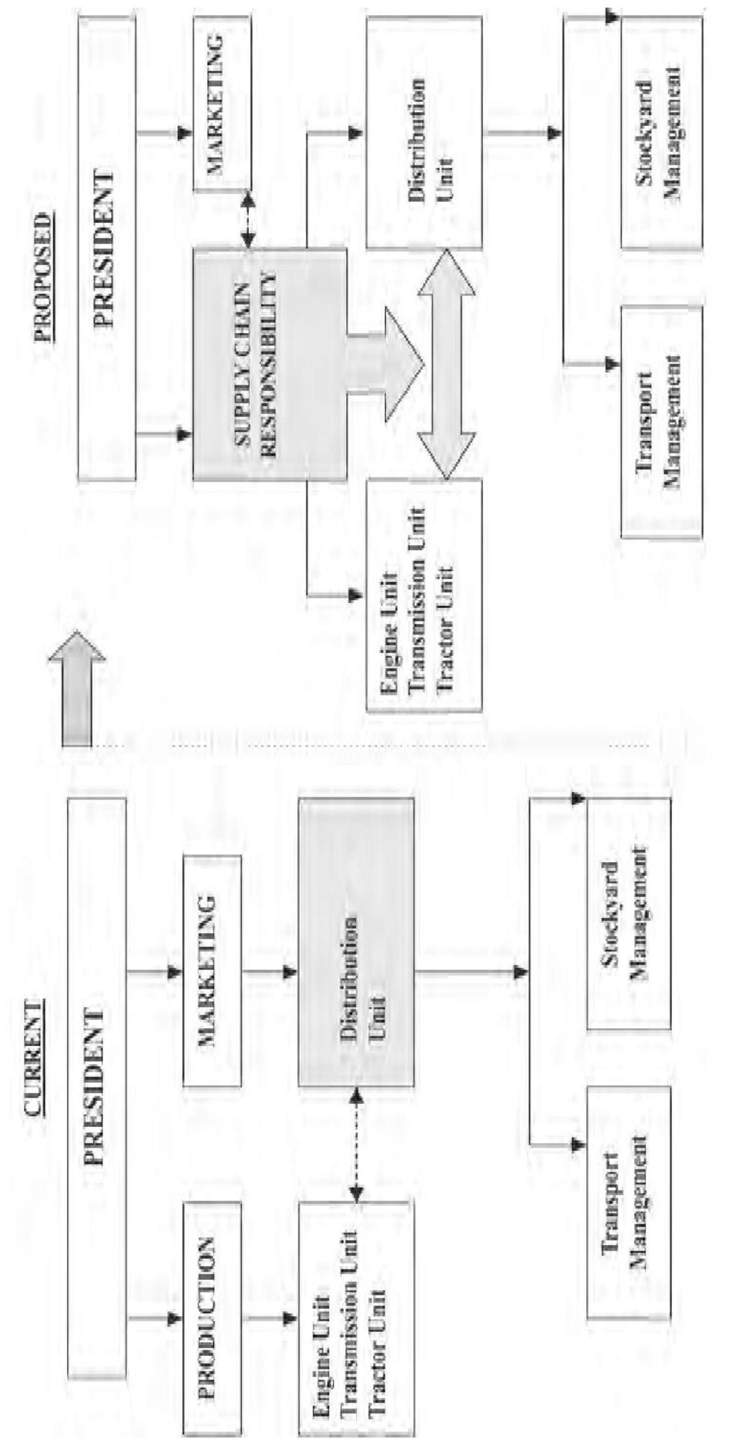

Exhibit 13

November 2, 1999

Mr Rajesh Bhatt
Logistics Team
FarmAid Tractors Limited
Thane, Mumbai

Dear Rajesh,

Regarding the restructuring of the supply chain, I have the following points.

1. The entire supply chain should service the customer requirements in a coordinated way. We aim to be like a "service" organisation.
2. We build on the premise that marketing's role is to be aware of the customer requirements, and interface with the customer, both directly as well as through the dealer. Hence, ideally, supply chain's responsibility should be up to servicing the dealer requirements. Thus, dealer and dealer customer interface becomes the front office function, servicing the dealer right from the raw material vendor through a series of transport, storage, and conversion activities is the back office function.
3. Given the above ideal supply chain structure, we can start examining activities prior to reaching the dealer, one by one, to see if there would be better effectiveness and efficiency if the activity was performed by the marketing (front office) or by supply chain (back office). The activities in reverse order would be
   (a) transportation from area stock yard to dealer
   (b) allocation from area yard to dealer
   (c) receipt, storage, inspection at area yard
   (d) transportation from central despatch to area yard
   (e) allocation to area yard
   (f) transportation from finished goods to area yard
   (g) ready for despatch inspection at the plant and so on.
4. If (a) above is better performed by marketing, then it could be part of marketing role. Apart from this activity, it appears that all the other activities should be a back office function under supply chain, so that complete responsibility is taken to ensure availability of the required tractors. Focus on activities like transportation, storage, inspection even at geographically dispersed places should reach the same level as a particular manufacturing process in a factory environment.

Thanking you,

Yours sincerely,

Prashanth

QUESTIONS FOR DISCUSSION

1. What are the factors leading to the perceived 'lack of control' and poor delivery quality?
2. What forecasting technique should be used for inventory planning at the plant and the stockyards?
3. Is there a need for a central dispatch yard? What are the pros and cons?
4. What is a good model for determining optimal location of stockyards and the associated allocation of dealers to the stockyards in the state of Gujarat?
5. Interpret the implications of the recommended locations versus the existing locations as given in Exhibit 11.

APPROACH FOR ANALYSIS

Quality, as determined by dealers, is an important driving element in the new supply chain. It throws up a number of steps and stages of supply which lead to poor quality. These need to be mapped out.

The demand forecast plays a major role as the next step in the whole analysis. Forecasts are made at three levels; at the national level, across all models, for overall capacity planning at the factory; regional forecasts across dealers in a region so that regional stockyards can order; and finally, dealer level forecasts. Seasonality needs to be addressed properly for the required service levels. Dealer level forecasts may have their limitations, and alternatives to this have to be considered.

The need for a central dispatch yard can be assessed from the perspective of inventory costs, quality costs and control issues.

The case has a number of scenarios in which to analyse the optimal stockyard location with transportation costs (primary and secondary) and stockyard location costs being the main factors. Constraints like minimum number of stockyards in a state and minimum number of tractors to be handled by stockyards have to be taken into account too.

A mathematical program can be formulated for solving this problem using the demand forecasts and cost estimates that are available. This model is usually of the location-allocation type, and would decide the locations of stockyards *together* with the allocations of dealers to these stockyards. Exhibit 10 gives the outcome through a model of this type.

The optimal stockyard locations in the various states, driven primarily by costs, could be different from the existing locations, which are based on proximity to the marketing offices. The optimal locations may, therefore, need a buy-in, for which facilitating mechanisms for improved communication and co-ordination would be required.

In the context of the above issues, the supply chain organization may also need re-structuring, to achieve better co-ordination between production, order processing and dispatching.

Case 5

CASE CONTEXT

The Senior Vice President, Marketing, of Titan Industries Limited (TIL) was examining the domestic growth scenario of Titan watches. The sales of TIL had dropped 11 per cent over the previous year. The traditional strengths of Titan had been in marketing, especially retailing, brand building and product design. To continue to remain profitable, the key attributes were recognised as continuous product innovation, and ensuring availability of the desired product or at least range. The top management led by the Senior Vice-President, Marketing felt that better supply chain management would be one key strategy and would lead to better professional practice within the organisation.

SUPPLY CHAIN MANAGEMENT at Titan Industries Limited

Bhaskar Bhat, Senior Vice President-Marketing of the high growth, high profile Titan Industries Limited, was examining the domestic growth scenario of Titan watches. Year-to-date sales as of August 1996 showed a drop of 11 per cent over the previous year. While some of it could be attributed to the general slowing down of the economy, there was also the lurking suspicion that growth in this segment of the high-end quartz analog watch market may be slowing down, owing to saturation and increasing competition from foreign entrants, thanks to liberalisation.

The traditional strengths of Titan have been in marketing (especially retailing – making watch buying a pleasure in itself), brand building, and product design. To continue to remain profitable and keep the market happy, the key attributes in test in the current context were recognised as continuous product innovation (offering dynamic variety over the already large variety offered), and ensuring availability of the desired product or at least range. Further, any expansion or related diversification required cash for which one possible source was the large inventory (estimated at one year's requirement from raw material to retail outlet). The attention of top management led by Bhat naturally moved on to better supply

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Written by G. Raghuram. Cases of Indian Institute of Management, Ahmedabad, are prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems. **Sales** (excerpted from the Annual Report 1995-96).

chain management as one key strategy. Apart from addressing many of the concerns raised above, Bhat felt that better supply chain management would lead to better professional practice within the organisation.

Background

Titan was set up in mid 1985 by the Tata group, bringing in a few select top executives from other Tata companies (including Bhat) along with a few executives from HMT (the public sector watch manufacturing company). After obtaining approvals, Titan set up the manufacturing unit in Hosur, Tamil Nadu, close to Bangalore, on the Bangalore-Madras national highway, just across the border from Karnataka. (The Tamil Nadu government offered incentives to industry to locate in Hosur, leveraging on the proximity to Bangalore.) Titan entered the Indian watch market during 1986-87 by just assembling watches and increased its manufacturing content through a phased manufacturing programme.

The appendix provides some basic information on world watch production, the Indian watch market, a fact sheet on the company, and excerpts from the annual reports on Government policy. Following the appendix, the organisation chart of the company as well as the manufacturing and marketing setups are enclosed. This is followed by a chart showing the manufacturing structure of a watch.

In spite of the Indian watch market growing by only 5 per cent, Titan continued its dominance, selling a total of 3.40 million watches in the domestic market as against sales of 3 million watches in the previous year. In addition, 4,30,000 watches were exported.

At the end of March 1996, Titan had a market share of close to 50 per cent of the quartz analog watches manufactured and sold in India. Together with Timex watches, which were entirely sold and marketed by Titan, the combined market share stood at 70 per cent of the Indian made quartz analog watches and close to 25 per cent of the estimated 21 million watches sold in India during the year, including mechanical, quartz, digital, and electronic watches from indigenous and imported sources, both legal and otherwise.

Titan's chain of exclusive retail showrooms increased from 80 to 86 and the number of Titan shops was 90 as of March 31, 1996. During 1996-97, Titan would further strengthen its retail network. The number of outlets would be significantly increased, showrooms upgraded in terms of general appearance, merchandise and service, and the Titan shop retail chain raised to a new level altogether. Titan shops would be rechristened "Timezone" and would sell multiple brands negotiated by the company. Every shop would be upgraded, as with the showrooms, and the Timezone chain would be heavily promoted as a chain of trusted watch shops retailing a wide variety of reliable, reputed, and high quality watches and clocks and offering excellent service.

Titan was also in the process of setting up a joint venture with Hour Glass of Singapore, one of the world's largest wholesalers and retailers of luxury watches. A memorandum of understanding to this effect had already been signed and the modalities, including the proposed investment and the brands which Hour Glass in India would carry, were in the process of being firmed up. The new company would set up watch boutiques in leading

Indian cities for the sale of luxury watches, mainly Swiss, and would also be responsible for wholesale and after-sales operations.

With cumulative sales of close to 20 million watches since 1987, the company was laying renewed emphasis on after-sales-service. Titan was constantly increasing the number of service outlets and exploring ways and means of upgrading these outlets to enable it to continue to provide high quality service and thereby ensure total customer satisfaction.

The success achieved by Titan in marketing excellence continued to receive recognition. During September 1995, Titan was once again voted "the most admired consumer durable company in India" in a poll conducted by the *A & M* magazine. Besides winning numerous gold medals under various categories at the Bombay, Madras, and Bangalore Ad Clubs award functions, Titan won the very prestigious "campaign of the year" awards presented by the Bombay and Bangalore Ad Clubs for its Tanishq advertising campaign, developed by Lintas. Titan also figured in the *Far Eastern Economic Review*'s survey of Asia's 200 leading companies, ten of which were Indian.

Despite its many success, in the words of the Managing Director, Xerxes Desai, "Titan recognises the need to further invigorate its sales and marketing organisation and strategies in view of the new competitive threats which are emerging. A new programme has been initiated to combat such threats and improve the 'sell through' rates at retail. At the same time, the Directors would like to extend their very special thanks to its prime business associates consisting of franchisees, stockists, dealers, and after-sales service providers for the significant contribution which they have made over the years to the company's success. The shareholders, directors, and management of Titan Industries count on their unqualified support as the company completes the first decade of its operations and commences another decade which will be marked by the emergence of new competitive forces in the Indian market. We believe that close cooperation between Titan's central selling organisation and its key business partners will enable the company to maintain its pre-eminent position in the Indian market."

Manufacturing (excerpted from the Annual Report 1995-96)

Titan's two new plants, the eurowatch plant and the jewellery plant, had their first full year of commercial production. Production was progressively stepped up at both plants – the eurowatch plant producing about 80,000 watches, and the jewellery plant producing almost 40,000 jewellery pieces and around 2,000 jewellery watches.

The eurowatches, launched this year in many European markets, had been extremely well received by the trade as well as the end customer. The company expected the sale of these watches in international markets to progressively increase in the coming months and had taken steps to further increase manufacturing capacity to meet this demand.

Titan totally produced 3.77 million watches, 3.70 million movements, and 1.98 million cases. Production would have been higher but for industrial action during wage negotiations which slowed output in Hosur.

Titan's manufacturing group had initiated a programme to place a whole new emphasis on world class manufacturing. PQCD (Productivity, Quality, Cost Control and Delivery on Time) had in fact become the new buzzword throughout the company. There was also a whole new focus on "customer satisfaction" as understood in its broadest sense. Titan would, in the current financial year, make an application for the JRD Quality Value Award. This award had been instituted by the Tata group in memory of the late Mr. J.R.D. Tata and his never-ending quest for perfection and quality, and recognised companies within the Tata group which excelled in quality management.

The CIF value of imported materials and components consumed during the year was Rs 40.29 crore as against Rs 21.55 crore in the previous year, largely because of the increase in volumes and imports of raw materials and components needed for the eurowatch collection created for the European market.

Supply Chain Management: Material Flow

The supply chain management in Titan was complex. At any time, 800 varieties of watches were made available to the retail outlets. These could be classified into seven regular ranges and four special ranges (either the export lines sold in India or designer specials). The number of varieties that had been offered and for which Titan would be technically ready to accept an order would be 1700.

These watches were sold through a variety of channels. The most important were redistribution stockists, institutional sales, franchisee operated shops, traditional outlets, and Titan shops. The watches were distributed to these outlets through CFAs who were spread regionally: 12 for the south, 10 for the west, 10 for the north, and 6 for the east. The watches moved to CFAs from three assembly plants, located in Hosur, Dehradun, and Ooty. Transportation from CFAs to retail outlets was essentially through road, often personally carried by a representative of the retail outlet. Transportation from the assembly plants to CFAs was by air, wherever possible, or else by road.

A watch assembly consisted of six components, five of which formed the appearance parts and the sixth was the movement (not visible). The appearance parts were cases, dials, hands, straps, and the crown. The overall variety was a function of variety in each of these parts. Currently, Titan operated with a variety range of 300 for cases, 1200 for dials, 800 for hands, 650 for straps, very few for crowns, and 32 for movements.

Titan manufactured and assembled the movements (at Hosur) and manufactured about 50 per cent of the cases (also at Hosur). All the remaining parts were sourced from outside and made into matched sets at Hosur, before being assigned to Hosur, Dehradun, or Ooty assembly plants. Transportation to the Dehradun plant from Hosur was by rail through a third party who organised a courier to carry the parts as a parcel. Transportation to Ooty was by road.

The matched sets were put together at the finished products store using assembled movements and the boughtout items which were intended from the raw material store. The assembled watch heads (without the strap) in Hosur were sent to a strapping section for fixing the straps, then packed and dispatched to CFAs through the despatch section.

In Hosur, a large assembly plant assembled both watches assigned to Hosur as well as all the movements required for assembly across the three assembly units. A separate movement manufacturing area made the over 100 components required for each movement. There was a lot of standardisation of components across the 32 movement varieties. For example, there were only five varieties of the backplate, one of the most important components in a movement.

The cases were made at the case plant in Hosur. For movements, three items were brought in from outside. The batteries and the quartz were imported from Japan while the electronic circuit board was manufactured by Titan in Goa and sent to Hosur.

All the watch related manufacturing units (except the new jewellery and bracelet units) in Hosur were located in one campus, though the layout across various buildings caused a lot of cross and duplicate moves of various components.

Technically sophisticated quality control procedures were instituted at every stage of procurement and manufacture, including the concept of pre-despatch inspection by Titan at its vendor locations.

Supply Chain Management: Information Flow

The information flow was driven by an annual forecast for case manufacture made in October/November for the following financial year. This was required for capacity planning as well as planning for sourcing with an estimated six month lead time. The large variety in cases also added to the complexity. A variant level forecast for cases was made quarterly, but three months ahead of the quarter, since procurement/manufacturing lead times were three months. It appeared that the case planning was the most important thing since all other appearance parts were sourced from outside with relatively shorter lead time. While movements were also manufactured in-house, like cases, the variety was not as large.

Once the quarterly forecast was accepted, a material procurement request was sent by the purchase department for the all the required appearance parts.

Based on actual availability of matched sets, a launch plan was prepared for assembly indicating the planned monthly watch production.

Company Performance

Exhibits 1 and 2 give the balance sheet and profit and loss account of the company for the past four years. Financial information on inventories which play a key role in supply chain management is given in Exhibit 3. Details of the operating and other expenses, which highlight the inputs consumed, are given in Exhibit 4.

Sales information is provided in Exhibits 5, 6, 7 and 8. While sales data for the range, region, and channel are secondary sales, CFA-wise sales are primary. As one measure of supply chain efficiency, the inter-CFA stock transfer data for the south zone (which is representative of the national scenario) is given in Exhibit 9.

To understand the requirements of the supply chain, ABC categorisation as well as sales and forecast data are provided, the latter two for one case. Exhibit 10 gives the cluster-wise (range-wise), case-wise, and dial-wise ABC categorisation for a sample of watches for 1995-96 and 1996-97. Exhibits 11a and 11b give dial-wise month-wise primary sales for 19 months until October 1996 for Case 141 (a representative sample). Exhibit 16 provides information on the sales forecast and subsequent revisions for various dials in Case 141. Month-wise production plan (launch plan) for these same dials is given in Exhibit 17.

An analysis of inventory vs. consumption is provided in Exhibit 12, while Exhibit 13 examines the total vs. obsolete inventory break up. The sourcing plan for cases, dials, and hands is given in Exhibit 14. The purchase department's objectives and procedures are given in Exhibit 15. Exhibit 18 provides a sample production scheduling for a few select components of a movement.

Supply Chain Management: Perceived Problem Areas

One of the important concern areas was high levels of inventory, including obsolete inventory. Various reasons were attributed to this situations: repeated forecast modification, long lead times, long time buckets, excess buffer planning (A category items - 2 months, B category - 1-1/2 months, and C category - 1 month), production driven by capacity utilisation, and lack of coordination resulting in mismatched sets. Even at the strapping section, watch heads waited for straps.

Another concern was loss of sales owing to stockout. There was a debate as to whether the focus should be on the top 150 variants or on a wider range of 800 variants essential for sales.

With liberalisation, one of the options was cutting back on inhouse manufacture and focusing purely on design, sourcing, assembly, distribution, retailing, and of course marketing.

While vendor development and management currently had a focus on quality, delivery flexibility was an issue yet to be addressed in a significant manner.

Production batch sizes were also an area of concern, especially since setup times, were perceived to be significantly high compared to the high rates of production. This caused problems of large inventories and matching components.

Bhat was wondering what may be the appropriate steps he should take in terms of ensuring a better marketing manufacturing coordination, both at the planning level and at the damage control level, to minimise inventories and have a leaner and more responsive supply chain support. Any step would of course require a proper justification to take the entire organisation along.

APPENDIX

World Watch Production

World watch production	1050 million
Toy watches, clocks, pen and stick watches	200 million
Wrist watch production	850 million
One watch for every 7 persons	

Wrist Watch Production (By Type)

(million)

	1989	1994
Quartz Analog	341	500
Quartz Digital	227	250
Mechanical	114	100
Total	**682**	**850**

*Share of analog and digital watches is growing

*Share of mechanical watches is declining

Indian Watch Market

(in lakh)

	1991–92	1992–93	1993–94	1994–95
All Watches	180.0	184.0	193.0	203.0
Mechanical	75.0	50.0	35.0	22.0
QAW	84.0	107.0	128.0	148.0
Digital	21.0	27.0	30.0	33.0
Brands of QAW				
Titan	23.1	23.6	22.2	25.4
Timex	–	1.8	8.0	12.0
HMT Quartz	14.5	13.0	7.3	6.0
Allwyn	6.0	2.5	1.0	1.0
IMFQ & Others	40.4	66.1	89.5	103.6
Total	**84.0**	**107.0**	**128.0**	**148.0**

India is only one of the dozen countries in the world manufacturing all the components for a watch (mechanical and quartz). The others are Japan, Hongkong, Switzerland, France, USA, Germany, S. Korea, and China.

Till 1985

Till the 1950s, watches used to be imported. The first company to produce watches in India was HMT, a giant public sector corporation, which established a watch assembly unit in collaboration with Citizen of Japan in 1961.

HMT produced 40 lakh watches per annum. The next biggest player was Allwyn watches, an Andhra Pradesh State Government undertaking, which had an annual production of 4 lakh.

There were also other marginal players in India like Indo-Swiss, Indo French, and Jayna which mainly produced mechanical watches. HMT chose to concentrate on mechanical watches even though the world moved to quartz analog watches in 1966. HMT entered the quartz segment only in 1981.

Allwyn watches, though innovative in design and fairly active in the automatic watch segment, did not establish long-term identity.

1986-87

Titan entered the market in 1986-87. During the period between 1986-87 to 1992-93, Titan acted as catalyst transforming the market from mechanical to quartz. Titan produced only quartz watches. Titan thus penetrated the market by bringing about brand/type switch from mechanical to quartz and imported to Indian.

1988-89

Allwyn introduced low price polyamide range branded "Trendy", inspired by the "Swatch" success.

1989-90

Titan's response was to create a new brand "Aqura" projecting a casual and refreshing side of an individual's personality.

1990-91

In the watch market:

There were a number of competitors spanning several price brands and product types.

Titan wanted to create and cater to high priced segment.

HMT started an extensive promotion of quartz watches.

1991-92

There was a steep increase in import costs on account of the devaluation of the rupee. Titan revised its price sharply by raising by 20 per cent and vacated price brands below Rs 600.

The IMFQ segment of the market gained a considerable cost advantage over the organised sector.

1992-93

Timex brand name became available to Titan as a result of its entering into a joint venture with the well known Timex Corp. of USA.

Allwyn incurred huge losses in 1989 and 1991 and was offered for sale.

1993-94

The shift of the Indian market from mechanical to quartz.

The hold on the watch market shifted from public sector companies like HMT and Allwyn to private sector - Titan and Timex.

Development and growth of the grey watch market including IMFQs and smuggled watches.

Development of new retailing network initiated by Titan using exclusive showrooms to sell its products.

Factsheet on Titan

Titan is acronym derived from - TATA Industries and Tamil Nadu.

Titan means descendent of the Greek god Uranus one who has extraordinary strength, intellect, and power.

Titan Industries Limited is a joint sector company, promoted by Tata Industries Limited and TIDCO to manufacture quartz analog watches and jewellery.

Tata's interests in watches dates back with the acquisition of minor stake in Hegde and Golay and an aborted collaboration with Fairchild. TIDCO was also interested in setting up a watch manufacturing unit at the same time. Thus, together with France Ebauches, a European movement giant, a tripartite agreement was signed and Titan Industries Limited was born in 1984, and started selling watches by 1987.

Present Locations

Offices

Corporate Office	Bangalore
Regional Office	Bangalore, New Delhi, Calcutta, Bombay
Branch Office	Madras
International Marketing Office	London, Paris, Dubai

Factories and Units

Main Plant	Hosur
Assembly Unit	Dehradun
ECB	Goa
ATP	Hosur
Stepper Motors	Hosur
Jewellery & Jewellery Watches	Hosur
Euro Watches	Hosur

Titan Vision

To be a leader in the watch market and to be admired and respected as innovative company.
To be well known in the International watch industry through its products.
To be a responsible corporate citizen.

Titan is perceived to be a professionally managed company with one of the finest watch plants in the world and with a high degree of innovativeness in marketing. In fact Titan is perceived to be in a fashion business rather than the watch business as a result of its beautiful products, promotions, and showrooms.

Today Titan is a Rs 275 crore company, the largest player in the Indian watch industry. Titan foresees the company play a major role in the international market. It is thus adding new brand and new dimensions to the personal accessories business to fulfil its aim and reach its goal.

1. Major Events

Government of India approval for watch production	August 1985
Government of India approval for Component manufacturing	May 1986
Commencement of watch assembly	March 1987
Government of India approval for Case manufacturing	July 1987
Commencement of component manufacturing	October 1987
Commencement of Case manufacturing	November 1989
Government of India approval for Dehradun Unit	March 1990
Commencement of Dehradun Watch assembly	March 1990
Commencement of Step motor manufacturing	August 1992
Commencement of Euro Case manufacturing	May 1994
Commencement of Euro Watch assembly	March 1995
Commencement of Ooty Watch assembly (Tansi Unit)	October 1995

2. Capacity Details

Annual Capacity	Watches	Hosur	2.1
		Dehradun	1.8
		Ooty	0.5
			4.4
		Cases Metallic	2.2
		Euro Cases	0.15
		Euro Bracelets	0.5
Movement Components (in sets)			4.0

3. Investment (approx) as on 31-03-1996 Rs 2000 million US$ 55.5 million

4. Turnover (approx) Value in millions

Actuals (1995-96)	Cumulative till	Target (1996-97)
Rs 3071	Rs 15111	Rs 4154
US$ 88	US$ 432	US$ 119

5. Production Statistics

Description	Actuals (1995-96)	Cum. Till 31.7.1996	Target (1996–97)
Regular Watches	3.6	20.05	4.175
Euro Watches	0.18	0.28	0.425
Movements	3.7	21.5	4.2
Cases (Metallic)	1.9	10.9	2.2
Cases (Euro)	0.08	0.13	0.145
Bracelet	0.019	0.033	0.45

6. Employee Statistics

Men	1864
Women	397
Supervisory and Managerial Staff	471
Total Workforce	2261
Average age of Employees	24.7 years
Tamil Nadu Nativity	2066
Handicapped Employees	
Physically Handicapped	31
Hearing Impaired	100
Sight Impaired	6
Total	137

7. Plot Area Details

Plot Area Details	sq.mts
Total Area	56,672
Built up Area	32,385
Air-conditioned Area	16,966

8. Number of Variants

Watch Models	more than 2500
Basic Movements	8
Movement Versions	32

9. Sales

Description	Actuals (1995-96)	Cum. Till 31.7.1996	Target (1996–97)
9.1 Watches Domestic	3.40	18.44	3.62
9.2 Watches Export	0.43	1.089	0.91
9.3 Movements Export		1.106	

10.	Domestic Sales Network (approx)	No's
	Clearing and Forwarding Agents	38
	Dealers	4738
	Towns Covered	1100
	Authorised Service Centres	226
	Redistribution Stockists	55
	Company's Service Centres	36
11.	Export Sales Network (approx)	No's
	Countries Covered	19
	Distributors	07
	Service Centre's	19
	Dealers	1904
	Towns Covered	89 +

Government Policy

(excerpted from the Annual Reports of 1994-95 and 1995-96)

1995-96

Smuggling still remains a menace in our country. Government policy makers continue to give insufficient attention to the repeated representations made by Indian manufacturers to make adequate reductions in excise and customs duties and to destroy seized smuggled goods as part of a strategy to combat smuggling.

Titan, and for that matter, the entire Indian watch industry, would like to see a more enlightened government policy where, in addition to customs duties on components being reduced to 20 per cent and on raw materials to 10 per cent, excise duties are reduced to a nominal 1 per cent and sales taxes are pegged uniformly at 3 per cent.

1994-95

In spite of repeated representations by Indian manufacturers, including Titan, sufficient attention has not been given by Government policy makers to the menace of smuggling. While customs duties have come down in the last two years, the current level of duties still remains high and, combined with the damaging effect of a 10 per cent excise duty as also high rates of sales taxes, octroi and turnover taxes, makes it extremely difficult for the legitimate Indian manufacturers to compete with smugglers, control over whose activities is largely ineffective. Most affected are watches priced below Rs 750.

Titan is of the considered view that, in addition to further reductions in customs duties on components to 20 per cent and on raw materials to 10 per cent or less, it is also essential for the Central Government to lower the excise burden on watches to a nominal 1 per cent and for state governments to peg sales taxes at 3 per cent. Equally importantly, vigilance, detection and punitive action against those who indulge in smuggling and defrauding the Government of India must be stepped up. Suggestions made to various ministries of the Government of India have met with a muted response much to the relief of the global smuggling fraternity. At the same time, government needs to review its present restrictions on the import of complete watches. We recommend that, in the first stage, watches with a CIF value of Swiss Francs 300 and above be allowed to be imported with special import licenses and floor prices gradually lowered thereafter. We also recommend that the import duty in such watches be no more than 40 per cent.

Exhibit 1: Balance Sheet as on March 31

(Rs lakh)

SOURCES OF FUNDS	1993	1994	1995	1996
Shareholder's Funds				
Share capital	4227.63	4227.63	4977.63	5227.63
Reserves and surplus	7781.71	8633.68	9874.49	11145.94
Loan Funds				
Secured loans	10181.65	11878.53	15595.24	19945.13
Unsecured loans	1262.33	3236.91	3567.95	10388.70
APPLICATIONS OF FUNDS				
Fixed Assets				
Gross block, at cost	14793.07	15861.04	24357.04	28513.32
Less: Depreciation	2751.17	3708.39	5010.99	6555.96
Net block	12041.90	12152.65	19346.05	21957.36
Advances on capital account and capital work in progress, at cost	1094.61	4511.52	1245.03	1009.57
Investments	6.00	1492.29	2181.85	2831.50
Current assets, loans and advances				
Inventories	8639.40	10184.60	11207.05	15253.69
Sundry debtors	1406.46	1432.09	3358.28	7784.63
Cash and bank balances	850.35	1265.22	962.74	1385.10
Loans and advances Less:	3018.94	1861.29	1893.52	4389.34
Current liabilities and provisions				
Current liabilities	2885.30	3819.51	4837.75	6387.62
Provisions	719.04	1103.40	1341.46	1516.17
Net current assets	10310.81	9820.29	11242.38	20908.97
Total	23453.32	27976.75	34015.31	46707.40

Source: Company Annual Reports, 1993-94, 1994-95, and 1995-96.

Exhibit 2: Profit and Loss Account

(Rs lakh)

	1993	1994	1995	1996
INCOME				
Sales	19121.45	22622.69	28034.24	35071.95
Other Income	159.85	258.09	359.31	294.50
TOTAL	19281.30	22880.78	28393.55	35366.45
EXPENDITURE				
Operating and other expenses	13599.00	15984.14	20028.48	24825.05
Excise duty	2026.14	2393.50	2364.62	2793.64
Depreciation	722.76	978.33	1311.35	1568.40
Interest	1846.19	1615.93	2179.77	3422.16
TOTAL	18194.09	20971.90	25884.22	32609.25
PROFIT FOR THE YEAR	1087.21	1908.88	2509.33	2757.20
TAXES	–	–	–	–
PROFIT AFTER TAXES	1087.21	1908.88	2509.33	2757.20
Povisions for taxes in respect to earlier year	4.82	–	–	–
Profit brought forward	123.92	78.40	675.37	1627.18
Amount available for appropriations	1206.31	1987.28	3184.70	4584.38
Appropriations	1127.91	1311.91	1557.52	1813.75
Transfer to debenture redemption reserve	57.00	55.00	29.00	28.00
Transfer to investment allowance reserve account	304.05	–	–	–
Proposed dividend (subject to deduction of tax)	688.86	1056.91	1268.52	1395.12
Transfer to general reserve	78.00	200.00	260.00	300.00
Balance carried to balance sheet	78.40	675.37	1627.18	2770.63

Source: Company Annual Reports, 1993-94, 1994-95, and 1995-96.

Exhibit 3: Inventories as on March 31

(Rs lakh)

	1993	1994	1995	1996
Inventories				
Consumable stores	438.33	482.01	435.39	405.45
Loose tools	64.88	96.71	108.39	165.71
Stock-in-trade	8136.19	9605.88	10663.27	14682.53
Raw materials and bought components	2167.80	2401.59	3051.37	4836.98
Work in progress	3710.12	3907.37	3857.94	3937.41
Finished goods	3296.92	2258.27	3753.96	5908.14
TOTAL	8639.40	10184.60	11207.05	15253.69

Source: Company Annual Reports, 1993-94, 1994-95, and 1995-96.

Exhibit 4: Operating and Other Expenses

(Rs Lakhs)

Operating and Other Expenses	1992–93	1993–94	1994–95	1995–96
Raw materials and components consumed	7574.62	8960.65	11580.74	14900.25
Stores and spare parts consumed	1445.95	1563.73	703.29	1010.34
Purchase of finished goods	47.69	145.84	198.48	361.93
Payments to and provisions to employees	1283.71	1788.64	2262.06	3219.83
Other expenses	4003.76	4940.29	5907.29	7709.40
Auditor's remuneration	4.42	6.88	8.40	10.24
Director's fees	0.26	0.17	0.30	0.31
Decrease/(Increase) in work in progress and finished goods	138387.66	16170.30	20252.95	24978.65
Less: Expenses capitalized	238.66	186.16	224.47	153.6

Source: Company Annual Reports 1993-94, 1994-95, and 1995-96.

Exhibit 5: Rangewise Secondary Sales

(000)

Cluster	1993–94	1994–95	1995–96
Type: Gents			
Classique	197.18	209.73	–6.00
Exacta	215.11	279.22	–23.00
Royale	181.29	179.48	1.00
Regalia	27.40	16.34	68.00
Others	27.09	26.79	1.00
Total: Gents	648.07	711.56	–9.00
Type: Ladies			
Classique	120.88	167.32	–28.00
Exacta	80.26	101.45	–21.00
Royale	92.14	85.37	8.00
Regalia	4.92	2.21	123.00
Others	7.16	9.25	–23.00
Total: Ladies	305.36	365.6	–16.00
Type: Others			
Pair	1.55	0.48	223.00
Grand Total	954.98	1077.64	–11.00

Exhibit 6: Regionwise Secondary Sales

(000)

Region	Channel	Ytd Aug 96	Ytd Aug 95	% Growth	Target 96-97	Annualized Sales/000
SOUTH	Showrooms	113.40	115.87	-2.13	313.17	
	Titan Shops	42.00	43.11	-2.57	112.03	
	Multibrand	202.65	225.38	-10.09	554.06	
	TOTAL	358.04	384.36	-6.85	979.26	14.48
WEST	Showrooms	64.89	64.38	0.79	210.91	
	Titan Shops	29.52	34.97	-15.58	100.27	
	Multibrand	122.80	130.62	-5.99	364.00	
	TOTAL	217.21	229.98	-5.55	675.18	8.70
NORTH	Showrooms	28.47	32.37	-12.05	101.64	
	Titan Shops	30.52	35.14	-13.15	108.62	
	Multibrand	147.23	183.46	-19.75	516.99	
	TOTAL	206.22	250.97	-17.83	727.55	8.65
EAST	Showrooms	26.44	28.64	-7.68	75.41	
	Titan Shops	11.71	12.90	-9.22	34.13	
	Multibrand	135.61	170.76	-20.58	394.13	
	TOTAL	173.76	212.3	-18.15	503.67	10.80
Total	Showrooms	233.20	241.26	-3.34	701.13	
	Titan Shops	113.75	126.12	-9.81	355.05	
	Multibrand	608.29	710.22	-14.35	1829.18	
	Grand Total	955.23	1077.61	-11.36	2885.66	

Exhibit 7: Channel's Contribution to Total Sales Volume (Ytd-Aug 96)

Channel	Sales Volume	% to Total	Avg UCP	Relative to Total (%)	Value (%) to Total
RDS	344463	36.3	1099	92.1	33.4
Institutional	159914	16.8	1055	88.4	14.9
Franchisee	156497	16.5	1469	123.1	20.3
Traditional	95184	10.0	1181	99.0	9.9
Titan Shop	72498	7.6	1328	111.3	8.5
CSD	56623	6.0	976	81.8	4.9
Non-Traditional	32499	3.4	1307	109.6	3.7
Showrooms	17222	1.8	1605	134.5	2.4
Others	14732	1.6	1490	124.9	2.0
Grand Total	949632	100.0	1193	100.0	100.0

UCP– Uniform Consumer Price in Rs

Exhibit 8: CFA Wise Primary Sales - 1996-97

(numbers)

CFA	Apr	May	Jun	Jul	Aug	Sep	Total
Bangalore	6851	25255	15662	17974	18042	28049	111833
Madras	4216	11563	12828	12603	14159	20297	75666
Hyderabad	5568	8028	7156	6245	10144	19723	56864
Coimbatore	1325	6572	6033	6328	7424	14910	42592
Madurai	476	4019	5344	5002	9068	12439	36348
Vijaywada	3117	7760	2559	3950	6685	9439	33510
Cochin	1186	4264	4095	4100	10545	7326	31516
Vizag	2059	4204	1857	2002	3550	6027	19699
Hubli	1649	3027	2063	1905	4113	5905	18662
Trichy	51	1601	2614	3015	4628	6646	18555
Calicut	446	1511	2320	1526	3765	3490	13058
Goa	513	991	1261	940	1852	3628	9185
Staff	300	472	511	250	498	0	2031
Region South	**27757**	**79267**	**64303**	**65840**	**94473**	**137879**	**469519**
Bombay	4947	10712	14011	17613	19205		66488
Ahmedabad	1001	2812	2862	5300	6620		18595
Pune	591	1616	3624	4865	5564		16260
Thane	118	1524	2244	3522	5779		13187
Aurangabad	241	849	1861	2501	2548		8000
Rajkot	251	1048	1300	2323	3007		7929
Bhopal	472	1675	550	2003	2800		7500
Nagpur	604	1578	1023	1553	1872		6630
Indore	286	950	1263	1355	1416		5270
Raipur	288	806	704	1216	1436		4450
Region West	**8799**	**23570**	**29442**	**42251**	**50247**		**154309**
Delhi	9412	13245	16908	15256	19421		74242
Varanasi	1589	6906	1000	3001	3014		15510
Lucknow	600	3843	2164	3234	4690		14531
Ludhiana	147	1487	704	5125	6848		14311
Meerut	472	1051	1969	2024	5204		10720
Jaipur	778	2042	1554	2114	3089		9577
Ambala	78	1790	1720	745	3124		7457
Jodhpur	464	1000	1772	2004	2200		7440
Chandigarh	122	265	805	1496	1374		4062
Jammu	182	561	701	940	762		3146
Region North	**13844**	**32190**	**29297**	**35939**	**49726**		**160996**
Calcutta	4313	9593	9887	16125	14830		54748
Patna	9300	17758	6367	6243	5084		44752
Jamshedpur	1697	5655	3601	3213	3048		17214

(Continued)

(Continued)

CFA	Apr	May	Jun	Jul	Aug	Sep	Total
Bhubaneshwar	1296	4066	3943	3941	3291		16537
Guwahati	1319	1681	2411	3438	3521		12370
Siliguri	241	2504	2154	2566	2341		9806
Region East	**18166**	**41257**	**28363**	**35526**	**32115**		**155427**
Region Total	**68566**	**176284**	**151405**	**179556**	**226561**		**940251**
CSD	**9938**	**8100**	**5994**	**14168**	**17427**		**55627**
Godrej	**0**	**87960**	**0**	**0**	**0**		**87960**
Domestic	**78504**	**272344**	**157399**	**193724**	**243988**		**945959**
Export	**10576**	**35827**	**34622**	**59797**	**43130**		**183952**
Grand Total	**89080**	**308171**	**192021**	**253521**	**287118**		**1129911**

Exhibit 9: Stock Transfer Issued Out Monthwise: Region South - 1996-97

(numbers)

CFA	Apr	May	Jun	Jul	Aug	Sep	Total
Bangalore	1273	4027	3165	2961	4099	3883	19408
Madras	929	2383	4025	3704	3922	2339	17302
Coimbatore	12	3144	2231	598	2022	639	8646
Hyderabad	0	959	349	1825	1310	327	4770
Cochin	0	270	74	40	439	1582	2405
Trichy	7	33	180	496	694	457	1867
Vijaywada	11	106	11	987	350	158	1623
Hubli	6	33	239	660	117	95	1150
Madurai	0	334	30	39	549	130	1082
Calicut	0	166	60	111	120	373	830
Goa	0	0	330	235	195	23	783
Vizag	0	114	15	148	29	0	306
Total	2238	11569	10709	11804	13846	10006	60172

Exhibit 10: Dial Categories for the Year 1995-96 and 1996-97

Type	Cluster	Case	Dial	Category	
				1995-96	1996-97
Ladies	EXACTA	103	D39	B	B
	EXACTA	103	D40	A	C
	EXACTA	103	F25	A	A
	EXACTA	103	F26	B	A
	EXACTA	103	Z147	C	
	EXACTA	107	A27	C	A
	EXACTA	107	A28	C	B
	EXACTA	107	A29	C	B
	CLASSIQUE	109	A33	B	B
	CLASSIQUE	109	C62	B	C
	CLASSIQUE	109	F28	A	C
	CLASSIQUE	109	F29	B	B
	CLASSIQUE	109	N96	B	B
	CLASSIQUE	109	N97	B	B
	CLASSIQUE	111	A37	B	C
	CLASSIQUE	111	D44	B	B
	CLASSIQUE	111	H58	A	B
	CLASSIQUE	111	L44	C	C
	CLASSIQUE	111	Z135	C	
	CLASSIQUE	111	Z171	C	
	CLASSIQUE	111	Z192		C
	CLASSIQUE	113	C60	A	B
	CLASSIQUE	113	K80	B	A
	CLASSIQUE	113	M90	B	A
	CLASSIQUE	113	N99	B	C
	CLASSIQUE	113	T218	C	
	CLASSIQUE	113	Z178	C	
	CLASSIQUE	113	Z197		C
	CLASSIQUE	113	Z198		C
	CLASSIQUE	117	A52	C	B
	CLASSIQUE	117	L46	C	C
	CLASSIQUE	117	L47	C	C
	CLASSIQUE	122	A71	A	A
	CLASSIQUE	122	A71R	C	
	CLASSIQUE	122	A72	B	A
	CLASSIQUE	122	D48	B	A
	CLASSIQUE	122	D48R	C	
Gents	EXACTA	122	L41	B	B
	EXACTA	138	B24	B	B

(Continued)

(Continued)

Type	Cluster	Case	Dial	Category 1995-96	Category 1996-97
	EXACTA	138	B25	B	B
	EXACTA	138	D11	B	B
	EXACTA	139	B26	A	A
	EXACTA	139	B27	A	A
	EXACTA	139	B88	A	A
	EXACTA	139	D12	B	A
	EXACTA	139	L81	C	C
	EXACTA	140	B29	A	A
	EXACTA	140	C65	A	B
	ROYALE	140	E26	A	A
	ROYALE	140	T510	C	
	ROYALE	140	T511	C	
	CLASSIQUE	140	T512	C	
	CLASSIQUE	141	B30	A	C
	CLASSIQUE	141	C43	A	A
	CLASSIQUE	141	K56	B	A
	CLASSIQUE	141	K57	B	B
	CLASSIQUE	141	K58	B	C
	CLASSIQUE	141	R50	C	
	CLASSIQUE	141	R51	C	
	CLASSIQUE	142	B33	A	A
	CLASSIQUE	142	C44	A	B
	CLASSIQUE	142	F81	A	A
	CLASSIQUE	142	K81	A	C
	CLASSIQUE	142	K82	B	B
	CLASSIQUE	142	R52	C	
	CLASSIQUE	142	T337		C
	CLASSIQUE	142	Z136	C	
	CLASSIQUE	142	Z138	C	
	CLASSIQUE	142	Z165	C	
	CLASSIQUE	142	Z172	C	
	CLASSIQUE	142	Z175	C	C
	CLASSIQUE	142	Z184	C	
	CLASSIQUE	143	B36	A	B
	CLASSIQUE	143	B37	B	A
	CLASSIQUE	143	D19	A	B
	CLASSIQUE	143	G26	A	A
	CLASSIQUE	143	G27	A	A
	CLASSIQUE	149	B49	A	A
	CLASSIQUE	149	C61	A	B
	CLASSIQUE	149	C61A		C

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Type	Cluster	Case	Dial	Category 1995-96	Category 1996-97
	CLASSIQUE	149	D21	A	A
	CLASSIQUE	149	G29	A	A
	CLASSIQUE	149	G29A		C
	CLASSIQUE	149	K63	A	A
	CLASSIQUE	149	K64	A	A
	CLASSIQUE	149	Z160	C	C
	CLASSIQUE	149	Z180	B	
	CLASSIQUE	149	Z187		C
	CLASSIQUE	149YL	Z216		A
	CLASSIQUE	153	B92	B	B
	CLASSIQUE	153	K90	C	C
	CLASSIQUE	153	P19	C	C
	CLASSIQUE	153	P20	C	B
	CLASSIQUE	155	C47	B	B
	CLASSIQUE	155	D33	A	B
	CLASSIQUE	155	E80	A	A
	CLASSIQUE	155	L11	A	B
	ROYALE	161	B73	A	A
	ROYALE	161	C17	A	A
	ROYALE	161	D35	A	A
	ROYALE	161	P42	B	A
	ROYALE	161	P43	C	A
	ROYALE	162	B74	A	A
	ROYALE	162	C49	A	A
	ROYALE	162	J20	A	A
	ROYALE	162	J22	A	A
	ROYALE	162	R57	C	
	CLASSIQUE	166	C12	B	B
	CLASSIQUE	166	K65	A	A
	CLASSIQUE	166	K67	A	B
Ladies	ROYALE	172	J85	C	B
	ROYALE	172	J86	C	B
	ROYALE	172	J87	C	B
	ROYALE	176	C52	B	B
	ROYALE	176	C53	A	A
	ROYALE	176	C54	B	B
	ROYALE	176	J53	A	A
	CLASSIQUE	177	D49	A	B
	CLASSIQUE	177	E35	A	A
	CLASSIQUE	177	F33	A	B
	CLASSIQUE	177	P21	C	B
	CLASSIQUE	177	P22	B	A

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Type	Cluster	Case	Dial	Category 1995–96	Category 1996–97
	CLASSIQUE	177	Z181	C	
Gents	CLASSIQUE	179	D23	A	A
	CLASSIQUE	179	E86	A	B
	CLASSIQUE	179	P23	B	A
	CLASSIQUE	179	P24	B	B
	EXACTA	180	D54	A	A
	EXACTA	180	D57	A	A
	EXACTA	180	G22	A	A
	EXACTA	180	G23	A	A
	EXACTA	180	H83	A	A
	EXACTA	180	H84	A	A
	EXACTA	180	H85	A	A
	EXACTA	180	L77	A	A
	EXACTA	180	L78	A	A
	EXACTA	180	L79	A	B
	EXACTA	180	Z124	C	
	EXACTA	180	Z141	C	
	EXACTA	180	Z164	C	

Exhibit 11a: Month Wise Primary Sales - Case - 141 (Gents Classique)

(numbers)

1995–96	Apr	May	Jun	Jul	Aug	Sep	Total
B30	53	1231	467	297	490	1181	3719
B31	121	385	37	174	590	802	2109
C43	197	758	610	428	580	1574	4147
D17	49	97	42	54	51	114	407
D67A	0	0	0	0	0	0	0
D68A	0	0	0	0	0	0	0
D69A	0	0	0	0	0	0	0
D70A	0	0	0	0	0	0	0
E68	107	637	225	176	426	675	2246
E69	0	0	1	0	0	0	1
E70	0	3	3	0	0	0	6
F94	0	3	1	0	0	0	4
F95	76	120	66	93	60	114	529
G24	11	48	12	11	27	40	149
G25	10	63	44	16	20	20	173
K56	24	415	764	241	356	1006	2806
K57	179	620	103	95	520	800	2317
K58	167	896	280	234	903	940	3420
K61	12	80	28	16	-2	27	161
K75	14	35	16	16	24	21	126
P12	4	13	24	-2	-19	11	31
P13	9	23	11	4	-12	38	73
P14	1	9	1	1	6	1	19
Q33	0	0	0	0	0	0	0
R50	0	0	0	0	0	0	0
R51	0	0	0	0	0	0	0
Total	1034	5436	2735	1854	4020	7364	22443
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Total**
B30	395	685	356	530	752	1243	3961
B31	167	92	637	354	316	687	2253
C43	683	740	465	661	743	1797	5089
D17	41	49	24	5	23	42	184
D67A	0	765	351	114	90	93	1413
D68A	0	148	169	29	209	296	851
D69A	0	824	298	93	64	95	1374
D70A	0	938	109	30	14	24	1115
E68	297	224	131	243	127	237	1259
E69	0	3	2	1	0	3	9
E70	0	0	0	0	0	0	0

(Continued)

(Continued)

1995–96	Apr	May	Jun	Jul	Aug	Sep	Total
F94	0	0	–1	1	–1	0	–1
F95	92	54	19	75	51	14	305
G24	29	7	3	14	9	7	69
G25	9	13	–4	19	6	11	54
K56	238	269	138	288	362	388	1683
K57	530	641	313	440	407	1283	3614
K58	580	588	535	822	670	444	3639
K61	45	24	6	9	9	14	107
K75	8	14	10	6	9	6	53
P12	40	8	10	23	5	4	90
P13	31	11	9	28	6	25	110
P14	4	4	–1	2	3	1	13
Q33	0	0	0	0	0	100	100
R50	0	0	0	0	0	465	465
R51	0	0	0	0	0	139	139
Total	3189	6101	3579	3787	3874	7418	27948

Exhibit 11b: Monthwise Primary Sales - Case - 141 (Gents Classique)

1996–97	Apr	May	Jun	Jul	Aug	Sep	Total	Oct
B30	98	278	215	275	157	473	1496	205
B31	46	193	84	52	35	21	431	12
C43	108	323	209	233	665	2406	3944	784
D17	3	2	0	5	7	78	95	37
D67A	15	25	32	35	41	264	412	58
D68A	24	25	11	22	37	171	290	41
D69A	16	16	20	20	10	111	193	22
D70A	9	3	5	3	4	13	37	3
E68	32	131	56	75	55	231	580	44
E69							0	
E70	0	0	0	1	1	0	2	0
F94							0	
F95	2	3	12	6	8	23	54	33
G24	2	3	0	1	1	4	11	0
G25	5	18	8	5	9	5	50	3
K56	126	306	209	221	515	1597	2974	677
K57	174	348	361	225	378	1592	3078	271
K58	67	437	281	189	71	57	1102	487
K61	4	6	2	–1	2	3	16	0
K75	1	3	1	1	3	3	12	0
P12	3	14	3	–3	6	0	23	2
P13	13	11	4	4	15	89	136	57
P14	1	1	–2	1	0	2	3	0
Q33	10	0	0	0	0	0	10	0
R50	229	385	208	248	325	133	1528	357
R51	187	282	138	56	81	131	875	42

Exhibit 12: Inventory Vs Consumption

(Quantity: 000; Value: Rs. lakh)

Head		Cases	Dials	M Straps	L Straps	M Glass
Stock as on 1-9-96	Qty	219	1125	441	401	230
	Value	360	540	246	196	30
Non Moving & Obsolete	Qty	9	281	70	70	35
	Value	15	135	39	34	7
Net Usable	Qty	210	844	371	331	195
	Value	345	405	207	162	23
Consumption in Sep'96	Qty	77	190	123	77	155
	%	37	23	33	23	79
Consumption in Oct'96	Qty	55	120	102	43	15
	%	26	14	27	13	8
Consumption in Nov'96	Qty	13	45	51	28	5
	%	6	5	14	8	3
Not usable in next 3 mth	Qty	65	489	95	183	20
	%	31	58	26	55	10

Exhibit 13: Total and Obsolete Inventory Break-up

(Quantity: 000; Value: Rs. lakh)

Item	As on 31.03.96		As on 30.06.96		As on 31.07.96	
	Quantity	Value	Quantity	Value	Quantity	Value
Total Inventory Break-up - Appearance Parts						
Cases	150	253	178	267	233	357
Dials	1249	522	1259	554	1322	631
Hands	988	141	1647	197	1562	197
Straps - M	561	455	469	325	451	322
Straps - L	296	130	508	246	431	222
Total		1501		1589		1729
Total Inventory Break-up – Others						
Case Component		112		95		87
Euro Comp		96		110		130
Preplated Parts		138		138		138
Movts+Comp		388		308		288
Raw Mat		372		274		411
Cons+Tools		223		212		209
Gold		58		43		73
Maint Spares		191		271		281
Packaging & Others		66		77		89
Others Total		1644		1529		1706
Grand Total		3145		3117		3435
Obsolete Inventory Break-up – Appearance Parts						
Cases	20	39		39		39
Dials	347	157		157		157
Hands	347	57		57		57
Straps - M	147	82		82		58
Straps - L	64	21		21		21
Total		356		356		332
Obsolete Inventory Break-up–Others						
Case Component		15		15		15
Euro Comp		11		11		11
Preplated Parts		138		138		138
Movts+Comp		19		19		19
Raw Mat		12		12		12
Cons+Tools		48		48		45
Gold						
Maint Spares						
Packaging & Others		9		9		9
Others Total		252		252		249
Grand Total		608		608		581

Exhibit 14: Sourcing Plan for 1996-97

Cases	Qty (000)	Rs lakh
Centura – Tumkur	508.5	302.37
Cosmos - Bidar	657.0	1155.83
Growel - Pune	299.5	561.22
Hitech - Bangalore	559.0	335.94
Sree Laxmi - Tumkur	128.0	90.59
Saha – Tumkur	26.0	15.74
TOTAL INDG	**2178.0**	**2461.68**
Dailywin - Hongkong	149.3	493.18
Kamyuen - Hongkong	191.5	712.16
K&S - Hongkong	17.0	83.45
TOTAL IMP	**357.8**	**1288.8**
TOTAL CASES	**2535.8**	**3750.48**
Dials		
KDDL - Bangalore	1818	502
KDDL - Parwanoo	1779	545
KAWAGUCHIKO - Japan & Taiwan	276	137
YICHANG - Taiwan	370	266
TAIWAN SHOKO - Taiwan	203	277
TOTAL	**4446**	**1727**
Hands		
MU Ltd - Hongkong (Mfg at Japan)	2383	254.89
Universo - Switzerland	2088	337.00
TOTAL	**4471**	**591.89**

Exhibit 15: Purchase Department

Objectives

- To provide uninterrupted supplies of materials for production requirement
- To keep the costs of inputs under control
- To help vendors in ensuring quality of material supplied by them

Activities

- Identification, Selection and Approval of Vendors to meet TIL's product requirement
- Releasing of orders to meet MPR requirements
- Follow up with suppliers for supplies
- Monitoring supplier's performance
- Assisting suppliers in Technical and Financial requirements
- Wherever required coordinating with planning, stores, QC, Assembly and Finance for receipt, inspection and payment to the suppliers
- Involving in make or buy decisions of cases
- Developing new variants of existing items procured
- Liaisoning with government agencies to obtain statutory licenses and approvals
- Indigenisation

Ordering Procedures

- MPR from concerned department with drawing
- Checked for all relevant details
- QTN obtained/comparative QTNs/repeat order price
- Proposal to section head/department head
- Approval obtained to place PO
- PO number booked in register
- Order released
- Order sent for approval/signature
- Order copies made to relevant departments
- PO to supplier
- Suppliers acknowledgement & acceptance obtained
- Order copy and acceptance letter filled

Other Procedures

1. Supplier Selection:
    - Based on product range available
    - Based on infrastructure, capacity available
    - Based on financial capability
    - Based Titan's visit to suppliers' work and impressions formed from this
    - Based on past records of supply to other parties, if any
    - Based on commitments received for delivery
    - Based on quality evaluation of samples

2. Price Fixation:
   - Products specs. identified
   - Quotation taken
   - Comparative quotations
   - Negotiation
   - Price fixation based on lowest quote subject to quality requirements being met
3. Vendor Rating:
   - Done based on department procedures
   - Analysis of vendor rating
   - Sent to supplier
   - Discussed in detail with supplier
   - Improved rating obtained based on discussions

Exhibit 16: Sales Forecast: Case - 141 Gents Classique

(numbers)

	Apr-Jun 96	Apr-Jun 96	Jul-Sept 96	Jul-Sept 96	Oct-Dec 96
	I - QTR	Revised	II - QTR	Revised	III - QTR
Dial					
B30	0	0	800	800	1550
B31	0	0	300	300	0
C43	0	0	800	800	1700
E68	0	0	0	0	0
K56	750	750	1000	1000	1500
K57	1000	1000	1000	1000	1500
K58	750	750	0	0	1500
R50	1500	1500	1200	1200	0
R51	1500	1500	1200	1200	0
T856	0	0	0	0	2500

Exhibit 17: Production Plan: Case - 141 Gents Classique

(numbers)

Dial	Oct-96	Nov-96	Dec-96
B30	100	0	700
B31	200	0	0
C43	600	0	100
K56	0	0	200
K57	0	200	300
K58	1100	0	300
R50	0	0	500
R51	1500	0	0
T856	0	0	500

Exhibit 18: Production Scheduling of Selected Movement Components

(numbers)

Component Description	Target for The Year 1996–97	Target for Oct Schedule on a given Day – Oct	Production	Target for Nov	Production Schedule on a given Day – Nov
Bridle Screw (FE42)	5326500	484000	15710	465000	
Elec Mod Screw (FE40)	1861500	290000	21000	278000	
Yoke Spring Screw (FE43)	1339500	140000		146000	
Hand Setting Train Cover Screw	2050500				
Stop Lever Screw (FE44)	1866000				
Minute Wheel Gaurd Screw-T90	277500				
Dial Screw (FE5)	1624500	345000		331000	
ECB Screw-T9092	304500				
Yoke Screw-T9092	226500	60000	11065	50000	
Dial Screw-T9092	333000				
Train Wheel Bridge Screw (FE4)	2094000	289000		278000	
Electronic Module Screw (FE34)	5517000	864000	41920	830000	21535
Setting Lever Jumper Screw (FE3)	6300000	1033000	18930	993000	18500
Hand Setting Train Cover Foot	11430000	1706000	71880	1640000	60965
Yoke Spring Stud 6000	2269500			470000	
Train Wheel Bridge Support Stud	150000				
Train Wheel Bridge Foot	3394500	148000			
Date Corrector Stud	12118500	1690000	38300	1140000	16120
Intermediate Date Wheel Stud	3357000	700000	39230	815000	

Exhibit 19: Watch Out For More Growth

Xerxes Desai, the 58-year-old Oxford educated Philosophy student of Karl Popper, is a man busy shuttling between nations. In an exclusive interview with *Business Barons,* Shobha Ramaswamy, the Vice-Chairman and Managing Director of Titan industries reveals his ambitious plans to make Titan a world brand.

- What opportunities attracted you to enter the personal accessories industry with Titan watches?

  Desai: The existence of a large and growing market which was imperfectly supplied and needed technical, managerial, marketing and financial inputs which the Tatas were well equipped to provide.

- What strategies did Titan formulate to ward off competition? Do you perceive threat from other companies, especially in the premium market?

  Desai: Titan will use every weapon available in the armoury of a successful marketer to confront competition, including product publicity, PR, sponsorships, sub-branding, expanding and upgrading the company's owned and franchised retail chains and working closely with the trade. We will have no qualms about using our market clout and will always maintain an aggressive posture. The globalisation of Titan and making it an international brand name will also benefit Titan in India. We believe that the least threat comes from European brands and the greatest threat from Asian brands.

- What are Titan's strengths and weaknesses?

  Desai: Titan's greatest strengths are its manufacturing, marketing and distribution resources, the powerful brand name that has been built, the vast amount of goodwill it enjoys with the trade, with media and with the general public, the fact that it is increasingly a global brand and, of course, the fact that it is a member of the Titan group.

  Titan's major weakness derives from its success and the huge expectations which people have of it: consequently, it is an organisation in a hurry, seeking, very rapidly, to expand, move upmarket, enter new markets and diversify its portfolio. This places significant stress on our people, our finances and, sometimes, our bottomline.

- What is Titan's marketing credo?

  Desai: To provide value for money, at many price segments, to a diverse public and be held in high regard for the products and services which we provide to our customers – both in India and globally.

- What are Titan's global plans?

  Desai: Titan plans to be a significant, trusted and respected global brand in the $ 70 to $700 price segment. We will be a generalised brand, selling a fairly wide spectrum of products with a heavy emphasis on innovation, contemporaries, styling, quality and value for money.

✧ Titan Industries net profit margins are under pressure. Have you over invested in Europe?

Desai: In fact, the profit before tax was marginally higher than in the corresponding period the previous year. The profit after tax was marginally down because of the introduction of MAT. But for MAT, Titan would not have any tax liability this year. At the same time, it is current to say that profits are under pressure this year not only because of the economic downturn resulting in a cut back in consumer spending but also because of the combined impact of the start-up phase of several projects, the simultaneous entry by Titans into new markets, high interest rates and significant dependence on short-term borrowed funds. Expansion, diversification and entry into new markets were planned strategies and they were expected to have an impact in profit in 1996-97. I believe we should think as industrialists and brandbuilders and take a longer-term view of the future.

A Global Player

Bhaskar Batt, Vice- President, Sales and Marketing, Titan Industries, on Titan's Global Strategy:

Over the years, the Titan brand itself has become one of our strengths. All elements of marketing have helped make it a premium brand. Our people, excellent pricing, the Tata culture, and a willingness to innovate are our other strengths.

The watch market was predominantly mechanical when we entered and quartz watches were smuggled into the country. We were able to convince the consumer that looks are mattered, while durability and reliability were inherent. Today Titan and Timex together have 70 per cent of the organised marketshare for watches in India.

Our international thrust began with West Asia: the UAE, Bahrain, Oman. We were able to establish volumes using the product ranges we were selling in India. However, sensing opportunities in Europe a few years ago, we decided to enter the European market. We now had to design a whole new collection of watches for Europe using their designers and set up separate manufacturing facilities to make those kinds of watches which are complicated in design.

Our marketing office in Europe contributes 10 per cent to our turnover from export sales. We are now poised to enter the American market. The reception has been extremely good. In West Asia initially, we were bought by expat Indians but increasing Arabs are buying our watches. We have become a brand to reckon with. In Europe, we have a unique positioning – a New World watch. We have been received very well.

The upper-end of the market is still very underdeveloped and awareness of the brand name is limited. What we offer in solid gold will be offered by others in non-precious metal. Moreover, their prices are extraordinarily high. We do not perceive them as competition as we are in different league altogether. Titan's strengths are its ability to design beautiful products, an understanding of the Indian market and the ability to retail and build a brand image. We will bring to the business professionalism and ethics.

Source: *Business Barons,* Vol.1, No.7, December 31, 1996.

QUESTIONS FOR DISCUSSION

1. What are the environmental issues (regulatory and competitive) that are affecting Titan's business?
2. What are the specific supply chain management issues that the Senior Vice President, Marketing, is concerned with?
3. What is the impact of the product variety, batch sizes and sourcing on the inventory held in the supply chain and can this be reduced?

APPROACH FOR ANALYSIS

The analysis for this case needs to view Supply Chain Management as a strategic area, which Titan can leverage to be a responsive player in the watch industry. The implications of various choices, keeping in view the positioning that Titan has built for itself, need to be examined.

Once the right questions in terms of linking Supply Chain Management with the strategic concerns are posed, the data in the case can help diagnoses of the same. For example, where dials are concerned, the sourcing and ordering policy can be questioned. Stocks as of a given month are over 25% obsolete, and after a further three months, 58% have been classified as 'not usable in the next three months'.

Diagnostics can be on different dimensions: geographic - for sales, channel-wise, product/component category wise and geographic—for sourcing

Case 6

CASE CONTEXT

This case looks at how to develop a marketing strategy for CONCOR, for transporting tea from gardens to the processing plants as containerized cargo by rail. The worldwide trend in product movement is towards containerization, but only 1% of domestic cargo movement in India is containerised. Tea is very well suited to containerization, in principle, but very little containerization actually takes place, particularly in the domestic segment in India.

The case identifies the reasons behind the preference of tea transporters for road over railways and the constraints faced by the railways and CONCOR. It also explores possible options that would help stem the shift of tea movement from the railways to road transport. The focus is on developing a logistics strategy that would attract tea transporters to containerization. Issues such as pricing, value added services like scheduling, tracking of consignments, insurance, etc are important.

CONCOR: TEA TRANSPORTATION

Early one morning in August 2000, Mr. Rambhai, Head of the Eastern Region of Container Corporation of India (CONCOR), was concerned as he ran through the figures of CONCOR's performance for 1998-99, on his excel sheet yet again. There had been signals from top management that the eastern region, more specifically the northeast, ought to do better. That year, the eastern region had contributed 6 per cent of total CONCOR throughput, with the northeast (Amingaon) contributing less than half per cent. Almost the entire outward movement from Amingaon consisted of tea for export. The domestic segment, however, registered much lesser volume and growth, with road transport competing and taking the lion's share. The figures for 1999-2000 were expected to be no different.

Prepared by G Raghuram, and Anusha Dhasarathy, Preeti Monippally, Rohit Phatak, Malavika Pillaim and Rohithari Ranjan. Research assistance provided by Premlata Agarwal is acknowledged. Case of the Indian Institute of Management, Ahmedabad, is prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems.

Mr Rambhai was now contemplating how to develop the domestic market and curtail the shift from rail to road transport. He knew that there was an unexploited opportunity in the domestic movement of tea from the gardens and auction centres in the northeast to various consumption centres, especially those in western India. (Western India had a high per capita consumption of tea.) He wanted to develop a comprehensive strategy to target the domestic tea market and exploit its true potential.

CONCOR

CONCOR was set up in 1987 under the Ministry of Railways. Its main objective was to promote containerization and boost India's international and domestic trade. It was currently the only provider of containerized freight transportation by rail. CONCOR's core business was divided into three main activities: containerized transport, terminal operations, and container freight station operations. Exhibit 1 gives a brief profile of CONCOR. Table 1 of Exhibit 1 gives the infrastructure of CONCOR.

The two basic customer segments it catered to, were export/import traffic and the domestic segment. Export/import container traffic of CONCOR was 5.8 lakh TEUs (twenty-foot equivalent units) in 1998-99, and constituted 30 per cent of the total export/import traffic of 19.2 lakh TEUs handled at the ports (Table 2, Exhibit 1). The CONCOR traffic was more than the ICD (inland container depot) movement of 3.3 lakh TEUs, indicating that CONCOR itself handled about 2.5 lakh TEUs at other than ICDs. CONCOR had been focusing on export/import traffic and consequently the share of domestic traffic out of the total traffic had declined from 41 per cent in 1995-96 to 27 per cent in 1999-2000 (Table 3, Exhibit 1). In absolute terms, however, the domestic traffic had remained steady. CONCOR was growing at an impressive rate of 20 per cent per annum since its inception, achieving a throughput of 9.3 lakh TEUs in 1999-2000. However, although CONCOR itself was doing well, the overall cargo movement split between rail and road traffic had shifted from 80:20 in 1950-51 to 40:60 in 1998-99. The ratio was expected to be closer to 35:65 by 1999-2000, out of approximately 800 billion-ton km of freight traffic. Substantial quantities of high value, small volume traffic that typically needed to be consolidated for movement by rail were being moved by road.

The income of CONCOR for 1999-2000 was Rs. 831.42 crore, registering a growth rate of 21.41 per cent over the previous year. Exhibit 2 gives the profit and loss account of CONCOR for the years 1999-2000, 1998-99 and 1997-98.

As mentioned earlier, and as seen in Exhibit 3, the eastern region's traffic contribution to CONCOR's total was six per cent during 1998-99. Within this, Amingaon, which was the only ICD in the northeast, contributed less than half per cent of CONCOR's total. About 2,400 TEUs were brought in empty, to be loaded with tea for exports. (80 per cent of the containerised tea exports were through one company, with four others accounting for the rest). On the domestic front, just 50 loaded containers had moved out and less than 200 containers had come in with cargo.

Exhibit 4 gives a map of eastern India, with key locations of CONCOR and the tea industry.

Potential for Domestic Movement of Tea

A description of the domestic tea market is given in the Appendix. Production in 1998 was 870 million kg, out of which 660 million kg were consumed in the domestic tea market and 210 million kg were exported.

Mr. Rambhai felt that the railways were well suited for tea transportation within the country on two counts: distance and damages. The main routes of the domestic movement of tea were from Assam and Kolkata to Maharashtra and Gujarat, and to a lesser extent to Madhya Pradesh and Rajasthan. (Exhibit 5 gives the state-wise share of consumption of tea. Maharashtra and Gujarat accounted for over 24 per cent of tea consumption. Gujarat, with a population of nearly six crores, consumed nearly 70 million kg). Thus, a particular consignment might have to cover a distance of more than 2,500 km, for which rail could be economical. Moreover, tea consignments were often moved during the monsoon. Tea was adversely affected by water. In open top trucks, even with tarpaulin covers, it was difficult to protect the consignment from water seepage during the monsoon season.

The Indian Container Leasing Company (ICLC), a subsidiary of the public sector Balmer Lawrie & Co and by far the country's biggest container leasing company, had identified tea as the commodity most easily amenable to containerization for movement within the country. ICLC had identified certain routes, including Guwahati-Kolkata, Kolkata-Ahmedabad, and Kolkata-Delhi, on which large quantities of tea moved in open top trucks.

The real advantages of rail-based containerised movement would be protection from damage, wastage, and pilferage and, perhaps the most important, ease of handling. Complaints of pilferage from sealed containers transported by trucks were quite common. Since the later part of the nineteenth century, when the railways in the northeast were built primarily to source the tea, transportation of tea by rail had grown both for exports and domestic movement until the 70s. However, with better road access to the northeast, the advantages of rail were offset by delays in delivery, extra cost of handling at multiple locations, and losses owing to pilferage, especially in the non-containerized wagon mode. Containerization could only hold on to some of the export traffic, and currently accounted for about 12 to 15 per cent of tea exports from the northeast. Over the years, the domestic tea movement out of the northeast had shifted almost entirely to road.

Channels for Sale and Marketing of Tea

The primary channels for sales and marketing of tea were auctions or garden sales. The recent trend had been an increase in garden sales (Exhibit 6). In the recent past, the proportion of garden sales had been increasing, from a low of 23 per cent in 1985 to 49 per cent in 1998. Most of the exported tea, however, was bought off the auctions. While traditionally the Kolkata auction had catered to the export market, the significance of the Guwahati auction was increasing. The shipper received instructions from the buyer as to the mode of transport, specific shipping line, etc. The primary source of tea which was containerized from Amingaon was either direct garden-based exports or export tea sourced from the Guwahati auction.

Exhibit 7 gives state-wise tea production in the past decade. Tea production in the northeast (Assam and West Bengal) accounted for 77 per cent of total production of 870 million kg in 1998. Out of the production in the northeast (670 million kg), about 50 per cent were direct sales from the gardens. The balance sales were accounted for by the Guwahati (45 per cent), Kolkata (30 per cent), and Siliguri (25 per cent) auctions. The share of the Kolkata auction was declining, while that of the Guwahati and Siliguri auctions was increasing. Exports were almost entirely through Kolkata and Haldia ports. Out of all the tea moved from this region, domestic movement accounted for 76 per cent of the total.

In the domestic market, a large number of intermediaries operated between the garden and the retailer. Hence, warehouses were required at each stage: origin, destination, and transportation nodes. This could translate into an opportunity for CONCOR if it could provide smooth and coordinated logistic services from the garden to the buyer's factory.

The reasons domestic buyers preferred trucks to the railways were as follows:

1. Service inflexibility: No less than container load was allowed. Pooling was not organised. The domestic segment did not have on-demand service.
2. Claims: There was very low leverage with the railways in case of damage or loss.
3. Large volumes: Often, volumes being moved were not large enough to justify a whole rake (a full train load).
4. Door to door service: This was offered by truckers.
5. Credit: Truckers offered three month credit, while CONCOR required buyers to pay in advance.

Exhibit 8 gives details of train services offered by CONCOR in the eastern region.

Operating Constraints

While Mr Rambhai was considering the various options available to him to increase domestic movement of tea by CONCOR, there were some operating constraints that he perceived.

The railways had little presence in most parts of the northeast. Capacity constraints on movement, both intra-regionally, and with the rest of the country, were a major problem of the region. Because of capacity constraints, the railways chose to concentrate on the movement of bulk materials for the core and priority sectors, namely power, steel, cement, oil, foodgrain, etc. thus losing its clientele in high value non-bulk sectors which often recorded higher growth rates. Actual demand for movement into the northeast was around 20 to 25 rakes a day. But the railways could move only 7 to 8 rakes a day.

Militancy was another problem. Road transporters would pay hafta, or protection money, which the railways or CONCOR (being government agencies) could not do.

Tariff

The tariff policy of the railways where passenger traffic was subsidised by freight meant a continual increase in freight rates which, in turn, was driving away even some of the long distance bulk traffic from the railways to road.

On the other hand, road transporters, being largely in the private sector, moved aggressively to occupy the space vacated by the railways. They were aided by a liberal permit and regulatory system for national trucking, cheap finance made available by the banking sector, and an energy pricing policy which subsidised diesel. (The railways paid an exceptionally high tariff for electricity consumption.)

The railways charged freight rates on a per TEU km basis from CONCOR to simplify the freight charging mechanism for the benefit of the customer as well as to avoid creating a large organisation and infrastructure (weighbridges, etc.) which would be necessary if the freight was on a per kg or per quintal basis. (Freight rates on TEU basis were calculated by considering the average weight being hauled for a particular commodity through the container wagon.) Exhibit 9 gives freight rates for movement of containers by CONCOR in the eastern region.

Tea, being a bulky but lightweight commodity, containers would typically be stuffed with about 6 to 7 tonnes of tea, as opposed to road transporters who could carry 9 to 10 tons. The cost of transportation per ton of tea was therefore higher when it was containerised. The CONCOR top brass said that freight charges for a round trip from Haldia to Amingaon and back would soon go up by about Rs. 1500 per TEU. The hike was necessary because CONCOR would be required to pay higher tariff to the railways. Currently, 90% of the TEU rates charged by CONCOR went to the railways. The loaded freight charges from Amingaon to Haldia were expected to go up to Rs. 9800 per TEU (from Rs. 9100). The empty freight charges from Haldia to Amingaon were expected to go up by Rs. 6800 per TEU (from Rs. 6200). The terminal handling charges of Rs. 3500 per TEU at Amingaon was also expected to go up.

CONCOR did not have much flexibility in lowering the rates as the charges to be paid to the railways were fixed. However, in the case of bulk movements, quantity discounts were offered within the margins available to CONCOR after payments to the Indian railways.

High transportation charges were a big issue since many tea shippers argued that ICD transportation had been rendered unattractive vis-a-vis road transportation mainly because of the high cost of moving empty containers between Kolkata/Haldia and Amingaon. There was virtually no cargo available for movement by containers between Kolkata/Haldia and Amingaon. (In 1999-2000, while 2,015 containers of tea were moved from Amingaon, only 22 loaded containers were received at Amingaon.) As a result, empty containers had to be moved, whatever the cost.

Although CONCOR did charge differential rates for loaded and empty containers, the rates were still too high when compared to road. Of course, truck drivers had the flexibility to cut rates, while railways resorted to a uniform tariff structure, which was not modified according to supply and demand.

Questions

Keeping all the above issues in mind, Mr Rambhai now needed to develop a strategy to stimulate growth in the domestic segment. The questions he needed to find answers to, were: Who should be CONCOR's key customers? On which point in the value chain should it focus? For example, should CONCOR attempt to provide door-to-door delivery services from the garden to tea factories? For this, it might be possible to have tie-ups with truckers and provide multi-modal transport solutions. Exhibit 10 gives a structure of flows of tea. Mr Rambhai was wondering if he could assess the quantum of flows on each segment to see the potential for containerised movement.

Given that flexibility in pricing was limited, CONCOR would have to decide on the value-added services it would offer like warehousing, time definite deliveries, tracking, or innovative solutions like organising pooled rake loads. At a more fundamental level, how were changes to be implemented in the organisation in order to change the negative image of CONCOR and the railways among tea merchants?

Exhibit 1: Brief Profile of CONCOR

As a pioneer in the field of containerised transportation, CONCOR had grown impressively since its establishment in 1987 under the Ministry of Railways. Its main objective was to be a catalyst for promoting containerisation and to give a boost to India's international and internal trade and commerce by organising multimodal logistics support.

CONCOR provided logistics services and support for the international and domestic cargo industry in India. It was the only means by which shippers could obtain containerised freight transportation by rail. CONCOR's network of facilities consisted of inland container depots (ICDs), container freight stations (CFSs), port container terminals, port side container terminals, and domestic container terminals. Table 1 gives a list of CONCOR's terminal facilities at various locations. ICDs and the other terminals were consolidation points up to/from which CONCOR handled the transportation. CFSs and other terminals where cargo-handling facility was provided, enabled customers to stuff and destuff containers. CONCOR's core businesses could be divided into three main operations: containerized freight carrier, terminal operator, and container freight station operator.

Freight Carrier: ***CONCOR provided rail connectivity as the mainstay of its transportation service. While some ICDs like Pithampur (Indore), Mulund (Mumbai), Milavittan (Tuticorin), Babarpur (Panipat), Daulatabad (Aurangabad) and Malanpur (Gwalior) were exclusively road-fed ICDs, majority of ICD and terminals in the CONCOR network were rail linked. As rail was price competitive over road for long leads (almost 20 per cent cost advantage), CONCOR had a natural competitive advantage.***

Terminal Operator: CONCOR's terminal operations were spread across the country. CONCOR owned and operated nearly 30 international container terminals and 10 domestic container terminals. Terminal operations were at a variety of locations, differentiated as deep and medium hinterland, portside and within port. For international operations, the intention was to cater to a diversity of clients, irrespective of lead from ports. For domestic operations, the objective was to increase the coverage and develop the container market.

Container Freight Station Operator: ***As a CFS operator, CONCOR provided value-added cargo handling services by offering transit warehousing to export/import cargo. Another segment growing in importance was bonded warehousing which enabled importers to store cargo and ask for partial releases, thereby deferring duty payment. Consolidation of less than container load (LCL) cargoes, air-cargo complexes, and hazardous cargo handling were business growth areas.***

The two basic customer segments were export/import and domestic. CONCOR believed that only about 30 per cent of port traffic originated from and terminated at places within 300 km from the port. The remaining 70 per cent was to and from the hinterland, representing a potentially large demand for CONCOR's services. However, as of now, only 17 per cent of export containerised movement and 17 per cent of import containerised movement was from/to ICDs. Table 2 gives the current profile of export/import containers handled by (i) CONCOR, (ii) ports, and (iii) ICDs. CONCOR's share of export and import traffic was 30 per cent in 1998-99. It is interesting to note that ICD handling was less than total CONCOR handling, indicating the significant role of port side handling by CONCOR. ICD handling constituted 57 per cent of CONCOR's export traffic and 55 per cent of CONCOR's import traffic. Movement of empty containers of shipping lines was also undertaken by CONCOR to balance the differential levels of exports and imports.

CONCOR was trying to develop the domestic container segment, targeting the piecemeal cargo movement in the country. CONCOR started Contrack service in 1997, and later on Conraj service. These were scheduled trains with specified frequencies, running between pre-determined pairs of points with guaranteed transit times. Client-focused customised services were the backbone of this segment. Large companies with substantial movement requirements were also being targeted. CONCOR owned and operated over 4,500 containers in the domestic sector, some of which were dedicated to specific industries for close-circuit operations. The share of export/import and domestic traffic over the last five years is given in Table 3.

Table 1: CONCOR's Infrastructure Network

ICD with CFS

(Customs-Bonded, Rail Linked, Cargo Handling Facility, Direct Port Link)

1. Tughlakabad (Delhi)
2. Ajni (Nagpur)
3. Whitefield (Bangalore)
4. Coimbatore
5. Sanat Nagar (Hyderabad)
6. Amingaon (Guwahati)
7. Tondiarpet (Chennai)
8. New Mulund (Mumbai)
9. Belanganj (Agra)
10. Guntur
11. Anaparti
12. Moradabad
13. Madurai
14. Sabarmati (Ahmedabad)

Road ICD with CFS

(Customs-Bonded, Cargo Handling Facility, No Rail Link)

1. Pithampur (Indore)
2. Mulund (Mumbai)
3. Milavittan (Tuticorin)
4. Babarpur (Panipat)
5. Daulatabad (Aurangabad)
6. Malanpur (Gwalior)

ICD without CFS

(Customs-Bonded, Rail Linked, Rail-Road Transfer, No Cargo Handling Facility, Direct Port Link)

1. Dhandari Kalan (Ludhiana)
2. Chinchwad (Pune)
3. Cochin
4. Vadodara
5. Raxaul

Port Container Terminal

(Customs-Bonded, Rail Linked, Rail-Road Transfer, No Cargo Handling Facility, within Port Premises)

1. Harbour of Madras (Chennai)
2. Kandla
3. Haldia

Port Side Container Terminal

(Not Customs-Bonded, Rail Linked, Rail-Road Transfer, Cargo Handling Facility, within Port Premises)

1. Cossipore Road (Kolkata)
2. Shalimar (Kolkata)
3. Wadi Bunder (Mumbai)
4. Dronagiri Node (Navi Mumbai)

Domestic Container Terminal

1. Tughlakabad (Delhi)
2. Dhandari Kalan (Ludhiana)
3. Salem Market
4. Whitefield (Bangalore)
5. Tondiarpet (Chennai)
6. Shalimar (Kolkata)
7. Cossipore Road (Kolkata)
8. Kankaria (Ahmedabad)
9. Wadi Bunder (Mumbai)
10. Turbhe (Navi Mumbai)

Future Terminals

1. Dadri, New Delhi
2. Rewari
3. Balasore
4. Jaipur
5. Kanpur
6. Cossipore Road (Kolkata)
7. Miraj
8. Ballabhgarh
9. Rajkot
10. Ankleshwar
11. Bhusawal

Source: Exim India, ICD-Sabarmati Special, June 2000

Table 2: Export/Import Container Traffic

(Lakh TEUs)

	Export			Import			Total
	Loaded	Empty	Total	Loaded	Empty	Total	Export/Import
CONCOR 1999-00 *(1)*	2.4	0.9	3.2	2.2	1.2	3.4	6.6
CONCOR 1998-99 *(1)*	2.0	0.8	2.9	1.7	1.2	2.9	5.8
Ports 1998-99 *(2)*	8.7	0.9	9.6	6.9	2.7	9.7	19.2
ICD Movement 1998-99 *(2)*			1.7			1.6	3.3

Sources: 1) Exim India, ICD-Sabarmati Special, June 2000
2) Major Ports of India: A Profile 1998-99

Table 3: Export/Import and Domestic Traffic

(Lakh TEUs)

Year	1995–96	1996–97	1997–98	1998–99	1999–00
Export/Import	3.5	4.2	5.0	5.8	6.8
Domestic	2.4	2.8	2.3	2.2	2.5
Total	5.9	7.0	7.3	8.0	9.3
Domestic %	40.7	40.0	31.5	27.5	26.9

Source: CONCOR Annual Reports and Company Sources

Exhibit 2: Profit and Loss Accounts

(Rs. lakh)

	Year Ended 31.03.2000	Year Ended 31.03.1999	Year Ended 31.03.1998
I INCOME			
Terminal and Other Service Charges	83141.6	68477.3	60625.4
Gross Interest on Short Term Investments/Deposits	2924.2	2845.5	1870.6
Miscellaneous Income	366.1	274.0	196.8
Excess Provision Written Back	56.1	39.2	162.3
Total Income	86488.0	71636.0	62855.1
II EXPENDITURE			
Terminal and Other Service Charges	51574.0	45280.0	40000.3
Employees Remuneration & Benefits	1179.6	1066.6	709.3
Administrative & Other Expenses	4945.2	3263.2	2996.3
Total Expenditure	57698.8	49609.8	43705.9
Profit Before Depreciation	28789.1	22026.2	19149.2
Less: Depreciation	2261.8	1227.4	1154.4
Profit After Depreciation	26527.3	20798.8	17994.9
Less: Provision for Taxes	9000.0	6651.2	6326.8
Profit After Tax	17527.3	14147.6	11668.1
Add/Less: Prior Period Adjustments (Net)	231.5	(82.4)	(87.8)
Net Profit	17758.9	14065.2	11580.3
III APPROPRIATIONS			
Proposed Dividend	3574.5	2924.6	1299.8
Corporate Tax on Dividend	643.4	292.5	130.0
General Reserve	1775.9	1406.5	11588.0
Balance Carried to Balance Sheet	11765.1	9441.6	8992.5
Total Appropriations	17758.9	14065.2	11580.3

Source: CONCOR Annual Reports 1999-00 and 1998-99

Exhibit 3: CONCOR's Performance: Eastern Region (1998-99)

Overall

(TEUs)

	Eastern Region	CONCOR's Total	% of Total
Export/Import	12004	576790	2.08
Domestic	36104	225156	16.04
Total	48108	801946	6.00

Export/Import Traffic

(TEUs)

	Export			Import			Total
	Loaded	Empty	Total	Loaded	Empty	Total	Export/Import
Cossipore Road	115	2225	2340	–	594	594	2934
Shalimar	9	120	129	3	346	349	478
Amingaon	2412	–	2412	22	2422	2444	4856
Raxaul	–	80	80	80	–	80	160
Haldia	265	289	554	2388	353	2741	3295
Adhoc total	–	281	281	–	–	–	281
Total	2801	2995	5796	2493	3715	6208	12004

Domestic Traffic

(TEUs)

	Outward Loaded	Inward Loaded	Total
Cossipore Road	2728	1351	4079
Shalimar	3205	8292	11497
Amingaon	50	189	239
Total	5983	9832	15815

Amingaon ICD

The revenues of ICD/Amingaon were approximately Rs 3.95 crore for 1999-2000. The approximate distribution of traffic between various tea companies at Amingaon was as follows:

Company	Share (%)
Williamson and Magor	80
Assam Company	10
Andrew Yale, Brook Bond, Tata Tea	About 3 each

Expansion Plans for CONCOR, East

CONCOR proposed to have a new ICD at Tinsukia in Assam. A feasibility report, assigned by CONCOR to Indian Market Research Bureau, was expected to be ready soon. The bulk of tea that was exported through Amingaon (Guwahati), ICD originated from tea gardens located around Tinsukia. This was because most of the tea companies participating in the ICD movement for exports had gardens concentrated in that region. If an ICD was installed close to these gardens, the long-road haulage of the consignments, as was undertaken to reach Amingaon ICD, would be rendered redundant. There would be substantial savings on transportation and handling costs.

There were some concerns with respect to the Tinsukia ICD. First, the broad-gauge railway line was yet to be extended to Tinsukia from Guwahati. Next, there were fears in many quarters that once the ICD became operational, the Amingaon ICD would lose its importance, as many tea shippers having gardens on the south bank of the Brahmaputra would abandon Amingaon in favour of Tinsukia.

However, the apprehension, according to many, was unfounded. According to leading shippers, the Tinsukia ICD, once operational, would cater mainly to the domestic trade - tea, plywood etc. The Amingaon ICD, according to them, would continue to account for the bulk of exports. The tea companies having gardens on both sides of the river, it was pointed out, would prefer Amingaon to Tinsukia. Also, many producer-exporters on the north bank who had so far shied away from Amingaon could be persuaded to use it.

Connecting Kolkata/Haldia with the Tughlakabad ICD had remained a thorny issue. Recently, American President Line had moved five rakes - three carrying imports from Kolkata/Haldia to Tughlakabad and two others carrying exports in the opposite direction. More shipments in both directions were expected to be achieved.

For shipments to and from Nepal, a full-fledged ICD on the India-Nepal border was expected to meet the requirements of the trade with/of the Himalayan kingdom. The present terminal facility at Raxaul was clearly inadequate. There was a talk of having a full-fledged ICD to be set up with World Bank assistance at Birgunj on the Nepalese side of the border. The effort would be meaningful if supporting facilities were strengthened on both sides.

Source: LINK – Global Trade and Freight Review, CONCOR, 1999.

Exhibit 4: Eastern India

Source: [www.mapsofindia.com]

Exhibit 5: Estimated Domestic Tea Consumption

Name of State	Share of Total Consumption (%)	Per Capita Consumption (kg/year) Kg/annum
MAHARASHTRA	12.9	0.96
GUJARAT	11.3	1.18
UTTAR PRADESH	8.2	0.34
PUNJAB	8.0	1.49
RAJASTHAN	8.0	0.78
WEST BENGAL	7.0	0.42
KERALA	6.1	1.06
MADHYA PRADESH	5.9	0.58
ANDHRA PRADESH	4.6	0.40
KARNATAKA	4.6	0.71
TAMIL NADU	3.9	0.33
ASSAM	3.4	0.67
BIHAR	3.4	0.19
HARYANA	3.2	0.99
JAMMU & KASHMIR	1.8	1.55
ORISSA	1.8	0.24
OTHERS	5.9	
TOTAL	100.0	0.70

Sources: 1) CTTA. TEA DIGEST, 1998

2) Reddy V N and Bose A, IIM Calcutta, 1995

Exhibit 6: Auction Sales vs Garden Sales

(Million Kgs)

Year	Total Production	Auction Sales	Garden Sales	Share of Garden Sales
1980	589.2	307.0	282.2	48
1981	560.4	376.2	184.2	33
1982	560.6	358.8	201.7	36
1983	581.5	338.9	242.6	42
1984	639.9	420.8	219.0	34
1985	656.2	505.3	150.9	23
1986	620.8	468.4	152.4	25
1987	665.2	472.5	192.8	29
1988	700.0	497.5	202.5	29
1989	688.1	477.4	210.7	31
1990	720.3	482.2	238.1	33
1991	754.2	501.6	252.6	33
1992	732.3	448.1	284.3	39
1993	760.8	441.7	319.1	42
1994	752.9	428.3	324.6	43
1995	756.0	428.4	327.6	43
1996	780.2	443.1	337.1	43
1997	810.6	459.0	351.6	43
1998	870.4	442.4	428.1	49

Source: CMIE Sector Report: TEA, July 2000

Exhibit 7: Production in Major Tea Producing States

(in per cent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1990–98 CAGR	1996–98 CAGR
Assam	53.89	52.59	56.14	53.95	53.22	53.26	54.34	52.48	53.17	-0.23	-1.08
West Bengal	20.79	21.10	20.63	21.38	21.10	20.84	21.12	20.97	22.48	0.53	3.18
North India	75.67	74.64	77.83	76.43	75.43	75.21	76.67	74.63	76.86	0.03	0.12
Tamil Nadu	15.35	15.90	14.11	14.83	15.61	15.60	14.85	16.11	14.37	-0.12	-1.62
Karnataka	8.42	8.86	7.48	8.15	8.39	8.57	7.89	8.59	8.11	-0.14	1.39
Kerala	0.55	0.60	0.58	0.59	0.57	0.62	0.59	0.67	0.65	1.78	5.38
South India	24.33	25.36	22.17	23.57	24.57	24.79	23.33	25.37	23.14	-0.08	-0.41
Total India (Million kg)	720.34	754.19	732.32	760.83	752.90	756.02	780.23	810.61	870.41	1.85	5.62
Total Exports (Million kg)	210.02	202.92	174.96	175.32	150.69	168.00	161.70	203.00	210.34	1.00	1.14
Total Export Value (Million Rs)	11133.51	11345.53	9953.31	11612.64	9891.37	12080.16	12468.72	17747.78	23094.36	1.10	1.36

Source: Asopa, V.N., *Competitiveness in Global Tea Trade,* Centre for Management in Agriculture, IIM, Ahmedabad, 2000

Exhibit 8: Scheduled Train Services (Eastern Region)

Export/Import: Fixed Services

CD Amingaon – PSCT Cossipore Road	Seasonal (2-3 trains per month)
CD Amingaon – PCT Haldia	

Export/Import: On Demand (Bi-Directional) Services

Terminal 1	Terminal 2
Mumbai area	Kolkata area, Haldia
Chennai area	Kolkata area, Haldia
Visakhapatnam port	Kolkata area
ICD Sabarmati	Kolkata area

Domestic Services

Stream	Frequency
Tughlakabad (Delhi) – Cossipore Road	Weekly
Gandhidam – Shalimar	Fortnightly
Kanpur – Cossipore Road	Weekly
Lucknow – Cossipore Road	Weekly
Moradabad – Cossipore Road	Weekly
Sanat Nagar (Hyderabad) – Cossipore Road	Fortnightly
Mumbai Area – Amingaon	On Demand

Mumbai area includes JNPT, Mumbai port, Wadi Bunder, Mulund and New Mulund. Kolkata area includes Kolkata port, PSCT Cossipore Road, and Shalimar.

Source: LINK – Global Trade and Freight Review, CONCOR, 1999.

Exhibit 9: Freight Rates for Movement of Containers by CONCOR (Eastern Region)

(Rs/TEU)

Between Vizag Port and	Empty	Loaded
Delhi	12400	–
Bangalore	7100	–
Coimbatore	7700	–
Chennai	5000	6900
Hyderabad	4300	6200
Guntur	3000	4400
Mumbai	9500	13500
Between Haldia and		
Delhi	8900	13400
Ludhiana	10400	15400
Cossipore Road/Shalimar/Kolkata	1800	2100
Chennai	10200	14800
Amingaon	6200	9100
Nagpur	6700	9600
Mumbai	11800	17900
Vizag	6100	–
Between Amingaon and		
Cossipore Road	6000	–
Vizag	11800	–
Haldia	6200	9100
Mumbai	15000	–
Between Shalimar/ Kolkata/ Cossipore Road and		
Mumbai	11800	17900
Chennai	10700	15500
Sabarmati	6100	–
Nagpur	12400	–
Vizag	6800	–

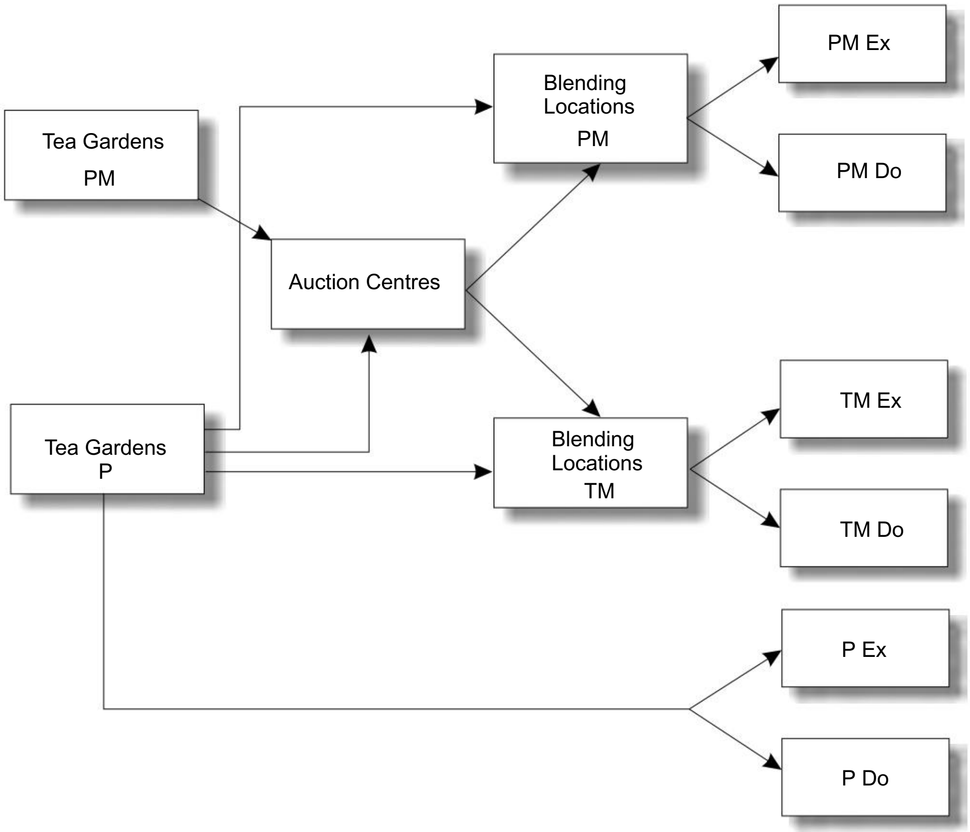
Source: LINK – Global Trade and Freight Review, CONCOR, 1999

Truck Rates

The average rate from Guwahati to Ahmedabad was around Rs 12,000 per truck. A truck would carry 9-10 tonnes of tea.

Source: Somabhai Tea Processors Ltd.

Exhibit 10: Structure of Flows of Tea



P	Producer	P Do	Producer Sales to Domestic Market
PM	Producer Merchant	P Ex	Producer Sales to Export
TM	Trader Merchant	PM Do	Producer Merchant Sales to Domestic Market
		PM Ex	Producer Merchant Sales to Export
		TM Do	Trader Merchant Sales to Domestic Market
		TM Ex	Trader Merchant Sales to Export

APPENDIX

THE DOMESTIC TEA MARKET

Domestic tea consumption was estimated to have been around 660 million kgs in 1999 and was growing at an average annual rate of 3.5 per cent per annum. Production, on the other hand, grew at a CAGR of 1.4 per cent during the last decade. The exportable surplus had therefore been declining over the last few years. Exports in 1998 amounted to 210 million kg.

In the domestic market, only 30 per cent of the tea produced was sold in packaged or branded form while 46 per cent was sold loose. Tea was, by far, the most popular beverage in India. Its penetration was 89.3 per cent in urban areas and 72.6 per cent in rural areas. Across India, tea penetration averaged 77.2 per cent.

Interestingly, tea penetration was higher in medium sized towns[1] at 93.3 per cent than in metros[2] where it was about 90.5 per cent. This could be due to the fact that coffee penetration was significantly higher in metros (24.2 per cent) than in medium sized towns (16.7 per cent).

Characteristics of Tea

Tea supply depended upon weather conditions. Tea prices fluctuated like those of any commodity driven by temporary shortages and surpluses. Demand for branded tea was highly price sensitive, with consumers shifting to relatively cheaper loose tea when prices of branded or packaged tea increased. The aggregate demand for tea, however, was not price sensitive.

Tea was a very sensitive commodity and was prone to damage easily under adverse and careless handling. The commodity was perishable and demand relatively inelastic to price. While demand had a secular growth rate, supply could vary depending on climatic conditions in the major tea growing countries. Unlike other commodities, tea price cycles had no linkage with the general economic cycles, but varied with agro-climatic conditions.

Key Players in Tea Sector

The major players in the tea market could be classified as:

- Producers
- Merchants
- Producer-Merchants

Producers were basically garden owners who sold their produce directly or through auctions to merchants.

[1] Medium sized towns are defined as those with population 0.5 to 1 million.

[2] Metros are cities with population above 1 million.

Merchants bought the primary product and processed it further (blending, etc.) and either exported this or sold to wholesalers, who then started off the value chain till the tea reached retailers and consumers.

Producer-merchants were those who both produced tea in their own gardens and purchased from auctions, and performed blending, etc. The big tea companies fell in this bracket.

The packed tea market was dominated by Hindustan Lever with over 45 per cent market share followed by Tata Tea, which had an estimated market share of 28 per cent. The rest of the market was highly fragmented. Some leading national players were Goodricke, Godfrey Phillips and Duncans. HLL procured most of its tea requirements from outside. Other major tea plantation companies included Harrison Malayalam, Warren Tea, Duncans, Goodricke, Bishnauth, and Eveready. Tata Tea, although the largest integrated tea producer in the world, accounted for only 7 per cent of tea production in India. A brief profile of some of the players is given below.

Tata Tea Limited (TTL): Tata Tea had gardens in both the Northeast and the South, besides tea estates in Sri Lanka. It owned and operated 54 tea estates (21 in Assam, 4 in West Bengal, 24 in Kerala and 5 in Tamil Nadu), spread over 25,714 hectares of land. TTL's estates yielded 62 million kg of tea in 1998-99. About 75 per cent of this was sold in packed form, while the balance was sold loose through auctions. TTL sold an estimated volume of 42 million kg in packed branded form in India. It recorded a total income of Rs 879 crore in 1997-98 (Rs 717 crore the previous year) and net profits were up by 74 per cent to Rs 102.16 crore.

Bishnauth Tea: The Bishnauth Tea Company was one of the largest tea-producing companies of the Williamson Magor Group. The company had focussed its attention on the export market and had generally recorded exports aggregating over 35 per cent of its turnover.

Goodricke Group: The Goodricke Group was a leading producer of Darjeeling tea and the third largest tea producer in the country. The company owned 17 gardens spread over 9,500 hectares. Primarily a seller in the auction market, Goodricke also had an equal proportion of sales in the bulk and packet tea segments, besides a significant presence in the export market. Besides selling bulk teas in domestic and international markets, the company also marketed tea in consumer packs. Goodricke sold 18.9 million kg of bulk and packed tea in 1998. The company set up an export-oriented tea packaging unit near Mumbai.

Duncans Industries Limited (DIL): Duncans Industries Limited (DIL) was the third largest player in the Indian packet tea market. DIL had a market share of approximately 9 per cent and sold about Rs 1.5 billion ($37.5 million) worth of tea in 1996-97. Almost the entire amount sold was in packets. DIL owned 16 tea gardens, 3 blending units, 6 packing units, and 22 depots. While tea gardens and blending units were concentrated in the northeast, the packing units and depots were scattered all over the country. DIL had a countrywide network of 11,500 distributors through whom the tea ultimately reached about 325,000 retailers.

Eleven of the gardens had on-site factories that processed tea leaves. The produce of gardens without factories was transferred to those equipped with processing units. The manufacturing of tea started when the plucked green leaves were withered (the leaves were placed on a trough and hot air was blown over them to remove the moisture). The usual moisture content in raw leaves was about 68 per cent; the process of withering continued for about 8 to 10 hours and took away about 10 to12 per cent of the moisture. The leaves were then cut and curled in the CTC (crush, tear and curl) machine. CTC tea, which was still green in colour, was spread out in large trays for some time, depending upon the temperature and humidity in the room for fermentation. The fermented granular tea, which was still wet, was charged into dryers and subjected to temperatures of 250 to 260 degrees Fahrenheit. The output, now dry and brown in color, was put through the sorter machine to separate the tea according to the size of the granules and remove fibres from the tea. Samples were then rigorously tested and the manufactured tea graded according to quality.

Tea from the gardens was sent to blending units, where teas of various grades were mixed in fixed proportions to produce blends of stipulated quality. Well known DIL blends included Sargam, Double Diamond and the prestigious Runglee Rungliot. Tea for blending, was also often purchased from auction centres. The progress of the Indian tea industry owed much to the tea auction system, which provided opportunities for sale and purchase of large quantities of tea of many varieties. The main auction centres were Kolkata, Siliguri and Guwahati in northern India. Tea was also occasionally sold by DIL at auctions.

Blended tea was transported to packing units. Several gardens had packing facilities. There were also six off-garden packing units in various parts of the country. In packing units, tea was placed in packets of different sizes and type. The combination of blend, size and packing type determined a line. Thus, Sargam tea, packed in 500 gram cartons, constituted a line, while Double Diamond, packed in 100 gram polythene pouches, constituted another. About 120 lines were produced in all.

DIL had a network of 22 depots in various parts of the country. The depots received stocks of packet tea from different packing units and in turn despatched these to distributors in the respective jurisdiction. Certain depots had to be supplied from specific packing units in order to take advantage of sales tax benefits provided by some states. There were 11,500 distributors through whom the needs of about 325,000 retailers were met.

Waghbakri Tea: This company was the leading player in Gujarat, with presence in Maharashtra and Rajasthan. Sales during 1999-00 was Rs 190 crore. It sold 8 million kg of its branded packed Good Morning Tea and about one million kg as branded loose tea. The average price of tea was Rs 170 per kg. Its main factory was in Dholka, about 40 kms from Ahmedabad. There was competition not only from national players like HLL and TTL, but other local brands like C Somabhai Tea. Waghbakri Tea had a 15 per cent market share in Gujarat.

Source: OR/MS Today, April 2000 (for DIL), Annual Reports and Internet.

QUESTIONS FOR DISCUSSION

1. What customer segments should the head of the Eastern region of CONCOR focus to provoke growth in containerised rail transportation of tea?
2. At what point in the value chain of tea should CONCOR focus, for maximum effectiveness?
3. What value added services and/or partnerships should he consider for an effective service offer?
4. Increased tea traffic will most likely involve further flow of empty containers back to the eastern region. Would these costs be borne by the intended market?

APPROACH FOR ANALYSIS

It would be important to understand the changing trends of the tea industry, in terms of size of gardens, role of auctions, export versus domestic consumption, and market spread. A value stream mapping for tea transport through rail containers may be useful. Domestic movement through containers could be possible in some markets in the country, in addition to the export markets.

While providing value added services, the delivery competence needs to be considered, along with the institutional arragements. Pricing would become an issue. Value added services could be an opportunity in increasing contribution, since on rail transport, the pricing of containers by Indian Railways is a significant cost. Empty flows can be handled in more than one way, by looking at markets at both ends.

Case 7

CASE CONTEXT

Chilli was the main earner in the Indian spices export basket. Incidents of adulteration of chilli powder (by carcinogenic dyes) by some unscrupulous and careless exporters had led to large-scale product recalls in the UK and tainted the image of Indian spices export industry. This resulted in a complete shake up of the sector with serious consequences, leading to the introduction of mandatory and expensive testing, certification, stringent safety regulations, food recall and threats by EU of banning imports from India.

This case focuses on the events that led to this as well as the status of food safety regulation in our country. The role of Spices Board of India (SBI) has been instrumental in protecting the brand image of Indian spices exports. The case revolves around SBI, the choices it had and the possible implications towards damage control and prevention.

CHILLI IN SOUP (A)

INTRODUCTION

It was a damp morning on June 10, 2003 with overcast sky, raining outside. The monsoon had arrived in Kerala a few days ago. Mr C J Jose, a tall well-built man in his fifties, the Chairman of the Spices Board of India (SBI), was in his spacious office deeply engrossed in a

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Case prepared by Tathagata Bandyopadhyay, G Raghuram, and Neeraj Sisodia, IIM Ahmedabad.

We acknowlwdge the research assistance by Vishal Kashyap. We are thankful to Mr Jose, Chairman and other senior executives of the Spices Board of India for their discussion and data support. Some data has been masked to protect sensitivities. Teaching material of the Indian Institute of a Management, Ahmedabad, is prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems.

file. It was 10 a.m. in the morning. His phone started ringing. It was a call from the Secretary, Department of Commerce, Ministry of Commerce and Industry, Government of India. The matter was of serious concern. The Secretary seemed to be worried and conveyed to him the following message. "Yesterday evening, the Ministry received a communication from the Charge d'Affaires, European Union (EU), regarding a notification. It came via the existing Rapid Alert System for Food and Feed (RASFF) of EU. The notification stated that French scientists have detected traces of Sudan I, a banned carcinogenic dye in a British food product in the last month. Further investigation revealed that the source of Sudan I was red chilli powder exported from India. The British firm used it as an ingredient. The Ministry was requested to inform the competent authority in India of these findings in order to help avoid such problems in the future. My office will be sending a fax of the notification in an hour". Closing the conversation, he said, considering the seriousness of the matter, the Ministry would like to be periodically apprised of the actions SBI would be taking in its capacity.

Mr. Jose hung up the phone and brooded for some time over possible actions he could take. He called his Personal Assistant, Mr. Raphael, and asked him to cancel all his meetings and appointments of the day unless something was exigent. He then discussed the matter with Mr. S Kannan, Director (Marketing), over phone, and immediately decided to summon a meeting at 11 a.m. of all the departmental heads and a few other officers whose inputs were desirable. (Exhibit 1 gives the functions and organisation structure of SBI.) He was expecting the fax to come before the meeting would start. He did all this in a few minutes after receiving the call.

Mr. Jose had, in his long administrative service (as an officer of the Indian Administrative Service), faced many a crisis in various capacities and always found these an interesting part of life. He was posted as the Chairman of SBI in April 2001. Until the previous day, it had been a relatively easy posting, doing routine regulatory work, besides looking for opportunities to enhance the markets outside India, meeting exporters, attending meetings with similar international bodies regarding export of Indian spices. But, the call from the Ministry in the morning looked like a sign of an impending crisis situation. He could smell it from his long experience. He started thinking logically about the stakes and the possible fallouts of the incident.

The fax came before the meeting. Three Mumbai based exporters had been identified as the suppliers of the contaminated chilli powder in the RASFF (Exhibit 2). During the meeting, Mr. Jose summed up the following issues which had to be addressed by SBI as the licensing authority of exporters of Indian spices.

(i) Assessing the damage done by the event and formulating strategies to control it.

(ii) Defending the brand image of Indian spices in the international market through confidence building exercise.

(iii) Formulating strategies to avoid future recurrence of such events.

At the end of the meeting, Mr. Jose requested Mr. Kannan to verify the EU claim and collect back-up information in the next few days and report to him. He also requested Mr.

KRK Menon, Senior Scientist, in charge of the Quality Evaluation Laboratory (QEL), to report on the quality parameters and the tests related to chilli powder that were being presently carried out in the SBI lab.

Mr. Kannan set about his task immediately towards the above. Examining past correspondence and records, he gathered the following:

1. Sudan I is a red dye that is used for colouring solvents, oils, waxes, petrol, and shoe and floor polishes. Under the colours in Food Regulations 1995 of EU, the red dye is illegal, and is considered to be a genotoxic carcinogen. Its presence, at any level, is not permitted in foodstuffs for any purpose. The ban came following the experimental results on rats, which suggested that the chemical could trigger the formation of malignant tumours. The details about its health risks (Exhibit 3) mention a significant fact that "the risk of cancer in humans from Sudan I has not been proven and any risk from these foods is likely to be very small indeed."
2. As per the RASFF (Exhibit 2) dated May 9, 2003, issued by the EU, consignments of chilli powder exported by the following firms to East West Spices, UK have been detained for the presence of Sudan I. All are based in Mumbai. The names are:

   (i) Gautam Export Corporation
   Flat 11-B, 3rd Floor
   Koolbreeze CHS Limited, Plot No. K-72
   17th Road, Khar (West)
   Mumbai-400 052

   (ii) Patons Exports Private Limited
   10, Koolbreeze CHS Limited,
   17th Road, Khar (West)
   Mumbai-400 052

   East West Spices, UK (the importers) provided the details of how they traced back the material to the exporters. In order to verify the correctness of the EU claims that the material actually went from the two named exporters (Gautam Export Corporation and Patons Exports Private Limited) to East West Spices, UK, an investigation was conducted by SBI. The investigation showed that the shipping marks and lot numbers of the material sampled corresponded to those used by Volga Spices and Masala Mills Private Limited, at the behest of the named exporters. Volga Spices, also a registered exporter, had processed and supplied the material to Gautam Export Corporation and Patons Exports Private Limited.

   Gautam Export Corporation's senior partner, Jagdish Advani was a big exporter of spices to Europe. His company used to trade around 5,400 tons of spice annually to Europe. Volga Spices was run by the Shaikh family. Imran Shaikh was one of its directors. Patons Exports Private Limited had directors from the Advani family who managed Gautam Export Corporation.

A consignment of 5 tons had been shipped from Gautam Export Corporation to East West Spices (UK), who had in turn exported part of the chilli powder, possibly clubbing with shipments from the other party to an importer in France where the Sudan I was detected.

3. Chilli is commercially important for two qualities, its red colour by the pigment Capsanthin and its biting pungency by Capsaicin. The price that chilli powder fetches in the market is determined by its pungency and colour. Sudan I, a cheap red dye, would brighten up the colour if mixed with crushed chilli (processed from cheap discoloured chilli) adequately during its processing. If Sudan I was present in chilli powder it should be the result of a deliberate act of adulteration performed to brighten up its colour, and hence its appearance. Experiments had shown that for good colour enhancement, couple of kgs of Sudan I would be required per ton of chilli powder. This would cost about US$ 5 and could potentially increase per ton chilli price from US$ 600 to US$ 1200.
4. Data related to Indian chilli exports and production (Exhibit 4), major importing countries of Indian chilli (Exhibit 5), and India's share of chilli imports of some major importing countries (Exhibit 6) gives a perspective on the export market scenario of chilli from India.

Mr. Menon, with the help of his subordinates, put together the following information regarding SBI's testing equipment and processes.

1. The SBI set up the QEL in 1990. The lab was ISO 9002 certified by the British Standards Institution (BSI) in 1994. The QEL adopted ISO 14001 Environmental Management System for its activities in the lab. The SBI also had two major concepts for quality improvement. The SBI awarded ISB logo to the consumer packs of spices selectively to the exporters who had certified processing and quality control capability and maintained a high level of hygiene and sanitation at all stages. For exports of spices and spice products in bulk, it awarded the Spice House Certificates to those processors/exporters who had a genuine commitment to sustainable quality and export growth and made investments in developing in-house processing facilities, infrastructure and had necessary competence to ensure consistent quality and reliability. These facilities should cover cleaning, grading, processing, packaging and warehousing.
2. The two important quality characteristics that determine the price of red chilli powder are its colour (measured in ASTA units) and pungency (Capsaicin percentage). Besides that, Aflatoxin (a toxic metabolite produced by certain moulds in food and feed) content is a critical parameter that should not exceed a threshold level (though different for different countries) in the exported chilli powder. Several other parameters could be tested in the SBI lab. (Exhibit 7 provides the analytical services offered by SBI including the list of tests, charges and the time taken for getting the report.)
3. The lab had five High Performance Liquid Chromatographs (HPLC) machines for detecting Aflatoxin content. HPLC was used to find the amount of a chemical

compound within a mixture of other chemicals. It could detect up to the level of 5 ppm (5 gm in a ton). An HPLC machine could also be used for detecting Sudan I. Each machine could analyse 20 samples a day.

4. Usually, the big exporters had their own testing facilities. Most of the requests for testing were received from small exporters who did not have their own facilities. On an average, around 30 samples were analysed each day by HPLC machines for various tests on different spices.

On June 13, 2003, Mr Jose, Mr Kannan and Mr Menon met to discuss the way forward. Mr Jose asked Mr Kannan for his views. Mr Kannan said "I was aware of the unregulated use of banned red dyes to brighten up the colour of red chilli powder in the domestic market in order to fetch good prices. But, this is the first time it has happened in the export market. May be, it has happened in the past too, but was not detected. The quantum of Sudan I added by the alleged exporters at 3,890 ppm was a deliberate act that needed stern action."

Mr. Kannan further added, "the events after 9/11 had changed the world. Since then, the threats of bioterrorism had been lurking in the minds of people in the USA and Europe. Consequently, the food regulatory authorities and the consumers had become more sensitive about any kind of adulteration. Checking had become more frequent and thus increased the chance of detection".

Mr. Jose mentioned that certain sources in Europe had informed him that EU had been seriously contemplating about imposition of some kind of restrictions to ensure import of Sudan I free chilli powder and chilli products to its member countries. It could lead to the requirement of an analytical report from well established labs certifying the export consignment to be Sudan I free. He continued, "If such a situation actually arises,

- How should the SBI act?
- Should the SBI consider mandatory testing of all the export consignments before shipping? In that case, the immediate question would be,
- Is the SBI (and the QEL) equipped to handle the task efficiently and in a reasonably short period of time? or
- Should the SBI license other laboratories which could do the testing and issue the analytical reports? or
- Should the SBI require the exporters to submit analytical reports by equipping their own quality control lab or through other labs? And also,
- How should the SBI monitor the whole process starting from taking the sample to the shipment of the consignment?
- Should they price the test? If so, what should be the price?"

Mr. Kannan informed that during 2002-03, about 8,000 consignments had been shipped out by nearly 150 exporters. While the largest exporter did about 4,000 tons, many exporters did even under 100 tons. Testing of all consignments would increase the work load of the SBI significantly and may have to be done using various other accredited laboratories in the country.

Mr Kannan also mentioned, "there were also a few private laboratories used by the exporters, but their quality and capacity was not up to the mark. Further, the trade felt that their charges for testing for Sudan I, at over Rs 4,000 per sample, are quite high. It would be better if SBI could make the testing mandatory and thus take control of the process. The SBI staff at its offices in the port cities could be given the responsibility of taking samples and sending them to SBI for testing."

Mr. Jose was very concerned about the fact that EU norms would require no trace of Sudan I, for which testing precision may have to be at the parts per billion (ppb) level.

Responding to Mr. Jose's concern, Mr. Menon specified that available HPLC machines were not equipped to test for Sudan I at ppb level. A superior machine called LC MS MS would be required for this. It would have a capacity of testing 40 samples per day and would cost around US$ 200,000. The variable cost (material and labour for sample preparation) per test would be about Rs. 700 excluding the collection charges. Supervisory costs would be in addition and would require one qualified technician per shift.

Mr. Kannan alerted that even though 8,000 consignments had been shipped over a year, the shipments are not uniform and are subject to high seasonality. Arrivals on a given day could be as high as three times the average.

Mr. Jose emphasised, "in case mandatory testing was to be brought in, it had to be done in a manner that the export time schedules are not affected. Almost all exporters were located at field office locations. Collection, courier of sample and return courier of the analytical report could cost about Rs. 300 per sample. While mandatory testing by SBI may not require additional human resources at the field offices, it would definitely be required at the Head Office, both for sample preparation and supervision." He was also aware that SBI being a government organisation, recruitment was banned and hence, not an option. Recruiting students with the appropriate educational background as "trainees" was a possible way out.

Though he had raised various questions, Mr. Jose wondered whether they were over-reacting. Mr. Kannan responded, "It seems that the alleged exporters get their orders through overseas middlemen. It is, thus, possible that parts of the same shipment could have gone to other processors/customers and the same could be true with other shipments."

Mr. Jose knew that a clear message had to be sent to the industry. He also had the inkling that some of the alleged exporters had political connections. He wanted to make sure that the entire trade must not suffer due to the greed of a few. Further, in terms of regulatory powers, SBI could only suspend (pending investigation) and revoke (after investigation) the exporter's registration for violation of conditions listed in the registration rules. (Exhibit 8 gives excerpts from the Spices Board Act, 1986 and the Spices Board Rules, 1987.) However, violation of food safety norms of the importing country or of the Prevention of Food Adulteration Act, was not a listed condition for which registration could be suspended or revoked by the SBI. The regulations also did not empower SBI to draw samples on a compulsory basis from the export consignment. To impose mandatory testing, the regulations would need to be amended.

Exhibit 1: Spices Board of India: Functions and Organisation Structure

SBI is governed by a 32 member governing body consisting of representatives of the Lok Sabha, Rajya Sabha, State Governments, certain Central Government Ministries, Planning Commission, plantation labour, spice growers, processors and exporters, and specialist organisations such as Central Food Technology Research Institute (CFTRI) and Indian Institute of Packaging (IIP).

Offices

The Head Office of SBI is located at Cochin. SBI has 22 Regional Offices, 13 Zonal Offices and 35 Field Offices. A central Quality Evaluation Laboratory (QEL) is located at the Head Office. A Biotechnology Lab also functions at the Head Office. Indian Cardamom Research Institute, a research wing of the Spices Board has its main station at Myladumpara (Idukki, Kerala) with Regional Stations located at Thadiankudissai (Tamil Nadu), Saklespur (Karnataka) and Gangtok (Sikkim).

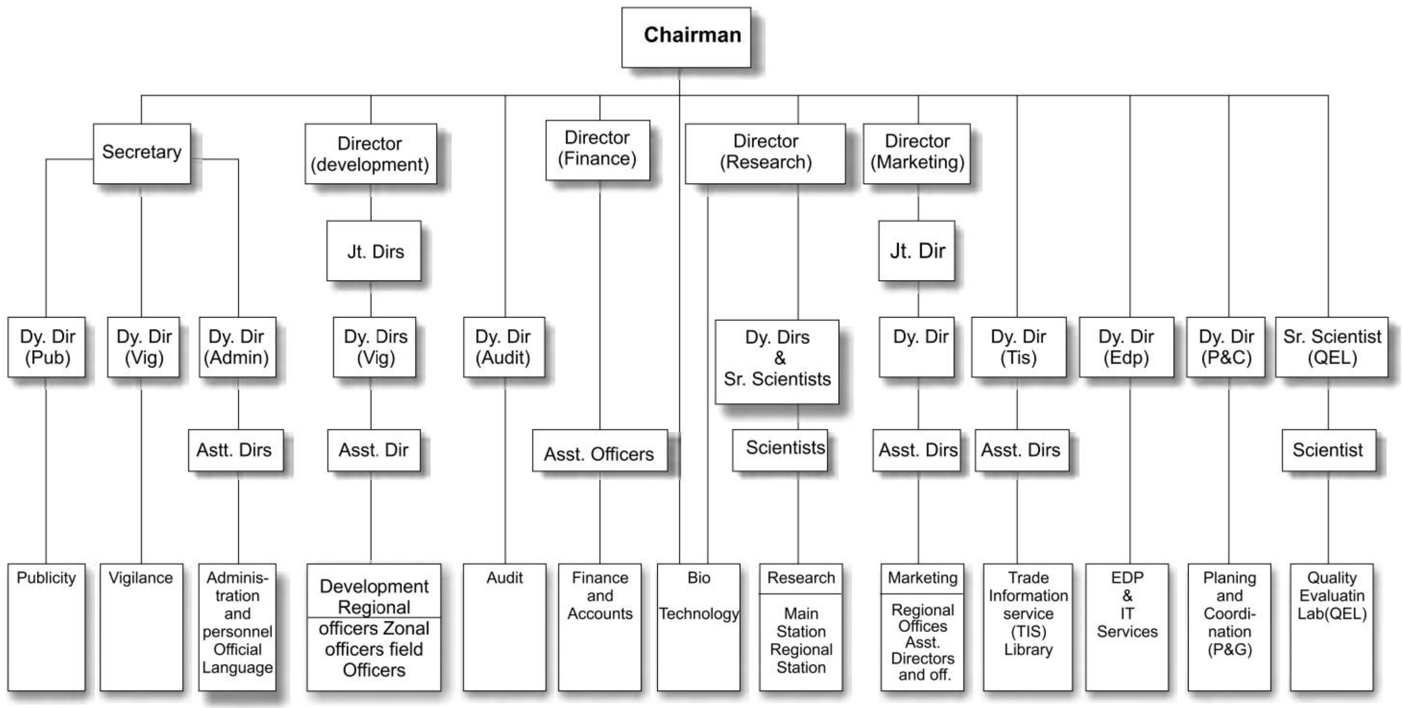
Main Functions

1. Export promotion of all spices through support for:-
   a) Technology upgradation
   b) Quality upgradation
   c) Brand promotion
   d) Research and product development.
2. Research, development and regulation of domestic marketing of small and large cardamom
3. Research and production development of vanilla
4. Post harvest improvement of all spices
5. Promotion of organic production, processing and certification of spices
6. Development of spices in the North East
7. Provision of quality evaluation services

Other Responsibilities Related to Export Promotion of Spices

1. Registration of exporters
2. Quality certification
3. Quality control
4. Collection and documentation of trade information
5. Provision of inputs to the Central Government on policy matters relating to import and export of spices.

Organisation Structure



Remark: JT. Dir-Joint Director, Dy. Dir-Deputy Director, Asst. Dir- Assistant Director

(Source: www.indianspices.com)

Regulatory Functions

1. Registration of exporters of spices.
2. Licensing of cardamom auctioneers
3. Licensing of cardamom dealers
4. Sampling, testing and analysing of samples of all the spices designated for export out of the country.
5. Suspending/revoking the certificates of registration of exporters for violation of the conditions of registration relating to food safety.

(Source: www.indianspices.com)

Exhibit 2: Rapid Alert System for Food and Feed

No. 1/22/2003-EP (Agri-V)
Government of India
Ministry of Commerce and Industry
Department of Commerce

Udyog Bhavan, New Delhi
Dated, 10^{th} June, 2003

Chairman
Spices Board
Cochin

Subject: - Rapid Alert Notification

Sir,

1. Kindly find enclosed Rapid Alert Notifications No 2003/111 dated 9^{th} May, 2003 for presence of colour Sudan I in hot red chilli powder exported by Gautam Export Corporation, Mumbai and M/s Patons Exports Private Limited, Mumbai.

Spices Board is requested to take necessary action in the matter.

Yours faithfully,
(KK Singh)
Section Officer

Encl: A/A

EUROPEAN UNION
DELEGATION OF THE EUROPEAN COMMISSION
TO INDIA, BHUTAN, MALDIVES, NEPAL AND SRI LANKA
Minister-Counsellor, Political Affairs and Coordination
Charge d'Affairs a.i.

CK/ck/222
09.06.2003

Mr YYY
Additional Secretary
Department of Commerce
Ministry of Commerce and Industry
Udyog Bhavan
New Delhi-110001

Dear Mr YYY,

According to Regulation (EC) No 178/2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety, I would like to bring to your attention the following notification received via the Rapid Alert System for Food and Feed (RASFF):

Notification:	2003.111 Date: 09/05/2003
Concerning:	hot red chilli powder
Despatched from:	INDIA Via UK
Having been the subject of:	market control
Reason for notification:	colour Sudan I

Detailed information is attached.

I would be grateful if you could inform the competent authorities in your country of these findings in order to help avoiding such problems in the future.
The RASFF contact point (fax number +32.2.222.77.77 or e-mail: sanco-rasff@cec.eu.int) is at your disposal should the authorities of your country have questions about the above mentioned information.

With kind regards,

Yours Sincerely
Dr ZZZ, Charge d'Affairs a.i.

EUROPEAN COMMISSION
HEALTH and CONSUMER PROTECTION DIRECTORATE-GENERAL
Directorate D – Food Safety: production and distribution chain
D3 – Chemical and Physical risks; surveillance

Brussels, 9 May 2003

RAPID ALERT SYSTEM FOR FOODS

FOOD

VERY URGENT – TRES URGENT

ALERT NOTIFICATION: 2003/111

ORIGINAL NOTIFIACTION

SUBJECT: COLOUR SUDAN I IN HOT RED CHILLI POWDER FROM UK

PAGE: Cover Pages (1) + 10

FAXNUMBER: ++32-2-222-77-77

EMAIL: sanco-rasff@cec.eu.int

http://forum.europa.eu.int

Market control product recall/Product withdrawal
Product distributed to France
Manufacturer: East West Spices (UK)

The contact point from UK is kindly requested to provide the possible distribution and details about origin of the incriminated ingredient

The contact point from France has communicated to the Commission the following information:

RAPID ALERT SYSTEM FOR FOOD AND FEED

REGULATION (EC) No: 178/2002 – Art 50/GENERAL INFORMATION

1*	NOTIFICATION TYP	FOOD
2*	CONTROL TYPE	MARKET
3*	NOTIFYING COUNTRY	FRANCE
4*	DATE OF NOTIFICATION	9.05.2003

HAZARD

5*	NATURE OF HAZARD		UNAUTHORISED COLOUR
6*	RESULTS OF THE TESTS		SUDAN I 3.89 G/KG
7*	COUNTER ANALYSIS		
8*	SAMPLING	DATES	30.04.2003
		No OF SAMPLES METHOD	TAKING A SAMPLE (2 PACKAGES OF 30 G EACH)
		PLACE	RETAILER
9*	LABORATORY		
10*	METHODS OF ANALYSIS USED		GC/MS
11*	PERSONS AFFECTED		
12*	TYPE OF THE ILLNESS		

PRODUCT

13*	PRODUCT CATEGORY	SPICES
14*	PRODUCT NAME	HOT RED CHILLI POWDER
15*	BRAND / TRADE NAME	

IDENTIFICATION OF THE LOT(S)

16*	CONSIGNMENT / LOT NUMBER		NOT AVAILABLE
17*	PUBLIC HEALTH CERTIFICATE	NUMBER	
	DATE		
	CVED No		
18*	DURABILITY DATES	USE-BY DATE	
	BEST BEFORE	DATE	
		SELL-BY DATE	
19*	DESCRIPTION OF THE PRODUCT	PRODUCT ASPECT	HOT RED CHILLI POWDER
		No OF UNITS	
		TOTAL NET WEIGHT	

ORIGIN

20*	COUNTRY OF ORIGIN		UK
21*	MANUFACTURER	NAME	EAST WEST SPICES, UK
		ADDRESS	
		VET AP-No	
22*	DISPATCHER/ EXPORTER	NAME	
		ADDRESS	

DISTRIBUTION

23*	DISTRIBUTED BY	IMPORTER	
		WHOLESALER	
		RETAILER	
24*	DISTRIBUTION TO MEMBER STATES		
	DISTRIBUTION LIST ATTACHED		NO
25*	EXPORTED TO THIRD COUNTRIES		NOT BY THE FIRM
	DISTRIBUTION LIST ATTACHED		NO

IN CASE OF A REJECTION AT THE BORDER

26*	POINT OF ENTRY		
27*	TYPE OF CHECK		
28*	COUNTRY OF DISPATCH		
29*	COUNTRY OF DESTINATION		
30*	CONSIGNEE	NAME	
		ADDRESS	
31*	CONTAINER NUMBER		
32*	MEANS OF TRANSPORT		

MEASURES ADOPTED

33*	VOLUNTARY MEASURES	DESTRUCTION
34*	COMPULSORY MEASURES	MONITORING OF THE DESTRUCTION
35*	JUSTIFICATION	INFRINGEMENT OF § 11-LID 1 OF THE FOOD AND COMMODITY ACT
36*	SCOPE	NATIONAL
37*	DATE OF ENTRY INTO FORCE	
38*	DURATION	

OTHER INFORMATION

39*	MINISTRY	
40*	PERSON TO CONTACT	NAME: TEL: FAX: E-MAIL:
41*	OTHER INFORMATION	
42*	CONFIDENTIAL	NO
43*	IF YES, WHICH BOXES (NUMBERS)	
44*	IF YES, REASON	

Attached were consignment notes identifying the following exporters from India:

1. Gautam Export Corporation
2. M/S Patons Exports Private Limited

As sold to East West Spices, UK

(Source: Spices Board of India)

Exhibit 3: Health Risks of Sudan I

Illegal dye: What is the health risk?

There is concern that the dye, Sudan I, has the potential to cause cancer.

However, the Food Standards Agency has said the risk is very low.

Professor Alan Boobis, an expert in toxicology at Imperial College London says there is little reason for the public to be alarmed.

Sudan I was banned from use in food products following experiments on rats, which suggested that the chemical could trigger the formation of malignant tumours.

However, Professor Boobis told the BBC News website that the levels of the chemical fed to the rats bore no relation to the kind of levels that people would be exposed to, if they ate contaminated products.

The rats who showed signs of developing tumours were given a daily dose of Sudan I of around 30 milligrams/kg of bodyweight for two years.

Animals given a lower dose – 15 milligrams/kg of bodyweight - showed no signs of cancer-related changes.

The contaminated products would contain Sudan I doses of a much smaller magnitude - micrograms, rather than milligrams.

The animals that did show signs of cancer - known scientifically as tumourigenic changes - started to do so only after many months.

In human terms, this would suggest that if the dye was to have any effect, the symptoms would not start to become apparent for around 20 years.

Genetic damage

The compound triggers cancer growth through what is known as a DNA reactive mechanism.

Within the body it is converted into a form which attacks the DNA of cells, causing damage which can be passed on to the next generation of cells in the affected tissue, ultimately leading to cancer.

However, Professor Boobis said that the risk of eating just one or two contaminated items was trivial.

While not an exact comparison, he likened it to the cancer risk associated with smoking just one cigarette in a lifetime.

Even if a person was to eat a contaminated product every day for several years, the risk of cancer, although higher, was still likely to be very low.

"This compound is not a very potent carcinogen in animals," he said. "People should not be unduly concerned about the health effects."

"It is a good idea to remove this substance from the food chain, but this is being done simply as a precaution, not because there is an immediate impact on health."

(Source: newsvote.bbc.co.uk)

Federal Institute of Risk Assessment (BfR)
"Dyes Sudan I to IV in food"
BfR Opinion of 19 November 2003

Sudan I was classified as a category 3 carcinogen and as a category 3 mutagen (Annex I of the Directive 67/548/EEC) according to EU criteria. Substances in category 3 give rise to concern because of a possible carcinogenic effect in man but cannot be definitively assessed because of the lack of information.

For Sudan I, the possible intake amounts can be compared in the following way with the dose which led in animal experiments to neoplastic liver nodules.

In the case of an assumed high dye level (3500 mg/kg) and a large consumption amount of chilli powder (up to 500 mg/day), 1750 µg Sudan I can be taken in per day in the worst-case scenario. This corresponds to 29.2 µg/kg bodyweight (at a bodyweight of 60 kg). This amount is below the dose of 30 mg/kg bodyweight by a factor of 1 × 103 at which a statistically significant increase in the incidence of neoplastic liver nodules (NTP, 1982) was observed in animal experiments in rats after chronic administration with Sudan I in feed. In other words, the difference between the amount of Sudan I which can be taken in based on these assumptions in the worst case scenario per day (29.2 µg/kg bodyweight) and the amount at which a statistically significant increase in the incidence of neoplastic liver nodules was observed in animal experiments (30 mg/kg bodyweight) amounts to three orders of magnitude.

Assuming a lower dye level (e.g. 10 mg/kg) and a large consumption amount of chilli powder (up to 500 mg/day), 5 µg Sudan I can be taken in per day in the worst case scenario. This corresponds to 0.083 µg/kg bodyweight (at a bodyweight of 60 kg). This amount is below the dose of 30 mg/kg bodyweight by a factor of 3.6 × 105 at which a statistically significant increase in the incidence of neoplastic liver nodules (NTP, 1982) was observed in animal experiments in rats after chronic administration of Sudan I in the feed. In other words, the difference between the amount of Sudan I which can be taken in based on these assumptions in the worst case scenario per day (0.083 µg/kg bodyweight) and the amount at which a statistically significant increase in the incidence of neoplastic liver nodules was observed in animal experiments (30 mg/kg bodyweight) amounts to six orders of magnitude.

Conclusions

From the above assessments, the conclusion can be drawn that in the case of one-off or occasional consumption of foods which are contaminated with Sudan dyes in concentrations of a few milligrams per kilogram, the risk of cancer is probably very low. This is because the difference between the dye or amine amount, which can be taken in per day in conjunction with a high consumed amount in the worst-case scenario and the dose at which carcinogenic effects were observed in animal experiments is roughly five to seven orders of magnitude.

However, this can no longer be assumed for concentrations of several thousand milligrams per kilogram because the difference between the dye or amine amount, which can be taken in per day in conjunction with a high consumed amount in the worst-case scenario and the dose at which carcinogenic effects were observed in animal experiments, is now only two to three orders of magnitude.

The estimation that in the case of one-off or occasional consumption of only a few foods contaminated with Sudan dyes, the risk of cancer is probably very low but does not mean that there is no risk at all. For carcinogenic substances in category 2, whose action constitutes a clear cancer risk for human beings according to the current state of knowledge, no concentration can be given which could still be considered to be safe (DFG, 2003). Furthermore, the risk of course increases in the case of frequent or ongoing consumption. For precautionary reasons, the intake of substances of this kind should, therefore, be kept as low as possible and any exposure, if at all possible, avoided. This applies even more since intake of carcinogenic amines may also result from other applications like hair dyes (Platzek et al, 1999; SCCNFP, 2002) and the action of several different carcinogenic amines can lead to additive effects.

Furthermore, it should be borne in mind that risks which may be tolerable in the safety at work range must be assessed differently in the food sector if these are avoidable risks as they are in this case.

(Source: www.bfr.bund.de)

Exhibit 4: Indian Chilli Exports and Production

Year	Exports		Production	Annual Average Spot Prices of Indian Chilli in New York (US$/t)	Annual Average Prices of Chilli in India (Rs/t)	Export Share of Production % (of t)
	Value (Rs m)	Qty ('000 t)	Qty ('000 t)			
1998–99	2,529	68	1,043	1698	4134	6.5
1999–00	2,547	64	1,056	1587	3300	6.0
2000–01	2,297	62	1,046	1345	2393	6.0
2001–02	2,524	70	1,113	1301	2660	6.3
2002–03	3,151	81	846	800	3358	9.6

(Source: Spices Board of India)

Exhibit 5: Major Importing Countries of Indian Chilli

Country	1998–99		1999–00		2000–01		2001-02		2002-03		Five Year
	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Average Qty ('000 t)
Sri Lanka	730	20	599	18	618	21	700	25	**785**	**22**	21
USA	441	7	649	12	682	13	757	15	**868**	**17**	13
Bangladesh	445	11	183	4	33	1	86	3	**460**	**16**	7
EU [1]	147	3	205	4	243	5	232	4	**247**	**5**	4
Malaysia	61	1	213	5	74	2	107	3	**150**	4	3
Pakistan	320	15	199	8	87	3	68	3	**17**	**1**	6
Total of Above	**2144**	**57**	**2048**	**51**	**1737**	**45**	**1950**	**53**	**2527**	**65**	**54**
Overall Total	**2529**	**68**	**2547**	**64**	**2297**	**62**	**2524**	**70**	**3151**	**81**	**69**
% Share of Above countries	**85**	**84**	**80**	**80**	**76**	**73**	**77**	**76**	**80**	**80**	**79**

1.The top ten importing countries of EU, which accounted for almost the entire EU imports are elaborated below.

Country	1998–99		1999–00		2000–01		2001-02		2002-03		Five Year
	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Value (Rs m)	Qty ('000 t)	Average Qty ('000 t)
UK	80.0	1.40	87.0	1.42	92.8	1.67	104.7	1.92	98.0	1.80	1.64
Netherlands	16.0	0.30	29.0	0.57	47.1	1.08	33.1	0.75	39.0	0.82	0.70
Italy	22.0	0.39	43.0	0.75	41.3	0.79	36.1	0.62	41.0	0.69	0.65
France	8.5	0.20	14.0	0.30	14.9	0.37	16.0	0.38	13.0	0.29	0.31
Germany	3.5	0.09	11.0	0.34	10.0	0.19	9.5	0.22	11.0	0.24	0.21
Spain	3.5	0.06	4.6	0.07	17.6	0.27	17.5	0.26	20.0	0.34	0.20
Poland	2.8	0.10	2.6	0.11	5.6	0.21	2.4	0.09	4.7	0.16	0.13
Greece	3.7	0.08	12.0	0.24	5.8	0.13	5.0	0.11	5.1	0.10	0.13
Belgium	4.1	0.10	2.4	0.05	3.5	0.06	2.2	0.04	6.9	0.11	0.07
Sweden	3.2	0.02	0.1	0.00	4.2	0.06	5.0	0.05	8.7	0.08	0.04
EU Total	147	3	206	4	243	5	232	4	247	5	4

(Source: Spices Board of India)

Exhibit 6: India's Share of Chilli Imports of Some Major Importing Countries

Country	1998–99		1999–00		2000–01		2001-02		2002-03	
	Value (US$ m)	Qty ('000 t)	Value (US$ m)	Qty ('000 t)	Value (US$ m)	Qty ('000 t)	Value (US$ m)	Qty ('000 t)	Value (US$ m)	Qty ('000 t)
USA (Total)	89	54	90	57	96	59	99	66	125	85
USA (India)	13	9	19	12	18	12	18	14	21	17
India's Share (%)	14.9	15.9	21.0	21.0	18.7	21.1	18.1	20.6	16.4	19.6
EU (Total)			72		75		96			
EU (India)			5.7		5.9		6.1			
India's Share (%)			7.9		7.9		6.4			
Malaysia (Total)	22	23	35	29	32	29	30	33	35	40
Malaysia (India)	0.2	0.4	4.8	5.0	4.5	5.0	2.0	2.7	4.8	6.5
India's Share (%)	0.8	1.5	13.7	17.4	14.3	17.5	6.8	8.3	13.8	16.1
UK (Total)	16	5.3	12	4.7	12	5.1	14	7.5	14	6.2
UK (India)	2.1	1.4	2.5	1.7	2.4	1.7	2.4	1.9	2.6	2.2
India's Share (%)	13.3	25.8	21.3	36.7	20.8	33.8	17.5	25.2	18.9	35
Sri Lanka (Total)			18	20			17		18	25
Sri Lanka (India)			18	20			17		17	24
India's Share (%)			96.3	96.1			99.5		96.2	96.6

(Source: unstats.un.org)

Exhibit 7: Analytical Services of Spices Board of India

The QEL offers analytical services to the exporters, traders, farmers and research organisations for analysis of spices and spice products for various parameters listed below.

Sl No	Name of Analysis	Minimum Quantity Required for Analysis (gram)	Charges (Rs)	Time Required (No. of days)
1.	Agmark specifications	500	*	%
2.	ASTA specifications	500/250 × 10 Nos **	*	1
3.	Acid Insoluble ash	250	200	6
4.	Aflatoxin (B1,B2,G1,G2) (HPLC-METHOD)	250@	1200	6
5.	Alcohol soluble extract	250	100	4
6.	Bacillus Cereus	100	300	6
7.	Bulk density/litre weight of spices	1000	50	1
8.	Calcium as CaO	250	100	5
9.	Capsaicin - HPLC method (%SHU)	100@	280	4
10.	Capsaicin - Hv difference method (%SHU)	100@	200	4
11.	Chromate test (Qualitative)	100	80	2
12.	Clostridium Perfringens	100	400	6
13.	Cold water soluble extract	100	100	4
14.	Coliforms	100	180	5
15.	Colour value (ASTA METHOD)	100@	150	4
16.	Common salt	100	80	5
17.	Crocine	10	150	3
18.	Crude fibre	100	250	6
19.	Curcumin (ASTA METHOD)	100@	210	4
20.	Excreta, mamalin	500/250	50	1
21.	Excreta, others	500/250	50	1
22.	Extraneous / foreign matter	500/250	50	1
23.	E. Coli	100	150	4
24.	Filth, heavy	100	240	4
25.	Filth, light	100	240	5
26.	Heavy metals (Cd,Cr,Cu,Fe,Mg,Mo,Pb & Zn)	100@	100&	5
27.	Insect defiled / infested	500/250	50	1
28.	Light berries	250	70	1
29.	Moisture (ASTA METHOD)	250	70	2
30.	Mould (Microbiological)	100	100	5
31.	Mould (Physical)	250	50	1
32.	Non - volatile ether extract	100	120	6
33.	Oleoresin (EDC extractables)	100	120	5

(Continued)

(Continued)

Sl No	Name of Analysis	Minimum Quantity Required for Analysis (gram)	Charges (Rs)	Time Required (No. of days)
34.	Pesticide residues. Organochlorine Pesticides (Isomers of BHC, Endosulfan, DDT, Heptachlor, Aldrin, Dieldrin, Endrin and Endrin aldehyde)	200@	1200	6
35.	Pesticide residues. Organophosphorous Pesticides (Chlorpyriphos,Dimethoate, Disulfoton,Ethion, Methyl Parathion, Phorate, Parathion, and Quinalphos)	200@	1200	6
36.	Pesticide residues. Pyrethroid Pesticides (Cypermethrin and Fenvalerate)	200@	800	6
37.	Pesticide residues. Single compound (any of the above)	200@	800	6
38.	Picrocrocine	10	150	3
39.	Piperine (ASTA METHOD)	100@	200	4
40.	Residual solvent	200	400	3
41.	Safranal	10	150	3
42.	Salmonella	100	350	6
43.	Starch	100	230	6
44.	Staphylococcus aureus	100	350	6
45.	Sulphur dioxide	200	180	4
46.	Total ash	100	120	4
47.	Total plate count	100	120	3
48.	USFDA specifications	500/250 × 10 nos **	*	6
49.	Volatile oil	200@	70	3
50.	Vanillin	100	200	3
51.	Water soluble ash	100	150	6
52.	Whole insects, dead (by count)	250	50	1
53.	Yeast (Microbiological)	100	100	5
54.	Yeast and mould (microbiological)	100	180	5

Authorised by : CMS Issue No. 8 Issue Date 15/05/2001

Notes

% Depends on the number of parameters for individual spices and number of samples.

* Charges based on the parameter specified for each spice.

** In the case of analysis for ASTA/USDFA parameters, sample size should be a minimum of 500 g for heavier items like pepper, ginger, turmeric etc and 250 g sample for low density items like chilli and seed spices.

@ In the case of analysis of oleoresin samples of spices for the above parameters, a minimum of 50g sample size is required and in case of coriander and herbs, a sample size of 300 g is required.

& Analytical charges Rs 100/- per element.

The samples may be sent to the Senior Scientist (QC), Quality Evaluation Laboratory, Spices Board, Sugandha Bhavan, Palarivattom, Cochin-682 025, along with analytical charges in the form of cash/DD drawn in favour of Secretary, Spices Board.

(Source: www.vigyanprasar.com)

Exhibit 8: Excerpts from the Spices Board Act, 1986 and the Spices Board Rules, 1987

Excerpts from the Act

Chapter II: THE SPICES BOARD

7. Functions of the board

(1) The board may—

(i) develop, promote and regulate export of spices;

(ii) grant certificate for export of spices and register brokers therefor;

(iii) undertake programmes and projects for promotion of export of spices;

(iv) assist and encourage studies and research for improvement of processing, quality, techniques of grading and packaging of spices;

(v) strive towards stabilisation of prices of spices for export;

(vi) evolve suitable quality standards and introduce certification of quality through "Quality Marking" for spices for export;

(vii) control quality of spices for export;

(viii) give licences, subject to such terms and conditions as may be prescribed, to the manufacturers of spices for export;

(ix) market any spice, if it considers necessary, in the interest of promotion of export;

(x) provide warehousing facilities abroad for spices;

(xi) collect statistics with regard to spices for compilation and publication;

(xii) import, with the previous approval of the Central Government, any spice for sale; and

(xiii) advise the Central Government on matters relating to import and export of spices.

(2) The board may also—

(i) promote co-operative efforts among growers of cardamom;

(ii) ensure remunerative returns to growers of cardamom;

(iii) provide financial or other assistance for improved methods of cultivation and processing of cardamom, for replanting cardamom and for extension of cardamom growing areas;

(iv) regulate the sale of cardamom and stabilisation of prices of cardamom;

(v) provide training in cardamom testing and fixing grade standards of cardamom;

(vi) increase the consumption of cardamom and carry on propaganda for that purpose;

(vii) register and licence brokers (including auctioneers) of cardamom and persons engaged in the business of cardamom;

(viii) improve the marketing of cardamom;

(ix) collect statistics from growers, dealers and such other persons as may be prescribed on any matter relating to the cardamom industry; publish statistics so collected or portions thereof or extracts therefrom;

(x) secure better working conditions and the provision and improvement of amenities and incentives for workers; and

(xi) undertake, assist or encourage scientific, technological and economic research.

Chapter IV: CERTIFICATE FOR EXPORT OF SPICES

11. No person to export spices without certificate

Save as otherwise provided in this act, no person shall, after the commencement of this act, commence or carry on the business of export of any spice except under and in accordance with a certificate.

Provided that a person carrying on the business of export of spices immediately before the commencement of this act, may continue to do so for a period of three months from such commencement; and if he has made an application for such certificate within the said period of three months till the disposal of such application.

Explanation- The reference in this section to the commencement of this act shall be construed in relation to any spice added to the Schedule by notification under the provision to clause (n) of section 2 as reference to the date with effect from which such spice is added to the Schedule.

12. Grant of certificate

(1) An application for grant of certificate shall be made to the board in such form and shall contain such particulars as may be prescribed and shall be accompanied by a receipt evidencing the payment of the prescribed fee.

(2) On receipt of such application, the board shall,

(a) if the application is not in the prescribed form, or does not contain any of the prescribed particulars, return the application to the applicant; or

(b) if the application is in the prescribed form and contains the prescribed particulars, grant the certificate subject to such terms and conditions as may be determined by regulations.

13. Cancellation, suspension, etc. of certificate

(1) The board may cancel any certificate on any one or more of the following grounds, namely:

(a) that the holder of the certificate has violated any of the terms and conditions of the certificate; and

(b) that in the opinion of the Central Government it is necessary in the interests of general public to cancel the certificate.

(2) Where the board, for reasons to be recorded in writing, is satisfied that pending consideration of the question of canceling the certificate on any grounds mentioned in sub-section (1), it is necessary so to do, the board may, by order in writing, suspend the operation of the certificate for such period not exceeding forty-five days as may be specified in the order and require the holder of the certificate to show cause, within fifteen days from the date of receipt of such an order, as to why the suspension of the certificate should not be extended till the determination of the question as to whether the registration should be cancelled.

(3) No order of cancellation of registration under this section shall be made unless the person concerned has been given a reasonable opportunity of being heard in respect of the grounds for such cancellation.

14. Appeal

(1) Any person aggrieved by an order made under section 13 may prefer an appeal to the Central Government within such period as may be prescribed.

(2) No appeal shall be admitted if it is preferred after the expiry of the period prescribed therefore:

Provided that an appeal may be admitted after the expiry of the period prescribed therefore, if the appellant satisfies the Central Government that he had sufficient cause for not preferring the appeal within the prescribed period.

(3) Every appeal made under this section shall be made in such form and shall be accompanied by a copy of order appealed against and by such fees as may be prescribed.

(4) The procedure for disposing of an appeal shall be such as may be prescribed:

Provided that before disposing of an appeal, the appellant shall be given a reasonable opportunity of being heard.

(5) The Central Government may confirm, modify or reverse the order appealed against.

15. Power to permit export without certificate

The Central Government may, if satisfied that it is necessary or expedient, so to do, in public interest, by notification in the Official Gazette and subject to such conditions, if any, as may be specified therein, permit any body or other agency to commence or carry on the business of export of spices without a certificate.

(Source: www.legalpundits.com)

Spice House Certificate

The certificate is issued to those processors/exporters who have a genuine commitment to quality, and whose long-term objective is sustained export growth. The Spice House Certificate seeks to identify and recognise processors who have made investments in in-house processing facilities and infrastructure, and have the necessary competence to ensure consistent quality and reliability. These facilities cover all critical areas—cleaning, grading, processing, packaging and warehousing. A foolproof system of quality assurance should be employed at all stages of processing - from raw material selection to final shipping. The processors are also expected to maintain a high degree of sanitation in the plant, while the workers must observe absolute cleanliness and personnel hygiene.

Spice House Certificate holders have quality upgradation as their ultimate objective, but with a basic difference in focus.

The certification programme aims at exporters of spices and spice products in bulk packing. The products covered by the certification programme include whole spices as well as value-added products like spice mixes, ground spices, curry blends, spice oils oleoresins and sterilized, dehydrated, pickled and candied spices.

(Source: The Spices Board Act, 1986, www.indianspices.com)

FORM VII

(See Rule 15A)

SPICE HOUSE CERTIFICATE

SPICES BOARD

(Ministry of Commerce, Government of India, Cochin – 25)

Number................

M/s..exporter of spices having Exporter Registration No. are hereby granted this Spice House Certificate on the basis of their facilities for cleaning, processing, grading, warehousing, packaging of spices/spice products.

This Certificate is valid upto the ....day of ....

Place: Cochin Secretary

Date: (Seal)

SCHEDULE

FACILITIES TO BE MAINTAINED BY AN EXPORTER OF SPICES FOR GRANT OF A SPICE HOUSE CERTIFICATE

Processing Unit:

A	Cleaning	Shall have facilities for washing, removal of extraneous matters, stone, dust manual or automatic
B	Processing	Facilities for processing spices, spice mix, spice powders, oils, oleoresins or any other value added item.
	Drying	Shall have facilities for drying spices. The drying yards shall have cemented floors without crevices, provided with skirting all around and nets for preventing entry of birds.
	Details of other processing technology and equipments	A laboratory capable of analysing raw materials and the finished products.
C	Grading	Shall have facilities for grading spices using sieves mechanically or manually operated or for grading the spices by sorting machines or by manual means.
D	Warehousing	Shall have store houses/storage area separate for a raw materials and finished products. Storage premises shall have cemented floors without crevices provided with ceiling and doors to prevent entry of rodents and birds shall be provided with wooden pallets/wire mesh and kept clean to avoid entry of rodents, insects, spiders etc.
E	Packaging	Shall have facilities for packaging spices (manual or automatic)
F	Other Facilities	The unit shall be provided with washing facilities for hands and feet at the entrance of the unit. Toilets facilities separate for ladies and gents, washing facilities with soap. Head gears for workers. The surroundings of the unit shall be maintained free of weeds and dumped waste materials have facilities for disposal of waste material.

(Source: www.indianspices.com)

Excerpts from the Rules

Chapter IV: CERTIFICATE OF REGISTRATION

15. (1) An application for grant of certificate under section 12 shall be made to the Secretary of the Board in Form I.

(2) Every application for grant of certificate of registration shall be accompanied by a receipt evidencing the payment of fees of Rupees two thousand for a block period of three years ending on the 31st August or part thereof. Renewal fee for such period shall be Rupees one thousand.

15 (A) An exporter of spices who has his own or taken on rent or leased premises having facilities for cleaning, grading, processing, warehousing and packing as given in the Schedule annexed to these rules, may apply to the Secretary in Form IV for grant of a Spice House Certificate. The Secretary, on being satisfied as to the facilities available in the premises owned or taken on rent or lease for a period of not less than three years, shall issue a certificate in Form VII. The certificate shall be valid for the block period of three years for which the Exporter Registration Certificate is valid and it shall be renewed if he

maintains such facilities. If, on inspection at any time, it is found that the exporter does not have such facilities, the Spice House Certificate issued to him shall be cancelled.

16. (1) Any person aggrieved by an order of the Board made under section 13 may, within sixty days from the date of making of such order, appeal to the Central Government.

(2) Every appeal made under sub-section (1) shall be made in Form II and shall be accompanied by a copy of order appealed against and a receipt evidencing the payment of Rupees twenty-five.

(3) On receipt of appeal under sub-rule (1), the Central Government shall, after giving a reasonable opportunity to the appellant of being heard, pass such order as it may deem fit.

Source: The Spices Board Rules, 1987, Spices Board, Ministry of Commerce and Industry, Government of India, Cochin.

QUESTIONS FOR DISCUSSION

Putting oneself in the shoes of Mr Jose, the following questions can be raised:

1. What are the consequences that this event could trigger? Could it lead to a crisis?
2. What should be done immediately to control the damage caused by the event?
3. What course of actions should be considered to prevent the future recurrence of such an event?

APPROACH FOR ANALYSIS

As described in the case, the consequences of the event are quite far reaching and potentially severe, being related to a food item used in other products in turn. The events that could be impacted by this crisis can be mapped using tools from quality management and process flow charting.

Both short-term and long-term actions could be considered, keeping in view various stakeholders. The options of (a) sampling and testing by different agencies, and (b) pricing of testing services could impact the effectiveness of the system that is designed. Scheduling of activities of agencies involved in this process could also affect the viability of the new system. The facilities for testing need to be planned for the required turnaround times and volumes, and the required accuracy.

Case 8

CASE CONTEXT

Bayer CropScience is a world leader in the crop protection business. Significant challenges exist in ensuring availability of pesticides to farmers spread all over India. Indian agriculture is predominantly rain fed and crucially depends on the seasonal monsoon. Different pests could attack the standing crop during different phases of the crop life cycle. Forecasting the type and intensity of pest attacks across geographically dispersed territories is a challenge. The case describes the existing supply chain structure and focuses on the design of an efficient and effective supply chain that can meet such challenges.

BAYER CROPSCIENCE: Science for a Better Supply Chain

September 14, 2005
Jadcherla, Andhra Pradesh

Suresh Babu, Territory Manager for Jadcherla, was a worried person. Standing in the middle of a cotton field, he could clearly see the telltale signs of an extensive bollworm attack. This was the second year that farmers in Andhra Pradesh had planted BT cotton, supposedly resistant to bollworm attacks. Acreage under BT cotton had increased substantially since last year. Owing to premium pricing, a major section of farmers had opted for BT cotton seeds from illegal third-party sources. The quality of these seeds was always under doubt. Suresh Babu had taken a big risk by giving a sales plan of Spintor that matched last year's sales volume. Spintor was highly effective in controlling the bollworm pest and was a premium brand in the market. The big risk taken seemed to be turning in his favour a few days ago as bollworm attacks were reported to be at the same level as last year. Yet, Suresh could not believe his bad luck. A few feet away, the farmer was filling up the spraying machine with a mix of water and a cola-based soft drink. A rumour had spread

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Written by Saral Mukherjee and G. Raghuram. Cases of the Indian Institute of Management, Ahmedabad, are prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems.

through the district that cola-based soft drinks were particularly effective in resisting bollworm attacks. Within a few days, cola-based beverages were selling at a premium in the market. This meant that Spintor sales would not be anywhere near the quantities that Suresh had stocked at dealers and distributors.

Kaithal, Haryana

Sampat Singh, Regional Manager, had just finished calling the Logistics and Distribution Department (LDD) of Bayer CropScience at the Mumbai headquarters. He felt a growing anxiety as he recalled the day's events. Earlier in the day, he had talked to major dealers offering them a 10 per cent discount if they lifted a specified quantity of Sherpa Alpha. Sherpa Alpha was a generic product sold in a highly competitive market. By offering this discount, Singh was sure about capturing at least 25 per cent of the market. He had planned his moves well in advance. The discounts were announced only Wednesday morning and he planned to deliver the quantities by next Monday. This way the competitors would not have enough time to react even if they came to know of the development through the grapevine. As an experienced sales manager, he knew that speed of execution was a prime factor in the success of such moves. It was absolutely essential that the shelf space at dealers be blocked before others could do so. The amount of Sherpa Alpha lying in the godowns was not enough to meet the huge demand. Realising this, Singh had already been in touch with LDD and arrangements had been made to divert excess stock from nearby regions. Arrangement had also been made with the plant in Chandigarh to produce the excess requirement on a war footing. LDD was reasonably sure that all demand could be met by Monday morning. "All's well that ends well," thought Sampat Singh as he uttered a silent prayer.

Background

Bayer CropScience Limited was a leading firm in the fields of crop protection, non-agricultural pest control, seeds, and plant biotechnology. For the year ended December 2004, its annual turnover of Rs. 7,865 million constituted a major portion of the annual turnover of Rs. 19,816 million of the Bayer group in India. (Exhibit 1 provides details about different Bayer group companies in India.) Bayer CropScience had a market share of 20.2 per cent in 2004, down from 22.8 per cent in the previous year. Its main competitors were established players like Syngenta, Dow Chemicals, Du Pont, Monsanto, and Rallis.

The firm converted six zonal sales offices into four zonal profit centres in a recent restructuring exercise. The objective was to inculcate a spirit of entrepreneurship through a decentralised structure, empowerment, and accountability. (The organisation structure is shown in Exhibit 2.) The general managers at the zonal level enjoyed substantial decision making powers and had complete responsibility over all zonal functions. At the zonal level, the distribution and finance functions reported to the general manager with dotted relationship reporting to the head office (Exhibit 3).

Pesticide Market

The pesticide market was made up of insecticide, herbicide, and fungicide segments. Sales in all these segments were highly seasonal (Exhibit 4) and depended crucially on a good monsoon. A good monsoon resulted in well-nourished crops, which in turn, attracted a variety of pests. Different pests could attack the same crop during different stages of a crop life cycle (Exhibit 5). Thus different types of pesticides were effective during different stages of crop growth. Certain pesticides were prescribed as prophylactic applications to ensure that the crop was resistant to pest attacks. Curative application of pesticides focused on saving the crop once a pest attack had taken place.

Bayer CropScience sold 53 different pesticides in various pack sizes. Most of these products were established brands having high recall among farmers. (Details about two such products are given in Exhibit 6.) The technical superiority of its products allowed Bayer CropScience to command a premium in the market.

Planning Process

The planning cycle in a year was divided into the kharif season (April to November) and the rabi season (December to March). The planning for the kharif season was done in April when sales managers forecasted the demand for a particular product. This was arrived at by first forecasting the acreage under cultivation for different crops. Then, the percentage of total acreage to be covered by a particular product was determined. The forecasted sales of the product was arrived at by considering several factors like recommended dosage, number of sprayings, etc. Sales targets could be modified to reflect region-specific targets for market share, stock availability, and strategic considerations. Bayer CropScience divided the 53 products into four segments according to their gross margins (see Exhibit 7). The sales plan reflected the increasing focus on A and B categories.

Once finalised, the sales plan was converted to a monthly sales plan using the liquidation trend of sales of the previous year and uploaded in the SAP system. At any point in time, rolling sales forecasts (RFCs) were available in the SAP system for m (current month), (m + 1), (m + 2) and (m + 3) months. RFCs could be modified by generating a mid RFC around the fifteenth of a month. Additional RFCs could be generated according to the need (Exhibit 8). The SAP system determined the master production schedule (MPS), which was further fine-tuned following discussions with distribution. Once firmed up, MRP was run to determine the production plan for different production facilities and purchase requirements. (Different monthly planning activities undertaken by the Industrial Operations Planning (IOP) Department are given in Exhibit 9.)

Production

The production process involved two distinct stages. In the first stage, technicals (active ingredients) were produced in batches in large integrated plants at Thane in Maharashtra and Ankleshwar in Gujarat. The Ankleshwar plant was the sole production hub for worldwide sales of several technicals. Certain technicals were sourced from the associate firm Bilag Industries and some were imported. Technicals were stored in bulk in warehouses constructed following strict norms for storage of hazardous materials.

In the second stage, the end products were formulated by dissolving the active ingredients, solvents, and emulsifiers, and packaged in different sizes. Almost 40 per cent of the volume was formulated at Ankleshwar. Another 40 per cent was subcontracted to a firm at Kharar in Chandigarh. The rest was formulated at Himmatnagar in Gujarat and other subcontracting locations, referred to as tolling locations. In January 2004, the state of Jammu and Kashmir announced its industrial policy which offered excise duty waiver (currently 16 per cent) and a tax holiday of 10 years for new industrial units. Bayer CropScience was considering shifting a major portion of its formulation activities from different locations to Jammu to avail the benefits of the tax cut.

There were four production units at Ankleshwar (see Exhibit 10). The EC unit contained five vessels for dilution of technicals, one having 5 kilolitre (kl) capacity, three having 6 kl capacity, and one having 12 kl capacity. One vessel having 6 kl capacity was dedicated to herbicide production. Hence, at any point, a maximum of five different products could be formulated. After formulation, the material from any vessel could be directed to one of seven filling stations. The filling stations were dedicated according to pack sizes (see Exhibit 11).

Depending on vessel capacity, a minimum batch size of 2.5—5 kl was required for effective stirring. A smaller batch was considered uneconomical as the cost of running the motor used for stirring was invariant of the actual amount inside the vessel. Changeover from one product to another required flushing the entire system with a solvent. The solvent could be reused either in a future flushing or as an ingredient to the formulation process. Strict norms were enforced for checking the quality of flushing. A presence of no more than 800 parts per million of an active ingredient was essential for changing over from one insecticide to another or from an insecticide to an herbicide. For changing from herbicide to insecticide, the norm was zero parts per million. Changeovers took two shifts on average. The formulation units worked on a single shift basis in general and three shift basis during peak season (April to September).

The tolling unit at Kharar was operated by Punjab Pesticides Industrial Cooperative Society Limited (PPIC) and had 14 formulation lines. It supplied formulated products to several manufacturers apart from Bayer CropScience. Several formulation lines were dedicated to Bayer CropScience products during peak season. Working on a single shift basis it could formulate and pack 150 – 200 kl in a month. The plant could produce a maximum of 750 kl in a month working on a two-shift basis.

Distribution

Bayer CropScience did not have retail presence; instead relied solely on a network of dealers, distributors, and preferred dealers to service the demand. The sales organisation was made up of four zones, 25 regions and 169 territories. The South Zone, headquartered in Hyderabad, was by far the biggest (Exhibit 12) and looked after the sales in Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala. Andhra Pradesh accounted for almost 25 per cent of national sales. SKUs were transported from any one of the 13 manufacturing/tolling locations to 25 warehouses of which 17 were managed by carrying and forwarding agents (C&FA). (Some of the prominent manufacturing locations and headquarters are shown in Exhibit 13.) South Zone warehouses were located in Hyderabad, Guntur, and Kurnool in Andhra Pradesh, Hubli and Bangalore in Karnataka, Trichy and Coimbatore in Tamil Nadu, and Kottayam in Kerala. Seventy-five per cent of transportation from the manufacturing location to a warehouse used single source-single destination-multi product-full truckloads. The rest involved movement from a single source to multiple destinations on a full truckload basis. From the warehouses, 80 per cent of the material was moved to the distributors in full truckload milk runs. The rest was sent as parcels to a single destination. Distributors managed the movement of material to dealers using auto-rickshaws and public transport. In Andhra Pradesh, for example, the dealer telephoned the distributor and placed his order. The orders received during the day were dispatched between 9.30 pm and 3.30 am. A preferred dealer (PD) was appointed in certain satellite markets. A PD was primarily a dealer who was serviced directly from the warehouses. PD could also act as a distributor and sell to other small dealers and big farmers who would in turn supply to co-farmers. In all, Bayer CropScience sold through a network of 2,500 distributors and 35,000 dealers.

Trade Promotions

Individual farmers bought their pesticide requirements from dealers located in nearby markets. Such dealers generally stocked other agricultural inputs like seeds and fertilizers besides pesticides. Trade promotions constituted an important marketing tool in stimulating demand in the market. The promotional schemes were territory-specific and could be categorised into two distinct classes. Liquidation discounts involved SKU-specific discounts offered to liquidate stocks with dealers. Such discounts were floated during the season and were intended to create a "hungama" (excitement) in the market. In contrast, placement discounts were based on the quantity of pesticide stock that a dealer ordered before the start of the season. For example, a dealer may be offered a cash discount of 10 per cent on demand draft and 9.5 per cent on cheques in January for stocks that were likely to be sold during the kharif season. The cash discount would reduce by 1.5 per cent each month. The discount could also be in the form of promotional schemes like gold coins. Such promotional schemes were commonly employed by almost all major players in the pesticide market.

The main objective of trade promotions was to garner shelf space. An effective way to "book" shelf space was to induce the dealer to park a part of his working capital with Bayer CropScience. A dealer could transfer a lumpsum amount to Bayer CropScience in January without specifying the SKU-wise requirement. The actual order was then placed at the beginning of the season in April and stocks delivered subsequently. The attractiveness of a promotional scheme depended on whether the dealer paid cash or took material on credit. In 2005, dealers in Punjab and Haryana had surplus cash and could afford to commit funds well in advance. In contrast, Andhra Pradesh was primarily a credit market.

Inventory Management

Availability of the right pesticide in the right market at the right time was key to profitability. The nature and quantum of pest attack was difficult to predict. The extent of a pest attack could be significantly affected by temperature and rainfall. Indian agriculture relied heavily on monsoon rains. Monsoon activity was difficult to predict in aggregate, more so at local level. (The sales forecast accuracy for the Jadcherla territory for 2004 is given in Exhibit 14.) The inherent uncertainty meant that stock built up at a particular location in anticipation of a pest attack could suddenly become redundant. Stocks returned from distributors to warehouses were termed sales returns. Sales returns averaged 3.4 per cent in 2004, down from 6-7 per cent in earlier years. Such stocks could then be moved to another location and were classified as intra-zonal or inter-zonal transfers (Exhibit 12) depending on the destination. The company did not separately track the intra and inter-zonal transfers arising from a sales return from those arising out of other reasons. Stocks returned by a zone from its warehouses to manufacturing units constituted branch returns. These stocks were either near expiry or expired stocks. Sales returns exhibited significant variability from one location to another and also from one season to another.

Bayer CropScience tracked the inventory lying in different manufacturing and warehouse locations using the SAP platform on a real-time basis. However, stock level information was available only till the distributor level. This information was used in deciding to call back stocks from one location for redeployment in another location. Redeployment entailed certain risks. In one example, the company decided to redeploy stocks following less than adequate rainfall in a particular territory. Five days after redeploying Rs. 41 million of stocks, substantial rainfall changed the odds of a pest attack. A decision was taken the day after the rains to rebuild the inventory in that territory. Of the Rs 47 million worth of stocks rebuilt, only Rs. 10 million was the same product as earlier stocked. Redeployment of stocks was possible to the extent that the crop sowing date differed from one territory to another. Redeployments were mostly to nearby territories and within a zone. Inter-zonal redeployments were rare.

Most pesticides had a shelf life of two years. The company tracked the expiry date of stocks located in different locations and classified stock as “near expiry” if the expiry date was less than three months away. After a season was over, dealers showed an aversion to keeping unsold stocks even if the stocks were not classified as near expiry. Unsold stocks were returned by dealers and could only be repositioned at the beginning of the next season, that too after offering a discount. Old stocks could be reprocessed any time before the expiry date. Reprocessing allowed the shelf life to be extended by two more years and entailed a reprocessing cost amounting to 28 per cent of the original manufacturing cost. The company employed first-in-first-out (FIFO) rule in all inventory related decisions. In a recent initiative, the zones were being asked to return all unsold stocks after a season for reprocessing. All expired stocks had to be incinerated. In 2004, the company had to write off Rs 85 million of stocks. A further Rs 70 million constituted material loss during reprocessing. It did not track the revenue loss arising from non-availability of stocks.

A further complication involved availability of different pack sizes for a particular product. On an average, each of the 53 products had four pack sizes, resulting in more than 200 SKUs. The pesticide price per ml depended on the pack size and could vary considerably (Exhibit 6). The IOP Department tried to schedule the production of bigger pack sizes during the season and smaller pack sizes during the off season. This was done since, for a specific production quantity, the filling time for smaller pack sizes were more than that for a bigger pack size.

Inventory planning was based on determination of the stock coverage representing the ratio of stocks to sales. The coverage ratio was tracked on a zonal and national basis and could be tracked on an aggregate basis and also on a specific SKU basis. A target inventory norm of 1.5 months coverage was considered ideal. In practice, the stock coverage varied from 1.5 to 3 months and could be set depending on the product and market conditions.

Science for a Better Supply Chain

September 14, 2005
Mumbai, Maharashtra

Susan D'Costa, planning executive at LDD, was updating a report on the forecast accuracy for presentation to top management. Forecast accuracy had been hotly debated in the headquarters. Earlier in the day, the report seemed to be almost complete when she received data regarding the sudden demand for Sherpa Alpha which was well above the sales forecast. More disturbing was the news about Spintor that came from the Hyderabad office. For a long time, D'Costa had been emphatically stating, "We need a better forecast". She felt time had come to reinforce the need for a better forecast.

As she finished updating the forecast data, D'Costa wondered whether there were alternative forecasting techniques for the pesticide market. Could a better forecast be a competitive tool? Could Bayer CropScience align its supply chain to be responsive to market requirements? Such a move could actually reduce the reliance on a sales forecast. But it may need substantial changes in the manufacturing and logistics processes apart from a change in the organisational mindset. Similarly, promotion schemes needed to be aligned with the supply chain strategy. On her desk, was a company brochure prominently displaying the mission statement adopted by Bayer worldwide: "Bayer: Science for a better life." Perhaps the need of the hour in the Indian pesticide market was a science for a better supply chain.

Exhibit 1: Bayer Group of Companies in India

Bayer CropScience Limited, erstwhile Bayer (India) Limited, constituted the core cropscience company and had production facilities at Thane, Himmatnagar, and Ankleshwar.

Bayer Diagnostics India Limited, with headquarters and production facilities in Vadodara, had been active in India since 1976 and had a leading position in the market for medical diagnostic devices.

Bayer Pharmaceuticals Private Limited was established in July 2000 and was a wholly owned pharmaceutical subsidiary of Bayer Industries Limited. The company handled pharmaceutical sales and marketing operations.

Bayer Material Science Private Limited was one of the largest producers of polymers and high-performance plastics. The company had a plant in Cuddalore, near Chennai, which manufactured thermoplastic polyurethanes.

Proagro Seed Company Private Limited, headquartered in Hyderabad, was involved in activities in bioscience to develop hybrid seeds for crops catering to specific farmers' needs across India. The company, incorporated in 1977, had emerged as a national player having the advantage of technology transfer, excellent R&D facilities, and presence in hybrid as well as field crops.

Bilag Industries Private Limited was one of the largest manufacturers of synthetic pyrethroids in the world.

Bayer Polychem (India) Limited, was a 100 per cent subsidiary of Bayer CropScience Limited, and handled non-cropscience businesses which were earlier part of Bayer (India) Limited.

Exhibit 2: Organization Structure of Bayer CropScience

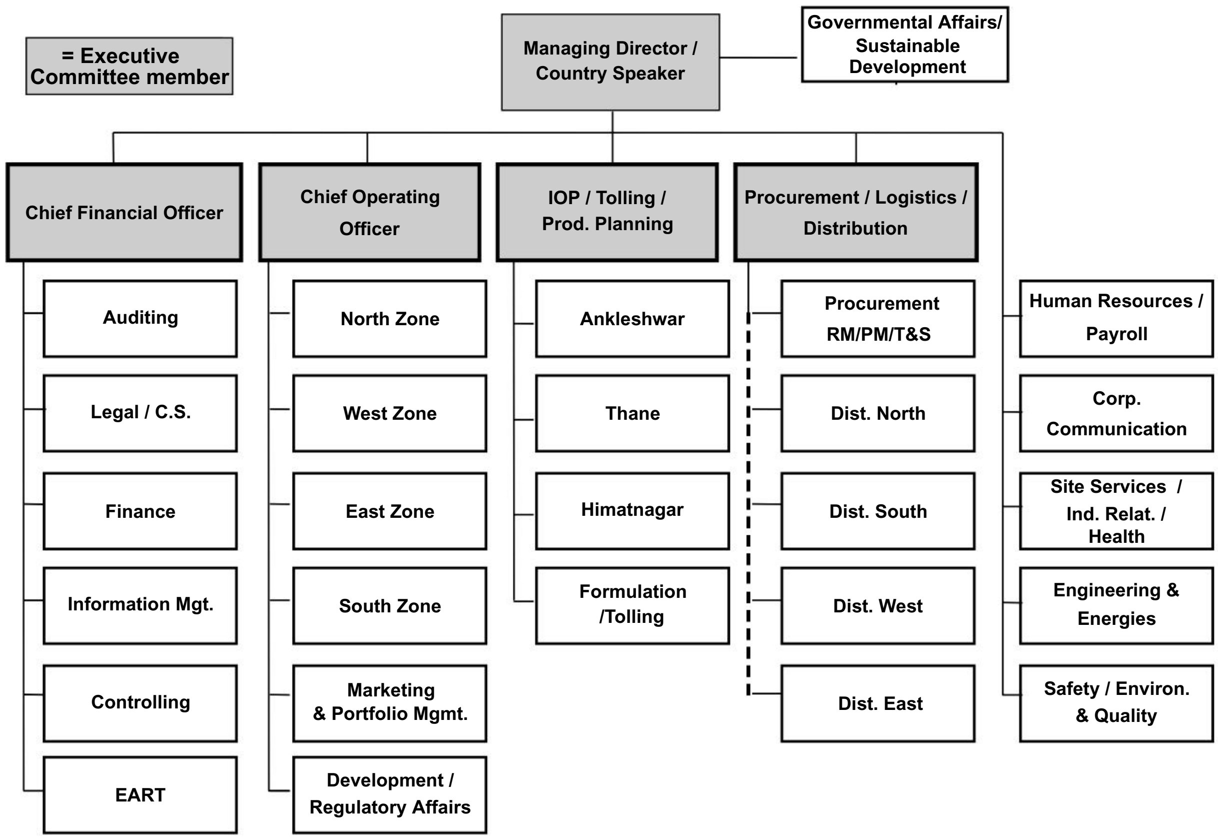


Exhibit 3: Zonal Organization Structure of Bayer CropScience

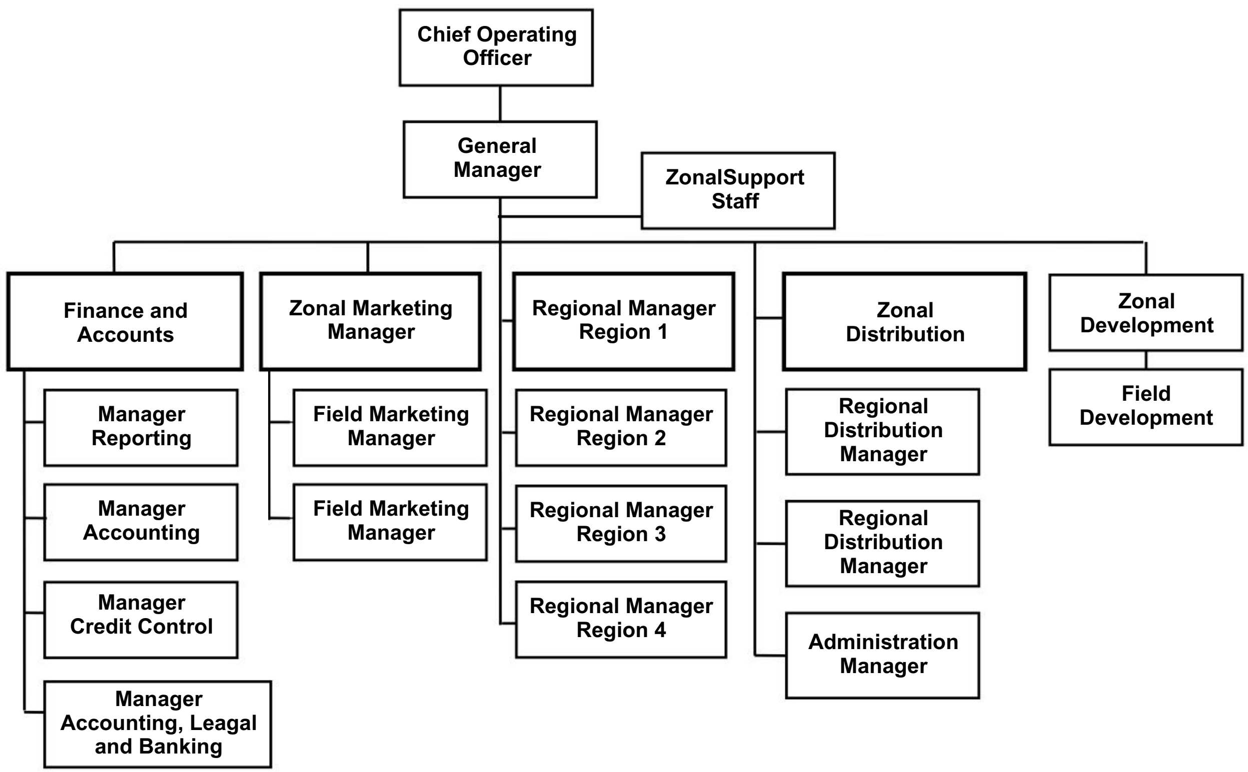


Exhibit 4: Seasonality

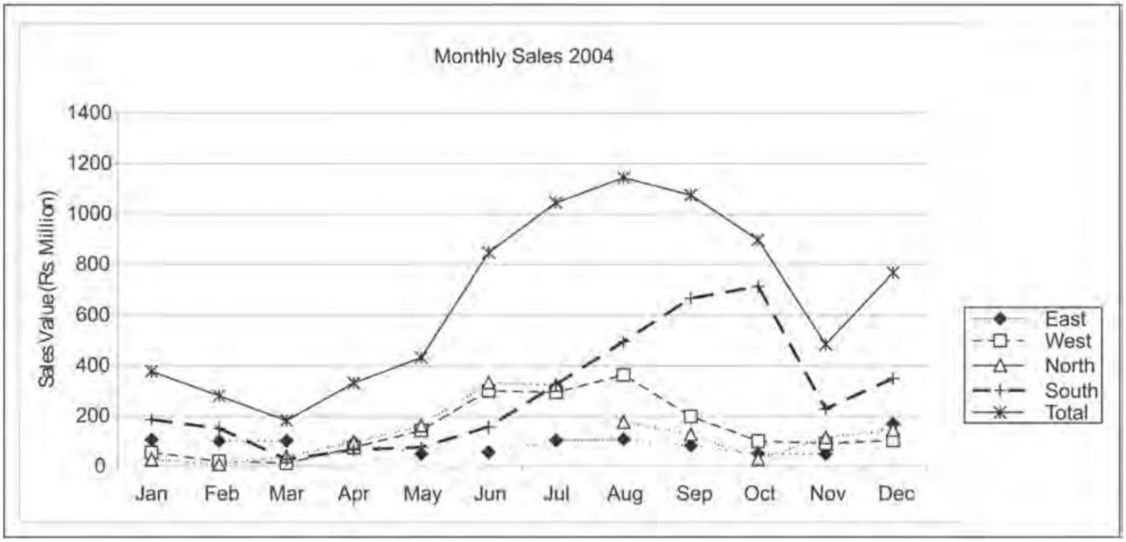


Exhibit 5: Pest Attacks on Cotton

Days	Pest	Application	Bayer Product
0 – 30	Sucking Pest	Prophylactic (50%)	Confidor
30 – 45	Sucking Pest	Prophylactic (50%)	Confidor-Metasystox
45 – 60	Bollworm	Prophylactic (20%)	Thiodan-Hostathion-Sherpa alpha-Bilcyp-Decis-Cybil
60 – 75	Sucking Pest + Bollworm		Thiodan-Hostathion-Spark Decis-2.8ec-Larvin-Spintor Decis100-Confidor-Metasystox
75 – 90	Mixed infestation	Curative (90%)	Thiodan-Hostathion-Spark Decis-2.8ec-Larvin-Spintor Decis100-Confidor-Metasystox
90 – 120	Mixed infestation	Curative (90%)	Thiodan-Hostathion Spark-Decis-2.8ec-Larvin Spintor-Decis100-Confidor-Metasystox

Exhibit 6: Product Details

Product	Spintor	Sherpa Alpha
Type	Insecticide	Insecticide
Technical	Spinocyte	Alphamethrin (Synthetic pyrethroid)
Crop	Cotton	Cotton
Pests	Bollworm	Initial Stage of Bollworm
Pack Sizes and MRP	75 ml – Rs 888 250 ml – Rs 2766 1ltr- Rs 377 5ltr- Rs 1850	250ml- Rs 103 500ml- Rs 193
Distributor Margin	25–30% of MRP	25–30% of MRP
Bayer Gross Margin	16% of MRP	32% of MRP

Exhibit 7: Categorisation of Products

Category	Gross Margin	Objective
A	30-40 %	Invest in branding
B	10-20 %	Milking
C	5-9 %	Phase out
D	< 5 %	Phase out

Exhibit 8: Monthwise Value of Projected Sales Plan as per First RFC and Variations: 2004

(Rs million)

East	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Plan	111.0	87.8	93.7	53.2	28.2	49.9	82.1	102.3	77.3	47.7	49.1	133.4	915.7
Additional	-3.8	13.2	8.2	42.2	22.3	6.8	21.4	6.0	5.6	3.4	0.8	35.8	162.0
Total	107.2	101.0	101.9	95.4	50.5	56.7	103.5	108.3	82.9	51.0	49.9	169.3	1077.7
% variation	-3.4	15.0	8.8	79.3	79.1	13.5	26.1	5.9	7.3	7.1	1.6	26.9	17.7

West	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Plan	43.5	20.2	12.6	72.3	119.9	275.4	314.8	366.3	129.3	89.5	86.4	74.5	1604.7
Additional	12.8	–0.2	0.7	3.2	23.4	25.3	-20.5	-2.8	69.0	12.0	5.3	28.9	157.1
Total	56.3	20.0	13.2	75.5	143.3	300.7	294.3	363.5	198.3	101.5	91.7	103.3	1761.8
% variation	29.5	–0.9	5.2	4.4	19.5	9.2	-6.5	-0.8	53.4	13.4	6.2	38.7	9.8

North	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Plan	31.4	50.5	44.6	71.0	131.2	328.8	211.7	258.6	58.1	52.0	111.6	123.9	1473.4
Additional	-3.7	–42.5	-5.3	23.9	31.2	4.0	110.7	-82.1	68.6	-21.5	3.3	21.5	108.1
Total	27.7	8.0	39.3	94.9	162.4	332.9	322.5	176.5	126.7	30.5	114.9	145.4	1581.5
% variation	-11.6	–84.2	-12.0	33.6	23.8	1.2	52.3	-31.7	118.1	-41.3	2.9	17.3	7.3

South	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Plan	165.1	157.8	17.5	50.4	68.1	150.1	267.6	458.1	501.6	531.1	227.7	217.4	2812.5
Additional	21.3	-6.5	10.6	15.2	8.7	6.4	57.0	37.2	165.7	183.4	0.8	131.8	631.5
Total	186.4	151.3	28.0	65.6	76.8	156.5	324.6	495.4	667.3	714.5	228.5	349.2	3444.0
% variation	12.9	–4.1	60.5	30.2	12.8	4.3	21.3	8.1	33.0	34.5	0.3	60.6	22.5

All 4 Zones	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Plan	350.9	316.3	168.4	246.9	347.4	804.3	876.2	1185.3	766.3	720.2	474.8	549.3	6806.2
Additional	26.7	–36.0	14.1	84.5	85.6	42.5	168.6	-41.6	308.9	177.3	10.2	218.0	1058.8
Total	377.6	280.3	182.4	331.4	433.0	846.8	1044.8	1143.7	1075.2	897.5	485.0	767.2	7865.0
% variation	7.6	–11.4	8.4	34.2	24.6	5.3	19.2	-3.5	40.3	24.6	2.2	39.7	15.6

Exhibit 9: Monthly Planning Cycle

Day of Month	Activity
4	Receipt of RFC
4 – 6	Generate MPS
6	Meeting between IOP and Distribution
6 – 7	Release Production Plan
8 – 9	Release Requisition for Procurement
12	Release Import Plan
16 – 17	Mid Month Review
28	Production Plan for next 10 days

Exhibit 10: Formulation Units

Unit	Type	Material	Monthly Capacity
WP I	Herbicide	Powder	100 t
WP II	Insecticide	Powder	90 t
Ezeetab	Insecticide	Tablets	1.2 m
EC	Insecticide/Herbicide	Liquid	750 kl

Exhibit 11: Filling Stations

Filling Station	Container Type	Pack Size	Capacity per Shift Units
Bulk	Flexible	20-200 ltr	300
	Flexible	5 ltr	1300
	Tin	5 ltr	1700
Small pack	PET	250/500 ml	9000
	PET	500 ml	8000
	PET	250 – 1000 ml	9000
	PET/ Co-EX	250 – 1000 ml	9000

Exhibit 12: Zonal Transfers (2004)

(Rs million)

	East	West	North	South
Sales	1077.7	1761.8	1581.5	3444.0
Transfer within zone	46.74	26.35	37.44	37.15
Transfers outside zone	6.68	29.56	87.14	5.78
Branch returns	4.40	0.91	3.75	1.40

Exhibit 13: Prominent Locations

Exhibit 14: Sales Forecast Accuracy for Jadcherla Market (2004)

Product	Pack	Forecast (Kg. or L)	Sales (Kg. or L)	Product	Pack	Forecast (Kg. or L)	Sales (Kg. or L)
Antracol	100 g	56	34.8	Metasystox	100 ml	56	12.6
	250 g	77	35.5		250 ml	84	26
	500 g	203	25.0		500 ml	91	38.5
	1 Kg	175	10.0		1 L	42	51
Bayrusil	500 ml	35	98.5	Planofix	100 ml	112	65.4
	1 L	175	178.0		250 ml	294	107.5
	5 L	210	125.0		500 ml	122.5	119
Bilcyp	100 ml	7	28.8		1 L	35	148
	250 ml	60	51.5	Quintal	100 g	39.2	22.2
	500 ml	210	57.0		250 g	39.2	30
	1 L	179	106.0		500 g	21	8.5
Bilzeb	500 g	70	13.8		1 Kg	28	4
	1 Kg	70	18.0	Raft	250 ml	385	250
Confidor	50 ml	49	19.8		500 ml	280	58.5
	100 ml	28	12.6		1 L	70	16
Decis	100 ml	7	16.2	Sevin	100 g	21	6
	250 ml	28	33.0		500 g	28	31.5
	500 ml	14	49.5	Sherpa Alpha	250 ml	21	8.5
Derosal	100 g	154	34.8		500 ml	70	36.5
	25 Kg	450	225.0		1 L	98	44
Folidol Dust	5 Kg	2100	1955.0	Spark	100 ml	21	29.4
	10 Kg	4200	2280.0		250 ml	56	57.5
	25 Kg	35000	26200.0		500 ml	63	86.5
Hostathion	100 ml	14	72.0		1 L	28	112
	250 ml	56	725.5	Spintor	75 ml	140	7.5
	500 ml	126	1451.5		250 ml	126	8.5
	1 L	8561	5235.0	Thiodan	100 ml	280	45.6
	5 L	14145	4355.0		250 ml	14	90
	20 L	1120	2020.0		500 ml	1050	945
Metacid	100 ml	4	43.2		1 L	6510	6861
	250 ml	14	74.5		5 L	9625	6765
	500 ml	35	118.5	Whip Super	250 ml	350	604.5
	1 L	140	111.0		500 ml	2660	3585

QUESTIONS FOR DISCUSSION

1. What are the supply chain challenges faced by Bayer CropScience?
2. Would Bayer CropScience be able to meet these challenges?
3. What would be the right inventories to hold at the beginning of each crop cycle?
4. What would be the changes to be implemented in a redesigned supply chain? This should be accompanied by an implementation plan.

APPROACH FOR ANALYSIS

Different performance measures can be used to diagnose whether the Bayer CropScience supply chain requires a re-structuring.

Uniform production would require some actions to deploy the output. One is to maintain inventory at the factories/warehouses and deploy them at short notice at the locations where they are demanded. Another is to push inventories to dealers in anticipation of demand, through a price promotional policy. If uniform production is not sacrosanct, restructuring the production process to blend chemicals appropriately to make the right products closer to time of use can be an option. These options can be evaluated from the data in the case.

The problem of stocking optimal amounts to avoid an excess of overstocking or an excess of shortages can be addressed through the tools of probabilistic inventory, in particular, the newsvendor logic. The probability of pests attacking can be estimated using the given data.

Case 9

CASE CONTEXT

FoodWorld was a division of Spencer's, the retailing company under RPG Enterprises (RPG). This case focuses on the supply chain strategy and throws up some fundamental questions to do with retailing, in the introduction. At the time of the case, FoodWorld operated with over 6,000 stock keeping units (SKU's), but were planning to rationalise to a figure closer to 3,000. The thrust on sourcing was to source directly from a point as far upstream as possible. This was also expected to reduce time and cost of procurement.

The above issues were rendered more significant due to FoodWorld seeing growth opportunities in (a) the perishables and non-branded groceries and (b) an increase in the number of outlets from the current 19 to 50 in two years, and to even more ambitious figures in the future.

FOODWORLD B: SUPPLY CHAIN STRATEGY

Introduction

"The key to our success, given where we are, is effective supply chain management," was the sentiment echoed by Mr Shiv Murti, the portly affable Vice President (Merchandising) of FoodWorld. Having established itself as a long term, large and "here to stay" player in the organised food retailing industry, the primary supply chain management concern for FoodWorld was how to negotiate best terms for supply of products and source them from as upstream as possible in the supply chain.

Case prepared by G. Raghuram, Bibek Banerjee and Abraham Koshy, Indian Institute of Management, Ahmedabad as a basis for class discussion. Research assistance of Parvathy Raman and Anita Basalingappa is acknowledged. The case is prepared as a basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The authors wish to thank Mr. PK Mohapatra, Mr. Shiv Murti, Mr. Ganesh Chella and other top managers of FoodWorld for their generous cooperation and financial support in preparing this case.

FoodWorld operated with over 6,000 stock keeping units (SKU's) of which 80% were from the organised sector. The remaining, which were from the unorganised sector, consisted of two supply channels. One was the perishables, which needed to be sourced fresh, with a focus on quality and direct delivery to stores. The other was the non perishables, which were repacked and sold under the FoodWorld brand. The challenge in the organised sector SKU's (which were essentially branded non perishables) was to be able to deal with the principal directly and obtain as much of a price advantage as possible. The challenge in the unorganised sector SKU's (which were growing in number and volume as per customer expectations, and also had the potential of high margins) was to identify right sources and have good quality management processes.

In a functional sense, the key issues to be dealt with were (a) what to stock, (b) whom and where to source from, (c) how to reduce total delivery time from vendor to store, and (d) how to reduce the cost of procurement.

Company Background

FoodWorld was a division of Spencer's, the retailing company under RPG Enterprises (RPG). RPG was among the top five business houses in India, with sales of about 65 billion rupees in 1996-97. Its asset base was over 75 billion rupees in 1997. RPG's business interests spanned a variety of sectors including power, tyres, agribusiness, telecommunications, retailing and others including financial services. RPG got into retailing with the acquisition of Spencer's & Co in 1989. It had a large number of partnerships with international companies, including from among the Fortune 500 companies. For FoodWorld, there was a partnership with Dairy Farm International, a large retail house in Hong Kong.

Spencer's & Co had been founded in Madras (now renamed as Chennai) in 1865 offering imported items to the large British expatriate and military population. By 1897, it had grown to be the largest store in India with 65,000 square feet of shopping space. At its peak in 1940, it had 50 stores in most of the major cities in India. It also had backward integrated into making some of the products that it sold, like soft drinks, cosmetics etc. After India gained independence from the British in 1947, sales dropped significantly, though Spencer's some how survived and continued to offer food, clothing, cosmetics and other high priced speciality items. The customers were primarily the expatriate community.

Due to its deteriorating sales, Spencer's had been open for acquisition. In the early 70's, ownership changed once. In 1989, RPG purchased Spencer's, and established it as a separate division under the leadership of P K Mohapatra, a senior RPG executive. The primary motive for this acquisition was the undervalued real estate.

At that time, Spencer's had nine stores and was the largest retail chain in India. Though one of the options was to simply focus on the development of the real estate offered by Spencer's, the RPG executives looking after Spencer's felt that the retail business potential should not be given up easily. It was decided to experiment with one store to test its potential. If the experiment failed, RPG would close the retail operations. The departmental store in Bangalore was modernised in 1991, retaining its product profile of hardware, food, kitchen appliances and clothing. When the store opened, sales increased to four times the previous levels and returned a healthy contribution. Shiv Murti, who had joined Spencer's to head merchandising, had played a significant role in this turnaround. This settled the issue in favour of continuing with the more important Spencer's activities including retailing, the airline general sales agency (GSA) and pharmaceuticals. From Rs. 25 crores at the time of acquisition, turnover had risen to Rs. 100 crores by 1994 through a careful process of nurturing the three activities, while dropping over 20 others. The airline GSA accounted for over 80% of the turnover.

During 1994-95, the RPG group went through a reassessment of its portfolio of activities with the help of a large international consulting firm. It was recommended that retail business development should be one of the key thrusts (along with telecommunication and financial services), since it offered a lot of growth potential. There was an emerging middle class who had barely had a glimpse of modern retailing. Retailing had traditionally been in the "non formal" small sector, and had remained unchanged for over a century.

The issue then was whether to build on the Spencer's image or consider a fresh start. Leveraging on Spencer's for retail business development had its risks. While the "Spencer's" brand name was widely associated with quality, it also had a connotation of high prices. The popularity of this was reflected in the expression, "paying the Spencer's price," which was commonly used to suggest the payment of high prices. Further, the existing Spencer's employees were both poorly qualified and underpaid. It was decided that a new retailing format, with no link to Spencer's, would be developed.

Based on a study of retail chains world over, it was felt that the retail format should be 'mass' based rather than 'niche' based, since it offered greater growth potential. In order to develop a mass base, it was decided that the retailing should focus on the daily livelihood of people. Food, clothing and health care products were considered. Clothing was dropped, since RPG had no background in either the fashion industry or textile manufacturing, considered essential for success in this area. Food was selected as the first area of entry, to be followed by health care products.

FoodWorld

After a study of customer preferences in early 1996, the supermarket format was selected to offer (a) value based on price and quality, (b) choice through self service from a spread of merchandise and (c) a better shopping environment. In terms of location, three choices were considered (in decreasing order of property prices), (a) commercial high street, (b) residential high street and (c) out of town. Since the supermarket was to be positioned as a one stop shop for all food related items during a shopping outing, the commercial high street was not that important. Further, with the mass based positioning, the middle income group was considered the primary target. This group would not have access to their own transport or would not fancy spending time on transportation for supermarket shopping. Hence, the out of town location concept was dropped and the residential high street was decided on.

Various 'ideal' sizes were considered, keeping in mind likely costs and availability of properties, ranging from 1,200 sq ft to 6,000 sq ft. Given the self service format and the merchandising choice, a minimum size of 3,000 sq ft was considered essential, while 4,500 sq ft would be the preferred size. All stores would be air-conditioned, and offer extensive assortments of groceries, personal care and the cleaning products, kitchenware, and tableware. There would also be a fast food and bakery section. The attempt would be to provide a pleasant ambience and offer outstanding customer service. With this concept in view, a name had to be selected for the supermarket retail chain. After brainstorming for a suitable name, and some market research, the FoodWorld name was selected, along with logo and the bright red and orange signature colour.

The first FoodWorld store was launched on May 9, 1996 in Chennai (Exhibit 1). This was followed by a store in Bangalore (August 20, 1996), and then by two more in Chennai (September 1, 1996). The M G Road, Bangalore and part of the Mount Road, Chennai Spencer's stores were converted as FoodWorld stores in December 1996. New stores were opened at regular intervals, until the current tally of 19 (six in Chennai, eight in Bangalore and five in Hyderabad). In the FoodWorld chain, an investment of Rs 65 crores had been made so far. The turnover during 1996-97 was Rs 21 crores, 1997-98 was Rs 42 crores, with a projection of Rs 87 crores in 1998-99 (of which Rs 52 crores had been achieved during April-November, 1998). Exhibit 2 gives the performance trends for 1996-97, 1997-98 and April-November, 1998, classified and aggregated according to the stores opened during the three periods.

The gross margin on this turnover was 16.7% in 1996-97, 18.4% in 1997-98 and projected at 20.5% in 1998-99. (The actuals during April-November 1998 was 18.4%.) Every one of the stores had broken even within a few months of start and made a contribution towards regional and corporate expenses. The store operating expenses as a percentage of sales reduced over time as seen in Exhibit 2. This figure during the first year of operations was higher for later stores, reflecting higher startup costs. The M G Road store in Bangalore had a gross margin and store operating expenses (as a percentage of sales) of 13.0% and 7.2% respectively in 1996-97, 18.7% and 7.4% respectively in 1997-98 and 18.3% and 6.8% respectively for April-November 1998. Within store operating expenses, salaries and wages accounted for about 2.5% of sales, rent about 2.2%, shrinkage about 1.6% and depreciation about 0.7%. In the future, salaries and wages, rent and depreciation was expected to increase as newer and more expensive properties were to be acquired. FoodWorld as a business enterprise was still in the red. This was typical of large retail startup businesses where a critical number of outlets were necessary before the bottom line was positive.

Apart from increasing turnover in each of the stores by leveraging a large store network, it would be imperative to increase margins to ensure sustainability and growth of the enterprise. This would require appropriate sourcing and negotiating with suppliers for better margins, and achieving efficiencies in the regional distribution system that FoodWorld had in place. In this context, the merchandising function (what specific products/brands to offer, whom to source from) and the distribution strategy (how to organize the logistics of supply to the stores) gained significance as critical success factors.

Merchandising Function

The merchandising function was carried both at the centralised level (in the corporate office of FoodWorld at Chennai) and the regional levels. Exhibit 3 gives the organisation structure of FoodWorld, showing the merchandising function along with other key "line" and support functions, including the regional setup. Exhibit 4 gives the organisation structure of the regional setup. The position of FoodWorld along with other profit centres, and corporate level staff functions under Mr P K Mohapatra is given in exhibit 5. Each of the six units (each consisting of profit centres and/or corporate level staff functions) was headed either by a President or a General Manager.

The merchandising strategy began with the customer preference study mentioned earlier. This study highlighted the following customer expectations in terms of considering the store for food purchase.

Product range

Variety for choice in a given product

Freshness

Availability

Reasonable price (not more than neighbourhood stores)

In response to this, FoodWorld executives decided that the core range of products would consist of everything that a household shopped for on a daily/weekly/monthly basis. Insights into this were obtained based on customers' shopping lists and budgets. A merchandising offer consisting of seven major groups, namely, staples, processed foods, beverages, non-food, health & beauty, perishables and hard ware and home appliances was finalised. These were divided into 49 categories, with a category descriptor as destination, strategic (routine), convenience and speciality (occasional), depending upon essentiality in the customers' purchase basket and frequency of purchase. Exhibit 6 gives a categorywise description as of December, 1998. These categories were then further divided into about 270 subcategories, to enable sourcing, keeping in mind range of products available from suppliers. The total number of SKU's in the original list was more than 6,000 (4,500 in six categories, 1,700 in hardware & home appliances, also called general merchandise. However, most stores carried about 150 basic items in general merchandise, unless there was an explicit section for this.)

The various categories, depending on their attributes, were to have the following strategies regarding the width (brand choice), depth (number of variants), price and tactical usage (for drawing customers to the store). In any category/sub-category, a minimum of *two* brands would be on offer.

	Destination	Strategic	Convenience	Speciality
Width	High	High	High	High/Med
Depth	High	Low	Low	Low
Price	Aggressive "Key SKU's" Best in City	Aggressive Value Added Price Range for Margin	MRP/KVI	MRP
Tactical Usage	High	Medium	Medium	Low

Most of the store sales came from branded non-perishables. However, the perishables and non-branded repack SKU's were expected to witness the highest growth with higher than average margins. The revenue share and margin spread of the main items were as given below.

Item	Revenue	Margin Spread
Perishables	15%	
Branded		
Frozen		10-20%
Dairy		4–10%
Unbranded		
Bakery		30%
Fruits & Vegetables		25%
Repack	10%	5–20%
All others	75%	15%

Almost all of the 'repack' items belonged to the staples group and carried a store branding. However, the total staples group had other companies' branded products categorised under 'all others'. While the repack items constituted 10% of revenue, the staples group constituted 28% of revenue. The top 1000 SKUs accounted for 70% of the revenues. Within this, the growth was expected to be in the repack and perishable items, which constituted about 100 SKUs.

Interior design and layout of a store was a fairly involved subject, taking into account basic ergonomics, purchase preferences, items on promotion, basic layout of the property etc. This also involved design of appropriate display hardware like gondolas (an open rack, typically eight feet in length and five feet in height, with five or six shelves), gondola ends (for special promotional displays), coolers and freezers, special display hardware for increased attention, channels on the gondola shelves for stickers, hardware for promotional material and signages, etc. It was also important to design a bay (a set of gondolas) keeping in mind the alignment of shelves etc. The number of checkout counters (tills), staff assignment, assignment of tills for different types of customers (large/small volume, cash/credit), security features were also decisions of significance.

In terms of product display, the destination categories (which were an essential component of the purchase basket) would typically be in the far end of the store. This would attract customers right into the store. The strategic and convenience categories were displayed so as to provide good visibility and access, like in the eye level shelves rather than in the top or bottom shelves. The various procedures followed for display in a store, signages, shelving and stacking were determined and documented with a lot of "science" behind them. These procedures were to be followed by the customer service supervisors and representatives. The daily routines of the key store staff including the customer service supervisors and representatives, cashiers at the checkout counters (tills), goods receiving staff, etc were developed to a great level of detail and constantly reinforced through training and periodic meetings including one before every shift.

The typical number of bays and SKU's, based on the type of the store was as given below.

Store Type	Trading Area (Sq feet)	No of Stores	Example Location	Typical No of Bays	No of SKU's
A	6000+	2	MG Road (Bangalore) Mount Road (Chennai)	120+	6000
B	3000+	9	Himayatnagar (Hyderabad) Gandhi Nagar (Chennai)	80-95	4500
C	2000+	8	Jaynagar (Bangalore) Marredpally (Hydreabad)	65-75	3000

Each bay was 3 feet in width, with a height of 5 or 6 feet. Correspondingly, number of shelves per bay was either six or seven. All the shelves had a depth of 15 inches except the bottom one which had 18 inches for increased visibility. A bay with six shelves thus had 18 running feet and could accommodate 45-70 facings of SKUs, depending on the SKU dimensions. An SKU may have one to three facings depending upon the sales volume and desired visibility. A description of SKU's in two bays is given in exhibit 7. (The "MBQ" and "SUF" attributes are described later under the indenting process.)

Distribution (Supply Chain) Strategy

The key elements of FoodWorld's distribution strategy, which actually addressed the supply chain management, were as follows.

i) Minimum Suppliers – This would have benefits due to (a) economies of scale, both in purchasing and supply logistics, (b) reduced overheads and control requirements and (c) easier vendor development

ii) Creation of Regional Hubs – Three regional offices (at Chennai, Bangalore and Hyderabad) were set up to address the statewise requirements. This facilitated over 90% central distribution (a level desired by FoodWorld. The remaining 10% were supplied direct to store (mostly perishable items like fruits and vegetables, bakery etc).

iii) Replenishment Frequency – The desired servicing of stores from the warehouses was daily, while the supply frequency for any specific SKU was twice a week. The desired ordering and servicing frequency from suppliers to the warehouses was weekly. Hardware and general merchandise items were treated as exceptions, to be indented and ordered as required.

iv) Sourcing with Minimum Intermediaries – The idea was to source from as "upstream" as possible in the supply chain. This would help reduce losses and increase margins for FoodWorld.

Indenting Process

This referred to the request for stocks made by the different stores on their servicing warehouse/direct supply. Most SKU's could be indented twice a week on nominated days, for which supply would be made from the warehouse after a gap of a day, again on nominated days (Exhibit 8). The nominated days enabled synchronisation of indent processing at the warehouse. Direct supply products were indented daily, directly from the suppliers. Hardware items were indented based on need, and using the information of the ordering schedule from suppliers by the warehouse (Exhibit 9).

Each SKU in a store had two specific attributes that helped indenting, namely minimum base quantity (MBQ) and supply unit factor (SUF). The MBQ was determined as follows.

$$\text{MBQ} = \frac{\text{120\% of highest sales achieved per month}}{4}$$

The rationale behind this was there should be enough stocks even if there was (a) a surge in demand and (b) short/no supply from the warehouse until the next indent, thus providing for a week. The indent quantity was determined after a physical verification of store stocks on nominated indent days, as follows. The average stock turns per year was 12 in 1997 and expected to be higher in 1998.

Indent quantity = (MBQ – Physical stock) in multiples of SUF

The quantity was in multiples of SUF to enable convenient repacking of suppliers' stocks at the warehouse. For most SKUs, the shelf space volume was less than the MBQ. This was by choice, to enable frequent replenishment and to provide a sense of fullness in the shelves. The indenting process was being automated, so that stock levels would be obtained based on point of sale data. As a result, indent quantities would be automatically generated. Key indicators like stock out percentage etc would also then get generated.

A random examination of certain records gave a 20% stock out figure. As explained by a store manager, the true stock out was only 10%. The rest was accounted for by items which had been discontinued, but not yet deleted from the indent records. The indent fill (no of SKUs) rates from the warehouse was typically 60%. The case fill (SKU quantity) rates were 85%. For certain SKUs, they were even more than 100%, especially if other sizes of the same brand or brands of the same item were not available. If the case fill rate was less than 75%, it was considered as the indent not having been serviced. Exhibit 10 gives a sample of two successive indents from the same store for the tea/coffee category. The stock in the store, the indented quantity and the picked quantity for supply from the warehouse are given.

Ordering Process

The category managers in the warehouse monitored the stock position of the SKUs under their control and placed orders from the suppliers. Exhibit 11 gives an example of three SKUs for which the base quantity stocks have been defined. For example, Cadbury's 5 Star (38 gms) had a base quantity (MBQ for A, B and C category stores were 240, 96 and 48 respectively) of 420 units in the warehouse (D). The actual stocks being 1046, no order was yet due. However, an order would be due for Surf Excel since actual stocks were less than the warehouse base quantity. Exhibits 12 and 13 give sample purchase orders placed on vendors and the goods receipt note from the vendors, respectively. In all the three cases, supplies were received within the third day.

For almost all of the SKUs, the supplies were made from the nearest vendor, who was the dealer appointed by the supplying company. Dealer margins were anywhere up to 10%. Most dealers were willing to operate with a weekly frequency of supplies to the warehouse, by consolidating all SKUs to be supplied by them. The average number of SKU's per vendor (supplying company) was about 20. Exhibit 14 gives the list of top vendors from whom the cumulative purchase value in a month was 75% of the total purchase, in which 63 vendors accounted for 4106 SKU's. (The top five companies accounted for about 1400 SKUs.) The order fill rate was typically in the range of 60% to 75%. More than one category manager could be dealing with the top few vendors for raising orders. For example, five category managers dealt with Hex Trading.

Generally, the products were received through LCVs (one to three tonners). On receipt at the warehouse, a quantity and quality check was undertaken before accepting the goods. The next step was to paste bar coded stickers as per FoodWorld's code, to enable easy processing at the point of sale. However, there were certain items like some of the vegetable oils, tetrapack drinks, etc for which sticker sheets were only enclosed with the cartons and left as a task for the stores to complete before display. This was due to the fact that such SKUs were sensitive to additional handling.

Indents received from stores during a given working day (say day 1) were processed on day 2 and then despatched to the stores on day 3. Non-branded staples were repacked using the FoodWorld brand, in a separate "repack" section in the warehouse, equipped with weighing and packet sealing machines. Most of the processing in the warehouse and in the store was computerised. However, integration had not yet been achieved. The store representatives and the warehouse staff consisted of both permanent and temporary personnel. The ratio was roughly even.

Vendor Development

The key elements of the vendor development process were as follows.

(i) Identification of the supplying company's one point contact.

(ii) Driving towards standardised trading terms across all three regions on the following dimensions.

(a) Credit
(b) Promotion
(c) Single point sources of supply across SKU's/categories, preferably direct from the company's depot/CFA
(d) Margins (over and above product retail margins) for turnover, distributors' allowance, new store opening, bar coding (for data) and trade schemes

The above strategy would also be driven by when a supplying company was willing to take notice of FoodWorld. This would depend on the volume of sales and perceived value of the level of services offered by FoodWorld. For FoodWorld, with an annual turnover of Rs 100 crores, dealing with a company like Hindustan Lever Ltd, with an annual turnover of Rs 7,800 crores (Exhibit 15) would be a challenge. In terms of branded food processing, the top five companies (led by Hindustan Lever Ltd. at Rs 2,000 crores) accounted for an annual turnover of Rs 6,000 crores. The top 20 companies accounted for Rs 10,000 crores. Certain consumer goods companies had been willing to provide better terms and services to FoodWorld, including direct supply from depots or at least having a specially selected dealer service the warehouse. The possibility of better information processing through electronic data interchange was also being considered. One of the arguments that suppliers had against direct supply was the implied reduced earning potential for their distributors.

The different supply chain structures in operation at FoodWorld are given below.

i. Supplier ——— CFA ——— Distributor ——— W/H ——— Store
(Branded products from consumer goods companies)

ii. Supplier ——— CFA ——— W/H ——— Store
(Experimental)

iii. Supplier——— Repack Section ——— W/H——— Store
(Non-branded staples)

iv. Supplier ——— Consolidation Point ———Store
(Some Fruits & Vegetables)

v. Supplier ——— Store
(Bakery, Diary, Some Fruits and Vegetables)

FoodWorld saw a potential of increasing their margins by 4% to 10%, by negotiating and sourcing directly from producing locations for branded products. The scope was even more in non-branded staples and perishables (like fruits and vegetables), where there could be many intermediaries even between producing locations and the visible suppliers. As seen in Exhibit 16, intermediaries, in comparison to a developed country like the United States, accounted for a larger share of the margins, while at the same time contributing less in terms of value addition.

As an example, the cost of rice procurement for the Madras region and its variation since January 1997 is given in exhibit 17. The selling price of the rice and its impact on sales, percentage and absolute margins is also provided. In the early months, rice of the appropriate quality used to be procured from the wholesale market in Madras. Later on, procurement from the markets near the millers in Andhra Pradesh was organised. The next step was to attempt direct procurement from mills, and then possibly from paddy markets after which milling would be done on a contract basis. While the scope for increasing margins would increase, FoodWorld might have to get into activities not necessarily within its realm of expertise.

Conclusion

FoodWorld felt that the number of SKU's they were dealing with was too large. A rationalisation effort focused on reducing the high end subcategories/SKUs, low volume SKUs and the depth (number of variants) was considered essential, to reduce the maximum SKU count to 3000. Exhibit 18 gives the expected profile of "value added" food consumption in India by 2005. Exhibit 19 gives the economics of a typical store, for which the breakeven would be Rs 20.8 lakhs/month at a 17% store margin.

The VP (Merchandising) was aware that over the next five years, an additional investment of Rs 300 crores was planned to increase the number of outlets from the present 19, to 26 by mid 1999, 50 by mid 2000, 120 by 2002, and 300 by 2004. The challenges for supply chain management in this context were going to be significant and needed a proper strategic response. As Mr. P K Mohapatra said, "Organised retailing pre-supposes retailer's ability to be able to influence or more importantly manage a set of supply chains to be able to deliver value to the consumer; in a commercially viable and sustainable way".

Exhibit 1: Storewise Description

Store Location	Date of Opening	Total Area Sq Ft	Trading Area Sq Ft	Store Type Based on Trading Area	Store Type Based on Sale	Oct.98 Sale Rs 000	Oct.98 GM %	Oprtg Exp Rs 000	PBIT Rs 000	PBT Rs 000
Madras										
Store 1	Dec 96	14065	7257	A	A	9156	22.41	694	1358.09	1005
Store 2	09.05.96	3000	2404	C	B	4415	19.43	351	506.66	428
Store 3	01.09.96	4494	3094	B	B	4619	20.12	392	537.34	398
Store 4	01.09.96	4231	3177	B	B	5431	20.39	399	708.33	538
Store 5	09.05.98	5000	3305	B	B	4151	19.89	485	340.80	137
Store 6	23.10.98	3500	2700	C	B	1269	19.89	212	40.45	-60
Bangalore										
Store 1	Dec 96	9500	6492	A	A	11487	19.04	754	1433.13	1265
Store 2	20.8.96	5720	3976	B	B	4072	16.61	494	182.36	127
Store 3	5.6.98	2565	2472	C	B	4910	17.18	420	423.54	285
Store 4*	29.12.96	4362	3729	B	B	4242	17.40	480	258.11	61
Store 5	5.4.97	3650	3421	B	C	2180	15.75	324	19.35	-44
Store 6	4.5.97	2862	2437	C	B	2910	16.84	342	148.04	95
Store 7	30.7.98	3024	2494	C	B	4825	16.81	388	423.08	65
Store 8*	25.4.98	3000	2656	C	C	2569	16.40	324	97.32	-4
Hyderabad										
Store 1	26.9.97	4500	2971	C	B	3117	16.78	349	174.033	150
Store 2	13.12.97	4000	3278	B	A	4690	16.20	426	333.78	301
Store 3*	17.4.98	3000	2168	C	C	2520	16.71	264	157.09	137
Store 4	1.10.98	4084	3500	B	B	3445	16.63	426	146.90	120
Store 5*	31.10.98	3500	3000	B	B	179	14.22	143	-117.55	-190

* Some of the data are estimated

Source: Company Records, December,1998

Exhibit 2: Performance Trends

(Rs lakhs)

Year	1996-97				1997-98				YTD Apr '98-Nov '98				1998-99		1999-00	
	Budget	% of **sales**	Actuals	% of **Sales**	Budget	% of **Sales**	Actuals	% of **Sales**	Budget	% of **Sales**	Actuals	% of **Sales**	Proj	% of **Sales**	Proj	% of **Sales**
Stores																
–New Stores96-97	8		7													
–New Stores 97-98					13		4									
–New Stores 98-98									10		8					
Total No of Stores	8		7		20		11		21		19					
Sales																
–New Stores96-97	2577		2088		3366		3654		2830		3148					
– New Stores 97-98					1118		579		764		898					
– New Stores 98-98									1241		1106					
Subtotal	2577		2088		4484		4233		4835		5152		8665	100%	12957	100%
Gross Margin																
–New Stores96-97	382	14.8%	349	16.7%	633	18.8%	671	18.4%	530	18.7%	587	18.6%				
– New Stores 97-98					152	13.6%	107	18.5%	143	18.7%	147	16.4%				
–New Stores 98-98									234	18.9%	212	19.2%				
Subtotal	382	14.8%	349	16.7%	785	17.5%	778	18.4%	907	18.8%	946	18.4%	1774	20.5%	2786	21.5%
Store Operation																
–New Stores96-97	346	13.4%	266	12.7%	480	14.3%	444	12.2%	286	10.1%	286	9.1%				
–New Stores 97-98					171	15.3%	126	21.8%	115	15.1%	112	12.5%				
–New Stores 98-98									284	22.9%	165	14.9%				
Subtotal	346	13.4%	266	12.7%	651	14.5%	570	13.5%	685	14.2%	563	10.9%	1408	16.2%	2119	16.4%
Warehouse/ Regional Office																
–New Stores96-97	136	5.3%	134	6.4%	219	6.5%	268	7.3%	143	5.1%	167	5.3%				
– New Stores 97-98					73	6.5%	42	7.3%	39	5.1%	48	5.3%				
– New Stores 98-98									63	5.1%	58	5.2%				
Subtotal	136	5.3%	134	6.4%	292	6.5%	310	7.3%	245	5.1%	273	5.3%	437	24.6%	494	17.7%
Corporate Opex																
–New Stores96-97	112	4.3%	96	4.6%	57	1.7%	76	2.1%	32	1.1%	40	1.3%				
–New Stores 97-98					19	1.7%	12	2.1%	9	1.2%	11	1.2%				
– New Stores 98-98									13	1.0%	14	1.3%				
Subtotal	112	4.3%	96	4.6%	76	1.7%	88	2.1%	54	1.1%	65	1.3%	95	1.1%	104	0.8%

(Continued)

(Continued)

Year	1996-97				1997-98				YTD Apr '98-Nov '98				1998-99		1999-00	
	Budget	% of **Sales**	Actuals	% of **Sales**	Budget	% of **Sales**	Actuals	% of **Sales**	Budget	% of **Sales**	Actuals	% of **Sales**	Proj	% of **Sales**	Proj	% of **Sales**
EBIT																
–New Stores96-97	–212	–8.2%	–147	–7.0%	–123	–3.7%	–117	–3.2%	69	2.4%	94	3.0%				
–New Stores 97-98					–111	–9.9%	–73	–12.6%	-20	–2.6%	–24	–2.7%				
– New Stores 98-98									–126	–10.2%	–25	–2.3%				
Subtotal	–212	–8.2%	–147	–7.0%	–234	–5.2%	–190	–4.5%	–77	–1.6%	45	0.9%	–166	–1.9%	69	0.5%

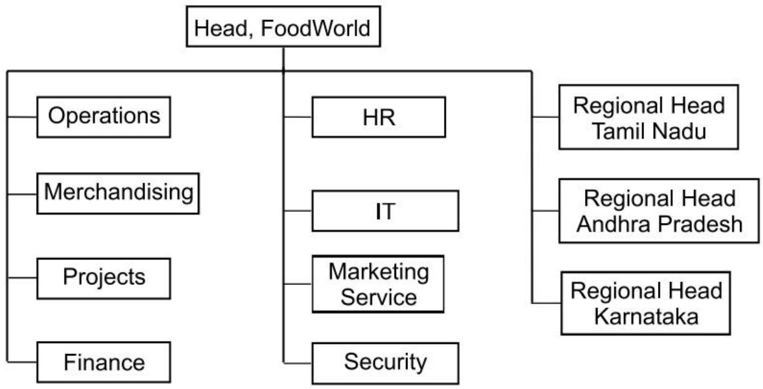
Notes: 1. Figures exclude notional rent on owned properties

2. POS Maintenance included under Maintenance

3. Warehouse & Corporate Opex apportioned to Existing and New Stores on the basis of sales

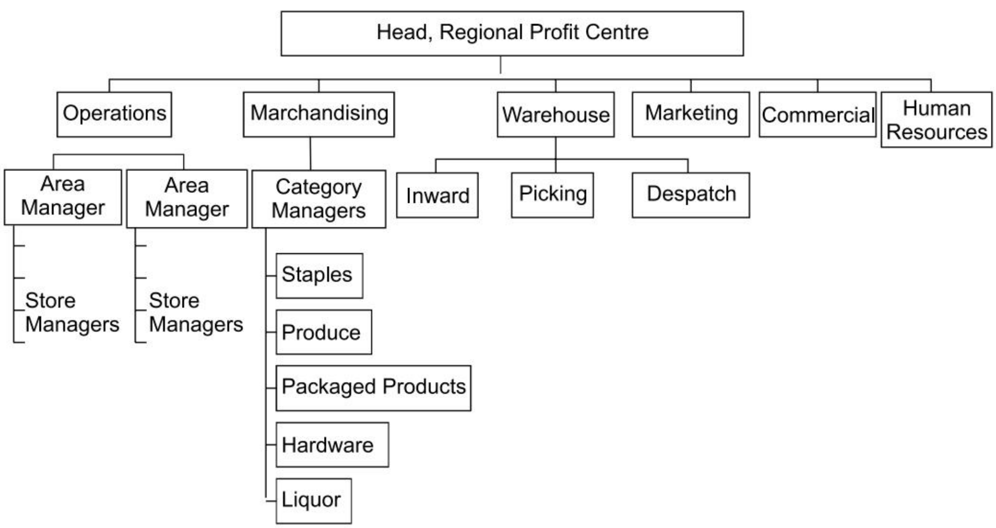
Source: Company Records, December, 1998

Exhibit 3: FoodWorld Organisation Structure



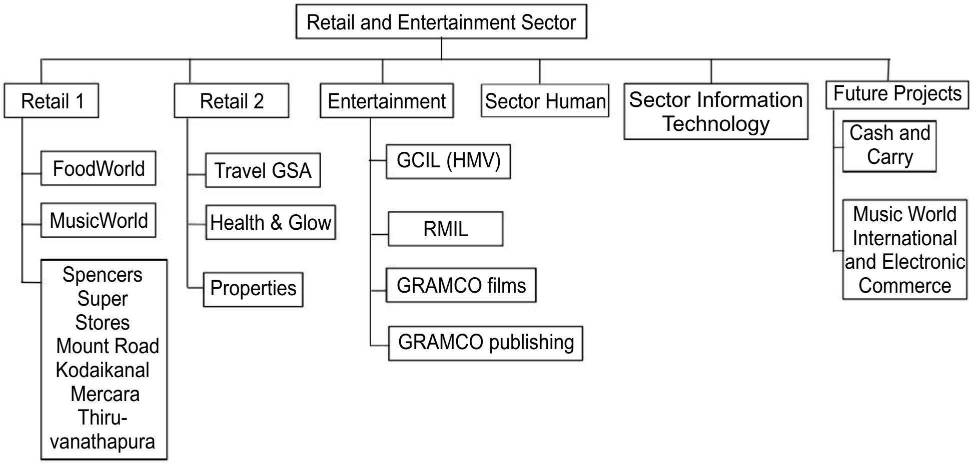
Source: Company Records, December, 1998

Exhibit 4: Regional Organisation Structure



Source: Company Records, December, 1998

Exhibit 5: Retail and Entertainment Organisation Structure



Source: Company Records, December, 1998

Exhibit 6: Categorywise Description

Category	Main Group	Sub Cate-gories #	SKUs #	Turn over (oct 98) Rs 000	Reve-nue %	Ave-rage Margin %	Hash Sale Qty #	Category Description
CEREALS 01	STAPLES	9	72	5909	7.47	10.95	69347	DESTINATION
PULSES 02	STAPLES	4	75	3432	4.34	16.61	143070	DESTINATION
FLOURS 03	STAPLES	5	70	2475	3.13	18.54	116394	DESTINATION
SPICES 04	STAPLES	8	250	5007	6.33	23.18	259619	ROUTINE
EDIBLE OILS 05	STAPLES	9	56	5632	7.12	8.63	84976	DESTINATION
SAVOURIES 06	PROCESSED FOODS	5	187	1959	2.48	29.91	132050	CONVENIENCE
BISCUITS 07	PROCESSED FOODS	7	98	1660	2.10	16.05	153810	ROUTINE
NOODLES 08	PROCESSED FOODS	4	64	838	1.06	16.71	52123	CONVENIENCE
CONFECTIONARY 09	PROCESSED FOODS	10	74	3519	4.45	16.49	195028	CONVENIENCE
CAN NON-VEG 10	PROCESSED FOODS	2	15	51	0.06	18.25	1182	CONVENIENCE
CAN FRUIT 11	PROCESSED FOODS	3	15	25	0.03	21.94	475	CONVENIENCE
CAN VEG. 12	PROCESSED FOODS	3	3	78	0.10	16.72	2071	CONVENIENCE
DESSERTS 13	PROCESSED FOODS	6	90	582	0.74	15.75	23242	CONVENIENCE
JAMS 14	PROCESSED FOODS	4	58	580	0.73	15.27	15938	ROUTINE
TINNED MILK 15	PROCESSED FOODS	2	20	279	0.35	9.12	5495	CONVENIENCE
SAUCES 16	PROCESSED FOODS	7	29	619	0.78	16.34	20678	ROUTINE
PICKLES 17	PROCESSED FOODS	4	106	538	0.68	17.29	14696	ROUTINE
READY TO FRY 18	PROCESSED FOODS	3	99	569	0.72	24.50	39357	ROUTINE
SOUPS 19	PROCESSED FOODS	2	26	462	0.58	14.37	20272	CONVENIENCE
BREAKFAST FOODS 20	PROCESSED FOODS	4	37	841	1.06	12.71	18099	ROUTINE
BABY FOODS 21	PROCESSED FOODS	4	33	234	0.30	9.27	2475	ROUTINE
DRINKS 22	BEVERAGES	9	94	2071	2.62	22.44	83500	CONVENIENCE
TEA/COFFEE 23	BEVERAGES	4	90	2443	3.09	9.84	50649	ROUTINE
HEALTH DRINKS 24	BEVERAGES	5	37	1432	1.81	10.25	19568	ROUTINE
LIQUOR 25	BEVERAGES	8	98	4482	5.67	20.05	30899	ROUTINE
DETERGENTS 26	NON-FOOD	4	70	2425	3.07	10.09	92479	ROUTINE
HOUSE CLEANING 27	NON-FOOD	6	114	2319	2.93	16.80	104996	ROUTINE
PAPER GOODS 28	NON-FOOD	5	40	463	0.59	40.32	14995	OCCASIONAL
HOUSEHOLD NEEDS 29	NON-FOOD	9	170	1253	1.58	28.75	69973	ROUTINE
CIGARETTES 30	NON-FOOD	3	20	348	0.44	9.34	11156	CONVENIENCE
PET FOOD 31	NON-FOOD	1	35	62	0.08	30.00	131	OCCASIONAL
SKIN CARE 32	HEALTH & BEAUTY	9	250	3281	4.15	12.81	143241	ROUTINE
HAIR CARE 33	HEALTH & BEAUTY	6	160	1551	1.96	14.16	32011	ROUTINE
ORAL CARE 34	HEALTH & BEAUTY	5	85	1378	1.74	16.28	58231	ROUTINE
SANITARY GOODS 35	HEALTH & BEAUTY	4	30	615	0.78	12.52	14398	ROUTINE
SHAVING NEEDS 36	HEALTH & BEAUTY	4	85	1299	1.64	15.45	21386	ROUTINE
O.T.C. 37	HEALTH & BEAUTY	5	70	369	0.47	22.71	14249	CONVENIENCE
BABY NEEDS 38	HEALTH & BEAUTY	3	55	546	0.69	15.84	10202	ROUTINE

(Continued)

(Continued)

Category	Main Group	Sub Cate-gories #	SKUs #	Turn over (oct 98) Rs 000	Reve-nue %	Ave-rage Margin %	Hash Sale Qty #	Category Description
COSMETICS 39	HEALTH & BEAUTY	10	94	197	0.25	19.50	2695	CONVENIENCE
HERBAL 40	HEALTH & BEAUTY	7	240	331	0.42	24.77	4262	CONVENIENCE
DAIRY PRODUCTS 41	PERISHABLES	7	60	2008	2.54	12.00	104150	DESTINATION
FROZEN FOODS 42	PERISHABLES	7	75	1610	2.04	17.00	41704	CONVENIENCE
BAKERY 43 &44	PERISHABLES	3	65	4497	5.69	27.78	157159	CONVENIENCE
VEGETABLES 45 & 46	PERISHABLES	2	110	4365	5.52	17.28	407030	DESTINATION
BATTERIES 47	H/WARE & HOME APP.	4	48	306	0.39	23.98	11967	OCCASIONAL
MISC. 48	H/WARE & HOME APP.	5	210	1770	2.24	20.21	10116	OCCASIONAL
HARDWARE 49	H/WARE & HOME APP.	24	1435	2350	2.97	25.42	51446	CONVENIENCE
TOTAL		264	5317	79060	100.00	17.17	2932990	

Source: Company Records, December, 1998

Exhibit 7: Description of SKU's in Two Bays

Bay No: 35

Section: Tea (Ht 5 Feet, 6 Shelves)

No	SKU	SKU Description	Company	Shelf	Depth	MBQ	Facings	SUF	Cost	MRP
1	191148	TAJ MAHAL TEA BAGS 25'S	HLL	1	15"	12	2	6	63.8	69
2	191146	GREEN LABEL 100 GMS	HLL	1		12	2	6	23.44	25
3	191087	YELLOW LABEL 100 GMS	HLL	1		12	2	6	15.89	17
4	191154	KOTADA TEA 100 GMS	Kotada	1		8	1	3	11.90	14
5	191052	TOP STAR 100 GMS	HLL	1		12	2	6	17.46	18.25
6	191057	TAJ MAHAL 100 GMS	HLL	2	15"	18	3	6	17.75	18.5
7	191027	RED LABEL 100 GMS	HLL	2		18	3	6	14.2	15
8	191147	GREEN LABEL TEA W.B. 250 GMS	HLL	2		4	1	3	94.12	110
9	191086	YELLOW LABEL TEA 250 GMS	HLL	2		12	2	6	64.15	68
10	191059	TAJ MAHAL TEA 250 GMS	HLL	3	15"	12	3	6	45.5	76.5
11	191026	RED LABEL 250 GMS	HLL	3		12	2	6	38.25	43
12	191064	GREEN LABEL TEA 250 GMS	HLL	3		8	2	6	64.15	68
13	191053	TOP STAR 250 GMS	HLL	3		8	2	3	39.86	76.5
14	191144	TAJ MAHAL TEA BAGS 100'S	HLL	4	15"	6	2	3	63.8	69
15	191025	RED LABEL 500 GMS	HLL	4		8	2	3	70	73
16	191085	YELLOW LABEL 500 GMS	HLL	4		8	2	3	79.44	85
17	191058	TAJ MAHAL TEA 500 GMS	HLL	5	15"	8	2	3	78	82
18	191000	RED LABEL 500 JAR	HLL	5		6	2	3	83.58	88
19	191020	SARGAM TEA 250 GMS JAR	Duncan	5		6	1	3	28.98	30
20	191153	KOTADA TEA 250 GMS	Kotada	5		12	1	6	24.23	28.5
21	191060	TOP STAR 500 GMS	HLL	5		6	2	3	73.91	76.5
22	191145	TAJ MAHAL TEA BAGS 200'S	HLL	6	18"	4	1	3	112.73	124
23	191101	SARGAM TEA 250 REFIL	Duncan	6		6	1	3	23.93	25
24	191021	RED LABEL 250 JAR	HLL	6		12	2	6	41.75	44
25	191065	LIPTON GREEN LABEL 500 GMS	HLL	6		12	1	6	128.3	136
26	191152	KOTADA TEA 500 GMS	Kotada	6		6	1	3	56.1	66
27	191035	SARGAM TEA JAR 500	Duncan	6		12	2	6	76.36	83

Bay No: 36

Section: Coffee (Ht 5 Feet, 6 Shelves)

No	SKU	SKU Description	Company	Shelf	Depth	MBQ	Facings	SUF	Cost	MRP
1	190015	GREEN LABEL COFFEE 50 GMS	HLL	1	15"	36	3	12	7.28	7.75
2	190012	BRU 50 GMS	HLL	1		36	3	12	24.3	28
3	190053	NESCAFE 25 GMS	Nestle	1		18	3	6	26.1	28
4	190088	SUNRISE PREMIUM 50 GMS	Nestle	2	15"	36	4	12	26.9	30

(Continued)

(Continued)

No	SKU	SKU Description	Company	Shelf	Depth	MBQ	Facings	SUF	Cost	MRP
5	190014	BRU SACHET STRONGM 50 GMS	HLL	2		24	2	12	24.3	26
6	190060	NESCAFE SELECT 50 GMS	Nestle	2		12	2	6	52.92	59
7	190092	SUNRISE EXTRA 50 GMS	Nestle	3	15"	36	3	12	23.35	25
8	190009	TATA KAPI 50 GMS	Tata Tea	3		24	2	12	24.23	28
9	190064	NESCAFE SELECT 100 GMS	Nestle	3		24	2	12	104.3	114
10	190056	NESCAFE SELECT 100 GMS JAR	Nestle	3		24	2	12	105	115
11	190091	SUNRISE PREMIUM 100 GMS	Nestle	4	15"	12	1	6	54.25	58
12	190007	BRU 100 GMS	HLL	4		12	1	6	50.49	54
13	190029	COORG PURE FILTER 100 GMS	Tata Tea	4		12	1	6	12.75	15
14	190016	GREEN LABEL 100 GMS	HLL	4		12	1	6	14.09	15
15	190034	BROOKE BOND CAFE 100 GMS	HLL	4		12	1	6	10.33	11
16	190042	COORG DOUBLE ROAST 100 GMS	Tata Tea	4		12	1	6	10.84	12.75
17	190090	SUNRISE PREMIUM 100 GMS JAR	Nestle	4		8	1	3	51.4	55
18	190084	SUNRISE PREMIUM 200 GMS	Nestle	5	15"	12	1	6	101.87	115
19	190008	BRU 200 GMS	HLL	5		12	1	6	104.67	112
20	190031	COORG PURE FILTER 200 GMS	Tata Tea	5		12	1	6	25.16	29.6
21	190041	COORG DOUBLE ROAST 200 GMS	Tata Tea	5		12	1	6	21.25	25
22	190010	TATA KAPI 200 GMS	Tata Tea	5		12	1	6	89.25	105
23	190065	FOOD WORLD PURE FILTER COFFEE 200 GMS	5		12	1	6	30	36	
24	190072	NESCAFE SELECT 200 GMS	Nestle	5		12	1	6	193.95	212
25	190080	NESTLE SUNRISE EXTRA 200 GMS	Nestle	6	18"	12	1	6	84.15	90
26	190020	GREEN LABEL COFFEE 200 GMS	HLL	6		12	1	6	28.57	30
27	190024	GREEN LABEL COFFEE 500 GMS	HLL	6		9	1	3	70.48	74
28	190027	COORG PURE FILTER COFFEE 500 GMS	Tata Tea	6		9	1	3	62.05	73
29	190040	COORG DOUBLE ROAST 500 GMS	Tata Tea	6		9	1	3	60	65
30	190066	FOOD WORLD COFFEE 500 GMS		6		9	1	3	75	90
31	190043	COORG DOUBLE ROAST 500 GMS	Tata Tea	6		9	1	3	67.38	73
32	190076	NESCAFE SELECT 500 GMS	Nestle	6		9	1	3	475.75	520

Note: HLL – Hindustan Lever Limited

Source: Company Records, December, 1998

Exhibit 8: Schedule of Indents and Despatches for a Region

Store Indent Schedule	Warehouse Despatch Schedule
SUNDAY	
DESSERT MIXES	BABY FOOD
B F CEREALS	TIN MILK
BISCUITS	TEA/COFFEE
JAMS	CONFECTIONARY
H DRINKS	H H CLEANING
BRANDED FLOURS	PAPER GOODS
H H NEEDS	DETERGENTS
HAIR CARE	ORAL CARE
LIQUOR	OTC
PICKLES	SPICES AND DAILY INDENT
AMUL PRODUCTS	
RICE FLOOR AND DAILY INDENT	
MONDAY	
SOUPS	CANNED FOOD
DRINKS	READY TO FRY
NOODLES/VERMACELLI	B R SAVOURIES
SAUCES	SANITARY
OILS	BATTERIES/ELECTRICAL
BRANDED SPICES	DAL AND DAILY INDENT
BRANDED RICE	
SKIN CARE	
SHAVING NEEDS	
HERBAL COSMETICS	
BABY NEEDS	
CHEESE	
SPICES AND DAILY INDENT	
TUESDAY	
TEA/COFFEE	DESSERT MIXES
CONFECTIONARY	B F CEREALS
H H CLEANING	BISCUITS
PAPER GOODS	JAMS
ORAL CARE	H DRINKS
DETERGENTS	BRANDED FLOURS
PLEASE DO TOP UP INDENTING TO DAY	H H NEEDS
	HAIR CARE
	CIGARETTES
	RICE FLOUR AND DAILY INDENT

(Continued)

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WEDNESDAY

JAMS	SOUPS
H DRINKS	DRINKS
BISCUITS	NOODLES/VERMECELLI
B F CEREALS	SAUCES
DESSERT MIXES	OILS
BR SAVOURIES	BRANDED SPICES
HAIR CARE	BRANDED RICE
SANITARY	SKIN CARE
H H NEEDS	SHAVING NEEDS
PICKLES	BABY NEEDS
DAL AND DAILY INDENT	PICKLES
	CHEESE
	SPICES AND DAILY INDENT

THURSDAY

DRINKS	TEA/COFFEE
NOODLES/VERMECELLI	CONFECTIONARY
SAUCES	H H CLEANING
OILS	PAPER GOODS
BRANDED SPICES	DETERGENTS
SKIN CARE	ORAL CARE
SHAVING NEEDS	ONLY DESPATCH OF TOP UP ITEMS
BABY NEEDS	
CHEESE	
RICE FLOUR AND DAILY INDENT	

FRIDAY

TEA/COFFEE	DESSERT MIXES
CONFECTIONARY	B F CEREALS
H H CLEANING PAPER GOODS	BISCUITS
ORAL CARE	JAMS
DETERGENTS	H DRINKS
BABY FOOD	BRANDED FLOURS
TIN MILK	H H NEEDS
OTC	HAIR CARE
SPICES AND DAILY INDENT	SANITARY
	ERBAL COSMETICS
	DAL AND DAILY INDENT

SATURDAY

CANNED FOOD	DRINKS
READY TO FRY	NOODLES/VERMECELLI
B R SAVOURIES	SAUCES
SANITARY	OILS
BATTERIES/ELECTRICAL	BRANDED SPICES
CIGARETTES	SKIN CARE
DAL AND DAILY INDENT	SHAVING NEEDS
	BABY NEEDS
	PICKLES
	CHEESE
	RICE FLOUR AND DAILY INDENT

Source: Company Records, December, 1998.

Exhibit 9: Hardware Indent Schedule for a Region

MONDAY
BHARAT/KLASSIK
TUESDAY
YERA GLASSWARE
ANJALI KITCHENWARE
WALT DISNEY/FISKARS
HALLMARK MUGS
WEDNESDAY
CLEARLINE
LA OPALA
PHILIPS
SS CUTLERY
DECOPRIDE
RAMSONS CUTLERY
FRIDAY
ARCHANA PRODUCTS
AB PLASTIC CONTAINERS
SATURDAY
SHRIPET PLASTICWARE
PRESTIGE COOKERS
BUTLERS/ANUPAM
SUNDAY
ROSEWOOD ITEMS
HIP FLASK
M/W PROOF CONTAINERS

Source: Company Records, December, 1998.

Exhibit 10: Store Indent on a Warehouse

Report No: 0F8 Indent Date: —/11/98 (Sunday)
Store No: 863 Store Name: AAA

No	Item Code	Category :TEA/COFFEE	Stock Qty	Indent Qty	Picked Qty
		Sub Category : 2301 GROUND COFFEE			
		Indent Number : [630486]			
1	190046	BROOKEBOND GREEN LABEL COFFEE	278	6	6
2	190024	BROOKE BOND GREEN LABEL COFFEE	244	12	12
3	190027	COORG FILTER COFFEE 500 GMS	74	9	9
4	190040	COORG DOUBLE ROAST COFFEE 500 GMS	83	12	12
5	190043	COORG D.R. 500 GM JAR	0	12	
6	190065	F.W. PURE FILTER COFFEE 200 G	0	12	
7	190066	F.W. PURE FILTER COFFEE 500 G	0	12	
		Sub Category: 2302 INSTANT COFFEE			
		Indent Number : [630487]			
1	190007	BROOKEBOND BRU INSTANT COFFEE	0	12	
2	190014	BRU SUPER STRONG 50 GM	0	12	
3	190053	NESCAFE 25 GM JAR	0	12	
4	190056	NESCAFE INST COFFEE 100 GM JAR	0	12	
5	190064	NESCAFE SELECT INST COFFEE 100	0	12	
6	190090	NESTLE SUNRISE PREMIUM 100 GM	0	12	
7	190091	NESTLE SUNRISE PREMIUM 100 GM R	0	12	
		Sub Category: 2303 DUST TEA			
		Indent Number : [630488]			
1	191037	SARGAM DUST TEA 500 GM	0	12	
2	191039	DOUBLE DIAMOND DUST TEA 250 GM	0	12	
3	191147	LIPTON GREEN LABEL TEA 250 W.B	0	12	
		Sub Category: 2304 CTC TEA			
		Indent Number: [630489]			
1	191000	BROOKE BOND RED LABEL 500 GM J	18	6	6
2	191006	BROOKE BOND 3 ROSES 250 GM JA	0	6	
3	191021	BROOKE BOND RED LABEL 25O GM JA	0	12	
4	191025	BROOKE BOND RED LABEL TEA 500	134	12	12
5	191026	BROOKE BOND RED LABEL TEA 250	310	12	12
6	191027	BROOKE BOND RED LABEL TEA 100	250	12	12
7	191028	CHEERS DARJEELING LEAF TEA 250	21	12	12
8	191043	DEVAN TEA 100 GM GREEN	208	6	6
9	191047	KANNAN DEVAN LEAF 250 GM	75	12	12
10	191111	RUNGLEE RUNGLIOT DARJEELING TEA	0	12	
11	191129	DUNCON DOUBLE DIAMOND LEAF TEA	0	6	

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No	Item Code	Category :TEA/COFFEE	Stock Qty	Indent Qty	Picked Qty
12	191146	LIPTON GREEN LABEL TEA 100 GM	207	6	6
13	191148	LIPTON TAJMAHAL TEA BAGS 25'S	368	24	24
14	191150	PRIME TEA 25 BAGS	0	24	
15	191151	KOTADA TEA BEARER 250 GM BRAND	0	6	
16	191152	KOTADA TEA BEARER BRAND 500 GM	0	6	
17	191153	KOTADA CTC SPL DUST 250 GM	0	6	
18	191154	KOTADA BEARER BRAND TEA 100 GM	0	6	

Report No: 0F8 Indent Date: —/11/98 (Thursday)

Store No: 863 Store Name: AAA

Sub Category : 2301 GROUND COFFEE

Indent Number : [630633]

1	190016	BROOKE BOND GREEN LABEL COFFEE	212	24	24
2	190020	BROOKE BOND GREEN LABEL COFFEE	205	24	24
3	190024	BROOKE BOND GREEN LABEL COFFEE	217	18	18
4	190027	COORG FILTER COFFEE 500 GM	47	12	12
5	190029	COORG PURE FILTER COFFEE 100 GM	66	18	18
6	190031	COORG PURE FILTER COFFEE 200 GM	83	24	24
7	190034	BROOKE BOND CAFE 100 GM	125	12	12
8	190040	COORG DOUBLE ROAST COFFEE 500 GM	68	12	12
9	190041	COORG DOUBLE ROAST COFFEE 200 GM	101	12	12
10	190042	COORG DOUBLE ROAST COFFEE 100 GM	98	18	18
11	190043	COORG DOUBLE ROAST COFFEE 500 GM JAR	0	3	
12	190065	F.W. PURE FILTER COFFEE 200 GM	0	12	
13	190066	F.W. PURE FILTER COFFEE 500 GM	0	12	

Sub Category: 2302 INSTANT COFFEE

Indent Number : [630634]

1	190007	BROOKE BOND BRU INSTANT COFFEE	0	18	
2	190008	BROOKE BOND BRU INSTANT COFFEE 20	271	24	24
3	190010	TATA KAAPI 200 GM	58	6	6
4	190012	BROOKE BOND BRU INST COFFEE 50	381	12	12
5	190014	BRU SUPER STRONG 50 GM	0	24	
6	190053	NESCAFE 25G JAR	0	24	
7	190056	NESCAFE INST COFFEE 100 GMS JAR	0	24	
8	190060	NESCAFE CLASSIC 50 GMS	254	12	12
9	190064	NESCAFE SELECT INST COFFEE 100	0	12	
10	190084	NESCAFE SUNRISE PREMIUM INST 2	291	12	12
11	190088	NESCAFE SUNRISE PREMIUM INST CO	323	12	
12	190090	NESTLE SUNRISE PREMIUM 100 GM	0	12	
13	190091	NESTLE SUNRISE PREMIUM 100 GM R	0	12	
14	500207	NESCAFE 3-IN-ONE 180 GM	0	12	

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Sub Category: 2303 DUST TEA

Indent Number : [630635]

1	191020	BROOKE BOND SUPER DUST JAR 500	0	3	
2	191037	SARGAM DUST TEA 500 GM	0	3	
3	191039	DOUBLE DIAMOND DUST TEA 250 GM	0	3	
4	191101	SARGAM TEA 250 GM REFIL	0	3	
5	191147	LIPTON GREEN LABEL TEA 250 W.B.	0	3	

Sub Category: 2304 CTC TEA

Indent Number : [630636]

1	191000	BROOKE BOND RED LABEL 500 GM J	6	6	
2	191006	BROOKE BOND 3 ROSES 250 GM J	0	6	
3	191009	BROOKE BOND 3 ROSE TEA 500 GM	69	6	6
4	191021	BROOKE BOND RED LABEL 250 GM JA	0	6	
5	191025	BROOKE BOND RED LABEL TEA 500	110	6	6
6	191026	BROOKE BOND RED LABEL 250	262	6	6
7	191027	BROOKE BOND RED LABEL 100	190	12	12
8	191029	CHAKARAGOLD 100 GM	55	12	12
9	191030	CHAKARAGOLD 250 GM	59	6	6
10	191035	DUNCANS SARGAM TEA JAR GARDEN	0	6	
11	191043	KANNAN DEVAN TEA 100 GM GREEN	190	6	6
12	191047	KANNAN DEVAN LEAF 250 GM	51	12	9
13	191052	LIPTON TOPSTAR TEA 100 GM	186	12	12
14	191053	LIPTON TOPSTAR TEA 250 GM	168	6	6
15	191057	LIPTON TAJ MAHAL TEA 100 GM	112	12	12
16	191058	LIPTON TAJ MAHAL TEA 500 GM	71	12	12
17	191059	LIPTON TAJ MAHAL TEA 250 GM	195	12	12
18	191064	LIPTON GREEN LABEL TEA 250 GM	42	12	12
19	191065	LIPTON GREEN LABEL TEA 500 GR	1	6	
20	191085	LIPTON YELLOW LABEL TEA 500 GR	86	6	6
21	191087	LIPTON YELLOW LABEL TEA 100 GR	190	12	12
22	191111	RUNGLEE RUNGLIOT DARJEELING TEA	0	3	
23	191129	DUNCON DOUBLE DIAMOND LEAF TEA	0	3	
28	191146	LIPTON GREEN LABEL TEA 100 GM	171	12	12
25	191148	LIPTON TAJMAHAL TEA BAGS 25'S	242	12	12
26	191150	PRIME TEA 25 BAGS	0	12	
27	191151	KOTADA TEA BEARER 250 GM BRAND	0	6	
28	191152	KOTADA TEA BEARER BRAND 500 GM	0	3	
29	191153	KOTADA CTC SPL DUST 250 GM	0	6	
30	191154	KOTADA BEARER BRAND TEA 100 GM	0	3	
31	500218	A V T ASSAM TEA 250 GM JAR	6	6	
32	500219	A V T PREMIUM TEA 500 GM	92	6	6
33	500220	A V T PREMIUM TEA 250 GM	92	6	6

Source: Company Records, December, 1998.

Exhibit 11: Ordering Process

FoodWorld Warehouse	Product Master (Master Maintenance Menu)		
Product Name	**Cadburys 5 Star 38 gms**	**Cadburys Crackle 35 gms**	**Surf Excel Refill 500 gms**
Product Code	263607	263573	901039
UOM	Gms	gms	gms
Packout	36	24	6
Description	Confectionery count lines	Confectionery block chocolate	Detergent powder
Dept/Group Code	906	905	2602
Tax Code	88	88	88
Stock Movement Flag			
Indent Flag	0	0	0
Prod-Company Code	50 Cadbury's	50 Cadbury's	125 Hindustan Lever
Vendor Code	CRA024 Ashwini Distributors	CRA024 Ashwini Distributors	CRU034 Upmarkets
ABC Code	A	A	A
Power Item	N	Y	N
Base Quantity	A:240 B:96 C:48 D:420	A:60 B:36 C:24 D:120	A:48 B:24 C:18 D:420
Buyer Code	003	033	007
Cost Price	Rs 8.83 from 24.9.98		
WIP: 8.83	Rs 12.37 from 24.9.98 WIP:12.37	Rs 59.28 from 3.12.98	
WIP: 59.28			
MRP	10.00 from 11.2.98	14.00 from 3.9.98	65.00 from 9.5.98
Prev Cost Price	8.89 from 15.9.98	12.46 from 15.9.98	59.58 from 21.11.98
Prev MRP	10.00 from 11.2.98	12.00 from 2.3.98	60.00 from 9.2.98
Stock Qty at Warehouse	1046	664	13

Source: Company Records, December, 1998.

Exhibit 12: Sample Purchase Orders

No	Product Name	Code	MRP	Qty	Cost	Value
Hex Trading						PO No: 37337
1	Brooke Bond 3 Roses 500 gms Jar	191007	101.50	24	96.97	2327.28
2	Brooke Bond Inst Coffee 200 gms	190008	124.00	180	115.89	20860.20
3	Brooke Bond Bru Inst Coffee 50 gms	190012	26.00	120	24.30	2916.00
4	Brooke Bond Green Label Coffee 50 gms	190015	8.15	80	7.65	612.00
5	Brooke Bond Green Label Coffee 500 gms	190024	78.00	120	74.29	8914.80
6	Brooke Bond Red Label 500 gms Jar	191000	86.00	48	81.50	3912.00
7	Brooke Bond Red Label Tea 250 gms	191026	43.00	96	41.25	3960.00
8	Brooke Bond Red Label Tea 250 gms Jar	191021	43.00	72	41.25	2970.00
9	Brooke Bond Green Label Coffee 200 gms	190020	31.60	120	30.10	3612.00
10	Lipton Green Label Tea 250 gms	191064	88.25	144	84.38	12150.72
11	Lipton Green Label Tea 100 gms	191146	31.50	120	29.98	3597.60
12	Lipton Tajmahal Tea Bags 200's	191145	130.00	18	118.18	2127.24
Dhanalakshmy Agencies						PO No 37554
1	Nescafe Select Inst Coffee 50 gms	190060	61.00	224	55.80	12499.20
2	Nescafe Sunrise Extra 200 gms	190080	100.00	72	93.50	6732.00
3	Nescafe Sunrise Inst Extra 50 gms	190092	27.00	256	25.25	6464.00
M S Vel & Company						PO No 37810
1	Coorg Double Roast Coffee 500 gms	190040	74.00	96.00	74.00	7104.00
2	Coorg Double Roast Coffee 200 gms	190041	30.00	120.00	30.00	3600.00
3	Coorg Filter Coffee 500 gms	190027	83.00	72.00	83.00	5976.00
4	Coorg Pure Filter Coffee 100 gms	190029	17.00	180.00	17.00	3060.00

Source: Company Records, December, 1998.

Exhibit 13: Sample Goods Receipt Notes

No	Product Name	Code	MRP	Qty	Cost	Value
Hex Trading		8201				DC No: 8201
1	Brooke Bond Bru Inst Coffee 200 gms	190008	124.00	180.00	115.89	20860.20
2	Brooke Bond Bru Inst Coffee 50 gms	190012	26.00	120.00	24.30	2916.00
3	Brooke Bond Green Label Coffee 50 gms	190015	8.15	80.00	7.65	612.00
4	Brooke Bond Green Label Coffee 500 gms	190024	78.00	120.00	74.29	8914.80
5	Brooke Bond Red Label 500 gms Jar	191000	86.00	48.00	81.50	3912.00
6	Brooke Bond Red Label Tea 250 gms	191026	43.00	96.00	41.25	3960.00
7	Brooke Bond Red Label Tea 250 gms Jar	191021	43.00	72.00	41.25	2970.00
8	Brooke Bond Green Label Coffee 200 gms	190020	31.60	120.00	30.10	3612.00
9	Lipton Green Label Tea 250 gms	191064	88.25	144.00	84.38	12150.72
10	Lipton Green Label Tea 100 gms	191146	31.50	120.00	29.98	3597.60
11	Lipton Tajmahal Tea Bags 200's	191145	130.00	18.00	118.18	2127.24
Dhanalakshmi Agencies		8205				DC No 8205
1	Nescafe Select Inst Coffee 50 gms	190060	61.00	224.00	55.80	12499.20
2	Nescafe Sunrise Extra 200 gms	190080	100.00	72.00	93.50	6732.00
3	Nescafe Sunrise Inst Extra 50 gms	190092	27.00	256.00	25.25	6464.00
M S Vel & Company		8207				DC No 8207
1	Coorg Double Roast Coffee 500 gms	190040	74.00	96.00	74.00	7104.00
2	Coorg Double Roast Coffee 200 gms	190041	30.00	120.00	30.00	3600.00
3	Coorg Filter Coffee 500 gms	190027	83.00	72.00	83.00	5976.00
4	Coorg Pure Filter Coffee 100 gms	190029	17.00	180.00	17.00	3060.00

Source: Company Records, December, 1998.

Exhibit 14: List of Top Vendors for a Sample Month

No	Vendor Name	No of Skus	Total Hash Qty	Purchase Value from Vendor	Company Name	Purchase Value %	Cumu-lative %
1	HEX TRADING	1076	94381	2235908.67	HLL	10.43%	10.43%
2	TAMIL NADU STATE MARKETING CORPN LTD	112	17220	1564409.00	TASMAC	7.30%	17.72%
3	VENKATESWARA AGENCIES	61	49461	716526.40	CADBURYS	3.34%	21.07%
4	DHANALAKSHMI AGENCIES	96	14541	524534.02	NESTLE CULNERY	2.45%	23.51%
5	ARIHANT AGENCIES	128	52775	518428.91	BRITANNIA	2.42%	25.93%
6	GAJALAKSHMI AGENCIES	34	33737	479216.90	NESTLE CONFECTIONERY	2.24%	28.17%
7	SATHYA FRUITS	18	18	474801.80	FRUITS	2.21%	30.38%
8	FRESH "N" GREEN	37	37	398832.05	VEGETABLE	1.86%	32.24%
9	MAHANTH ENTERPRISES	22	5395	396753.23	ITC	1.85%	34.09%
10	DEW CONSUMER PRODUCTS & SERVICES LTD	54	54	377733.51	BAKERY	1.76%	35.85%
11	SRI GANESH AGENCIES	26	13190	377540.90	AAVIN	1.76%	37.61%
12	BHAWAR SALES CORPORATION	59	6470	353170.10	P & G	1.65%	39.26%
13	J J UDYOG	4	12100	326025.00	DAL, JALGAON	1.52%	40.78%
14	V R MUTHU & BROTHERS	11	5092	301768.00	V V S IDAYAM	1.41%	42.19%
15	BHIKSHU MARKETING	87	11513	299039.89	R C I	1.39%	43.58%
16	E I D PARRY (INDIA) LTD	4	20000	276000.00	PARRY - SUGAR	1.29%	44.87%
17	SAKTHI SOFT DRINKS LTD	17	4425	248985.05	COCA COLA INDIA	1.16%	46.03%
18	AKASH MARKETING CENTRE	41	14132	242436.90	GUJARAT CO-OP. MILK — AMUL	1.13%	47.16%
19	MAC MARKETING COMPANY	44	4797	237024.90	NESTLE - IMPORTED	1.11%	48.27%
20	SRI JEET TRADERS	65	19503	229731.90	DRY FRUITS, MASALAS, WHOLESALE	1.07%	49.34%
21	SURESH ENTERPRISES	31	8993	218623.37	KELLOGG'S	1.02%	50.36%
22	SANDHYA AGENCIES	54	4037	218378.52	I S P L	1.02%	51.38%
23	SRI SAI ENTERPRISES	118	7351	218004.92	JOHNSON & JOHNSON	1.02%	52.39%
24	GODREJ PILLSBURY LTD	25	8540	216546.90	GODREJ PILLSBURY	1.01%	53.40%
25	K AHAMED HUSSAIN & SONS	40	9282	214779.84	S K B	1.00%	54.41%
26	ASSOCIATED AGENCIES	320	5935	202409.19	HARDWARE	0.94%	55.35%
27	SHREE MANISH & CO	79	10368	195430.74	COLGATE PALMOLIVE	0.91%	56.26%
28	CHANG FOODS PVT LTD	40	40	188287.55	OLD CHANG KEE	0.88%	57.14%
29	SRIJEET ENTERPRISES	47	14488	180802.85	DALS, DRY FRUITS	0.84%	57.98%

(Continued)

(Continued)

No	Vendor Name	No of Skus	Total Hash Qty	Purchase Value from Vendor	Company Name	Purchase Value %	Cumu-lative %
30	K NARAYANASAMI	12	12	165758.40	VEGETABLE	0.77%	58.76%
31	PANKAJ TRADERS	31	10071	157127.50	DALS	0.73%	59.49%
32	AGRI FLORA	24	24	151176.30	EXOTIC F&V	0.71%	60.19%
33	M S VEL & COMPANY	47	4363	147066.10	TATA TEA	0.69%	60.88%
34	AMUDHAN AGENCIES & SERVICES PVT LTD	150	1834	146564.95	MODI REVLON	0.68%	61.56%
35	FATHIMA AGENCIES PVT LTD	84	7933	135679.05	PONDICHERRY MINERAL WATER	0.63%	62.20%
36	SERVICE UNLIMITED	41	12186	133302.15	CHILLY, DANIYA	0.62%	62.82%
39	AMALGAM FOODS LIMITED	113	1523	126132.75	SUMERU' AMALGAM FOODS LTD	0.59%	64.60%
40	SALECHA INDUSTRIES	1	4900	124950.00	DALS,	0.58%	65.18%
41	RAJA'S MARKETING CO	38	6098	121382.00	HENKEL SPIC	0.57%	65.74%
42	SREE SUBHA MILK PRODUCTS	75	7949	118424.00	DAIRY PRODUCTS	0.55%	66.30%
43	VENKAT	1	3000	112050.00	FRUITS & VEG.	0.52%	66.82%
44	THE NILGIRI DAIRY FARM LTD	15	15	111299.60	DAIRY PRODUCTS, NILGIRI'S	0.52%	67.34%
45	SRI SINGHI SPICES PVT LTD	12	2084	110940.00	SATNAM OVERSEAS, KOHINOOR BAS	0.52%	67.86%
46	BULLWORK TRADERS	29	9942	105224.40	JAGGERY, TAMARIND,	0.49%	68.35%
47	NAVEEN INDIA	50	6129	99579.34	BEST FOOD INTERNATIONAL, CPC	0.46%	68.81%
48	FIVE STAR AGENCIES	41	13859	98799.65	NUTRINE	0.46%	69.27%
49	BALAJEE ASSOCIATES	23	23	98188.60	BAKERY	0.46%	69.73%
50	CORAL ENTERPRISES	19	8190	91231.00	CHILLY, DANIA, PEPPER, DALS	0.43%	70.16%
51	BAWAR SALES CORPORATION	15	2154	91190.95	P & G	0.43%	70.58%
52	SIL AGENCIES	67	2607	90081.39	KAYTIS, COSTAS, PRUTINA-TIN VEG & NON,VEG, SUZAANE	0.42%	71.00%
53	KAMAL STORES	103	8100	89891.00	SAVORIES, UNBRANDED	0.42%	71.42%
54	PAZHA MUDIR CHOLAI	6	6	88077.20	F & V	0.41%	71.83%
55	TOBACCO CENTRE	43	3170	83941.63	I T C	0.39%	72.22%
56	RAAJ TRADE LINGHS	89	2911	82943.15	PARK AVENUE, J K HELEN CURTIS	0.39%	72.61%
57	ASHOK M.LULLA	33	33	81501.15	NEW GANGODHRI, CHAT ITEMS	0.38%	72.99%
58	NEW BHARATH ENTERPRISES	29	1964	80697.57	DABUR INDIA	0.38%	73.37%
59	JAIN MARKETING	70	3673	78293.68	HALDIRAM NAGPUR	0.37%	73.73%
60	SAROJ ENTERPRISES	24	6134	76111.66	M T R FOODS	0.35%	74.09%

(Continued)

No	Vendor Name	No of Skus	Total Hash Qty	Purchase Value from Vendor	Company Name	Purchase Value %	Cumu-lative %
61	SRI SARAVAN ENTERPRISES	11	1586	75693.20	GOODNIGHT., GODREJ HI CARE	0.35%	74.44%
62	N. SURESH BABU	2	7500	74962.50	IDLI RICE	0.35%	74.79%
63	S K SWAMY ENTERPRISES	27	5029	74962.39	KARNATAKA SOAPS, MYSORE SOAPS	0.35%	75.14%
	Total of Top 63	**4106**	**596847**	**16110360.74**			
	Others	3697	283168	5330701.33			
	Grand Total	**7803***	**880015**	**21441062.07**			

* The total number of SKU's reflect many which have been discontinued, but have not yet been taken off from the database

Source: Company Records, December, 1998.

Exhibit 15: Hindustan Lever Limited: Sales Profile – 1997

(Rs Crores)

Sl No	Items	Amount
1	Soaps & Detergents	3360
2	Beverages	1544
3	Personal Products	884
4	Others	613
5	Processed Triglycerides Oils and Vanaspathi	542
6	Animal Feeding Stuffs	272
7	Speciality Chemicals	155
8	Ice Cream & Frozen Desserts	153
9	Branded Staple Foods	112
10	Canned & Processed Fruits & Vegetables	97
11	Diary Products	87
	Total	7820

Source: The Economic Times, December 30, 1999.

Branded Food Processing (1996)

(Rs Crores)

Company	Amount
Hindustan Lever Limited	2,000
NDDB	1,200
Nestle	1,000
Siel	850
Britannia	650
Total (top five)	6,000
Cadbury	250
Total (top twenty)	10,000

Source: Compiled FAIDA report, CII & McKinsey and Co, 1997.

Exhibit 16: Role of Intermediaries: Comparison between India and United States of America

	India	United States of America
Intermediaries between Farmer and Consumer (Fruits and Vegetable)	6 (Consolidator, Commission agent, Trader, Commission agent, Wholesaler, Retailer)	2 (Wholesaler, Retailer)
Intermediaries between Farmer and Mill (Wheat)	2 (Commission agent, Grain trader)	1 (Grain trader)
Markup	33–50%	9%
Farm-gate prices as share of consumer prices		
Apples	30%	40%
Tomatoes	25%	41%
Milk	90%	NA
Share of intermediary margin contributing to value addition costs	50%	80%

Milk co-operatives in India have demonstrated that by reducing the number of intermediaries, the farmers' share of revenues can be increased from 50% to over 90% of the processor price.

Source: Compiled from FAIDA Report, CII & McKinsey and Co, 1997

Exhibit 17: Ponni Rice Sales and Purchase for Madras Region

Month	Sales (kgs)	Sales Value (Rs)	Selling Price (Rs/kg)	Purchase (kgs)	Purchase Value (Rs)	Net Cost (Rs/kg)	Margin (%)	Absolute Margin (Rs)
Jan' 97	5572	109783	19.70	5100	74573	15.72	20.20	22191.16
Feb' 97	4689	92703	19.77	4900	71894	15.78	20.20	18710.58
Mar' 97	6147	118685	19.31	6000	88022	15.77	18.30	21746.81
Apr' 97	5925	114353	19.30	5800	85313	15.82	18.05	20619.00
May' 97	6974	129166	18.52	7100	100159	15.17	18.10	23370.42
June' 97	10884	195011	17.92	11000	150300	14.69	18.00	35125.04
July' 97	14082	265823	18.88	14000	201290	15.46	18.10	48115.28
Aug' 97	13368	253456	18.96	13500	195194	15.55	18.00	45583.60
Sept' 97	10192	192817	18.92	9900	141959	15.42	18.50	35656.36
Nov' 97	12022	201200	16.74	12000	153154	13.72	18.00	36258.16
Jan' 98	11444	204414	17.86	11500	154357	14.43	19.20	39277.08
Feb' 98	9848	176193	17.89	9000	121297	14.49	19.00	33495.48
Mar' 98	9850	174899	17.76	10500	142180	14.56	18.00	31483.00
Apr' 98	9314	165888	17.81	9600	131138	14.69	17.53	29065.34
May' 98	13225	242520	18.34	13500	185085	14.74	19.61	47583.50
June' 98	22959	388368	16.92	24000	319037	14.29	15.50	60283.89
July' 98	69840	1098688	15.73	82500	1043625	13.73	12.72	139784.80
Aug' 98	95760	1437846	15.02	150000	1891500	13.43	10.54	151789.20
Sept' 98	106330	1603653	15.08	290000	3787400	13.55	10.15	162881.50
Oct' 98	120000	2035054	16.96	320000	4848000	14.86	12.40	251854.00

Source: Company Records, December, 1998

Exhibit 18: Expected Profile of "Value Added" Food Consumption in India by 2005

(Rs Crores)

Sl No	Items	Amount
1	Oil	50,000
2	Packaged Milk	36,000
3	Fresh Poultry	27,000
4	Sugar	24,000
5	Packaged Atta	15,000
6	Soft Drinks	10,500
7	Bakery	10,000
8	Cereals	10,000
9	Processed Meat and Poultry	9,000
10	Tea and Coffee	7,400
11	Indian Dairy Products	7,300
12	Confectionery	6,500
13	Value Added Western Diary Products	4,700
14	Fruit Drinks	2,000
15	Fresh Vegetables	1,200
16	Spices	1,200
17	Puree, Jams and Sauces	1,000
18	Frozen Vegetables	350
	Total 'value added' food consumption in 2005 (Approximately)	225,000
	Total 'value added' food consumption in 1996 (Approximately)	77,000
	Total food consumption in 1996	250,000

Source: Compiled from FAIDA Report, CII & McKinsey and Co, 1997.

Exhibit 19: Economics of a Typical Store

Size :	3500 Sq Ft
Investment :	Rs 40 Lakhs/Fitout
	Rs 10 Lakhs/Rent Deposit
	Rs 50 Lakhs
Costs	**Rs**
Rent	90,000
Salaries	80,000
Power/Fuel	50,000
Selling Exp	15,000
Bank Charges	10,000
Security/Others	10,000
Repair/Maintenance	20,000
Advt/Promotion	15,000
TOTAL	**3,00,000**
Depreciation	50,000
Interest on W/Cap	5,000
TOTAL OPEX	**3,55,000**

Source: Company Records, December, 1998.

QUESTIONS FOR DISCUSSION

The key issues to be dealt with are the following:

1. The merchandising decision i.e. what to stock in each retail location?
2. The vendor development decision i.e. whom and where to source from?
3. The best distribution strategy, i.e. how to reduce total delivery time from vendor to store, and reduction in the cost of procurement?

APPROACH FOR ANALYSIS

ABC analysis (pareto analysis) and category management can help to manage variety better and to make a better merchandising decision. In the organised segment, the approach to vendor development can be through supplier relationship management in a variety of ways, including collaborative marketing efforts and lobbying for a single point of contact at the supplier (especially with large suppliers). In the unorganised sector, traditional vendor development can be done.

The current ordering process and inventory norms can be assessed for cost effectiveness, from the data given. The role of the warehouse in effectively servicing the retail outlets can be examined.

Different supply chain structures are already identified for the different types of products. Each of these needs to be evaluated for improvement possibilities.

Case 10

CASE CONTEXT

Seth Dhaniram is a carrying and forwarding agent (C&FA). The case deals with his company, Raj Distribution Services (RDS), which provides carrying and forwarding services to JOSH Denims, a leading manufacturer and marketer of denim garments. A year after the initial arrangement, an entire tier in the JOSH's supply chain was eliminated and the C&FA's direct customers exploded from 10 distributors to 180 retailers. This change had direct implications on the cost and complexity of the C&FA operation. Dhaniram was left with the option of either continuing the agency operation with some renegotiation, or giving it up.

This case highlights the significance of each channel partner in the supply chain, and also emphasizes the implications of eliminating a link in the supply chain to the other channel partners. It also introduces some subtle aspects like family owned businesses, the role of networking, and the value-added by transporters.

SETH DHANIRAM C&FA

July 1999

Seth Dhaniram was a worried man. As he looked out at the gathering monsoon clouds from his plush office in the commercial district of Ahmedabad, his thoughts went back to the latest problem that one of the businesses in his group faced. Since the past few weeks, he had been pondering over whether to continue with the carrying and forwarding agency (C&FA) operations of "JOSH Denims," or give it up.

Prepared by Chudasama and G Raghuram. Teaching Material of the Indian Institute of Management, Ahmedabad, is prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems.

Background

Dhaniram was at the helm of a family owned business, which was over a 100 years old. It was jointly owned and operated by his brothers, sons and nephews. The organisation, "Logistics Solutions" provided logistics services to both domestic and multinational corporations. These services included carrying and forwarding (Glossary), distribution and stocking. The firm offered its services to organizations in industries as diverse as pharmaceuticals, processed foods, fast moving consumer goods (FMCG), consumer durables and readymade garments (RMG). The C&FA operation of each customer was registered as a separate agency and each agency was treated as a distinct business entity, mainly for accounting purposes. Dhaniram had grouped the various agencies based on their synergies (Exhibit 1).

These groups of agencies had been allocated among various family members based on their skill sets and experience. For example, his younger brother, Sakharam solely looked after the edible oil agencies, while his sons Raj (BSc (Chemistry)) and Shyam (MCom (Accountancy)) jointly handled the pharmaceutical agencies. However, the various agencies fell under the umbrella of the parent company Logistics Solutions headed by Dhaniram.

Over the years, the firm had developed an excellent portfolio of agencies by roping in market leaders in pharmaceuticals, processed foods and FMCG. In fact, one of the market leaders in processed foods, a Swiss multinational, had benefited from the firm's services for over 60 years. The company had a focused approach and over the years had (unlike other firms in the C&FA/distribution business) restrained from expending its limited resources into allied businesses like warehousing and transportation.

In spite of its long-standing reputation in the market and financial soundness, the working capital requirements of Logistics Solutions were financed by personal sources such as borrowings from relatives and business associates. This practice was not unusual in the Ahmedabad market where the average businessman was known for his dexterity at circulating capital effectively in the marketplace. The number of working capital turns/year for trading firms could be as high as 36 to 40. This was essentially achieved because of high inventory turnover resulting from low order cycle times and near zero ordering costs. In effect, as Dhaniram put it, "judicious circulation of working capital could yield high rates of return."

Since the mid-nineties, Dhaniram had withdrawn from day to day operations and had restricted his role to that of providing strategic direction and grooming the next generation to take over the reins of the business. His nephews, Amit and Akhilesh had returned from the United States with MBA degrees in finance and were being trained regarding the financial aspects of the Logistics Solutions operation.

JOSH Denims and the C&FA Appointment

In January 1998, Dhaniram gathered from the grapevine that JOSH Denims (JOSH), a market leader in denim garments was in search of a C&FA to administer the distribution of its products in the state of Gujarat (Exhibit 2). Dhaniram was aware that JOSH conducted its distribution operation from a company owned and operated facility based in Ahmedabad.

The appointment of a C&FA was a part of the company's ongoing policy of outsourcing several key functions.

Dhaniram soon saw an advertisement in the local newspapers calling for applications from experienced parties who would be interested in providing the C&FA services to JOSH. He also received a phone call from an executive at JOSH, asking him to contact the General Manager (Distribution) since JOSH wanted to consider Logistics Solutions as a possible candidate. In the meantime, Dhaniram gathered that JOSH had contacted other similar agencies and their major distributors who were well connected in the market. He knew that this was a general practice followed by principals like JOSH.

Dhaniram decided to send in his organisation's profile, along with an expression of interest in JOSH's agency. A month later some of the executives from JOSH visited the premises of Logistics Solutions and discussed issues related to their existing profile, services and infrastructure. They said that such visits were being carried out to a short listed set of applicants, primarily based on the following factors:

- ✓ Market reputation
- ✓ Financial soundness
- ✓ Infrastructure/facilities
- ✓ Professionalism
- ✓ Techno friendliness

Subsequent to this visit, Dhaniram was invited to the corporate office of JOSH to discuss the expected service levels and his capability to fulfill them. This meeting was attended by several key executives from the Distribution, Finance and Marketing operations of JOSH. He came to know that there were four other candidates in the final list. Knowing that this process was characteristic of how the market typically operated regarding appointment of a new C&FA, and given his reputation and networking skills, Dhaniram was sure that he was one of the serious contenders. He decided to give his best, since he also valued this account.

There were a few more rounds of negotiations. Dhaniram was elated about the prospect of handling a completely new, highly "sophisticated" product. The product range included designer denim trousers and jackets with variations in colors, sizes, and style including position of zippers and number/type of pockets. The role of the C&FA essentially involved making supplies to 10 distributors, who in turn would cater to 180 company approved retail outlets (Exhibit 3). Each major district had one distributor (Exhibit 4) and several retail outlets.

The job profile of the C&FA involved the following:

1. Warehousing
2. Order processing, invoicing, dispatching, transportation and tracking of goods
3. Collection of payments and acknowledging receipt of payments
4. Reordering inventory

5. Handling goods returned (reverse logistics)
6. Providing sales reports to the field force
7. Dealing with taxation and regulations (Octroi, Sales Tax & FDA)
8. While doing all of the above, adherence to the guidelines set by the principal

The remuneration, on a fixed package basis, was attractive at INR 60,000/month. This amounted to a margin of nearly 2% on sales approximating INR 3 million/month.

The C&FA contract was ultimately awarded to Dhaniram. He was to begin operations in April 1998. The contract stated the terms and conditions for the C&FA operation and would be periodically reviewed every two years. It was orally understood between him and the JOSH executives that the periodic review of the contract would more or less be a renegotiation of the remuneration, as most of the other JOSH's terms and conditions would remain stable.

The C&FA Experience

The new C&FA was registered as Raj Distribution Services (RDS) and the operations began at a leased warehouse in April 1998. The title of the warehouse was owned by RDS.

The transportation function was outsourced by RDS to several private carriers. A preferred carrier was nominated for every destination depending upon i) distributor's recommendation and ii) carrier performance/service level. The service level of a carrier for a particular destination was a function of the frequency of vehicles departing to that destination. The distributor's recommendation was normally accepted unless the recommended carrier quoted high freight rates or failed to meet Logistics Solutions' minimum standards in terms of the service level, reputation and age of the fleet.

RDS had a dedicated vehicle to ship the customer orders from the warehouse to the carrier's dock. The carrier had a unique role of consolidating shipments at both ends. Firstly, it consolidated the shipments of several customers shipping to a particular destination. Secondly, at the destination, it consolidated the shipments for a distributor from his/her several suppliers. For example, if distributor ABC located in Surat had shipments from 15 suppliers arriving at the carrier's dock on a given day, the carrier would consolidate all of ABC's shipments that arrived from several C&FAs/stockists before making a single door delivery to ABC. This system was facilitated by the fact that RDS and other C&FAs in the market usually appointed a distributor recommended carrier. However, inspite of consolidation, almost all the shipments were less than truck load.

The average number of cases sent to a distributor was about 250 per month. Exhibit 4 provides a list of the destinations serviced by carriers from Ahmedabad, along with the freight rate and share. The transporters followed a system under which the greater the freight volume for a destination, lower the transportation rate/case. The rates were also dependent on the distance. The rates were negotiated annually for each destination based upon the freight volume in the previous year.

JOSH extended a 21 day credit to the distributors. However it was the C&FA's responsibility to receive payment on behalf of JOSH and deposit the checks in JOSH's bank account. There were minimum order quantity norms and distributors could not place orders for less than case lot quantities. (One case lot contained 12 trousers or jackets, and generally of the same size and style).

Exhibit 5 summarizes the distribution of costs incurred at the C&FA between the C&FA (RDS) and the principal (JOSH). There were marginal requirements of repackaging some cases and sending some cases using a courier service.

Dhaniram found the task challenging and interesting. This agency was proving to be a good training ground for his nephews. He expected that their business could leverage the experience with this account for further growth.

Policy Change

Within 15 months of operations, in a major policy change, JOSH decided to eliminate an entire tier in its distribution structure by doing away with all its distributors. In July 1999, RDS was instructed to make direct supplies to all the 180 retail outlets, with no additional remuneration. This was to begin as soon as possible and definitely by the end of the month. Dhaniram was not exactly pleased with this development. Apart from being a surprise, the policy change would have manifold consequences for RDS.

The retail outlets were spread in 14 districts (four more than the ten distributor locations). These outlets were located in the major town (and some of the outlying suburbs) of each of the districts. Usually a retail outlet sourced its requirements from the distributor located in its district. If a retail outlet was located in a district that did not have a distributor, then it would approach the nearest distributor in another district. For example, a retail outlet located in Amreli would source its inventory from either Rajkot or Bhavnagar. Now the expectation was that the retail outlets would source directly from the C&FA.

Retail outlets were currently permitted to order in less than case lot quantities. Based on some data shared in one of the recent distributor meets, Dhaniram had estimated that the total outbound shipments from the distributors was about 3,600 cartons, two-thirds of which were a result of repackaging. The repackaging was necessitated both due to order quantities and mix requirements. Repackaging requirements were more for the smaller retailers. The number of carton requirements per retailer ranged between 10 and 35 per month, with 50% of the retailers requiring 15 or less cartons. Distributors had to maintain inventory records both at the piece level (in the case of repackaging) and the case lot level.

Apart from the repackaging activity, Dhaniram also visualised increasing complexity in organising the transport and delivery, credit and collection management, and customer servicing including query handling. Additional labour and clerical staff would be required.

Distributors also took care of transportation to the retailers, who were mostly within a radius of 25 kms of the distributor location. In terms of credit, retailers generally paid for the previous order when the next order was delivered. There were instances, however, when the credit went up to a month based on the relationship. For the various services including transportation and ownership of the inventory rendered by the distributor, they were given a trade margin/discount ranging from 7% to 10% of purchase value. Given JOSH's price list, retailers enjoyed a margin of 15% to 25% of the sales value.

The Decision

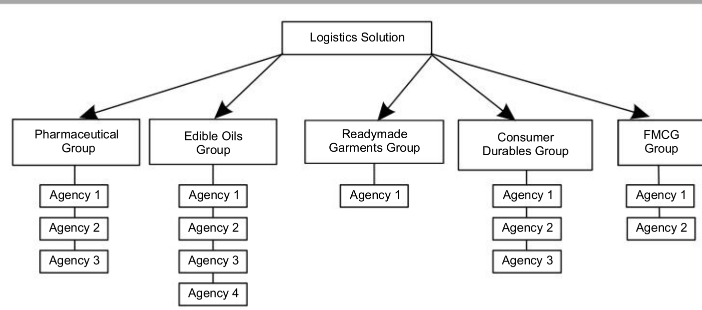
Dhaniram was in a quandary whether to continue with the agency operation or give it up. Though financially the project was no more attractive, JOSH was a leading brand in the market and operating its C&F was by itself a very prestigious affair. Renegotiation was a possibility, but seemed farfetched. Several agents with experience in logistics in Ahmedabad were eager to take up the agency operations. His other hope was to negotiate a higher remuneration when the contract came up for periodic review after about eight months. Dhaniram felt to himself, "JOSH was saving a tidy amount by bringing about the proposed changes in its supply chain. Did he, as a channel partner, not deserve a share of the savings?"

Dhaniram was wondering what to do.

Glossary of Terms

1	BSc	Bachelor of Science
2	C&FA	Carrying and forwarding agent – one who does not assume the title of goods, but distributes them and collects payments on behalf of the manufacturer
3	FDA	Food and Drugs Administration
4	INR	Indian Rupee
5	MCom	Master of Commerce
6	Octroi	A tax levied by the local government on all products entering the municipal limits of a city
7	Principal	A term which is the equivalent of a manufacturer
8	Sales Tax	A tax levied by the state government on every sale that takes place within the physical boundaries of the state
9	Seth	An honorable prefix used for a businessman

Exhibit 1: The Logistics Solutions Organisation Structure



Note: Agency: Carrying and Forwarding Agency

Exhibit 2: The District Map of Gujarat

Exhibit 3: The JOSH Denims Supply Chain

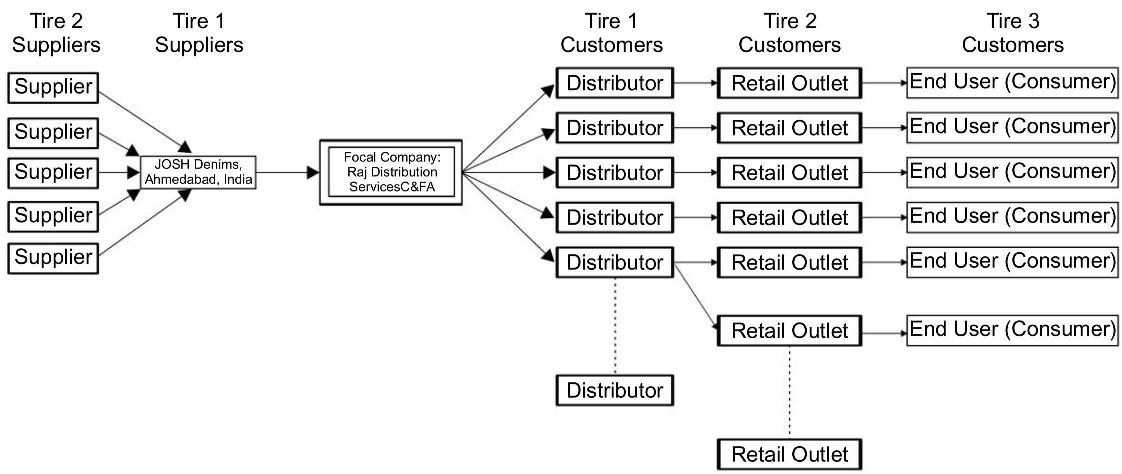


Exhibit 4: List of distribution Locations

Distination	Distancw	Preferred Carrier	Rate/Case (INR)	% of Freight Share
Anand	65	Suraj Carrying	12	7
Bharuch	200	Surya Roadlines	18	3
Bhavnagar	200	Raj Carrying Corporation	18	3
Gandhinagar	30	Vashram Transport	16	5
Jamnagar	300	Raj Carrying Corporation	20	5
Navsari	300	Suraj Carrying	20	8
Rajkot	220	Raj Carrying Corporation	16	12
Surat	260	Surya Roadlines	14	19
Vadodara	120	Surya Roadlines	12	18

The tenth destination was Ahmedabad. The retailers were serviced at an average of INR 8/case

Note: INR: Indian Rupees

All transit times were overnight

Exhibit 5: Costs Incurred by the C&FA (RDS) and the Principal (JOSH Denims)

RDS:

Remuneration per month: 60,000 INR

Costs

Item	INR
Warehousing	12,000
Manpower (1 manager, 1 store keeper, 1 computer operator, 2 packer)	18,000
Transportation from warehouse to the carrier's dock (60 trips/month * 60 INR)	3,600
Electricity	1,000
Computer and related hardware (one time fixed expense)	70,000

JOSH Denims:

Costs

Item	INR
Transportation from Ahmedabad (C&FA) to distributor destination	34,000
Repackaging	3,000
Security	2,000
Courier	3,000
Consultancy and all other charges related to sales tax and other levies	1,000
Service tax (5% of the C&FA remuneration)	3,000

QUESTIONS FOR DISCUSSION

1. What is the estimated cost incurred by RDS due to JOSH's changed policy?
2. Can the company still get advantages of economies of scale in the new arrangement?
3. Is it viable for RDS to still continue with the relationship with JOSH?

APPROACH FOR ANALYSIS

The present cost for distributing the goods to the 10 distributors can be calculated. In the new arrangement, there would be additional costs due to re-packaging and administrative costs of dealing with many more downstream entities. Different options can be explored in the distribution network to see if any partial aggregation can help. Credit arrangements and cash implications for RDS also need to be considered.

These cost implications have to be considered in conjunction with Seth Dhaniram's overall business portfolio and the importance of companies like J

Case 11

CASE CONTEXT

The vision of AFL was to be the acknowledged leader in providing world class "Integrated Logistics Solutions" (ILS). The company had the background of a family business involved in clearing and forwarding, dating from 1867. AFL came formally into existence in 1945. In 1979, a tie up with DHL Worldwide Express permitted AFL to introduce India to the concept of "Express Delivery", giving birth to the term "The Courier". In 1988, AFL began a new untried service: Express Distribution, which involved providing distribution services with time guarantees, thus adding more value to its already existing niche services.

With its wealth of experience and expertise, AFL decided to enter a new growth phase, towards becoming the ILS provider to corporate India within the next three years. In this context, the chairman and managing director of AFL was further concerned with building the appropriate information technology and physical infrastructure to enable this to happen. The question that he had was 'how will we do it?'

AIRFREIGHT LIMITED

Mr. Cyrus Guzder, Chairman and Managing Director, Airfreight Limited (AFL), in an interview with the case writers in April 1997, was verbalising the implications of his vision for AFL, which was to be the acknowledged leader in providing world class "Integrated Logistics Solutions" (ILS). The company had the background of a family business involved in clearing and forwarding, dating from 1867. The current generation prided itself in being the fifth in the line. Mr. Guzder was concerned with strengthening company's leadership position. Based on the company's primary strength of "mastery over movement" and the changing customer needs, he was quite clear that the future direction ought to be in

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Written by S. Manikutty and G. Raghuram. Assistance provided by Mr. Sunil Jaryal is acknowledged. This case was made possible by funding from the Research and Publications committee. Teaching material of the Indian Institute of Management, Ahmedabad, is prepared as a basis for class discussion. Cases are not designed to present illustrations of either correct or incorrect handling of administrative problems.

providing ILS, but felt that the market needed to be appropriately developed and accessed. In this context, he was further concerned with building the appropriate infrastructure to enable this to happen, namely information technology infrastructure and physical infrastructure. The repeated question that he had was 'how will we do it ?'

He was also clear about the framework within which this 'how' would be set and had already expounded a statement of values for AFL. Exhibit 1 gives the vision, mission and values of AFL.

The Organisation

AFL came formally into existence in 1945, when Tata Airlines appointed its founder Jamshed N. Guzder, as its first sole cargo agent in India. This started a long association with "freight forwarding". Following closely thereafter, in 1948, its travel division was set up. In 1979, a tie up with DHL Worldwide Express permitted AFL to introduce India to the concept of "Express Delivery", giving birth to the term "The Courier". In 1988, AFL began a new untried service - Express Distribution, which involved providing distribution services with time guarantees, thus adding more value to its already existing niche services. A new activity that AFL got into in 1994 was international money transfer in an express mode, in collaboration with Western Union, a US based international giant in this service. With its wealth of experience and expertise, AFL decided to enter a new growth phase, towards becoming the "Integrated Logistics Solutions Provider" to corporate India by the year 2000 AD.

AFL had the following business divisions and subsidiaries:

Business Divisions
DHL (International Express)
ACE (Domestic Express Distribution)
Air Cargo
Indtravels (Travel and Tours)

Subsidiaries
Astra Shipping
Astra Infotech
Astra Worldwide

The original beginnings of the freight forwarding service was in the cargo division, followed by the travel division. The international express division provided the courier service. While international courier service was the mainstay of this division, domestic courier service was also provided with the same infrastructure. The DHL brand was used for international while Airfreight brand was used for domestic. The domestic express distribution service was offered through ACE (Advanced Cargo Expertise), using surface transport. Astra Shipping was involved in shipping focused primarily on the ocean freight business as a non vessel owning common carrier (NVOCC). Astra Infotech was involved in developing software products related to the transport sector. Astra Worldwide was in merchant exports, primarily focused on leather shoes and engineering valves. This subsidiary was set up in 1990, primarily for the then needed foreign exchange cover and tax benefits. The subsidiaries had marginal, but complementary business activities.

The corporate support functions for the business divisions were finance, information technology, human resources, audit and methods, corporate relations, planning, and integrated logistics solutions. The integrated logistics function put all the business divisions together with the subsidiaries and support functions for marketing integrated logistics solutions.

Exhibit 2 gives the organisation structure of AFL. Similar support functions existed at regional levels for each of the business divisions, which were run as profit centres. Until March 1995, at the regional level, these support functions were available only as a common resource for the various business divisions until a restructuring exercise was carried in 1995. As per some of the executives heading the business divisions/corporate functions, the areas of operations tended to overlap, sometimes resulting in internal confusion and extra need for coordination.

While AFL was organised into business divisions and functions as given above in terms of man power and resource allocation, it described its products as:

DHL Worldwide Express

AFL Domestic Express

AFL Cargo

AFL Travels

AFL Distribution Services

AFL Logistics

AFL Shipping

AFL Infotech

The above structuring reflected the "product" focus that AFL was continuously striving for, in its evolution. Exhibit 3 gives a brief business profile of the above products.

Exhibit 4 gives the growth in turnover, net worth and number of employees of AFL from 1990-91 till 1996-97 and the growth in turnover and revenue for the four AFL divisions. Exhibit 5 gives the financial highlights of the company over the same period. Exhibit 6 gives the profit and loss account for the years 1994-95 and 1995-96. Exhibit 7 gives the balance sheet for the years 1994-95 and 1995-96.

Some of the important achievements until 1995-96 were that the turnover had grown at the rate of 25% annually during the last five years, networth had grown at a compounded rate of 40% in the last five years, long term debt equity ratio had been maintained under 0.5, and ROI exceeded 30% and PBT was between 10 - 12% of revenue.

As seen in exhibit 4, AFL had an estimated turnover of Rs 4850 million during 1996-97 with a PAT of nearly Rs 1400 millions. Currently about 50% of the turnover and 70% of the contribution was from the Express divisions. Roughly Rs 200 million was from the AFL

Distribution services during 1996-97. This had grown from Rs 26 million in 1993-94 to Rs 76 million and Rs 142 million in the intermediate years. AFL Cargo had a turnover of Rs 1380 million during 1996-97. The travel division had a turnover of Rs 770 million. The turnover and revenue figures differ significantly for the Air Cargo and Indtravels divisions, and the international money transfer activity with Western Union (included in the DHL figures). As per the industry practice, turnover reflects the actual freight and ticket billings, while the commission earned is shown as revenue. The profit and loss account in Exhibit 6 reflects the revenues for the group.

History of the Organisation

It all started in 1867, when Framji Guzder was entrusted with the entire transport and shipping arrangements of the British Commissariat campaign supplies, by Nusserwanji Tata, the founder of the Tata empire. Soon, Framji and his son, Sorabji, set up a clearing and forwarding agency called Sorabji Pestonjee & Co., which was renamed N.S. Guzder & Co. in 1892. It came to be closely associated with the House of Tatas. In 1930 when J.R.D. Tata thought of setting up an airline in India, it was N.S. Guzder & Co. that cleared the first aircraft imported by him - a de Havilland Puss Moth. By 1934, the company had extended its operations to the Wadias (Bombay Dyeing) and the Century Mills. During the second world war, the company secured the exclusive clearing agency contract for the Government of India Supply Department, resulting in clearing of lakhs of tonnes of freight, imported by the Government, for nearly two decades after the war. It also included handling, clearing and transporting critical machinery for major projects, such as the Bhilai Steel Plant, the Oil Refineries of Baroda and many others. N.S. Guzder & Co. continued to be a parallel transportation business operation, while AFL, which was set up in 1945, had taken on new business dimensions, leading to the present business structure in the transportation industry.

Exhibit 8 gives a more lucid account of the history of the organisation in the words of Jamshed N. Guzder, the father of Cyrus N. Guzder and President of AFL.

Structure of Current Business

The structure of the current business of AFL in terms of various products were:

Courier

International/Domestic door to door express delivery of documents, parcels and commercial packages

Cargo

Air/Sea import consolidation
Air/Sea import/exports
Domestic air cargo
Customs clearance

Warehousing
Documentation

Express Distribution

Domestic surface door to door cargo
Warehousing
Distribution
Invoicing
Collection
Statutory documentation

Travel

International/domestic travel
Inbound tours
Conferences
Trade fairs

Money Transfer

International money transfers

ILS

Tailormade single window 'Integrated Logistics Solutions' to key accounts

As of now, relatively, the ACE division of AFL had built up greater experience towards integrated logistics, by continously increasing its scope of services.

ACE – Express Distribution

To strengthen Airfreight's presence in the domestic market, ACE was launched in April 1993. A new division was formed to offer door-to-door express cargo service using surface transport to the Indian market.

The service package originally comprised of:
Door pickup and door delivery
Assured transit times
Safety
All India network
Track and trace information

This service was essentially targeted at high-value commodities (value to weight ratio upward of 500 rupees per kg) like:
Computers

Telecom
Consumer durables
Pharmaceuticals
Engineering spares, etc.

ACE had developed infrastructure in terms of:
Offices
Information technology
Communications systems
Manpower
Hubs for transshipment

The procedures were set and well documented. As business progressed, additional routes were introduced and existing ones modified related to capacity utilisation. The network had expanded from servicing 25 to 250 locations and continuous efforts were being made to expand it further. ACE had 9 hubs through which almost 90% of the cargo was transhipped for the purpose of deconsolidation, sorting, and consolidation for onward movement

After 2 years of launch, ACE had diversified into total distribution service, where, in addition to door-to-door express movement, the services included:
Warehousing
Order processing
Invoicing
Stock keeping and related documentation
Collection of payment on delivery
MIS

The idea was that this would help the customer organisations focus on their core competencies in marketing and manufacturing and outsource part of the logistics function to a specialized agent. This was seen as a distinct value-addition and as a cutting edge to stay ahead of competition. Related to expansion in the distribution services, infrastructure had been enhanced, developing warehousing capabilities in about 20 locations in the country.

ACE had recently entered into refrigerated movement by providing logistics support to McDonald's. ACE was handling the total supply chain movement for its frozen and dry products and acted as a key interface between the suppliers and the distribution centers. Exhibit 9 gives an overview of the performance, reports provided to customers and customers of ACE. Typically, the ACE division did not deal with customers who required any international servicing.

Integrated Logistics Solutions

This function was set up formally on January 1, 1997, after various brainstorming sessions within AFL over the earlier few months. This was intended to be a coordinating function to enable this value-added service to be provided, leveraging on the strengths of the other divisions. This function was headed by a General Manager (the person selected for the post was a long time company executive, committed to this idea, and described as a soft spoken consensus seeker), a Deputy General Manager to support him, two Managers looking after the west and south respectively, along with a secretary. The geographical focus on the west and south was because most of the targetted corporates had their headquarters in theses regions.

In the early months of this function, customers were targetted for presentations on how they could gain by out sourcing integrated logistics. Customers were also pursued based on a rebound from any of the other divisions, if scope for integrated logistics was percieved. Most of the early customers were those who required atleast some international servicing like import consolidation, customs formalities etc. The presentations usually involved homework on various costs to the customers, often as suggested by the customers. Representatives from the business divisions also went for the presentations along with the GM - ILS.

It was still early to talk about successes. However, reflecting on some of the efforts which did not yield results, Mr. Guzder felt that while the customer often explicitly stated that the price was not right, there could be more to it. For example, the customer may have expected the MD to be present, or the presentation to be made by one person rather than asking the functionaries of the divisions to talk about their strengths.

Exhibit 10 gives excerpts from a concept note presented to a customer, describing the experiences of providing ILS to two other customers.

Market Profile

Given the success of AFL in the variety of activities related to transportation, along with value added attributes like timeliness and door to door deliveries, AFL saw the future in providing integrated logistics solutions. The market for this was visualised as having the following customer attributes:

Increasing sensitivity of product movement to speed

Increasing sensitivity of product movement to reliability

Increasing awareness of inventory costs

Increasing focus on core competence of manufacturing, marketing and purchasing, while outsourcing procurement and distribution logistics

According to an industry executive, “in the conventional distribution model, distribution costs form about 2-3% of sales while inventory costs form about 4%. By adopting this outsourcing model, the distribution cost increases to 5% of sales, but there is virtually no inventory. As a result, there is a net saving of about 2%.” It was estimated that logistics and supply chain management related costs are in the range of 12 to 15 per cent of the GDP. In a developing country context, the same proportion was in the range of 18 to 20 per cent. The difference resulted in better customer service parameters and in fact a better material quality of life. Since customer sensitivity was moving along similar lines in India, the significance of this activity would certainly grow.

Some of the changes taking place in the Indian corporate sector were:

(a) Increasing functional focus on this activity by appropriate restructuring and positioning of this function in the organisation structure.

(b) Increasing coordination between marketing, manufacturing and procurement through better planning systems and use of IT. However, this area was the one where a lot of work was required since the corporate ethos in India was strongly "departmental" with implications on educational background, protected promotional avenues, ability to pass the buck etc.

(c) A recognition that inventories needed to be reduced by reducing lead times and uncertainties. However, organisations were often not clear as to how to go about it, especially since measuring the impact on inventory related costs was difficult, while assessing other opposing costs like transportation, which were essentially out of pocket, was easier.

(d) A recognition that customer service needed to be measured and monitored if supply chain performance had to be improved.

(e) A slow openness to review manufacturing processes including choice of technology, production structuring, layouts and product design and packaging with a focus on improving the supply chain.

(f) Increased focus on vendor development and outsourcing to rely more on one's own competence. The outsourcing also extended to activities related to logistics like transportation, storage and even managing the entire procurement and/or distribution processes. Many of the multinationals coming into India preferred using third party logistics services.

The supply side to effective logistics and supply chain management was characterised by poor infrastructure, especially in the area of transportation and storage. IT infrastructure was improving at a faster pace. The service sector which was characterised by "not so" professional and local agents involved as clearing and forwarding agents, distribution agents, stockists, wholesalers etc. who competed primarily on "contacts" was giving way to a branded national service requirement being provided by third party logistics companies. These companies also managed the transportation and storage infrastructure, an area crying for attention.

In this context, AFL was planning to offer integrated logistics support and supply chain management. This would require providing services to customers for streamlining distribution in order to ensure that products reached their customers in the shortest time possible. This not only meant transport of finished goods from factories to point of sale, but also transport of raw materials or components from suppliers and vendors to points of manufacture, and storage of finished goods and raw materials in their godowns. This extension of activities to supply chain management was a logical extension of AFLs expertise in transport, warehousing and - just as importantly - tracking the whereabouts of goods.

Much of the demand was expected from new entrants who did not have an existing distribution network. For multinationals, outsourcing their logistics requirements provided an easy route to the Indian market. Since their intention was to penetrate the market in as little time as possible, they could not affort to waste time in setting up a distribution network.

An integrated logistics service provider would also be expected to handle activities like order processing, sales tax and excise duty documentation, invoicing, repacking and secondary distribution, collection of bills, tracking consignment movements, claims processing, warehouse management and inventory management.

According to a business magazine, the total market size was estimated as a Rs. 5,000 million business, with a potential of Rs.1,0000-1,2000 million within a couple of years. The growth was expected to be at a healthy 30-40%, persuading a number of traditional surface transport companies, courier companies and freight forwarders to cash in on their existing infrastructure for this business. Transport companies leveraged their fleet size and experience in transporting cargo. Courier companies banked on experience in moving high value, small volume items and could draw on their huge staff strength, large network of offices, tracking expertise and infrastructure (including cargo planes) to help them set up logistics operations. They expected the growth of the industry to come from the domestic market where the yields were high, and the faster growth of parcels over documents. Freight forwarders leveraged their consolidation expertise and knowledge of the transport system. The entry barriers were the long gestation period, high capital investment in physical and IT infrastructure and low margins at 15-18%.

Some of the competitors were Dart Apex and Dart Surfaceline, divisions of the Mumbai based courier company Blue Dart; Mumbai based courier company Elbee express, Hyderabad based GATI and XPS, Chennai based Sembawang Shriram Integrated Logistics, Pune based Dynamic Logistics Delhi based courier company Safexpress, Clockwork Cargo, a division of road transport major Prakash Roadlines and Bangalore based Pafex, a division of Patel Roadways. Exhibit 11 gives a brief overview of the activities of some of the competitors.

The AFL Advantage

The distinguishing features that AFL felt that it could offer based on its internal strengths were:

1. The one stop shop - ILS services
   Tailor made
   Single window
2. Inhouse express agencies
   Time saving
   Flexibility
3. Physical distribution network
   Across the country
   International
4. Information Technology
   Own network
   Inhouse software
   Focused on customer

5. People
   Dedicated and trained staff
   Key account manager
6. Cost
   Communication and co-ordination efficiencies and long term variable cost structure
   Low entry cost due to established infrastructure

The company executives elaborated on their expertise and network:

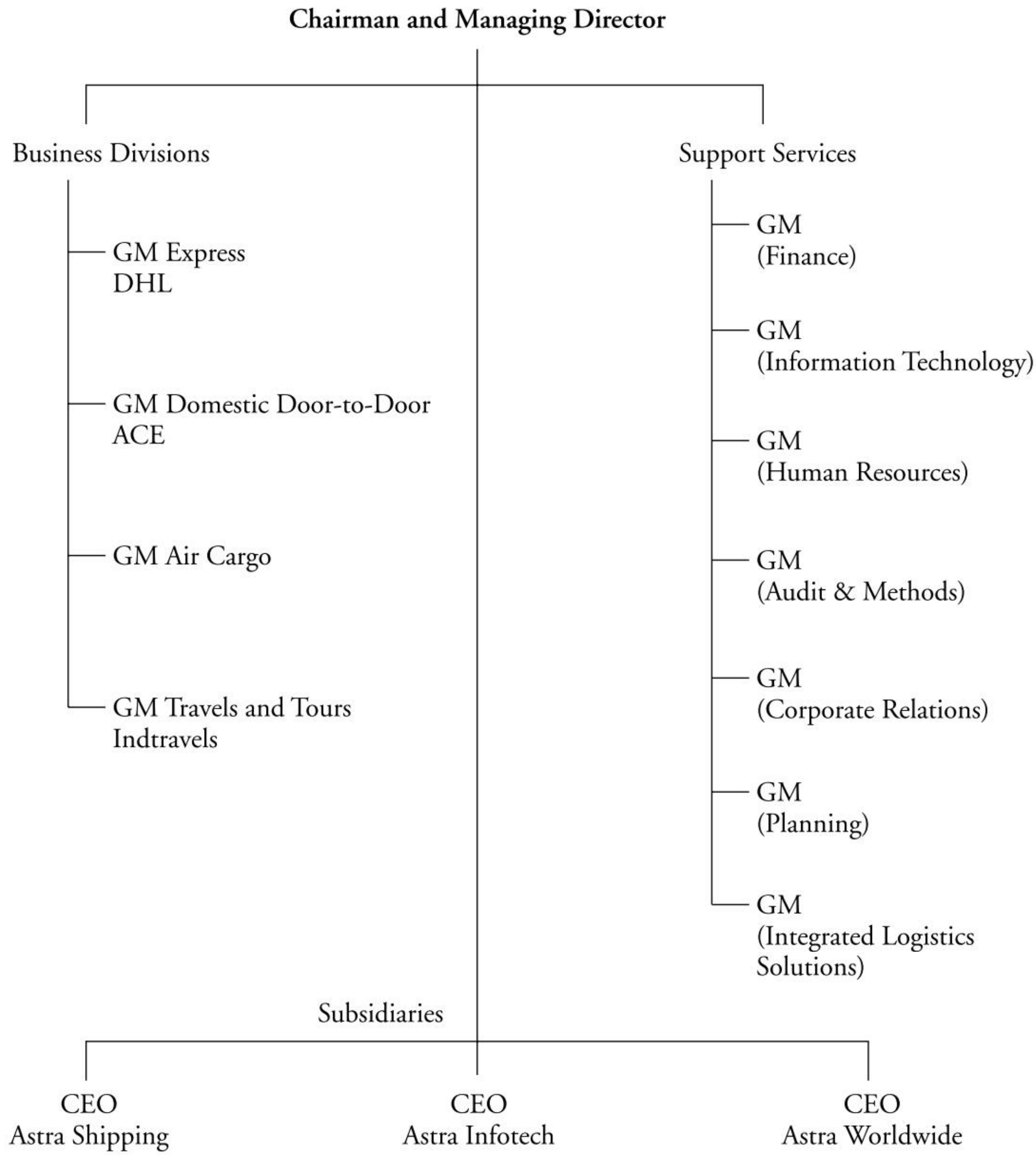
> "In the process of moving people and things from one place to another over the last fifty years, AFL has learnt, not just the basic art of movement, but observed and studied, important aspects such as, 'how to move', 'when to move', 'the shortest route to be followed', 'the most economical mode of movement', 'the different types of packaging required', the legal and regulatory formalities involved in movement of men and materials', such as octroi, customs etc., and just about anything required to ensure smoothness of the process. Time and again, the company has pioneered new concepts in relation to movement and set trends and standards for the other players in the industry to follow."
>
> "Over 200 hundred offices, 150 warehouses, about 330 vehicles and 3500 employees is what keeps AFL always in a state of readiness. Since inception, AFL has been very concious about the need for a strong, far flung, but intricately woven network. It has constantly kept adding to this network, both nationally as well as internationally, to give itself a global reach. In November 1995, the country's fully automised Hub was commissioned at Marol in Mumbai. It is housed in the most intelligent building in India, 'Airfreight House'. Investing in similar Hubs, equipped with hi-tech material handling facilities, in Delhi, Calcutta and Chennai, has become a priority for the company. As a result, today, their is a bigger time window available to customers to send documents and packages, allowing them maximum flexibility."
>
> " The IT network called ENA (Electronic Network of AFL) has a 64 kbps backbone connecting the metro cities of Mumbai, Bangalore, Chennai, Delhi and Calcutta, with 9.6 kbps links to atleast 20 other locations. The ENA is also linked by a 64 kbps line to the international DHL NET, a 64 kbps line to the Internet through VSNL, and by a 9.6 kbps link to the Vashi hub of AFL Distribution Services. Customers can connect to the closest ENA node through dial up/leased line for shipment and inventory data flow."

Exhibit 12 provides a view of how the business activities of AFL would all come together for providing ILS. Exhibit 13 details the same framework showing the ILS model with information and material flows.

AFL felt that it had all the ingredients required to make a business out of integrated logistics solutions based on some of the early successes with clients served by the DHL, ACE and Air Cargo divisions. One of the questions facing AFL was whether it was necessary, and if so, what was the appropriate time to make ILS as a profit centre.

Exhibit 1: Vision, Mission and Values
Vision To Be The Acknowledged Leader In Providing World Class "Integrated Logistics" Solutions.
Mission To Provide Organisations And Individuals The Best Value In "Integrated Logistics" Through A Global Network, Innovative Use Of Technology And Caring People
Values We shall respect the dignity of the individual and so we shall: Not discriminate on the basis of caste, religion or gender Be caring to all employees Treat people as we would like to be treated ourselves Create an environment that is conducive to learning and development We shall be transparent and fair in our behaviour, by: Being honest in our dealings with customers and business partners Being open to new and diverse ideas and approaches from our employees and customers Ensuring a fair system of assessment of performance We shall nurture personal initiative, commitment and loyalty, by rewarding those who: Take the lead and are pro-active in their approach to work Take a continued interest in improving the performance of our business Set and exhibit high standards of performance and excellence We shall foster team spirit by supporting those who: Build good working relationship with colleagues across all departments Are willing to take responsibility and offer support through their own initiative Contribute actively to the improvement of services to customers We shall always feel responsible to the communities in which we live and work through: Good conduct in public and with our neighbours Support of civic improvements Reducing wastage of every kind and protecting the environment
Source: Company Documents,1997

Exhibit 2: Organisational Structure



Source: Company Documents, 1997

Exhibit 3: Business Profile

DHL Worldwide Express

DHL Worldwide Express is the worlds largest international express distribution company, delivering documents and parcels in over 226 countries across five continents. As of 31-12-1996, it had over 49,000 employees worldwide and was backed by state-of-the-art equipment and technology. It handled over 88 million consignments, for over 900,000 regular customers worldwide. Its annual turnover exceeded US$ 4.2 billion.

Geographically speaking, it is the largest express company in the world delivering to 90,000 destinations in over 226 countries, where it is the leader in the documents and parcel market, with an average market share of around 40%. It services 97% of the fortune 500 companies and every 58 seconds, a flight takes off with DHL material on it. Over the last five years, it has grown at the rate of 20% per annum.

AFL, pioneered a new concept in 1979, when it tied up with DHL Worldwide Express, formally introducing to India to "The Courier". Today, DHL Worldwide Express has become synonymous with AFL Limited. Through DHL India, the company controls a market share in excess of 55% in the international documents and packages business.

DHL India is now diversifying into the area of commercial as well as heavyweight, high value packages (JUMBO and JUMBO JUNIOR BOXES), heeding to the demands of the local export fraternity, who were in dire need of an easier and economic system, to send their product samples overseas.

DHL has worked towards forging alliances and forming partnerships with customers, while establishing on-line, direct communication links between itself and them. The advantage of having a national network to deliver things in a pre-determined time window, has also opened up many more opportunities, one of them being, the money transfer facility, from overseas to any place in India, in association with Western Union, USA.

On the anvil is a 'Repair and Return' facility for foreign electronic goods, through the creation of Express Logistics Centres, at strategic locations in the country. At the end of 1995, DHL's most modern HUB in India (with hi-tech material handling facilities) was commissioned at Marol in Mumbai, giving customers the flexibility of a bigger time window to send their documents and packages. Still allowing documents to be on-time, every time.

AFL Domestic Express

In 1982, AFL extended "The Courier" concept to the domestic level, starting a domestic courier services called, AFL Domestic Express. AFL Domestic Express has been expanding rapidly using the network of local AFL local stations and express centres all over the country. In this process , the Domestic Express Service has not just covered, but practically managed to link the whole of India.

Under this service, all consignments are handled on desk - to - desk basis, exactly like DHL Worldwide Express. In short it carries documents and packages from one place to another, anywhere in India.

Keeping up-to-date with latest technology, AFL Domestic Express monitors the movement of shipments from origin right upto the destination, transmitting online document and parcel information between AFL stations around the country. By doing this, customers can have easy access to all the necessary information regarding their shipments, by just calling the AFL station of origin or destination.

AFL Cargo

AFL pioneered the freight forwarding industry in India, beginning with the air cargo operation s in 1946. The same year it was appointed the first Cargo Agent of IATA (International Air Transport Association). It has blazed new trails time and again in the cargo industry, setting new trends and forcing other companies to follow suit.

With an extensive network IATA approved cargo offices throughout the country, AFL Cargo is responsible for the expeditious handling of incoming and outgoing shipments by air and by intermodal transportation facilities, between various countries around the world and in India. Its gateway offices monitor the transit of cargo moving between inland stations and foreign destinations.

It now offers a wide range of services, covering pick-up of cargo, warehousing pending export clearance, carting, processing of customs clearance and export formalities, booking of space, consolidation of inward air cargo, constant monitoring of shipments, via state-of-the-art computer systems, break-bulk and delivery facilities at destinations.

Its global tie-ups with AFT Inc. of Canada, LEP International of UK, and Yusen Air of Japan, make its reach truly global. Despite stiff competition AFL Air Cargo continues to enjoy a strong leadership position in the domestic air cargo segment, while also having a significant market share in the Air Exports Cargo Movement (non perishables).

Today, AFL Cargo is being scaled up to Multimodal Transport Operator business.

AFL Travels

In 1948, AFL decided to move into the business of travel and Indtravels was born. It was among the first travel agencies to be approved by IATA in India and was also among the first, to be linked to Air India's Computerised Reservation Systems, for offering instantaneous bookings to customers. Besides international and domestic air bookings, AFL Travel's services include, obtaining and renewing passports and visas, RBI sanctions, booking of hotel accommodation, handling unaccompanied baggage, personal and baggage insurance, etc.

AFL Travels is one of the most experienced and leading government Tour Operators in India, and member of reputed travel and tourism related bodies. In association with the world's leading tour promoters abroad, it offers foreign tourists to India, well planned itineraries for their inbound tours.

In 1988, AFL Travels heralded the management of conventions, conferences and exhibitions in India. Infact it is the member of the Indian Convention Promotion Bureau and is on the approved list of Trade Fair Authority of India.

Today, it's transforming itself, from a Travel Agency to a Corporate Travel Counsellor, and thereby optimise the travel costs of the customers. It has tied up with Carlson Wagonlit - one of the top Corporate Travel Agencies in the world (worldwide turnover of US$ 12 billion) and has integrated its systems with their global system, resulting in world class service to its corporate clientele.

Additionally, medical insurance cover is offered to foreign tourists, through a tie-up with Europ Assistance - one of the worlds leading companies in travel insurance and emergency rescue.

AFL Distribution Services

An offshoot experiment of AFL's Cargo business in 1988, gave rise to its Advanced Cargo Expertise, nicknamed as 'ACE' - the Express Distribution Division - specialising in total distribution management.

Its initial concentration was on tailor made Door-to-Door cargo services across the length and breadth of this country, taking care of everything from pick-up of cargo, booking through economic and convenient mode of transportation, clearance of consignments coming by air, at the destination and the final delivery to the consignee. Today, besides this activity, AFL Distribution Services focuses on a specialised Logistics functions - Distribution Management.

A tie-up with Detroit based Logistics Management Company F.X.Coughlin has further honed its expertise in logistics, making it capable of offering specialised logistics solutions on a turnkey basis, to a host of Indian and multinational clients, who are setting up operations in the country. This, in turn, has led to the establishment of a 'Cold Chain', consisting of Refrigerated Transport vehicles to take care of the corporates in the Food and Pharmaceutical business.

By providing Logistic Services, to the full extent of managing the customer's Supply Chain, corporates like HP, HCL, Microland, Baccarose, Godrej Locks and McDonald's now have more chance, to concentrate on their core business.

AFL Logistics

As the Indian Economy moves into the next phase of its growth, many of the leading corporates are exploring the possibility of outsourcing, and need experienced partners, who can take care not only their Distribution, but Supply Chains as well.

AFL Limited, as expected has taken the lead in this area. Starting with its AFL Distribution Services' division, handling the transportation, warehousing and distribution of high-value cosmetics for Baccarose Cosmetics. It was the company's ability to its information technology network, to pro-actively provide them information with regard to movement and distribution of their stocks, inventory position and cash collection, with together helped evolve Logistics.

'Logistics' simply mean planning the distribution process in a scientific and systematic manner, right from transportation of raw material to the place of manufacture, to the reaching of finished product to the customer, using proper routing, best mode of transport available in terms of speed and economy, type of packaging required, etc. This concept has been conceived with the very idea of offering customers all movement related services under one roof. Providing them complete solutions. In a nutshell, this simply means 'Supply and Distribution Chain Management'.

Today this concept has been institutionalised and AFL has a full fledged Integrated Logistics Solutions Department, which focuses on 'Customization' and 'Account Management'. This entails study of customer's business, supply chain and distribution network, in order to formulate a comprehensive integrated logistics strategy, which will help render all supply related services from a single window point.

The ability to provide integrated logistics solutions under one roof, is the result of the company's expertise, built over the last fifty years and the investments in the vast infrastructure, networks and international tie-ups.

AFL Shipping

AFL Shipping was formed in early 1996, with the idea of focusing more closely on consolidation of Ocean Freight business. AFL Shipping gives a distinct identity to the sea freight business of the company.

AFL Shipping is a Non-Vessel Owning Common Carrier (NVOCC), which enjoys all the previliges of a normal shipping line. It is engaged in booking container space on any shipping line and handles export consignments in any part of the country with ease, due to its national presence.

Its main business focus is Less Than Container Load Consolidation (LCL Consolidation), with its prime customer targets being Custom House Agents and Exporters, for whom this service is of vital importance.

Utilising the AFL network, AFL Shipping services odd destinations, guarantees sail time and continuously tracks its cargo.

AFL Infotech

AFL Infotech was formed in 1994, as a niche software development house, for the transport sector. Backward integration helps it to use the existing industry knowledge for developing software for other players, in similar businesses. It specialises in providing complete world class software solutions on a global level, primarily to the Airline and Transportation industries as well as to Distribution and Freight Forwarding companies and Travel Agencies.

Developing specialised and creating tailor-made software packages for the Airline industry is AFL Infotech's primary focus.

Its most popular software is the innovative passenger reservation system "Reser Vision" which is an ideal software solution for small and medium size airlines across the world. This software incorporates ticketless and credit card authorisation modules, while providing comprehensive reporting from its Informix database.

Source: Company Documents, 1997

Exhibit 4: AFL – Growth

Year	Turnover (Rs million)	Networth (Rs million)	No of Employees
1990-91	975.2	46.2	1800
1991-92	1305.5	77.9	2000
1992-93	1740.7	122.7	2500
1993-94	2239.9	206.8	2600
1994-95	3130.0	377.4	2700
1995-96	4090.0	541.9	3100
1996-97 (Est)	4850.0	650.0	3500

AFL – Divisionwise Turnover and Growth

(Rs million)

	1993-94		1994-95		1995-96		1996-97	
	Turnover	Revenue	Turnover	Revenue	Turnover	Revenue	Turnover	Revenue
DHL	1250	1250	1530	1530	2020	1920	2460	2300
Air Cargo	780	150	980	240	1250	270	1380	350
Indtravels	490	80	540	100	610	110	770	140
ACE	30	30	80	80	140	140	200	200
Others	40	40	30	30	70	70	40	40
TOTAL	2590	1550	3160	1970	4090	2500	4850	3020

Source: Company Documents, 1997

Exhibit 5: AFL – Financial Highlights

	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Operating Margin (%)	12.60	13.00	12.60	12.60	18.40	13.90
PAT/REVENUE (%)	4.75	4.23	4.59	5.82	9.17	7.83
Return on Net Worth (%) [1]	59.90	42.50	40.50	42.60	47.20	40.30
Long Term Debt/Equity	0.36	0.20	0.25	0.42	0.39	0.31
Current Ratio	1.17	1.23	1.38	1.52	2.06	1.65
DSCR (Times) [2]	4.67	7.50	7.29	10.38	7.47	4.82
Interest Cover [3]	10.39	16.29	16.97	11.96	9.96	5.71
DSO (Days) [4]	54	52	53	53	64	60

1{PAT/(Equity + Reserves)}

2Debt Service Coverage Ratio { PBDIT/(Interest + Principal repayable in one year)}

3{PBIT/Interest + Principal payable in one year)}

4Days Sales Outstanding {Outstandings/Daily Turnover}

Source: Company Documents, 1997

Exhibit 6: Profit and Loss Account for the Year Ended 31st March, 1996

Rs in millions

	1995-96		1994-95	
Revenue				
Servicing, Transportation, Clearing and Handling Receipts		2,356.86		1,844.49
Commission		67.41		54.80
Export Division		0.00		12.137
Shipping & Heavy Transport Division		2.00		3.60
Financial Services Division		36.59		23.32
Other Income		7.73		29.88
		2,470.59		1,968.21
Expenditure				
Operational Expenses		1,370.83		1,041.70
Employees' Remuneration and Benefits		2,85.33		188.56
Administrative Expenses		471.74		387.43
Financial Expenses		50.57		30.64
Depreciation		53.76		45.47
		2,232.23		1,693.81
Profit Before Tax		238.36		274.40
Less: Provision for Taxes		45.00		92.50
Net Profit After Tax		193.36		181.90
Add: Earlier Year's Adjustment (Net)	-10.58		-16.68	
Earlier Year's Adjustment (Tax)	223.18	21.26	-20.86	-3.75
Net Profit		214.62		178.15
Add: Balance Brought Forward		12.00		6.35
		226.62		184.50
Less: APPROPRIATIONS				
Proposed Dividend	100.00		75.00	
Transfer to Reserve Under Section 205 (2A) of the Companies Act, 1956	250.00		200.00	
Reserve for Earning in Convertible Foreign Exchange	25.00		50.00	
Transfer to General Reserve	1625.00		1400.00	
		200.00		172.50
Balance Carried to Balance Sheet		26.62		12.00

Source: Annual Report, AFL, 1995-96

Exhibit 7: Balance Sheet

Rs in millions

	As at 31st March, 1996		As at 31st March, 1995	
Sources of Funds				
Shareholders' Funds				
Capital		50.00		50.00
Reserve & Surplus	532.05		327.43	
		582.05		377.43
Loan Funds				
Secured Loans	431.16		307.19	
Unsecured Loans	102.97		172.97	
		534.13		480.16
		1,116.18		857.59
Application of Funds				
Fixed Assets				
Gross Block	792.02		517.74	
Less : Depreciation	162.22		114.69	
Net Block		629.80		403.06
Investments		32.64		23.49
Current Assets, Loans & Advances				
Spare Parts	6.00		6.50	
Sundry Debtors	674.48		481.05	
Cash & Bank Balance	81.00		67.88	
Loans & Advances	283.79		283.74	
	1,045.27		839.16	
Less : **Current Liabilities & Provisions**				
Liabilities	621.65		400.62	
Provisions	10.00		7.50	
Net Current Assets	631.65	413.62		431.44
Miscellaneous expenditure (to the extent not written off or adjusted)	40.12	0.00		
			1,116.18	857.59

Source: Annual Report, AFL, 1995-96

Exhibit 8: History of the Organisation*

In 1867, my great-grandfather, Framji Guzder, came to Bombay from Gujarat to seek his fortunes.

That same year, King Theodore of Abyssinia hanged the British Ambassador and took 60 Europeans hostage. Britain decided to retaliate, choosing Bombay as the base from which to launch the offensive.

General Sir Charles Napier, the Commander-in-Chief of the British forces in India, was in charge of the operations. He awarded the entire Commissariat Contract for the campaign supplies to Nusserwanji Tata, the father of Jamshedji Tata - founder of the house of Tata's. Nusserwanji Tata entrusted Framji Guzder with the transport and shipping arrangements. And this was the beginning of a long, solid relationship with the house of Tata's, which continues till today!

A meeting of destinies... and the seeds of AIRFREIGHT were sown.

Pioneering with Pioneers

After the Abyssinian expedition, Framji Guzder, and his son, Sorabji, set up a clearing and forwarding agency called Sorabji Pestonjee & Co. In 1892, this agency was renamed N S Guzder & Co.

The first major industrial enterprise set up by Jamshedji Tata was the Empress Textile Mills at Nagpur in 1877. The clearing and forwarding of all the important machinery, from the docks to Nagpur, was entrusted to N S Guzder & Co. Subsequently, the shipping, clearing, forwarding and transporting operations of each industrial enterprise that Jamshedji Tata set up, and the enterprises that were set up after him, were entrusted to N S Guzder & Co. As a result, they handled all imports and transport-related operations not only for the Tata Textile Group, but also for Tata Chemicals, the Taj Mahal Hotel, Tata Electric Companies, Tata Airlines and others, right from their inception.

In fact, when Jamshedji Tata first conceived the idea of generating hydro-electric power for Bombay utilising water resources of the Western Ghats, my father provided the launches and accompanied Jamshedji and his project team to explore the coastal rivers. These expeditions led to the identification of several sites, where Tata's hydro-electric projects were eventually set up.

As the country progressed rapidly along the path of industrialisation, N S Guzder & Co grew with it. When J R D Tata thought of setting up an airline in India in the 1930s, the first aircraft imported by him - a de Havilland Puss Moth (which made the historic solo flight from Karachi to Bombay in 1932) - was cleared at the Bombay Docks and transported to Juhu by us.

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*Source: The words of Mr. Jamshed N Gulzar, President AFL from *A Portrait of Many Portraits,* AFL, 1993.

When this flight carried the first Air Mail bags into Bombay, my father was prominent among those who received J R D Tata at the Juhu airstrip. In fact, when J R D Tata repeated his solo flight 25 later, my father was the only surviving member of the first welcoming entourage to greet him when he landed.

AFL Takes Root

On January 18, 1934, I joined my father actively in the management of N S Guzder & Co. Hitherto the company had restricted its activities to two major groups - the Tatas, the Wadias (Bombay Dyeing) and the Century Mills.

During the Second World War, I expanded its activities and secured the exclusive clearing agency contract for the Government of India Supply Department. As a result, we handled the clearing of lakhs of tonnes of freight imported by the Government of India for almost two decades after the War.

We exclusively handled, cleared and transported import machinery for major projects around the country including the Bhilai Steel Plant, the Oil Refineries of Baroda, and many others.

In January 1945, it was evident that the Second World War was coming to an end. I thought that a new era in air transportation would soon begin and therefore, that same year, I requested Tata Airlines to appoint me as their first air cargo agent in India, which they did. I therefore set up a company called Airfreight Limited, and transferred the agency license from my name to this new venture which became Tata Airlines' first, and at that time the only, air cargo agent in India.

Thus, AFL was born.

AFL Spreads it Branches

Tata Airlines became Air India in 1946, and grew rapidly, domestically and internationally. AFL kept pace with this expansion. The next year, AFL was appointed as official Cargo Handling Agent for TWA, the first international airline to touch Bombay in 1947.

From then on, AFL has moved from one landmark to another:

1946 Housed India's fir Air Customs unit to clear import air cargo, For the first six months, this unit operated from our premises. The only instance where a customs house operated from the premises of a private company.

1947 Awarded the handling contract for both, incoming and outgoing cargo by TWA, thus becoming the first Air Cargo Agent to be appointed at Bombay Airport.

1948 Among the first of the IATA-approved Air Cargo Agents in India; and set p our Travel Division—INDTRAVELS - among the first to be approved by IATA in India.

1954 Appointed as the first accredited Passenger and Cargo Sales Agent for Indian Airlines Corporation and Air-India upon the nationalisation of the airlines in India.

1960 Opened the Tours Division to promote tourism to India and earn foreign exchange.

1965 Became Indian Airlines' exclusive Delivery Agent in Bombay for incoming domestic cargo.

1979 Pioneered international courier services in India in association with DHL International.

1981 Together with N S Guzder & Co Pvt Ltd, handled one of the single largest packages —the Stator-Generator for the Tata Electric Power Plant (weighing over 250 tonnes) —to have landed in the port of Bombay.

1982 Introduced domestic courier services in India.

1983 Set up a Conference Division in New Delhi.

1985 Opened the Project Transportation Division to transport and delivery heavy project equipment to remote areas in India.

1987 Together with N S Guzder & C Pvt Ltd, successfully completed the clearance and transport of Indo-Gulf Fertilizer Corporation's total plant to site (Jagdishpur, Dist. Amethi, U.P.). We used our own barges and tugs to move the heavy packages (250 tonnes to 400 tonnes each) by river from Calcutta to Mirzapur.

1988 Launched ACE - the first "door-to-door" domestic cargo services within India.

1988 Opened the Trade Fairs & Exhibitions Division, accredited by the Trade Fair Authority of India.

1992 As part of a planned diversification programme, set up an Export Division.

Over Four Fruitful Decades

AFL began modestly in 1945 with a staff of five persons in a small office. It has grown rapidly into an enterprise with nearly 100 offices all over India employing 2,400 persons. We have expanded into such diverse fields as Air Cargo, Import Consolidation, Sea-Air, Airport Cargo Handling for Airlines, Travel & Tours, Document and Parcel Courier Services, Heavy Lift Transportation, Trade Fairs & Exhibitions and now, Exports.

Through the years of rapid growth and expansion, we have developed a reputation for service and reliability. This tradition is being carried on by the next generation - my three sons and a highly competent team at the helm. We aim to enhance this image, always keeping in mind the best interest of our clients.

Exhibit 9: ACE Express Distribution

Performance

	1993-94	1994-95	1995-96	1996-97 (Est)
Turnover (Rs million)	260.0	760.0	142.0	200.0
Tonnage (metric tonnes)	2400	6900	12900	16500
Shipments (Nos)	34,000	86,400	1,51,900	1,50,800
No of branches/express centers	24	40	55	70
Network (No of locations)	120	160	200	250
Manpower (Nos)	170	270	400	475
Vehicles: own	29	36	36	36
:contracted	15	20	30	30
Investment in IT (Rs millions)	5.6	8.0	25.0	28.0
Warehouse space (Sq ft)	15,000	25,000	45,000	80,000

Reports to Customers

Stock Statement and Productwise Stock Ledgers
Stock Valuation
Goods Received Report
Goods Issued Report
Sales/Stock Transfer Statement
Adjustment Report
Order Executed/Pending Order Statement
Dealer/Stockist Reports
Sales
Collections
Outstanding
Debtor Ledgers

Customers

Hewlett-Packard
HCL Frontline
Larsen & Toubro
Microland (Compaq)
Godrej & Boyce (Locks division)
Hughes Escorts Communication Ltd.
Unicorp
Orbit Peripherals
Baccarose Cosmetics
Tupperware

Over 3,000 large/medium organisations for door-to-door express transportation.

Source: Company Documents, 1997

Exhibit 10: Concept Note on ILS

... We have foreign tie-ups with leading players in the international market which enables not only to service domestic customers abroad but also have access to international practices and standards. It is pertinent to note that all the above mentioned services will be required by any manufacturing organisation. With the necessary resources in terms of physical infrastructure and systems already in place, we are ideally suited to handle the total logistics requirements of our customers. We term this comprehensive service package when designed to meet the logistics needs of a customer as an Integrated Logistics Service.

The activity similar to yours is being handled for organisations such as Hewlett Packard, Godrej, Larsen & Toubro, HCL etc. The typical activities performed for two of our customers are as follows:

CUSTOMER 1

The company is a multinational organisation involved in the manufacture of Information Technology equipments. The manufacturing facility is situated overseas and the product is marketed in India through distributors. The logistics services involved were:

a) Pickup from the supplier overseas
b) Import into India
c) Customs clearance
d) Movement from port to warehouse
e) Warehouse management
f) Order processing
g) Despatch
h) Provide information

Warehousing Activities

Receipt in pallets, break bulk, storage, order processing, data management, documentation, shipment tracking.

The India office of the company which manages the operations, has been dealing with different agencies for different activities in the initial stages when the product ranges and their respective volumes were relatively small. The contract has been with us for the last three years though the scope has reached its full potential in the last one year based on the confidence created through achieving the committed service levels. The service scope evolved as follows:

a) We were involved only in transportation part of the business, i.e. moving the consignments from one location to another.
b) Subsequently the customs clearance part of the business was included in the scope.

c) Finally the warehousing and information management of the whole operation was handed over to us.

Their plan was to gradually hand over the responsibility to an outside party only after ascertaining the partner's capability and intentions to go along on a long term basis. The situation at present has reached a stage of fruition when we have instilled the necessary confidence in them to select us as their logistics partner in India.

Benefits

Since the entire service is handled by a single agency, the total cycle time required for servicing the Indian market has been reduced by almost 50% from 38 days to around 18 days. (Though some of this benefits has accrued due to better inventory management on the customer's part). From our side, the contribution has been in the area of customs clearance, documentation clarity and prompt despatch of the consignments.

	Before using	Through us
Average time from supp	8 days	4 days
Customs clearance time	15 days	4 days
Order processing time	3 days	1 day
Average transit time	7 days	4 days

There is a reduction of 20 days in the cash-to-cash cycle resulting in tangible savings for the organisation.

CUSTOMER 2

The product range handled by us are safety locks which are sold through dealers. The dealers then route it through a chain of retailers to the final customers. The business involves sourcing from the manufacturing sites through a series of warehouses and final delivery to dealers. The logistics services involved were:

a) Pickup from the production sites
b) Documentation
c) Warehouse management
d) Movement
e) Order processing
f) Recovery and banking
g) Provide information

We have worked in tandem to develop a customised software capable of merging the data with the total information base of the customer.

The activity flow is relatively simple, i.e. production to warehouse to dealers. The complications arises due to the number and location of production centres, warehouse and dealers.

No. of production centres	- 10
No. of warehouses	- 18
No. of dealers	- 50

The documentation involved in the movement depending on the nature of movement (stock transfer or sales) and the location also adds to the complication with rules being different for different states and changing periodically. Data management of this many-to-many movements also poses a stiff challenge to our capabilities.

Benefits: Since the operations was being managed under the group's distribution system, the resources had to be allotted in terms of vehicle space, order processing priority and responses to queries/complaints. This being one of the many products sold by the company, the response time for any indent or order to be processed and despatched was almost 6 to 7 days. This has been brought down to a single day in our system resulting in not only reduced pipeline inventory, but also relieving the resources previously used to other products of the group.

There are other benefits in terms of improved information flow and the possibility of using the resources for other products of the group.

Basis of Costing

With a view to simplifying the method of arriving at the total cost payable for the service rendered, we have divided the entire process into basically four activities.

Activities	Basis
a) Customs clearance	No. of TEU/Shipments in case of air
b) Movement from port to the factory	No. of ULD's/Distance
c) Warehousing	Fixed monthly charge
d) Movements between factory, Warehouses, Dealers, Direct Customers	Weight/Mode/Distance

Data Requirements

As mentioned earlier in this note, we have listed the data that would be required by us to make a commercial proposal. They are as follows:

a) Places where service will be required
b) Number of line items in the warehouse
c) Method of measuring service levels with benchmark
d) Volumes and frequency of movement between suppliers, factories, warehouses, dealers/ customers
e) Reporting frequency, formats and mode

General

There are areas which has not been covered in this note. This has cost and service implications and is possible to comment on them after further discussions. These are:

a) Software required to be used for managing the warehouse and movement
b) Hardware required in terms of computers, printers, scanners, modems etc
c) Packing material to be used for repackaging
d) Any other services not covered

Kindly note that this is a concept and will be firmed up after exchanging our views on the above mentioned points...

Exhibit 11: Brief on Competitors*

Blue Dart

Blue Dart Express was a public limited company based at Mumbai. It was started in 1983 and had a revenue of Rs 1145 million and a profit after tax of Rs 98.6 million during 1995-96. During 1996-97, the figures were Rs 1486 million and Rs 4.9 million respectively. As stated by the company, the reduced profits were attributable to an increased interest and depreciation due to project related expenses. Blue Dart had a tie up with Federal Express of USA. But its operations were still strongly domestic. Blue Dart had acquired two airplanes (Boeing 737s) in 1996, because it was thought that this could enable much later cut off times for pick ups, and reduced costs. It had pumped in lot of money in technology. The Chief Executive of Blue Dart remarked: "Capacity was another important factor which we have achieved with the aviation business. Our timings have become convenient and our cut-off time is the best. Our competitors would have a cut-off time of 8:00 p.m. while our plane lands in Mumbai at 1:30 a.m. and we can take the consignment till one hour before. Our major growth has come from that segment."

One of the airplanes had got grounded and consequently stripped and sold. A third aircraft was purchased as a replacement. The total cost of the three aircrafts was Rs 300 millions.

Blue Dart was now trying to target logistics and distribution services for the industrial belt for which a multimodal system and 19 warehouses had been set up across the country. They had 237 branches and were planning an extensive franchise programme. They were also looking at alliances with other smaller operators to increase reach and had one such alliance in place in the south. Blue Dart was planning to get more aggressive about the logistics business including provision of warehousing, order processing, express distribution and

*Source: Business Magazines and Newspapers, and Company Brochures, 1996 and 1997 inventory management to its clients. It was hoping reach a revenue of Rs. 10,000 million by the year 2000.

One of the earliest and long-standing customers of Blue Dart was HCL, for whom the entire peripheral and spare part distribution was being managed.

A new agreement had been signed with Federal Express, starting May 1997, in which Blue Dart was to be a pick up and delivery agency, apart from their own operations. Thus Federal Express would have a more significant presence in India.

Elbee

Elbee had a strong domestic network and acquired two planes around the same time as Blue Dart. It had a tie-up with UPS of the US. In the domestic courier and integrated logistics business, Elbee held the number two position. One of the aircraft, unfortunately, crashed in the first week of July 1997, taking with it both the pilots.

An important customer that Elbee had was Walt Disney, which had set up shop in India to manufacture a range of products that bear distinctive Disney characters. It had decided to farm out all its distribution requirements to Elbee Express. Says a Walt Disney executive looking after retailing : "At our current volumes, it was just not economical to establish our distribution network. And if we did, it would have taken us four-five years to get our network in place. Disney's decision to turn to Elbee is also expected to help the company keep inventory costs low. At present, Disney has leased 1,000 sq ft of warehouse space from Elbee only in Bangalore. However, once it expands operations to other cities, it will hire six more 1,000 sq ft warehouses for its chain. "

GATI

GATI (from the Hindi word *gati*, or speed) was originally a subsidiary of a large Secundrabad-based trucking major called TCI. They were the pioneers in surface-based express distribution in the country. Subsequently, they have become an independant company and also have a tie up with Indian Airlines. During 1996-97, GATI had invested Rs.100 million in fleet addition and in information systems such as the satellite-based vehicle tracking system for its logistics division, Business Logistics Services (BLS).

Sony was one of GATI's clients. When Sony entered India, it faced a classic dilemma: should it set up its own distribution network or hire a logistics service provider instead? After much deliberation, the Japanese electronics giant decided to sign on GATI, one of the dozen or so companies specialising in transportation and warehousing that had sprung up in recent years. "Since it was necessary for us to quickly establish a strong distribution network to achieve a high level of penetration in the market, we chose to outsource our distribution requirements," says a Sony India manager looking after logistics.

Sembawang Shriram Integrated Logistics

Sembawang Shriram Integrated Logistics, a new joint venture company between Sembawang Corp of Singapore and the Shriram group of Chennai, had invested close to Rs. 1,100 million in land for warehouses and on its fleet. The company had yet to begin operations in a significant way. In the meantime, the company was building a professional base through its manpower sourced from Indian Railways and other transport related organisations.

Dynamic Logistics

Dynamic Logistics, which was incorporated in the year 1983, was one of the flagship companies of the 'Talera Group'. It had expanded from just leasing out warehouse space to handling integrated logistics solutions, supply chain management systems, re-engineering processes and distribution systems of various companies especially in the automotive sector.

Their brochure claimed the following specialisation:

JIT Systems
EDI
Quick Response Systems
Reducing Inventory Levels
Reducing Transportation Costs
Routing and Scheduling
Cutting Warehouse Costs
Increased Flexibility
Cross Docking/Freight Consolidation
Custom Bonded Warehouse
Container Freight Station
Contract Warehousing
PDI (Pre-Inspection Delivery) and more

The brochure mentioned the following customers:

TELCO
Mahindra Ford India
Mercedes Benz India
Motorola
Greaves
Larsen & Toubro
Asian Paints
Castrol
ABB Alfa-Staal
Glaxo
Steel Tubes of India
Gulf Oil
Kirloskar Oil Engines

One of Telco's executives elaborated on the service being provided to Telco, "the Telco's spare parts warehouse was located at Thane earlier. In December 1992 it was shifted to Dighi in Pune which is very close to our Pimpri works. Telco appointed Dynamic Logistics as our logistics contractors as is the trend worldwide. Spare parts required for the Telco's 207 family of vehicles as well as shop made items for Pune manufactured commercial vehicles are stocked here to fulfill the requirements of our valued customers. At Dighi we have a covered area of 1,00,000 sq.ft.

Advantages of setting up warehouse at Dighi:

1. The passenger car customers get the attention they deserve.
2. Service levels are near 100% and as Dighi is in the octroi free zone, Telco saves on octroi duty.
3. Telco saves on overheads as Dynamic Logistics looks after our warehousing activity.
4. Packing and unpacking costs are also eliminated as the material from Pimpri Works to Dighi, can be sent loose in open bins rather than in packed cases.

The monetary savings due to the above practice is expected to be around Rs. 40 millions per annum based on an estimated turnover of around Rs. 800 million in 1995-96."

Another example is Mahindra Ford, which had a warehousing arrangement with Dynamic Logistics. The logistics company stored spare parts and components for the automobile major. Whenever a Mahindra Ford dealer needed a particular spare part, Dynamic Logistics delivered in two to eight days, depending on the location. While Mahindra Ford looked after the placement of orders, inventory planning, scheduling, and providing the required software, Dynamic handled stocking and delivery. Dynamic Logistics chief executive Praful Talera said "Nowadays companies do not want to get mired in operative logistics. They prefer to outsource."

Questions

1. What would be the profile of the market for ILS?
2. What are the strengths needed to provide ILS?
3. Given the strengths and weaknesses of AFL, what internal strucutres and processes are required to make ILS successful?

QUESTIONS FOR DISCUSSION

1. What would be the market profile for Integrated Logistics Services (ILS)? Try to detail this profile in terms of type of product, importance of logistics services in the customer firm, customer capability in managing its own logistics, and scale of operations.
2. For key market segments, what would be the major requirements that an ILS provider would have to satisfy?

3. What is the major advantage that an ILS provider can offer to a company, as compared to the company doing those functions itself?
4. Given the strengths and weaknesses of AFL, what internal structures and processes are required to make ILS successful?
5. Assess the major infrastructural elements required to make the ILS concept workable, keeping in mind the existing infrastructure of the various arms of AFL?
6. What would be a reasonable method of costing and pricing for ILS? Since many aspects of ILS would be internally provided by different existing businesses of AFL, what would be the rationale for turning ILS into a profit centre?

APPROACH FOR ANALYSIS

Logistics services become important to a firm at a certain stage of growth of volumes of business, spread of markets and value perception of customers. AFL is trying to provide a quick and cost effective way of providing these logistical services just at the time when they become necessary, without the company having to invest in infrastructure for the purpose. AFL would rely on using their established infrastructure for a number of customers so that a competitively priced service could be provided. This is the economy of scope argument for AFL.

From an analysis of existing and potential customer profiles and requirements, the specific gaps in the existing service options (offered both by AFL and by competitors) can be identified. The idea of a one-stop ILS provider has to be fleshed out by looking at the various specialised services (both within AFL and though possible external sources), to decide whether co-ordination per se is a viable option or whether a major restructuring is required to achieve the desired integration. Here, the economy of scope for AFL would be that it is relatively easy to diversify to provide or make provisions for the service package that may be required for offering a product such as ILS.

Apart from general infrastructural requirements, a customer focused activity as envisaged by the ILS concept would require appropriate use of IT for managing the information flow related both to the services to the customers and the cost control of AFL. These needs can be spelt out.

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