The Development of a Supply Chain Operations Reference Model for the Telecommunications Industry

Thesis prepared in partial fulfillment of the Degree of Masters in Industrial Engineering at the University of Stellenbosch

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety, or in part been submitted at any university for a degree.

Date 25 · 11 · 1991

Morné Alfred Weyers

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Opsomming

Die doel van hierdie tesis is die daarstel van 'n model wat die toevoerketting van 'n telekommunikasie maatskappy beskryf. Die telekommunikasie industrie binne Suid-Afrika is besig om groot veranderinge te ondergaan, veral met die bekendstelling van kompetisie tot die industrie.

Hierdie bekendstelling van kompetisie het tot 'n skielike groei in die infrastruktuur gelei, soos Suid-Afrika se telekommunikasie maatskappy, Telkom, voorberei vir hierdie kompetisie. Vaardighede word gesoek wat maatskappye die voorsprong sal gee op hul mededingers. Een so 'n voorsprong is die bestuur van die toevoerketting. Alhoewel die telekommunikasie maatskappy tradisioneel gesien word as 'n diensverskaffer, is daar gevind dat dit ook vervaardigings elemente bevat. Hierdie vervaardigings elemente kan heel moontlik beter bestuur word deur te kyk na die vaardighede van vervaardigings ondernemings, en dan hierdie vaardighede toe te pas op die telekommunikasie maatskappy.

Een manier om hierdie vaardighede toe te pas, is deur 'n model te ontwikkel wat die telekommunikasie industrie beskryf. Daar is gewys dat die nuwe model wat ontwikkel is wel die industrie kan beskryf. Die tesis wys verder ook dat die tegnieke verbonde aan die bestuur van die toevoerketting sowel as die gebruik van die model, wel 'n telekommunikasie maatskappy kan onderskei van sy mededingers.

Synopsis

The goal of this thesis is to develop a model that will describe the Supply Chain within a telecommunications company. The telecommunications industry within South Africa is faced with a number of changes, the most important of which is the introduction of competition into the market.

Telkom, South Africa's telecommunications company, has started with a project of rapid expansion of its network in response to these potential entrants. Skills are being sought that will give the company the edge over its competitors. One of these skills is Supply Chain Management. The telecommunications company is traditionally seen as a service organization. Despite this fact, it has been shown that the company does have manufacturing dimensions. These manufacturing dimensions may be improved by considering the skills used within a traditional manufacturing firm, and applying them to the telecommunications company.

One way of introducing these skills is by developing a model that will describe the telecommunications company. This has been done within this thesis. It will be shown that the model is capable of describing the company. It is shown that the use of Supply Chain Management skills and the use of the model could give a telecommunications company the edge over its competitors.

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Terms of Reference

This thesis was carried out in partial fulfillment for a Masters Degree in Industrial Engineering at the University of Stellenbosch. The goal of this thesis is to develop a Supply Chain model for the telecommunication industry. The project is supported by Telkom, a South African telecommunications company. The requirements for completing this thesis are to

- Explore the field of Supply Chain Management
- Describe the telecommunications industry
- Develop a model that would integrate the concepts of Supply Chain Management with that of the telecommunications company.

The project was initiated in January 1999 after identifying a need for cost improvements in the company and identifying Supply Chain Management as a means to achieving this goal. The project should be completed by August 31st, 1999.

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Executive Summary

This thesis describes the development of a model that has been developed specifically for modeling the Supply Chain of a telecommunications company. The need for such a model was identified when the nature of the business of a telecommunications company was considered.

Telecommunications companies are network-based companies. The value of network-based companies to their customers is the ability to connect customers to one another. Banks, airlines, internet service providers, railway carriers, telecommunications companies, etc. can all be seen as network-based companies. This ability to connect customers implied that the company was adding value by establishing a network for customers to use. This was the domain of this thesis: the processes involved in building network capacity in order to allow customers to communicate. These processes were considered to be a number of Supply Chains contributing to the final network.

The company used as the model telecommunications company was Telkom SA Ltd., South Africa's only fixed line telecommunications provider. In considering the Supply Chain of the telecommunications company, a number of questions had to be addressed:

1. Is there any value in considering the Supply Chain concept for a telecommunications company, or could the company commit its resources to other initiatives that could yield higher returns?
2. To what extent are Supply Chain Management techniques, as used in traditional manufacturing companies, applicable to the telecommunications company?
3. How can the knowledge and information regarding Supply Chain Management within a telecommunications company be captured and represented?

The first problem is addressed by considering the nature of the telecommunications industry. The telecommunications company is first discussed and it is shown that the installation function could potentially benefit from Supply Chain Management practices. The performance of this installation function was then evaluated within the context of the South African telecommunications industry. It was shown that the industry

- was spending large amounts of capital to provide services to customers that may not even be profitable;
- was growing to meet service level agreements set to the company, and needed capital to fund this growth in the network;
- was under threat of competition in the near future; and
- and had inefficiencies in the way that business was done.

All these problems could be addressed by considering the Supply Chain of the telecommunications company.

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The second question is addressed by considering the Supply Chain of a manufacturing company, and then applying the techniques to a telecommunications company. This involved a detailed literature study of implementations, designs, descriptions, etc. of Supply Chains in industry. The nature of the telecommunications company is then considered. This is firstly done by taking a holistic view of the company and describing the business and the industry by using models. It was also done by conducting interviews with employees within the company to determine the specific operations performed. It is seen that the practices do have value in certain functions of the company, but that there are still differences. Scenarios that differ include:

- the inventory of a telecommunications company become fixed assets and not turnover;
- the company does not have a "deliver" function as it it produces the products at the point of use; and
- projects are identified based on forecast network status, and not based upon customer orders

These are only some of the differences. An interesting result was that there are many similarities. There are many Supply Chain Management practices that are applicable to the company, indicating that there are definite benefits in considering the current practices within the manufacturing organization and applying them to the telecommunications company.

The third question is addressed by using the Supply Chain operations reference (SCOR) model. The SCOR model is developed by the Supply Chain Council and has become widely accepted by industry as a tool used to model the Supply Chain. The model contains metrics, best practices, and software features, all used to develop accurate models. Developing a similar model, but specifically for the telecommunications company would provide a way to capture the practices of the company in a format that would allow users to access best practice knowledge in designing and optimizing their Supply Chains.

The model was developed using the information discussed in the previous paragraphs. Interviews with employees were used to gain insight into the flow of processes within the company. With the knowledge of these processes, the original SCOR model was used as framework for the new model. Upon investigation, it was found that the SCOR model had a number of inconsistencies. This was primarily due to the growth of the model. As the model developed, errors occurred, as updates were not done throughout the entire model. This problem was addressed by developing a database that would "house" the model. This decreases the chances of errors arising in the model.

To test this model, it was used to model the installation process of SDH equipment. This installation process involved three departments within the company, and one function that was outsourced. It was

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shown that the model was capable of modeling the chain, within this environment of projects and services.

The greatest change to the model was the addition of a sourcing of services process. The telecommunications SCOR model can now accommodate services that are outsourced in partial completion of a project. This was added as Telkom (the telecommunications company used as application) had started to outsource its functions. The approach suggested here could also prove of value to other organizations. The Supply Chain Council has shown interest in modeling services, and the approach suggested here is one possible solution.

In conclusion, this thesis has shown that Supply Chain Management is of value to the telecommunications company. It has also been indicated that the developed model can describe the telecommunications industry, as well as give insight into how the processes should be managed and measured.

It is recommended that this model be used as a framework in studying the Supply Chain of the telecommunications company, at the same time building and developing the content of the model. The model has the potential to add great value to the telecommunications industry, provided the content be validated and updated.

Thesis Structure

To avoid confusion, the structure of the thesis will be discussed in this section, briefly explaining the various components of the thesis and how they have been put together to form a logical flow for the thesis document.

There are two fields of study in this thesis, the first is Supply Chain Management and the other is the telecommunications industry. The goal is to design a model based on the principles of Supply Chain Management that will be suited for the telecommunications industry.

The telecommunications industry is not normally associated with a concept like Supply Chain Management. Because of this, the thesis first considers the theory of Supply Chain Management. Two chapters are devoted to considering Supply Chain Management theory and describing it with regard to the rest of the organization.

The next chapter considers the SCOR model. The SCOR model is a model used to describe and represent Supply Chains. It is necessary to look at this model, as the SCOR model will be used as a reference model for the final telecommunications SCOR model.

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The focus of the thesis then leaves Supply Chain Management and turns to the telecommunications industry. The telecommunications industry is described in two chapters. The first chapter considers the telecommunications industry in general, and the second focuses more specifically on South Africa. This is necessary to provide the reader with a background to understanding some of the decisions made in developing the SCOR model for the telecommunications industry.

The next chapter is a discussion of the result of building telecommunication company concepts into the SCOR model. The chapter highlights some of the major changes made to the model and gives examples of how some of the changes affect the use of the newly developed model.

The following chapter applies the newly developed model to a case study within South Africa's sole telecommunications provider, Telkom. By using the model on this case study, the method of using the model as well as its ability the represent the current Supply Chain is illustrated. If the model can accurately describe the current Supply Chain, it can be seen as a success.

The last two chapters discuss some of the observations made in completing the thesis. Many areas for improvement were identified in considering Telkom and its business practices. These observations have been documented in the first of the two chapters. The second chapter considers some areas within Telkom that could be improved by using Industrial Engineers. This chapter is important as Industrial Engineers are not associated with companies like telecommunications companies in general. This chapter shows that there is in fact room for the Industrial Engineer within the telecommunication company environment.

The findings of the thesis are lastly discussed in the conclusions.

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Table of Contents

Chapter 1: Introduction 1

Chapter 2: Problem Statement and Objectives 3

Chapter 3: What is Supply Chain Management? 5

3.1 The Evolution of Supply Chain Management 6

3.2 The Supply Chain Vision 8

3.3 Supply Chain Compass 10

3.4 Supply Chain Decision Process Assessment 12

3.5 Supply Chain Management Maturity Model 13

3.6 Summary of Models 16

3.7 Conclusion 17

Chapter 4: Position of Supply Chain Management 18

4.1 Supply Chain Management within the Organization 18

4.1.1 Virtual Enterprise Life Cycle 19

4.1.2 Virtual Product Life Cycle 20

4.1.3 Enterprise Engineering Roadmap and Supply Chain Management 21

4.2 Level of Detail of Supply Chain Management 22

4.3 Definitions 24

4.4 Conclusion 25

Chapter 5: Supply Chain Management Operations Reference Model Overview 26

5.1 The Uses of SCOR 27

5.2 What is a Process Reference Model? 27

5.3 Boundaries of the SCOR Model 28

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5.3.1 The Scope of the SCOR Processes 29

5.4 The SCOR Model Structure 30

5.4.1 Top Level (Level 1) 31

5.4.2 Configuration Level (Level 2) 31

5.4.3 Process Element Level (Level 3) 33

5.4.4 Implementation Level (Level 4) 34

5.5 Overview 34

Chapter 6: The Telecommunications Industry Overview 36

6.1 Network-based Companies and Value Networks 36

6.2 The Telecommunications Value Chain 38

6.3 Service Life Cycle 40

6.4 Setting the Boundaries for this Project 41

6.5 Other Supply Chains 42

6.6 Conclusions 43

Chapter 7: The South African Telecommunications Industry Overview 45

7.1 Potential Entrants 46

7.2 Conclusions 51

Chapter 8: Terminology 53

8.2 Overview 56

Chapter 9: Telecommunications Supply Chain Operations Reference Model 57

9.1 The Need for a New Model 57

9.2 Working Method 59

9.2.1 Gathering Information 59

Stellenbosch University https://scholar.sun.ac.za

9.2.2 Populating the Model 60

9.3 Developing the Telecommunications SCOR Model 60

9.3.1 Model Level Changes 60

9.3.2 Plan Processes 63

9.3.3 Build Processes 63

9.3.4 Source Processes 63

9.4 The Application of Telecommunications SCOR to Other Industries 65

9.5 Conclusion 66

Chapter 10: Case Study: SDH Feed 67

10.1 Background 67

10.2 SDH Installations 68

10.2.1 SDH Processes 69

10.2.2 As-Is Network Thread Diagram 70

10.2.3 Transmission Chain 70

10.2.4 Construction Chain 73

10.2.5 Power 74

10.3 Feasibility of Solutions 75

10.4 Conclusions 75

Chapter 11: Identified Areas for Improvement 77

11.2 Overview 81

Chapter 12: Reccomendations 82

12.1 Industrial Engineering 82

12.2 Supply Chain Management 82

Stellenbosch University https://scholar.sun.ac.za

12.3 Overview 83

Chapter 13: Conclusions 84

Chapter 14: References 85

Appendix A: teleSCOR A-1

Appendix B: Database Design B-1

B.1 Current Problems B-1

B.2 SCOR Modeling Framework B-2

B.3 Database Requirements B-3

B.4 Model Structure B-3

B.4.1 tConstructs B-3

B.4.2 tLevels B-5

B.4.3 tConstructTypes B-5

B.4.4 tAttributes (and tAttributeTypes; tAttributeAssociations) B-5

B.4.5 tBestPractices B-6

B.5 Displaying the Model B-6

B.5.1 Suggestions for Improvement B-8

B.6 Conclusions B-8

Appendix C C-1

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List of Figures

Figure 1: Hierarchy of Objectives 3

Figure 2:Evolution of Supply Chain Management 7

Figure 3: Elements of a Supply Chain Vision 9

Figure 4: Supply Chain Compass 11

Figure 5: Most Important Decisions in Supply Chain Management 13

Figure 6: Supply Chain Management Maturity Model 14

Figure 7: Supply Chain Management and the Virtual Enterprise Life Cycle 20

Figure 8: EER and Supply Chain Management 22

Figure 9: Supply Chain Scenario (A Pragmatic Approach) 23

Figure 10: Process Reference Model 27

Figure 11: SCOR Model Structure 30

Figure 12: Level 1 Performance Metrics 31

Figure 13: SCOR "Configuration" Toolkit 32

Figure 14: Supply Chain Example – *Company A* 32

Figure 15: Level 3 Example - *S1 Source Stocked Product* 33

Figure 16: Element Definition, Standard Performance Metrics, Best Practices, and Software Features 34

Figure 17: Spectrum of Network-Based Businesses 37

Figure 18: Telecommunications Value Chain 39

Figure 19: Service Life Cycle 40

Figure 20: Nature of the Installation Process 42

Figure 21: Telecom Operations Map 43

Stellenbosch University https://scholar.sun.ac.za

Figure 22: Forces Driving Industry Competition 46

Figure 23: Data and Telephone Traffic Volumes 48

Figure 24: The Deliver Process Within the telecommunications Company 58

Figure 25: Telecommunications SCOR Process Categories 61

Figure 26: Services Supply Chain Thread 64

Figure 27: tS5 Process Elements 65

Figure 28: SDH Network Configuration 68

Figure 29: As-Is Transmission Supply Chain Tread Diagram 70

Figure 30: To-Be Transmission Supply Chain Thread Diagram 72

Figure 31: As-Is Construction Supply Chain Tread Diagram 73

Figure 32: To-Be Construction Supply Chain Thread 74

Figure 33: To-Be SDH and Power Supply Chain Management Thread Diagram 74

Figure 34: Costs of Inventory 77

Figure 35: SCOR Database Extended Entity Relationship Diagram B-4

Figure 36: Process Reference Model C-4

Figure 37: SCOR Model Structure C-7

Figure 38: Level 1 Performance Metrics C-8

Figure 39: SCOR "Configuration" Toolkit C-9

Figure 40: Supply Chain Example – *Company A* C-9

Figure 41: Level 3 Example - *S1 Source Stocked Product* C-10

Figure 42: Element Definition, Standard Performance Metrics, Best Practices, and Software Features C-11

Figure 43: SCOR Methodology: Applied in Four Steps C-20

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Figure 44: As-Is Supply Chain: Mature Product Line C-23

Figure 45: Process Elements C-24

Figure 46: Process and Execution Elements C-27

Figure 47: Level 1 Performance Metrics C-29

Figure 48: Level 1 Benchmark Results C-30

Figure 49 : Gap Analysis for Mature Product C-39

Figure 50: Gap Analysis for New Product C-40

Figure 51: Identify Plan Processes and Assign Metrics C-48

Figure 52: Assign Performance Targets to Metrics C-48

Figure 53: P2-P4 Process Metrics C-49

Figure 54: P2-P4 Process Metrics Targets C-49

Figure 55: To-Be Pocess Configuration C-56

Figure 56: To-Be Mature Geographical Map C-57

Figure 57 : Process S1 ..... C-61

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Glossary of Terms

DOS	Days of Supply
ECO	Engineering Change Order
EER	Enterprise Engineering Roadmap
EtO	Engineer to Order
FG	Finished Goods
ISCM	Integrated Supply Chain Management
MtO	Make to Order
MtS	Make to Stock
PLC	Product Life Cycle
SATRA	South African Telecommunications Regulatory Authority
SCC	Supply Chain Council
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference
SDH	Synchronous Digital Hierarchy
SKU	Stock Keeping Unit
TDMA	Time Division Multiple Access
URL	Universal Resource Locator
WIP	Work in Progress
WWW	World Wide Web

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Chapter 1

Introduction

To state that the telecommunications industry has gone and is going through radical change would be an understatement. Ward (1998) gives three main reasons for these changes: 1) deregulation and privatization; 2) globalization; 3) Internet and other (new) technologies.

Telecommunications companies have not always had to compete, however, this is changing all over the world and will soon change in South Africa as well. Competing enterprises (companies), be it on price, attributes of their product, quality of service, etc. have become use to evaluating and adopting new management and redesign techniques to give them a competitive edge.

This is only one side of the coin. Not only is South Africa preparing for a competitive telecommunications market, but it is also expanding its current infrastructure to provide services to previously disadvantaged market segments, resulting in growth in infrastructure and service provision.

The problem with growth within any industry is that it requires investment of capital. In the South African market the strategic equity partners in the consortium consisting of SBC Communications Inc. and Telekom Malaysia Berhad provided this. According to the Telkom Annual Report for the financial year ending 1999, the debt equity ratio had increased to 0.9 in comparison to the 0.5 of 1998. This ratio illustrates that the company is funding at least some of its expenses by using credit. Any savings in the expenditure of capital could thus be beneficial to the company.

In any industry, a company's growth is limited by the demand for its products or services, but the South African market is of such a nature that the demand far outstrips the ability to fulfil this demand. Telecommunications companies are thus to an extent, limited by their ability to grow fast enough to meet the demand, and this requires the availability of additional capital (cash). This presents a challenge that has been dealt with by competitive companies in the past. Bowersox (1999) describes this as "learning to do more and more with less and less until you are doing everything with nothing." (In the extreme).

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These challenges will have to be addressed if a telecommunication company (new or old) is to succeed in the South African telecommunication industry. The challenge for telecommunications companies is thus to establish business competencies that will give them the competitive edge. Instead of developing these competencies from scratch, it may prove useful to evaluate and migrate competencies used in other industries and evaluate how these apply to the telecommunication industry. One such competency or skill is (efficient) Supply Chain Management.

It can be argued that every company has at least one Supply Chain and considering the nature of the environment that telecommunications companies find themselves in, especially in South Africa, there are definite benefits in concentrating on this Supply Chain. This will not be discussed here, instead it will be explained throughout the rest of this thesis.

The challenge is now to apply Supply Chain principles to the telecommunications company. The goal of this thesis is to build a model that will be able to describe the Supply Chain of a telecommunications company, and more specifically a South African telecommunications company. This distinction will be discussed further at a later stage of this thesis.

Building such a model requires two elements, a structure for the model and the information to populate it. Instead of designing a model from scratch, the SCOR model will be used as a basis. The SCOR model has been developed to model the Supply Chains of typical manufacturing organizations. In using the SCOR model as basis, the validity of the SCOR model first has to be established. This will then provide a suitable and reliable framework to contain the newly developed telecommunications SCOR model.

Once a reliable structure has been developed, the model should then be populated with the correct information. This will be done by considering a Supply Chain within Telkom. Doing this will not only provide a complete and all encompassing model for the industry, but will also illustrate the methods that should be used to build such a model.

The aim of this thesis is to develop a SCOR model for the telecommunications industry. All the arguments presented to derive this model will be discussed within this thesis. These topics including Supply Chain Management, the SCOR model and the telecommunications company, are not well known concepts. For readers unfamiliar with these topics, appendices have been included to elaborate on the discussion.

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Chapter 2

Problem Statement and Objectives

In an environment were a company is faced with rapid expansion, the management of cash flow is critical. Telkom is a company faced with this environment of rapid expansion, and Supply Chain Management can be seen as a paradigm that has definite benefits, one of which is the management of cash flow. A marriage of the two would be the ideal solution. This project will suggest ways in which these two concepts can be used together.

The objective of this thesis is to provide a Supply Chain Modeling Tool that is applicable to the telecommunications industry. In order to achieve this goal, a few other problems, or smaller objectives, must be addressed.

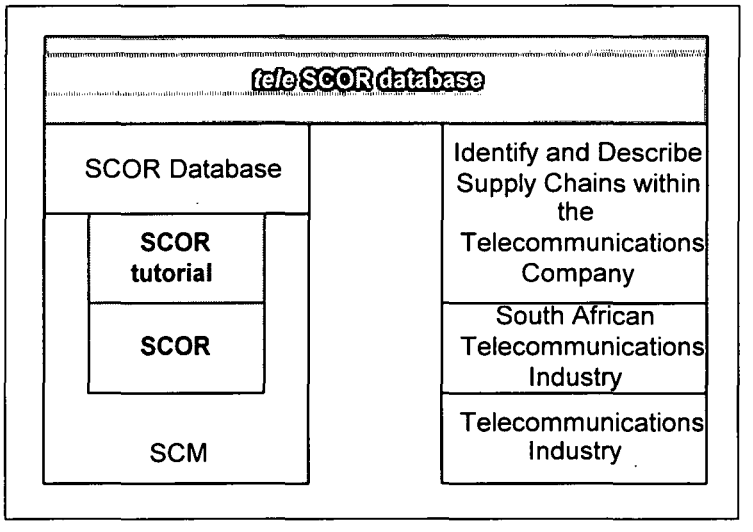

Figure 1: Hierarchy of Objectives

Figure 1 shows the structure of this thesis. The goal of the thesis is the telecommunications SCOR model. In order to achieve this, two areas must be explored: Supply Chain knowledge and the telecommunications industry.

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In considering the Supply Chain, the field of Supply Chain Management is explored. Various models are considered, and Supply Chain Management is defined with regards to the rest of the organization (chapters 3 and 4).

Contained within the knowledge of Supply Chain Management is the Supply Chain operations reference (SCOR) model. A basic overview of the model is provided in chapter 5. The reader however, requires a more detailed knowledge of the model to understand the steps taken to develop the new model. The SCOR model is usually fully understood after attending a SCOR workshop presented by the Supply Chain Council. This is not always practical, as the course is run in the United States, which results in large expenses. It is thus necessary to provide a stand-alone manual that can be studied at the reader's convenience, without any formal tuition. This objective is realized by creating a case study that will describe the major concepts of Supply Chain Management (Appendix C).

After the model has been studied, the model must be represented in a database format. It will be shown that this database representation was necessary to provide a reliable and accurate SCOR model. The development process and results of this database has been included in Appendix B.

The second area to consider is the telecommunications industry. In order to understand the decisions made in the telecommunications SCOR model, the reader has to understand the telecommunications industry in general, but also the environment of the telecommunications industry in South Africa. This is described in chapters 6 and 7.

With the pillars of the structure shown in Figure 1 in place, the final component, the telecommunications SCOR model, can be developed. The telecommunications industry specific model will be based on the SCOR model. In this thesis the SCOR model will be used as a partial model. "A partial model is a model which is not fully instantiated, and which can be re-used and customized by business users for building their particular models" (Vernadat, 1996). This is discussed in chapters 8 and 9.

The thesis will be considered complete if the use of this model can be illustrated. This is done in chapter 10 by considering a Supply Chain within the company, and showing how the telecommunications SCOR model can be used to model this Supply Chain.

Finally the telecommunications SCOR model is presented in Appendix A.

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Chapter 3

What is Supply Chain Management?

This chapter will explain Supply Chain Management. The traditional approach to explaining Supply Chain Management is to discuss the various best practices and techniques associated with it. This includes techniques like postponement, supplier and customer segmentation, etc. It is the author's opinion that this is not a description of Supply Chain Management, but rather a description of some of the practices associated with it. These practices are furthermore case specific, meaning that they are not applicable to all Supply Chains. To discuss Supply Chain Management and only discuss the practices associated with it would result in a distorted or unclear image of Supply Chain Management.

The approach taken in this thesis is rather to focus on Supply Chain Management itself. This chapter explores various models and thoughts on Supply Chain Management. The idea is thus to view the concept from different perspectives and in so doing build a more complete picture of it. This is similar to the elephant analogy (Du Preez, 1998). The elephant analogy shows that an elephant is too big to consider in one swoop. It may be necessary to view the elephant piece by piece and then in this way consider the elephant as a whole. This is the basis for the approach taken in this chapter.

The chapter starts by considering the evolution of Supply Chains. This section will show that Supply Chains are nothing new, but rather the integration of a number of fields of study. The next section states the Supply Chain vision. Looking at the Supply Chain vision provides a reference of what is required from the Supply Chain. It considers a high level look at Supply Chain Management.

The remaining sections focus on models. The first model is a one-dimensional model, describing the current state of the Supply Chain along a five-phase scale. This model suggests a number of characteristics of companies at the various phases of the model.

The next section presents a questionnaire that was used to identify the decisions important to Supply Chain Management. There are two reasons for using this questionnaire. Firstly it provides the decisions that the experts regard as the most important decisions in managing the Supply Chain. The

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second reason is that the next model, the Supply Chain Management maturity model, is based on this questionnaire.

The Supply Chain maturity model, unlike the first model, is made up of two dimensions: stages describing the maturity of the company and categories to analyze the dimensions. This introduction of dimensions gives the model the functionality of depicting a company that is mature in one dimension, and less mature in another, hence the matrix representation of the model.

These models are followed by an overview of all these models. The value of each of the various models will be illustrated in this section. Considering the models in isolation may become confusing at times. The reader is advised to rather consider the core thoughts of the section and move on to the overview where all the models are discussed in relation to one another.

3.1 The Evolution of Supply Chain Management

To understand the field of Supply Chain Management as it is now, it is useful to consider how it has evolved. Metz (1998) describes the evolution of Supply Chain Management in four stages. These stages are: the physical distribution stage; logistics stage; integrated Supply Chain Management stage; and the super Supply Chain Management (see Figure 2).

The names given to each of the stages are not important. Many authors have different names for the same stages, some authors may aggregate two stages and others may decide on a finer resolution of stages. This is not wrong. The model proposed here does however, provide an overview of the entire process.

The first stage is the physical distribution stage. Physical distribution consists out of two components: warehousing and transportation. Physical distribution management is the integration of these two components. The benefits gained from physical distribution management are:

- inventory-reduction benefits from use of faster, more frequent, and more reliable transportation;
- shorter response times via faster warehouse handling;
- increased forecast accuracy with faster transportation decreasing the length of the forecast period (Metz, 1998).

Physical distribution management is enabled by improved communications between the different warehouses; and more accurate and complex analyses in forecasts and costing. The improved communications and analyses techniques allow more complex decisions to be made.

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The second stage is the logistics stage. The manufacturing, procurement and order management components are added at the logistics stage. This stage is supported by electronic data interchange (EDI), worldwide communications and a greater availability and access of computers for data storage and analysis (Metz, 1998).

The third stage is the integrated Supply Chain Management stage. Metz (1998) describes this stage as the "current" stage. "Integrated Supply Chain Management (ISCM) is a process-orientated approach to

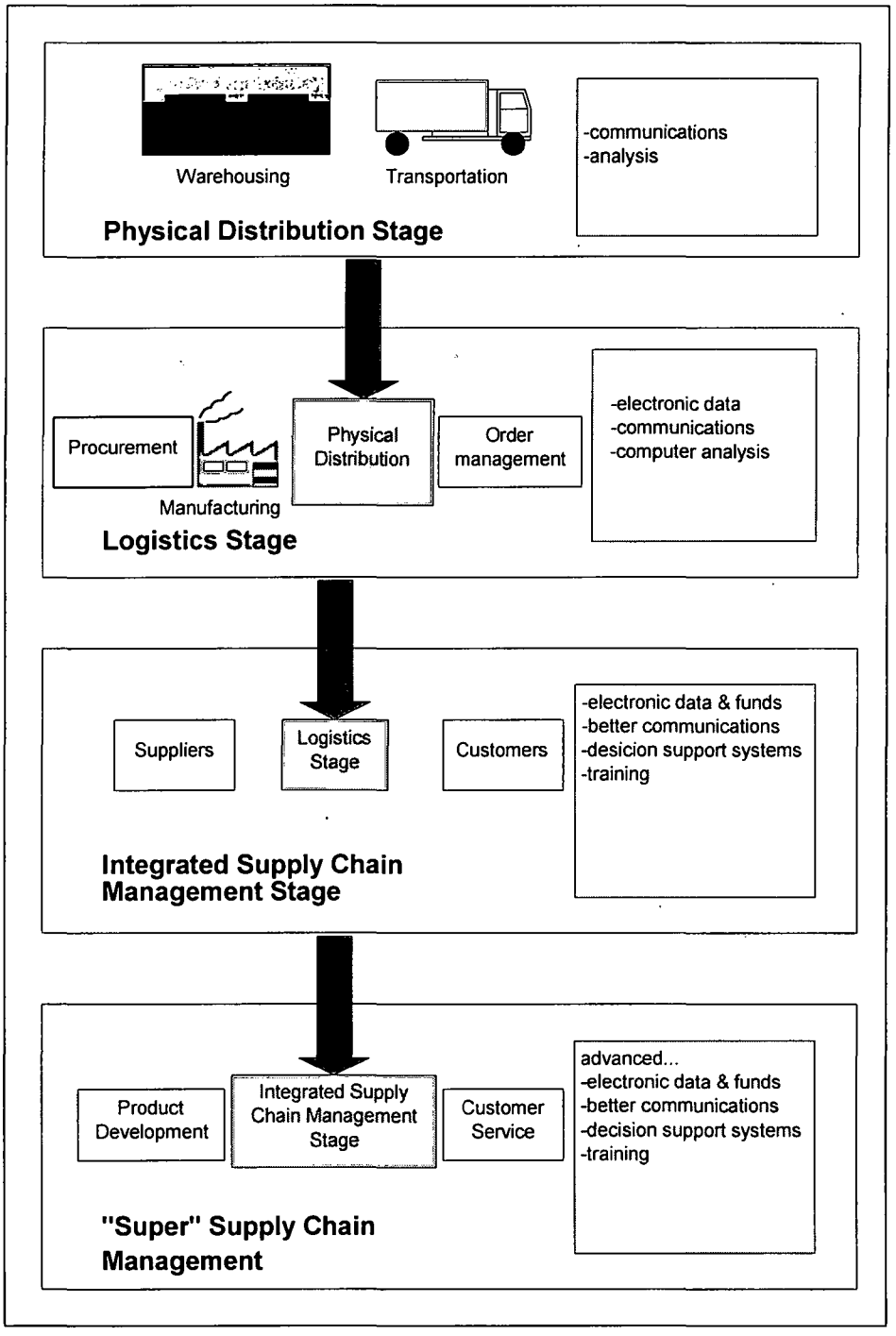

Figure 2:Evolution of Supply Chain Management

(Metz, 1998:49)

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procuring, producing, and delivering products and services to customers. The focus is no longer on the functional department, but is on the flow of the product, across the various functions. ISCM has a broad scope that includes sub-suppliers, suppliers, internal operations, trade customers, retail customers, and end users. ISCM covers the management of material, information, and funds flows".

In the integrated Supply Chain Management stage the customer and supplier elements are added. This stage relies on cutting edge technological solutions. Here the focus is on electronic data, electronic fund transfer, higher bandwidth communications, and computerized decision-support systems for planning and execution.

The final phase, the super-Supply Chain Management phase, incorporates functions like product development, marketing and customer service. This phase will be supported by advanced communications, better and more user-friendly computerized decision support systems, and increased training. Here concepts like design for manufacture and design for assembly become important. This has in fact been realized by a number of companies. Hewlett Packard designs their components so that the same component can be used on a number of products (Christopher, 1997). Other companies are designing their products in order for the products that have been recovered to be used again, this is known as design for disassembly (ISO 14000 as cited in Hormozi, 1999:46). Another interesting aspect is the design for shipping and handling. Companies are designing their products for easy shipment and easy handling, especially in the supermarket industry (Christopher, 1997). The super Supply Chain phase will be considered again in section 4.1.2 under the virtual product life cycle.

3.2 The Supply Chain Vision

The previous section considered the evolution of the Supply Chain and the components of Supply Chain Management. This section considers Supply Chain Management in the company itself. In considering a vision, it becomes clear what organizations hope to achieve by improving their Supply Chain.

A Supply Chain vision identifies the goals and objectives that a company typically has when considering Supply Chain Management. Mainardi, Salva and Sanderson (1999:47) provide a framework for a Supply Chain vision (shown in Figure 3).

The vision shown in Figure 3, is generic in the sense that it is applicable to many organizations. The vision is not directly applicable to all firms, it may need customization on the part of the user of the framework. The vision considers decisions from the strategic level decisions down to the operational level. This emphasizes the fact that the Supply Chain has an impact on all levels of the organization. Donier (1998:49) suggests that "an operations and logistics strategy must be comprehensive,

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- **Global supply-chain management based on clear operating strategy**
  - Production allocated to plants based on global economics and local market requirements
  - Pan-regional production and distribution networks designed according to the lowest cost-to-serve
  - Global procurement strategies based on total acquisition costs
- **A global clearing house to manage standardization and stock-keeping unit (SKU) rationalization**
  - Cross-functional product board (markets and supply chain) established
  - Standard menu offering variety
  - Technology and manufacturing standards set to deliver global, regional and local product specifications
  - Consistent manufacturing capabilities developed to insure identical SKU's manufactured at different locations have no discernible differences
- **Processes and tools to clear product demand and manufacturing capacity worldwide**
  - Strengthened planning and forecasting processes to enhance investment and capacity decision-making based on economics to provide legitimacy for execution across both the markets and the supply chain function
  - Operating and customer service policies clearly defined by customer, product and market
  - Upgraded decision support tools
  - Inventory visibility
  - Accurate and timely information, including accurate marginal and total product costing
- **Clear organizational accountability and efficiency**
  - Shared inventory ownership between markets and the supply-chain function
  - Factory replenishment orders controlled be regional hubs with all factories reporting to a central supply chain organization
  - Master Schedules developed at the plant level
  - Best practices shared globally
  - Scarce resources built and shared through Centers of Excellence
- **A fact-based, analytical culture**
  - Increased process discipline and better data
  - Openness and sharing
  - Modified incentives and performance measures (e.g., standard transfer pricing and non-financial measures such as forecast accuracy)

Figure 3: Elements of a Supply Chain Vision

(Mainardi *et al.*, 1999:47)

but at the same time must break down the complex web of decisions into analyzable pieces."

A logistics strategy is made up of eleven decision categories:

1. structure of facilities networks
2. choice of operations process technology
3. choice of logistics process technology
4. vertical integration of Supply Chain
5. work force
6. operations planning and control
7. distribution planning and control
8. quality management
9. transportation policy
10. customer service policy
11. organisation souring (Dornier, 1998:49)

Although this has been described for global logistics, it is very applicable to Supply Chain Management (authors easily confuse the two concepts, it will be differentiated within the thesis). The decision categories proposed here are very generic. They do however, list all the major functions involved in a Supply Chain strategy.

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This vision (shown in Figure 3) introduces a few interesting concepts. Figure 3 introduces the concept of economic analysis when making decisions as to the best solution. This point is very important, as making a profit is arguably what business is all about. Choosing the best solution financially is thus the main consideration when weighing up factors.

Some may argue that factors like market share and growth are also important. This may be true, but need not necessarily be true (Hesket, Sasser and Schlesinger, 1997). The deciding factor is still a profit. It is doubtful that a company will pursue growth or market share, or any other measure for that matter, if it does not expect a return in the form of a greater profit.

The vision also has a strong focus on information. Information is very important if the company is to be managed correctly, and is important for the next point, namely decision making. It is seen that decision making is an important component of Supply Chain Management, but can only be done with the correct information. This focus of decisions will be considered again in a later section.

Mainardi *et al.* (1999:48) suggests that a Supply Chain vision should include at least the following:

1. Decisions about network structure, asset utilisation and vertical integration.
2. A definition of the value-added roles throughout the value chain.
3. A clear customer, product and market focus for each production and distribution site.
4. Standards of performance for cost, quality and service, including expected economics.
5. The identification of strategic processes and technologies.
6. A description of those capabilities necessary to systematically outperform competitors, including required knowledge, business processes, tools and technology.

A last comment, although it has been made all too often, is still relevant at this point in time. "By definition, developing a vision requires leadership from the chief executive officer because the decisions made by top management will have significant impact on the cost structure, product design, number and location of factories and warehouses, and supplier selection. Only when these issues are resolved will the advantages of a global production network be realized" (Mainardi *et al.*, 1999:48). This again echoes the idea that Supply Chain decisions impact all levels of the organization.

3.3 Supply Chain Compass

The discussion of Supply Chain Management now turns to the first model of Supply Chain Management. Fox and Holmes (1998) propose a different approach (to those already discussed) in describing the Supply Chain. The authors describe any company as having a Supply Chain at a stage along a single dimension. Each of these stages is described in terms of attributes. These attributes are business pain, driving goal, organizational focus, process change, metric, IT focus, key planning tools and key execution tools. One of the objectives of this roadmap is to "create a common framework and

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foundation to help companies understand Supply Chain Management and its supporting technology" (Fox *et al.*, 1998:56). The model is thus a compass as it firstly provides the company with a roadmap, telling them were they are, which then indicates the direction for future improvements. It is the author's opinion that the use of the word "roadmap", here is incorrect. It should rather be considered a yardstick, measuring the Supply Chain Management position of the company along a single dimension. The compass does not indicate an area for improvements as much as it indicates what the next stage is (you can only move forward or backward). The maturity model, (introduced in section 3.5) could rather be called a Supply Chain roadmap (showing various directions to move to).

The Supply Chain compass is divided into five stages. Each of these stages will now be described in more detail:

Stage one, or the "Fundamentals" stage, focuses on quality, from the quality of the products being manufactured up to and including its packaging and delivery. To meet the standards set by stage one, each department or function within the organization must focus on its contribution to quality and product cost. The ultimate goal is to achieve predictable costs, delivery times and production rates. Companies in this phase usually focus on automating existing functions and tasks. The key to progressing from stage one to stage two is the use of information technology.

Stage two, or the "Cross-functional Teams" stage, focuses on customer service. The driver in this stage is customer satisfaction. The emphasis here is on shipping orders complete and on time to satisfy customer demand. To remain competitive the customer becomes the driving goal. Success in this stage is measured on how well the company meets its customer-service objectives and its cost and profit targets.

	STAGE I	STAGE II	STAGE III	STAGE IV	STAGE V
	Fundamentals	**Crossfunctional Teams**	**Integrated Enterprise**	**Extended Supply Chain**	**Supply Chain Communities**
Business Pain	Cost of Quality	Unreliable Order Fulfillment	Cost of Customer Service	Slow Growth, Margin Erosion	Non-Preferred Supplier
Driving Goal	Quality and Cost	Customer Service	Profitable Customer Responsiveness	Profitable Growth	Market Leadership
Organisational Focus	Independent Departments	Consolidated Operations	Integrated Supply Chains (Internal)	Integrated Supply Chains (External)	Rapidly Reconfigurable
Process Change	Standard Operating Procedures	Crossfunctional Communications	Crossfunctional Processes	Customer Specific Processes	Reinvented Processes
Metric	Predictable Cost & Rates	On-Time, Complete Delivery	Total Delivered Cost	Share of Customer	Net Worth
IT Focus	Automated	Packaged	Integrated	Inter-Operable	Networked
Key Planning Tools	Spreadsheets	Point Tools	Enterprise Supply Chain Planning	Point-of-Sale Supply Chain Planning	Synchronized Supply Chain Planning
Key Execution Tools	MRP & Other Homegrown Applications	MRP II	ERP	Customer Management Systems	Networkcentric Commerce

Figure 4: Supply Chain Compass

(Fox *et al.*, 1998)

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Stage three, or the "Integrated Enterprise" stage, focuses on efficiency. Here the company builds on the customer satisfaction achieved in the previous stage by providing a highly responsive and flexible service, while at the same time accomplishing these goals at the lowest possible cost. The high responsiveness is achieved by focussing on flexibility and the integration of the Supply Chain from the acquisition of goods to the delivery of the product to the customer. This stage is characterized by a cross-functional approach rather than the traditional functional silos.

Stage four, or the "Extended Supply Chain" stage, focuses on market value. "The driving goal is increased market share and profitable growth, accomplished by providing customer-tailored products, services, and value-added information that differentiate them from competitors" (Fox et al, 1998:59). The goal here is to achieve "preferred partner" status. By developing close partnerships with customers and suppliers, companies can collaborate on forecasts and planning. This collaboration can also lead to co-operation in the design of products and services.

Stage five, or the "Supply Chain Communities" stage, focuses on achieving synchronous integration of common goals, objectives and metrics with the supplier community. The company now moves to the role of market leadership. Only the companies that have achieved Supply Chain maturity are seen as part of the chain.

This stage will have Supply Chains that are rapidly reconfigurable, they will be organized to meet the needs of the customers and will then disappear, only to become part of the next customer demand that is identified.

3.4 Supply Chain Decision Process Assessment

The Supply Chain decision process assessment was a study done in order to identify the practices and principles that best correlate to superior decision-making performance in Supply Chain Management. It was conducted by Complete Business Solutions, Inc. (CBSI) under McCormack (1998).

Considering this study is useful as it gives an indication of what questions the experts ask when describing the Supply Chain and also shows what decisions the practitioners feel are important to their Supply Chain successes or failures.

The questions asked are based on the SCOR model (described later in Chapter 5) developed by the Supply Chain Council. The questions are grouped under *plan*, *source*, *make* and *deliver*. These groupings correspond to the components of the Supply Chain as identified by the SCOR model. The questions were developed by experts working on Supply Chains as well as members of the Supply Chain Council. These questions are answered in the form of a five point Likert scale, ranging from "1

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– never or does not exist" up to "5 – always or definitely exists". The last question in each group is a question asking the correspondent to rate the overall performance of the group.

The scores of the various questions were then correlated to this final measure of performance. The aim was to identify these questions that had high correlation with the last question (rating the organisation performance). If many questionnaires had a low score for a specific question (say dimension A), but that organization was found to be performing, the reverse was also should be true (high scores result in bad performance). It would be clear that this dimension A, did not lead to better performance levels, in fact it did just the opposite. The same argument is valid for high scores with high performance levels and low scores with low performance levels. No correlation would indicate that the dimension is not important to Supply Chain Management performance, or that it has not been correctly applied.

At this point it is important to note that the scores are subjective. The importance of this study lies in the results. What decisions determine the success of the Supply Chain? The top five correlations of each dimension are given in Figure 5.

Plan
- Is the forecast credible or believable?
- Are your demand management and production planning processes integrated?
- Does this process use historical data in developing the forecast?
- Do you have a documented demand forecasting process?
- Do sales, manufacturing and distribution organisations collaborate in developing the forecast?

Source
- Do you measure and feedback supplier performance?
- Are the supplier inter-relationships (variability, metrics) understood and documented?
- Is your Procurement process documented (written description, flow charts)?
- Do other functions (manufacturing, sales, etc.) work closely with the procurement process team members?
- Do you share planning and scheduling information with suppliers?

Make
- Does your current Process adequately address the needs of the business?
- Do you have weekly planning cycles?
- Do the sales manufacturing and distribution organisations collaborate in the planning and scheduling process?
- Do you have someone who "owns" the process?
- Do you have a documented (written description, flow charts, etc) production planning and scheduling process?

Deliver
- Does you information system support Distribution Management?
- Do your information systems currently support order commitment process?
- Is the Distribution Management process integrated with the other supply chain decision processes (production planning and scheduling, demand management, etc.)?
- Are Distribution Management process measures in place?
- Are the network inter-relationships (variability, metrics) understood and documented?

Figure 5: Most Important Decisions in Supply Chain Management

(McCormack, 1998)

3.5 *Supply Chain Management Maturity Model*

The Supply Chain Management maturity model is based upon the Supply Chain decision process assessment discussed in the previous section. The model gives the user information as to what step to take next in managing and developing the Supply Chain that will most effectively move the (Supply Chain) process forward (McCormack, 1999:12). The model is greatly influenced by the ideas of Philip Crosby, one of the quality gurus, who suggested that small evolutionary steps, rather than revolutionary ones, are the basis for continuous process improvement.

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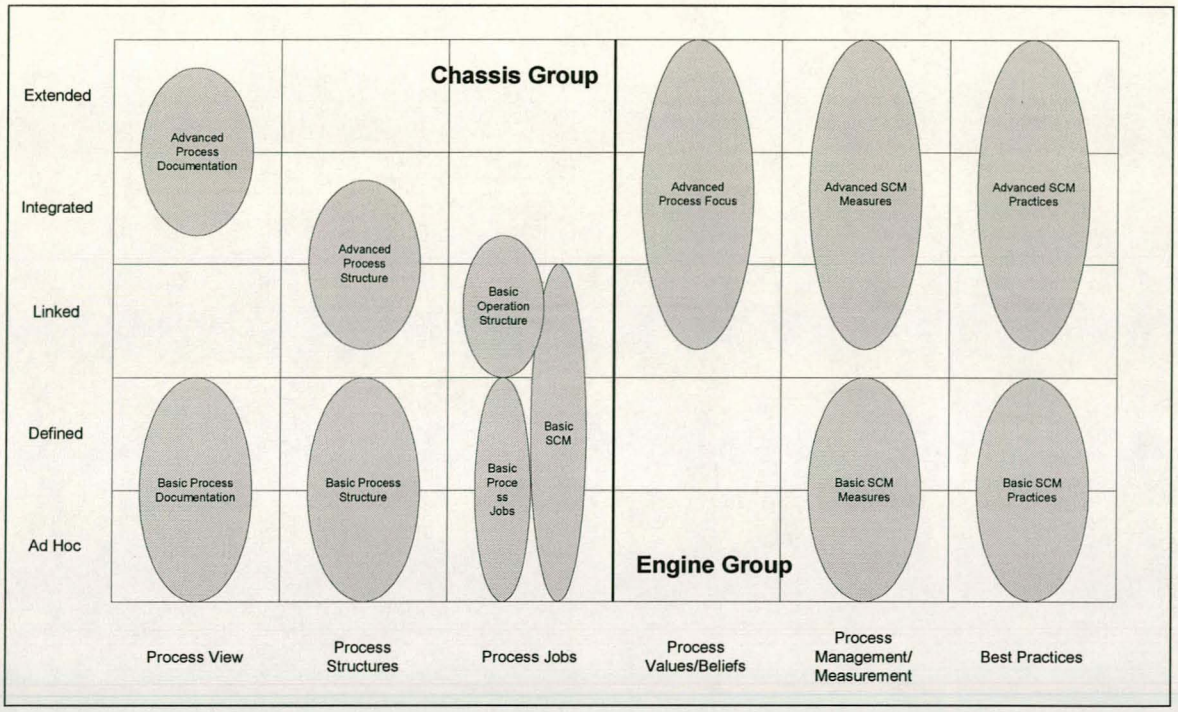

Figure 6: Supply Chain Management Maturity Model

(McCormack, 1999)

The model uses the questionnaire shown in the previous section, and then plots the results on a grid (shown in Figure 6). The exact method of relating the questions to the grid are not clear. At the moment all questionnaires are sent to CBSI at which point the results are returned to the correspondent. The ellipses in Figure 6 are then shaded depending on the maturity score achieved. The resulting score is thus depicted by the proportion to wich the various ellipses are shaded. The model has demonstrated good predictive value when considering the subsequent business performance (McCormack, 1999:14).

The rest of this section will consider the matrix and explain its framework. The model firstly defines five stages, these stages will now be discussed. The first stage is the "ad hoc" stage: here Supply Chain Management practices are unstructured and ill defined. Process measures are not in place and jobs and organizational structures are based upon the traditional functions and not on the cross-functional approach.

The second stage is the "defined" stage: at this stage basic Supply Chain Management processes are defined and documented. Processes have been captured in flowcharts and changes have to go through a formal procedure. Representatives from various departments co-ordinate, but on a very basic level.

The third stage is the "linked" stage: this is considered as the breakthrough level. Managers now start to think in terms of Supply Chain Management. Cross-functional teams are now formed for decision making and attention is given to the measures of the entire Supply Chain.

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The fourth stage is the "integrated" stage. The organisational structure is now designed around that of the Supply Chain and not a traditional silo approach. Supply Chain Management measures are now deeply embedded in the organisation. Advanced Supply Chain Management practices are now in place.

The fifth stage is the "extended" stage: here the company realises that the performance of the entire chain determines the competitive position of the company. Muskin (1998:31) describes this best suggesting that "business firms don't compete, value chains do". "A horizontal, customer-focused, collaborative culture is formally in place" (McCormack, 1999:13).

These stages are plotted on the vertical axes. To better describe each of these stages, they are divided into six categories. These categories are plotted on the horizontal axes. The six categories are divided into two groups, namely the chassis and engine. "Chassis groupings, as the name implies, provide the framework necessary for achieving higher maturity levels. Engine groupings are items that provide the power and control mechanisms for Supply Chain Management performance" (McCormack, 1999:13).

The first category that forms part of the chassis is the "Process View". This measure describes the extent to which processes are documented and formalised. The next category is the "Process Structure" category. This describes the extent to which the organisation structure supports cross-functional collaboration. The last category that is part of the chassis group is the "Process Jobs". This structure defines the extent to which the job functions are integrated into a Supply Chain team.

The first category in the engine group is the "Process Values/Beliefs" category. This is a measure of "the beliefs that energize an organization" (McCormack, 1999:14). The next category is "Process Management/Measurement". This category identifies the extent to which the company is measuring and rewarding performance of the Supply Chain. The last category in the engine group is the "Best Practice" category. This category measures to what extent the company is using practices regarded as best practices within industry.

The model gives a good indication of what dimensions in general make up what is known as Supply Chain Management.

It may be useful to compare this model with the model proposed by Fox *et al.* (1998). As with the model provided by Fox, the Maturity model has a phase grouping. The difference is that the maturity model allows a company to be mature in one dimension and less mature in another. Intuitively this is a better representation of reality. It would be naïve to think that all companies mature in all dimensions in the same way.

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3.6 Summary of Models

This section will simply draw attention to the most important issues illustrated in the various sections. The evolution of Supply Chain Management illustrates that Supply Chain Management is nothing new. It is also not a field in its own, it is rather a collection of a number of fields of study like transportation, warehousing, manufacturing, etc. These fields are all well known and have been studied and discussed in detail. Supply Chain Management simply adds a new dimension. The fact that these systems are not in isolation, all interact and influence each other, and managing this interaction could provide an advantage to the company that can accomplish this.

The next section, the Supply Chain vision, shows that the measures must make economic sense. The Supply Chain vision shows that Supply Chain Management is not the responsibility of only management or only the operational staff, it is rather the responsibility of all levels within the company. The vision also gives an indication of what aspects are important in Supply Chain Management to the specific company.

The next issue is that of the Supply Chain compass. It is important to note here the dimensions listed at each of the stages identified. These dimensions do not belong to one department alone, it involves all departments within the company, even the IT department which is traditionally seen as a support function and not as one of the operational functions. The model also demonstrates that all companies does have a Supply Chain. These Supply Chains may just not be mature or as mature as those of other organizations.

The questionnaire (section 3.4) for the first time mentions best practices associated with the Supply Chain, but this is not the only use of the questionnaire. It is also important to consider what you are measuring with this questionaire, and the answer is decisions. A large part of Supply Chain Management is decision making, what to do at a certain point in time and place (also discussed with the Supply Chain vision). Making decisions is not the only dimension to Supply Chain Management, but is definitely an integral part.

The last section uses the questionnaire to build a Supply Chain maturity model. The maturity model provides the company with a map of where they are and the areas that need improvement. The important point demonstrated by this model, is the fact that it shows that the company may be mature in one dimension, but not in another. The company should thus focus on improving those areas where it is less mature.

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3.7 Conclusion

This chapter considered the most important aspects of what Supply Chain Management is. It would be naïve to think that Supply Chain Management has been defined in full within this chapter.

The aim was rather to sketch the various pictures of Supply Chain Management as seen from various perspectives.

In describing anything, one could do this by answering the questions: *how*, *why*, *what*, *where*, and *when*. The *why* has been discussed in the introduction, and will also become clear throughout the rest of this thesis. Many companies are considering Supply Chain Management strategies as they feel that the *why* means higher profits. The *why* will not be discussed explicitly in this thesis, although its importance should be clear.

The *how* depends on the situation. Authors publish books trying to explain the *how*, although it only considers one dimension of the field. The *how* should be considered based upon the scenario being dealt with. This includes the type of industry, type of inventory, type of organization culture, etc. The *how* will not be considered explicitly in this document, although a number of suggestions will be given, but these are industry specific and will not be discussed in detail.

The *what*, has been considered in this chapter. What is Supply Chain Management? The approach was to take a number of snapshots of the same item (Supply Chain Management) and present them to form a bigger picture of an already large concept.

The final two questions, *where* and *when* are considered in the next chapter. It is necessary to consider *where* Supply Chain Management fits into the organization, and also *when* it becomes applicable.

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Chapter 4

Position of Supply Chain Management

A very confusing issue regarding Supply Chain Management, is its role within the organization. Many feel that Supply Chain Management is the driver of their business: the business exists because of its Supply Chain. Others see Supply Chain Management as a mere dimension of the business, among many other drivers. It is thus necessary to describe the various thoughts and consider the major issues involved in understanding the position of Supply Chain.

The previous chapter considered the *how* and *what* of Supply Chain Management, this chapter will focus on the *when* and *where*. In discussing this, there are two issues to address: Where does Supply Chain Management fit into the rest of my business, and secondly at what level of detail should Supply Chain Management be considered.

It will also be shown that there is a need for distinguishing between Supply Chain Management and Supply Chain design. These issues are easily confused, or simply discussed as Supply Chain Management. This is not the case, a Supply Chain is designed, so that it can be managed.

4.1 Supply Chain Management within the Organization

The models previously discussed all had one common theme, the fact that they considered a number of functions or departments like manufacturing, marketing, etc.

The question now is where and how it fits into the organization. One approach to understanding the position of Supply Chain Management, is to consider the IE Toolkit. "The IE Toolkit is based on a virtual enterprise wide matrix, which consists of a virtual product life cycle and a virtual enterprise life cycle. ... The combination of the Product Life Cycle and the Enterprise Life Cycle creates a framework within which all this information (about the product, the enterprise design and the

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interaction between the product design and the enterprise design) can be stored in such a manner that it is easily retrieved and facilitates integration" (Du Preez and Reid, 1998:87).

If this is taken to be true, the enterprise life cycle and product life cycle do in fact provide a sufficient framework for describing information within the enterprise. It would be best to describe Supply Chain Management with respect to both these life cycles. This will then be used to illustrate the role of Supply Chain Management within the organization.

Before continuing, it should be made clear that this is simply the author's opinion with regard to the role of Supply Chain Management within the enterprise. There are other perspectives as well. These will be pointed out in the discussions that follow.

4.1.1 Virtual Enterprise Life Cycle

"The enterprise life cycle represents the sequence of phases characterizing the entire existence of an enterprise. The phases include: enterprise inception, definition phase, requirements definition, system design and specification, system implementation, system operation, change management, and system dismantlement" (Vernadat, 1996:31).

It is thus clear that the Supply Chain would be contained in either of these steps, a combination of these steps or in all of these steps (implying that the enterprise life cycle is contained within the Supply Chain).

In considering a manufacturing enterprise, Vernadat (1996) suggests that the following items should be modeled and integrated:

- Products
- Resources
- Information
- Organization and Decisions
- Business Process
- Humans

It is the opinion of the author, and also the approach of this project, that the Supply Chain manages and models the product flow through the organization. Supply Chain Management is thus contained within the operational stages of the enterprise life cycle (see Figure 7, Approach B).

The alternative approach is to consider Supply Chain Management as the main drive of any business, and to consider the enterprise as an entity created to support the Supply Chain (see Figure 7 approach

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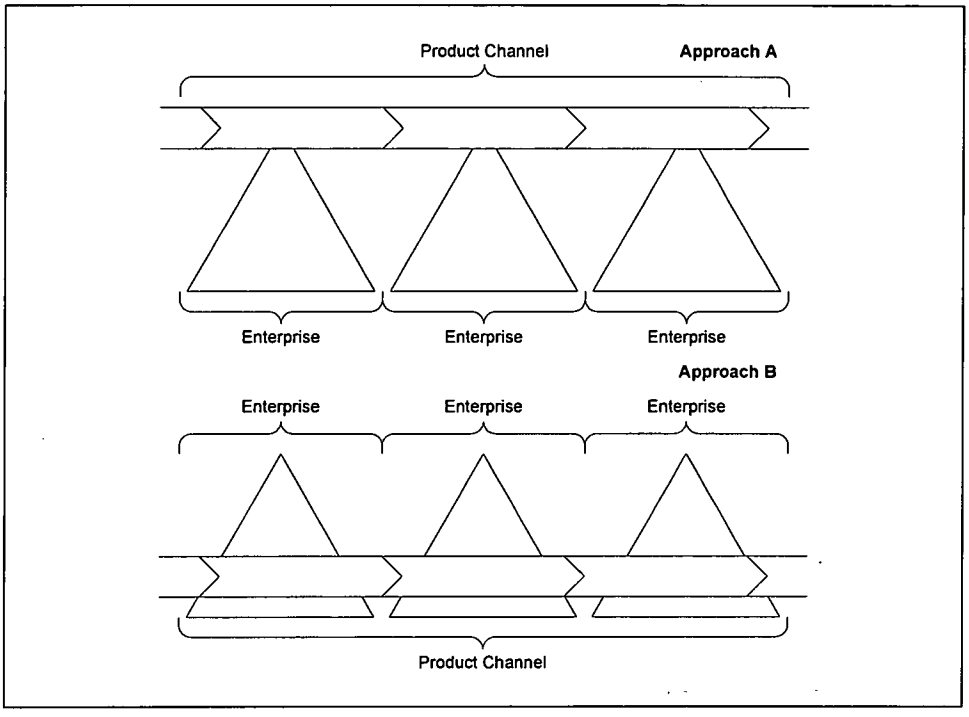

Figure 7: Supply Chain Management and the Virtual Enterprise Life Cycle

A). This approach is not wrong, and it is very much a chicken-egg scenario: does the organization exist because of the Supply Chain, or does the Supply Chain exist because of the organization.

The discussion is necessary here, as the approach taken (that Supply Chain Management is a component of the enterprise life cycle) implies that Supply Chain Management only describes activities and decisions directly related to the product (as will be shown in later sections).

4.1.2 Virtual Product Life Cycle

"Products move along the product life cycle (PLC) and as they do, the character of their competitiveness changes. By the same token, products in different geographic markets are shown positioned in different stages of the PLC. Companies need to adjust the logistics system in order to accommodate this dynamic process" (Dornier, 1998:47).

From this discussion it is clear that the Supply Chain changes because of changes in the product life cycle. This is not to say that the Supply Chain does not affect factors in the product life cycle like product design, etc. It does however imply that Supply Chain Management is only relevant in the operational stages of the product life cycle, and there it is determined by the stages of the life cycle. This is contrary to the approach proposed by Metz (1998:49) and discussed in section 3.1, that the final state or evolution of final Supply Chain Management lies in the integration of product development.

This discussion is relevant as it shows that Supply Chain Management discusses the product in its operational stages of its life cycle. It thus describes the management of the Supply Chain. It is also

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important to note that this also described the *when* of Supply Chain Management. Supply Chain Management is present when the physical product is produced and handled.

4.1.3 Enterprise Engineering Roadmap and Supply Chain Management

The department of Industrial Engineering at the University of Stellenbosch is currently working on a project using both the product and enterprise life cycles to provide a framework for describing information. This provides the user with a roadmap to guide him or her in making any changes within the organization, and understanding the effects of any changes throughout the entire enterprise.

In creating this roadmap, enterprise life cycles have been divided into 5 generic regions. These regions being concept, functional analysis, implementation, operations and disposal. The product life cycle has been divided into 8 generic regions consisting out of concept-, research and development-, definition-, design-, prototyping and market trials-, production-, product distribution-, product usage and support - and lastly disposal phases.

The exact definitions of these phases are not important for the discussion of Supply Chain Management within this project. The important fact is that Supply Chain Management is present at the operational stages of these life cycles, and with the product life cycle this can be elaborated to say that Supply Chain Management is present from the point were a physical product flows.

Here it is important to distinguish between Supply Chain Management, and the design of a Supply Chain system. It can be argued that the Supply Chain does have an effect on the strategy of the business, the development of the product, etc. But these issues are considering the design of a Supply Chain system, or Supply Chain design. One would design a Supply Chain so that it can be managed and operated on a daily basis. Issues like product design, etc. are thus described by Supply Chain design. Supply Chain Management is however part of one or more of the phases of the product and enterprise life cycles. This is illustrated in Figure 8 where it is shown that Supply Chain Management relates to the rest of the organization through Supply Chain design.

An important issue here is the domain covered by Supply Chain design. It is the author's opinion that all activities within the organization impact on the Supply Chain. Supply Chain design thus involves all activities in the organization.

This section has thus shown that there is a difference between Supply Chain Management and Supply Chain design. These issues are easily and incorrectly confused within literature. Supply Chain Management, as the name implies, only considers the management of the Supply Chain. It is up to Supply Chain design to incorporate all issues of the organization into this management process, creating a system to be managed.

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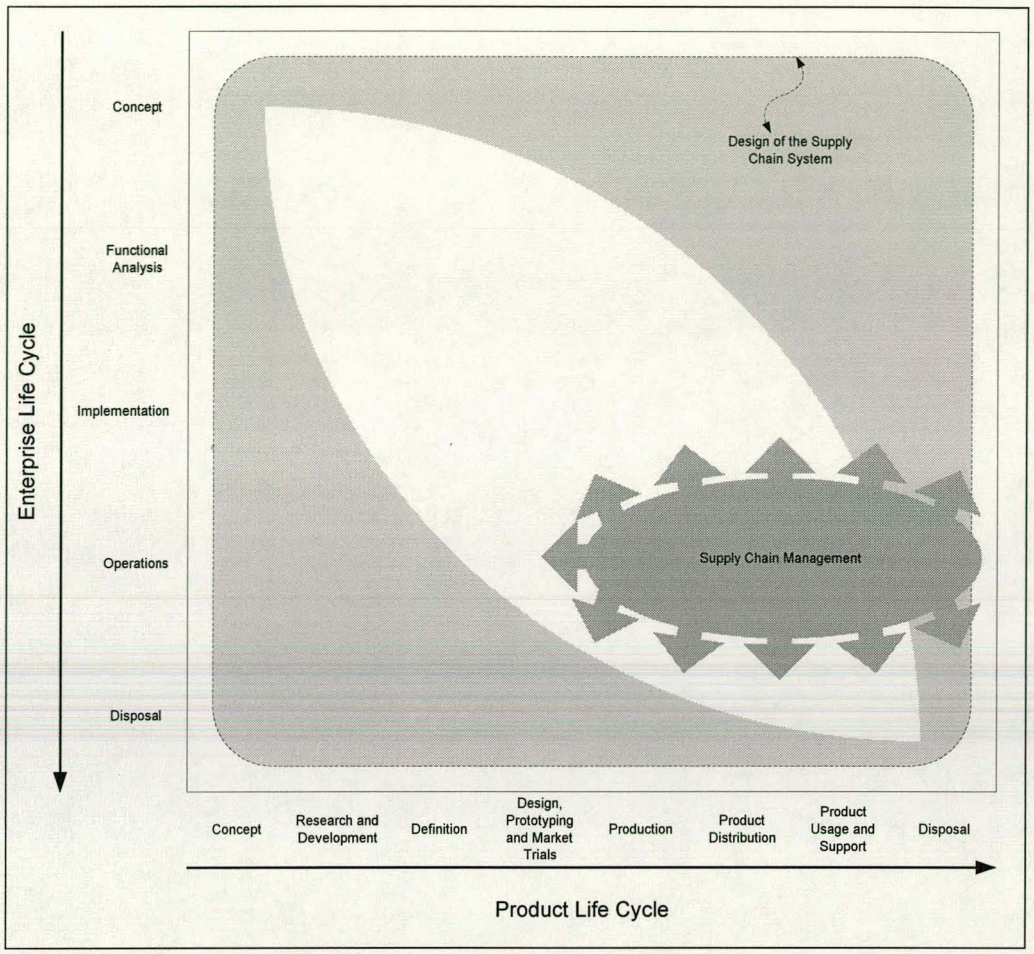

Figure 8: EER and Supply Chain Management

4.2 Level of Detail of Supply Chain Management

The previous section discussed the role of Supply Chain Management within the organization, and described how it fits in with the rest of the organization. There is however a second issue to consider when discussing the *where* of Supply Chain Management, and that is the level of detail: Does Supply Chain Management require the description of the finer intricacies of the system, or is it sufficient to simply understand the system as a whole? This argument will be presented by means of an example.

It should be noted that this is an example. It is a very specific Supply Chain scenario. The concepts discussed here are not applicable to all Supply Chains, neither are all the complexities of Supply Chain Management contained within this example.

Consider the scenario were a product enters the organization, it is kept in a warehouse for storage and passed to manufacturing for conversion to the finished product. The finished product is then kept in a warehouse until a customer orders the product, at which time it is shipped to the customer. The intra Supply Chain is depicted in Figure 9. When considering the Supply Chain, each of these elements are considered as a black box. We simply need the attributes and inputs and outputs of each element to

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model the chain. Say for example the company would like to minimize their amount of inventory carried within its warehouse. The company has gathered the following information:

- the customer is guaranteed a product within 2 days of his or her order
- the lead time to source from the supplier takes 2 months
- the manufacturing process takes 5 hours

With this basic information, it is clear that the company could easily keep great amounts of raw material stock according to forecasts, and then manufacture the products as orders arrive. If the manufacturing time had been, say 3 days, the company might decide to go into the manufacturing process to optimize the process and in so doing decrease manufacturing time. At this point, the focus is not on Supply Chain Management any more, but rather on issues like manufacturing optimization, scheduling, factory layout, etc.

From this discussion it is clear that Supply Chain Management attempts to consider the system as a whole, and improve the system as a whole. There is great value in taking this approach, as many problems occur because the system is not considered in its entirety.

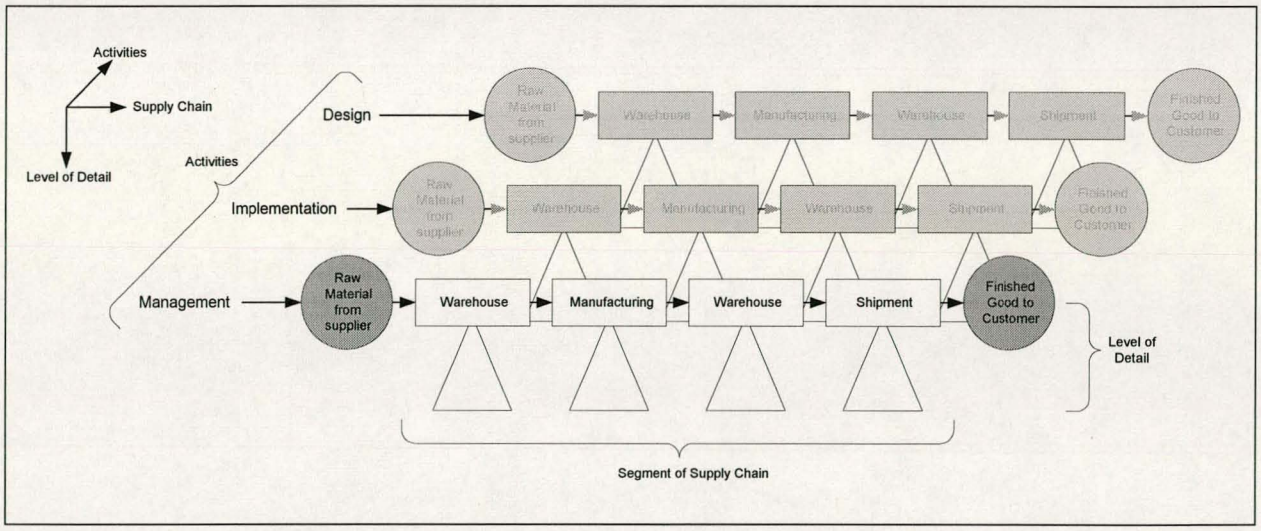

Figure 9: Supply Chain Scenario (A Pragmatic Approach)

Consider for example the scenario where the product must first go through a quality inspection before being shipped, and assume that this quality inspection involves tests that take 5 days. Decreasing the manufacturing time would not help, as the bottleneck is still the quality inspection. Considering the whole chain could point out many other issues that would improve the performance of the company.

It is thus important to note here that Supply Chain Management is not the optimization of every detail, it is rather the process of optimizing or improving the system as a whole. This is not to say that the detailed information is not important, the Supply Chain practitioner should understand each process, as this will determine the metrics and measures used to measure each element and the entire system.

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Figure 9 again illustrates how Supply Chain Management and Supply Chain design are two different activities. From this discussion and the figure it is clear that Supply Chain Management involves any activity that will ensure the delivery of a product or service to the customer, but on a aggregated level.

4.3 Definitions

The foregoing discussions have attempted to build on the foregoing sections and provide insight into the role of Supply Chain Management within the organization. It is now necessary to define a number of concepts in order to eventually define Supply Chain Management.

Management: "The action or manner of managing, in senses of the vb.; the application of skill or care in the manipulation, use, treatment, or control (of things or persons), or in the conduct (of an enterprise, operation, etc.)" (The Oxford English Dictionary, 1989a:293).

(Business) Process: "A business process is a sequence (or partially ordered set) of enterprise activities, execution of which is triggered by some event and will result in some observable or quantifiable end result" (Vernadat, 1996:22).

(Enterprise) Activity: "An enterprise activity (or simply activity) is a set of partially ordered basic operations executed to perform things to be done within an enterprise" (Vernadat, 1996:23).

System: "A set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan" (The Oxford English Dictionary, 1989b:496)

Customer: "One who acquires ownership by long use or possession" (The Oxford English Dictionary, 1989c:169).

In light of the foregoing definitions, Supply Chain Management can now be defined.

Supply Chain Management: The management of all activities, processes and systems (directly related to the product or service) that support and enable the delivery of that product or service to the customer.

Supply Chain Design: The design of all activities, processes and systems (directly related to the product or service) that support and enable the delivery of that product or service to the customer.

It is important to note that these definitions imply that the Supply Chain ends when it reaches the customer. This means that the definition is greatly dependent on the definition of the customer. If the customer is simply next to the organization in the chain, the Supply Chain would be the intra company Supply Chain. If it spans more than one organization, it would be an inter company Supply Chain.

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The customer could well be someone disposing of the product eventually or using it as part of a recycling process. This definition of the customer is becoming more important as companies are forced to manage their products throughout its entire life cycle.

By defining the final customer correctly, one could even be discussing the reverse Supply Chain. The field of reverse logistics is one of the newest fields in Supply Chain Management. This has become important after legislation is forcing organizations to take ownership for products that they produce (especially in Europe).

4.4 Conclusion

This discussion took a holistic approach to defining Supply Chain Management, and describing its role within the organization. Supply Chain Management was placed within the framework of the organization, and its interactions with the rest of the organization were illustrated by concluding that this interaction is facilitated by Supply Chain design.

The level of detail of Supply Chain Management was also considered by means of an example. This illustrated the fact that there is great value in looking at the whole chain, as well as drilling down into the finer details. Only considering the finer details would not always ensure the best solution. The reverse of this argument is also true.

Although this chapter contained discussions of abstract theoretical concepts, it is important to consider the results because of these discussions: definitions for Supply Chain Management and Supply Chain design. In considering these definitions, it becomes clear that the challenge for the industrial engineer is not to manage the Supply Chain, but rather to design a Supply Chain that will be managed. This is the focus of this thesis, developing a tool to aid in designing a Supply Chain. These definitions will be the basis for the following discussions of Supply Chain Management within this project.

Still keeping with the discussion of Supply Chain Management, the next chapter is an overview of the SCOR model. The SCOR model must be discussed, as it is the framework that this thesis is based on.

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Chapter 5

Supply Chain Operations Reference Model Overview

The Supply Chain Operations Reference (SCOR) model is used to describe, measure and evaluate Supply Chain configurations. It was developed by the Supply Chain Council (SCC) to provide a standard "language" for Supply Chain practitioners to use when describing their Supply Chains.

There was a need for an industry standard as different companies had to find a way of communicating their Supply Chain to their suppliers and customers. This led to the development of the SCOR model. It should be noted that the model is by no means perfect or complete. It is a very new model, and work is constantly being done to evaluate and improve it.

The Supply Chain Council was formed in 1996 by Pittiglio Rabin Todd & McGrath (PRTM) and AMR Research. The SCC initially included 69 voluntary members. This figure has now grown to 400 members, with most of these members being companies (Supply Chain Council, 1999a:8). The council boasts with a growth figure of 30 members per month. This information is significant, as it is an indication of the acceptance of the council and also the SCOR model as the industry standard in Supply Chain Management. Even more interesting is the regional breakdown of the membership. The SCC was initially supported by members from the United States. This has started to change. Chapters in Europe (55 members) and Japan (40 members) have now formed and the first Supply Chain world conference in Europe is scheduled for September 1999.

This section will provide an overview to the model. It is based upon the SCOR Model Overview presentation presented at each of the Supply Chain world conferences as well as a SCOR Model Overview published, and distributed to all council members.

This section will explain the basic functionality of the model. The SCC presents a SCOR workshop to explain the proper use of the model. The Department of Industrial Engineering at the University of Stellenbosch has also developed a tutorial (see Appendix C) that can be used to understand the model.

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This tutorial is based on the SCC workshop and uses material that has been adapted from this workshop. The model has been customized for the South African context, although it is still applicable to any environment. It is recommended that the reader study this tutorial before using the SCOR model.

5.1 The Uses of SCOR

The opening statement of this chapter described SCOR as a "process reference model designed for effective communication among Supply Chain partners" (Supply Chain Council, 1999b:24). This illustrates that the model has three dimensions: it is used to describe, measure and evaluate.

The model is used to describe virtually any Supply Chain, using standard process definitions. Standard SCOR metrics enable the easy measurement and benchmarking of the Supply Chain's performance. This makes the model a useful tool in configuring and reconfiguring a company's Supply Chain.

5.2 What is a Process Reference Model?

"Process reference models integrate the well-known concepts of business process reengineering, benchmarking and process measurement into a cross-functional framework" (Supply Chain Council, 1999b:2).

The process reference model, once complete contains standard descriptions of management processes,

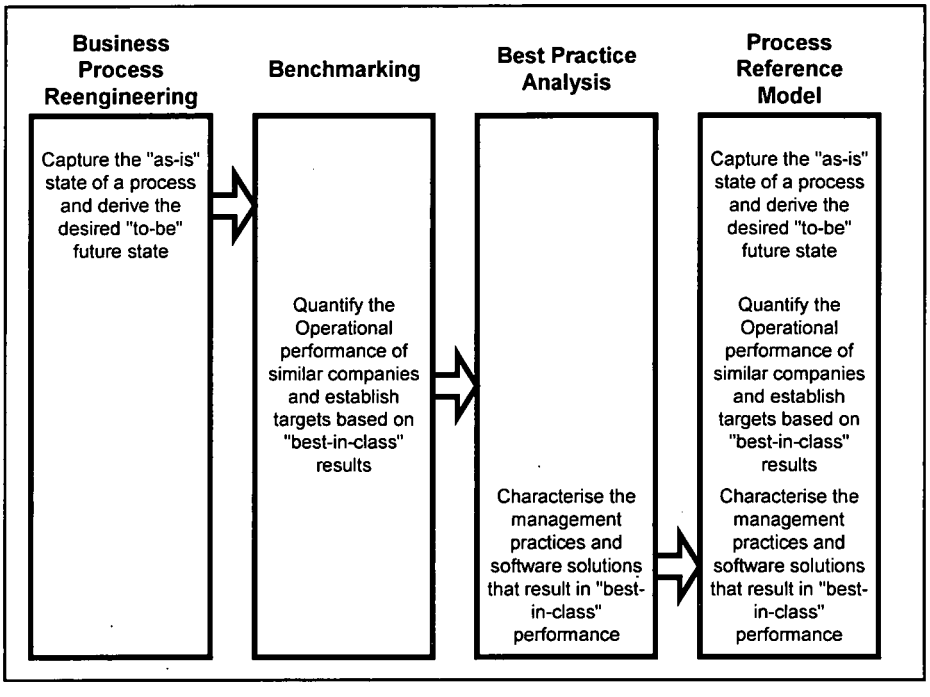

Figure 10: Process Reference Model

(Supply Chain Council, 1999b:2)

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a framework of relationships among standard processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and standard alignment to software features and functionality.

This is also a high level description of the outputs of a complete SCOR implementation. These are however only the tangible outputs. A great benefit of using such a model, is in fact the process of creating your own model. Creating the model requires an understanding of the processes being modeled, an understanding that the practitioner may have had before, but not in the detail that is required to efficiently manage those processes.

5.3 Boundaries of the SCOR Model

The principles and techniques described by the field of Supply Chain Management are not complex, in fact, they seem rather obvious and intuitive. The problem arises when implementing these ideas. The environment in which it is applied is filled with complexities and interdependencies. A small change at one point may have an effect on a later process.

With these complexities in mind, the SCC has set boundaries to their model. The most important function of the model is that it must be able to describe the entire Supply Chain, from the supplier's supplier, to the customer's customer. The SCOR model spans:

- All customer interactions, from order entry through paid invoice
- All physical material transactions, from the supplier's supplier to your customer's customer, including: equipment, supplies, spare parts, bulk product, software, etc.
- All market interactions, from understanding of aggregate demand to the fulfillment of each order.

SCOR does not include:

- Sales administration processes
- Technology development processes
- Product and proces design and development processes
- Post-delivery customer support operations including technical support processes (SCC, 1999b:4)

Links to processes not included in the scope of the model, like product development, are noted within the model. The SCOR model is based on four distinct management processes. These processes are plan, source, make and deliver. All decisions made within the Supply Chain are aggregated to one of these processes. Some models have added more processes, for instance a store process. In the SCOR model the store function has been included with the deliver process. The number of aggregations are

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not important. It is more important for the model to be able to explain and represent a Supply Chain, and this is possible with the four processes as defined.

The various model processes will now be discussed in more detail.

5.3.1 The Scope of the SCOR Processes

The Plan process is used to describe demand and supply planning. It is defined as the "Processes that balance aggregate demand and supply to develop a course of action which best meets the established business rules" (SCC, 1999b:8). The planning here refers to daily operational planning as well as long term strategic planning. Operational planning decisions include: the assessment of supply resources, aggregation and prioritization of demand requirements, planning of inventory, distribution requirements, production, material, and rough-cut capacity for all products and all channels. Strategic decisions described by the Plan process are: make/buy decisions, Supply Chain configuration, long term capacity and resource planning, business planning, product phase-in/phase-out, manufacturing ramp-up, and end-of-life management, product-line management. The process also describes the management of the planning infrastructure. The Infrastructure elements are those elements that are needed to support the various processes, in this case planning processes. The Plan process is the process used most often in designing and managing the Supply Chain.

The Source processes are used to describe sourcing or material acquisition. It is defined as "Processes that procure goods and services to meet planned or actual demand" (SCC, 1999b:8). The sourcing operations described how to obtain, receive, inspect, hold, and issue material. As with the Plan process, the Source process also describes the management of the source Infrastructure element. The Source Infrastructure describes vendor certification and feedback, sourcing quality, in-bound freight, component engineering, vendor contracts, and the initiation of vendor payments.

The Make process describes production execution. It is defined as "Processes that transform goods to a finished state to meet planned or actual demand" (SCC, 1999b:8). The Make process is used to describe the elements of: request and receive material, manufacture and test products, package, hold and/or release products. The Make process also has Infrastructure elements. These elements are: engineering changes, facilities and equipment, production status, production quality, shop scheduling or sequencing, and short-term capacity.

The final process, the Deliver process describes order management, warehouse management and transportation and installation management. It is defined as "Processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management, and distribution management" (SCC, 1999b:8). Elements relating to order management include: enter and maintain orders, generate quotations, configure product, create and maintain customer database, manage allocations, maintain product or price database, manage accounts

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receivable, credits, collections and invoicing. The Warehouse management elements include: pick, pack and configure products, create customer specific packaging or labeling, consolidate orders, ship products. Transportation and installation management elements are divided into the elements needed to get the product to the customer premises, and then to actually install the product at this premises. These elements are: manage traffic, manage freight, manage product import/export, schedule installation activities, perform installation and verify performance. The Infrastructure elements for the deliver process describe the management of: channel business rules, order rules, delivery inventories, and delivery quantity.

5.4 The SCOR Model Structure

The SCOR model is divided into 3 levels of detail (see Figure 11). In the previous section, reference was made to the SCOR processes: Plan, Source, Make and Deliver. Reference was also made to the process elements; which are elements that make up a process. The processes and process elements all fit in different levels in the model. These levels will now be discussed in more detail.

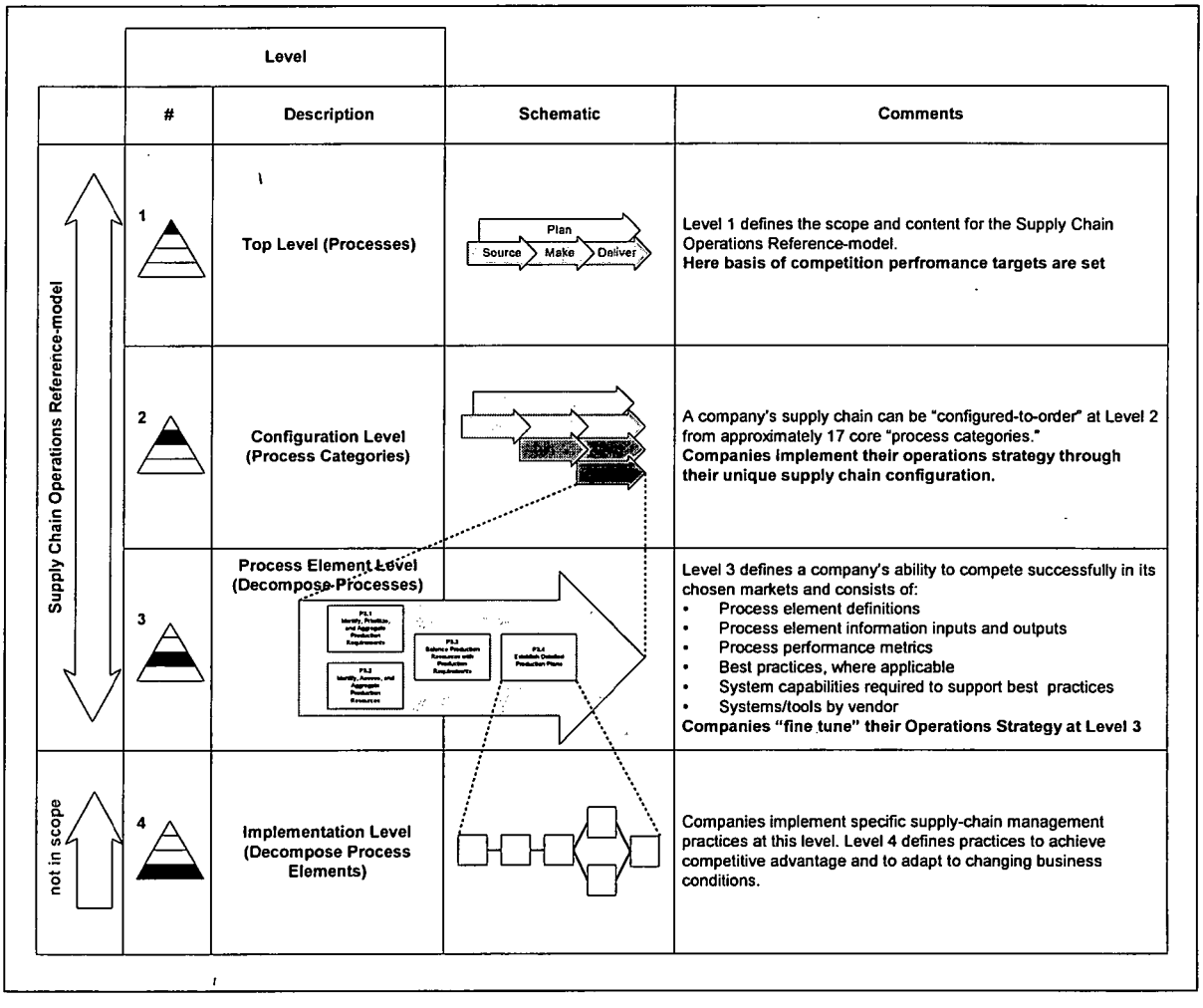

Figure 11: SCOR Model Structure

(Supply Chain Council, 1999a:14)

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5.4.1 Top Level (Level 1)

Level one defines the scope and content for the SCOR model. This is done by grouping processes into one of 4 categories: plan, source, make, or deliver. Definitions for each of these processes were given in section 5.3.1. The outputs of the top level are the global performance metrics for the Supply Chain. These metrics are the metrics that the company sees as important for their Supply Chain. It is important to note that the metrics have not been assigned or attributed to any process or function. These are simply global metrics (see Figure 12).

5.4.2 Configuration Level (Level 2)

In level one, processes were categorized into one of four processes. In level two, each of these processes is further described in three dimensions, called process types. The three process types are planning, execution, and infrastructure.

Planning is defined as "a process that aligns expected resources to meet expected demand requirements" (SCC, 1999b:9). The planning processes balance aggregated demand and supply, consider consistent planning horizon, occur at regular, periodic intervals, and can contribute to the Supply Chain response time.

Execution is defined as "a process triggered by planned or actual demand that changes the state of material goods" (SCC, 1999b:9). The execution processes generally involve scheduling or sequencing, transforming goods, and moving goods to the next process. The execution processes can contribute to the order fulfillment cycle time.

	Customer-Facing		Internal-Facing	
SCOR Level 1 Supply Chain Management	Delivery Performance/ Quality	Flexibility & Responsiveness	Cost	Assets
Delivery performance	✓			
Order fulfillment performance	✓			
Fill rate				
Perfect order fulfillment				
Order fulfillment lead time	✓			
Supply chain response time		✓		
Production flexibility		✓		
Total logistics management cost			✓	
Value-added productivity			✓	
Warranty cost of returns processing cost			✓	
Cash-to-cash cycle time				✓
Inventory days of supply				✓
Asset turns				✓

Figure 12: Level 1 Performance Metrics

(Supply Chain Council, 1999b:9)

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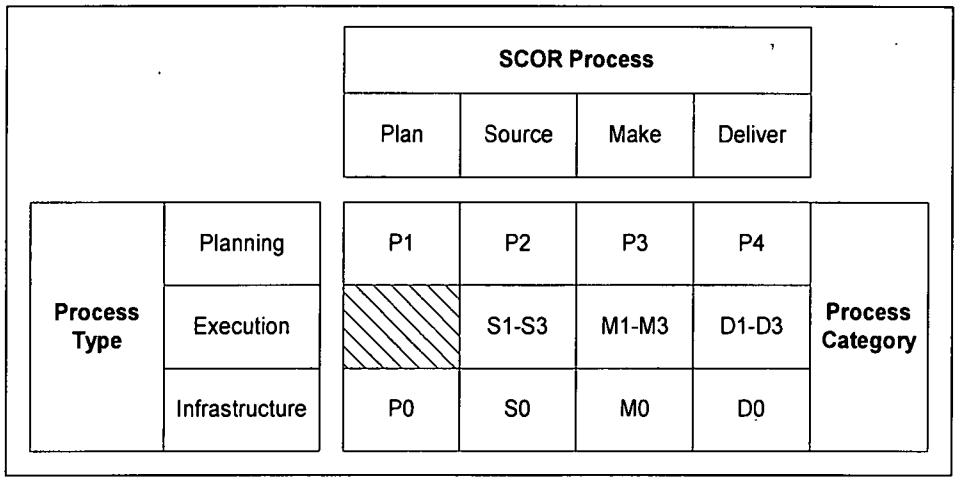

Figure 13: SCOR "Configuration" Toolkit

(Supply Chain Council, 1999b:8)

Infrastructure is defined as "a process that prepares, maintains, or manages information or relationships on which planning and execution processes rely."

Figure 13 shows the relationships of the processes and process types. The result is the process categories. The process categories are used as building blocks to map and configure their Supply Chains. There are 17 process categories in total. Figure 13 shows the numbering convention used in the model. All Plan processes are assigned the label *P*, source processes are assigned a label *S*, Make processes *M* and lastly Deliver processes are labeled *D*. Each of these groups consist out of a number of process categories, hence the numerical suffix to each process label. The S1 –Source Stocked Product process element will be discussed as an example in section 5.4.3.

To illustrate the use of these categories, consider a scenario were a Company A is supplying products

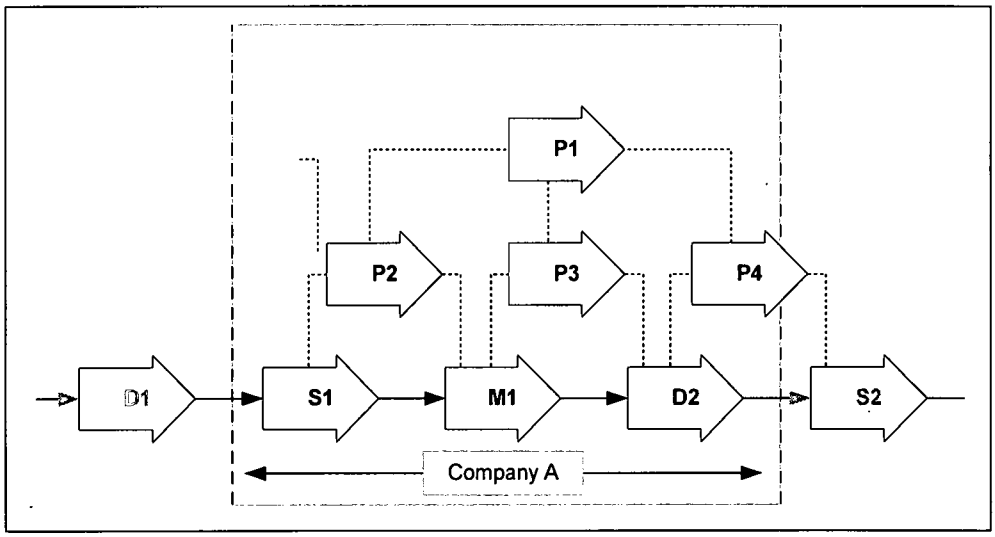

Figure 14: Supply Chain Example – *Company A*

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to a distributor. The company has a policy of only purchasing standard components that are freely available. The customer has a number of choices in configuring the product. The company manufactures the product according to this order. Figure 14 shows the SCOR representation of the scenario just described.

This now provides a departure point for analyzing and reconfiguring the Supply Chain if the company finds that the Supply Chain is not performing as desired, or even when searching for areas for improvement.

5.4.3 Process Element Level (Level 3)

The next step is the process element level. Here the process category defined in level two is decomposed. This level consists out of process element definitions, process element information inputs and outputs, process performance metrics, best practices (where applicable), system capabilities required to support best practices, and systems or tools. Each of these items have been defined for each element. An element is a sub component of a process category (discussed in section 5.4.2). Figure 15 shows the level three S1: Source stocked material process category. The diagram shows each of the process elements performed in this category. It also shows the process flow (sequence of elements), the inputs, and the outputs to the elements.

Figure 16 shows the process element definition, and performance metrics. These metrics are not necessarily applicable for the context it is used in, they are simply the suggested metrics. The final choice of metrics is left to the discretion of the user of the tool. Figure 16 also shows the recommended best practices and software features for the specific element. As with the metrics, these best practices and software features are simply suggestions, the final choice is left to the user.

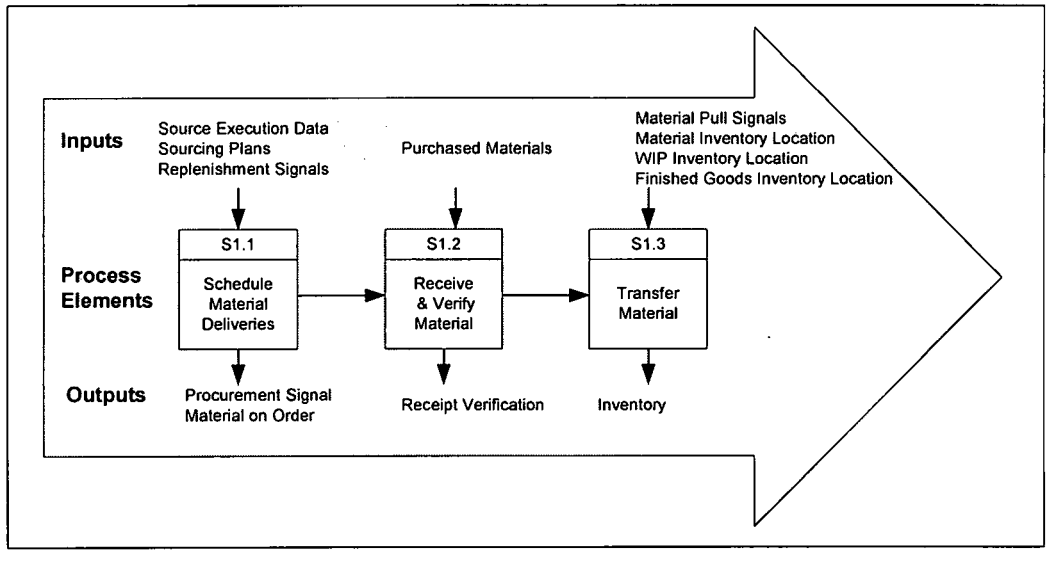

Figure 15: Level 3 Example - *S1 Source Stocked Product*

(Supply Chain Council, 1998)

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Process Element: Schedule Material Deliveries — Process Number: S1.1

Process Element Definition

Scheduling and managing the execution of the individual deliveries of material against an existing contract or purchase order. The requirements for material releases are determined based on the detailed sourcing plan or other types of material pull signals.

Performance Attributes	Metric
Cycle Time	Total Source Lead Time
Cost	Materials management as a % of Material Acquisition Costs
Service Quality	% Deffective
Assets	Raw Materials Days of Supply (DOS)

Best Practices	Software Features Required
Utilise EDI transactions to reduce cycle time and costs	EDI interface for 830, 850, 856, and 862 transactions.
VMI agreements allow suppliers to manage (replenish) inventory	Vendor managed inventories with scheduling interfaces to external vendor systems
Mechanical (Kanban) pull signals are used to notify suppliers of the need to deliver material	Electronic Kanban support
Consignment agreements are used to reduce assets and cycle time while increasing the availability of critical items	Consignment inventory management
Advanced ship notices allow for tight synchronisation between source and make processes	Blanket order support with scheduling interfaces to external vendor systems

Figure 16: Element Definition, Standard Performance Metrics, Best Practices, and Software Features
(Supply Chain Council, 1998:42)

5.4.4 Implementation Level (Level 4)

The implementation level is not in the scope of the model. At this point the person using the model will start to look into the actual processes involved in completing the process elements described in the previous level. It now becomes a reengineering exercise, with the focus on describing and improving that specific process element.

5.5 Overview

This section introduced the SCOR model. It was shown that the model allows the user to represent the entire Supply Chain in a standardized form. It also provides guidelines regarding best practices, metrics, etc.

It was shown that the model has the ability to describe the Supply Chain in various levels of detail and also aggregating the detailed levels back to a global view of the chain. It is the author's opinion that this, coupled with the ability to move through the model horizontally is what makes the model of great value to anyone working with the Supply Chain of any company.

This chapter did not attempt to suggest how the model should be used, the aim was rather to explain each of the dimensions of the model. There is in fact no "correct method" for using the SCOR model.

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The Supply Chain Council does have suggestions in using the model, but these are simply suggestions. In fact, various lecturers presenting the SCOR workshop have different ways of applying the model. Any method is acceptable, as long as it can fulfill the needs of the users of the tool.

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Chapter 6

The Telecommunications Industry Overview

The chapters leading to this chapter have discussed Supply Chain Management and how it fits into the company. This thesis will focus on the development of a Supply Chain Operations Reference model for the telecommunications industry. As the telecommunications industry is not traditionally associated with concepts like Supply Chain Management, it is necessary to analyze the nature of the industry in detail. This will be the objective of the next two chapters.

This chapter will start by considering the telecommunications company, discussing two models of such a company and describing the various functions of this type of company. The chapter also considers the nature of the business of a telecommunications company by considering the concept of a value network. Finally, the domain of this thesis is discussed. The operations reference model that is developed is intended for a specific domain within the company. This is not to say that there are not other chains within the company. The thesis will however be limited to showing the application of the model to a specified domain.

6.1 Network-based Companies and Value Networks

In considering the telecommunications company, it is necessary to determine if the company does in fact have a Supply Chain. In determining the Supply Chain, the approach was to first determine the value chain of the company. The reason for searching for the value chain (and hence the value adding activities) of the company was that industry has come to use the concepts, Supply Chain and value chains inter-changeably.

Although this intuitively feels incorrect, there is no way to prove that this is in fact not true, neither would there be any value in proving this within this thesis. The goal was thus to find a value chain within the telecommunications industry. Finding the value chain would then imply that there might be a Supply Chain.

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A model that identified and described the value adding activities of a telecommunications company (or the telecommunications industry) was the network based business model. "Network-based businesses are those that deliver a significant portion of their value to their customers by transporting people, goods, or information from any entry point on a network to any exit point. These businesses can be categorized by the degree to which their value to customers resides in the network or in the individual outlets" (Coyne and Dye, 1998:99).

From this description it is clear that a telecommunications company is a network-based organization. Figure 17 shows the spectrum of network-based businesses.

Stabell and Fjeldstad (1998) present the concept of value network. "Value networks...rely on a mediating technology who are or wish to be interdependent" (Stabell et al., 1998).

From this it is seen that part of the value adding activity of a network-based business is the provision of a network. Stabell et. al. (1998) suggests three primary activities of the value network. These three activities are:

- "Network promotion and contract management consists of activities associated with inviting potential customers to join the network.
- Service provisioning consists of activities associated with establishing, maintaining, and terminating links between customers and billing for value received.
- Network infrastructure operation consists of activities associated with maintaining and running a physical information infrastructure."

With this in mind, this thesis will focus on the second activity mentioned: the assumption is thus that there is a Supply Chain within the activity of providing a network. This statement will be explored in the sections that follows.

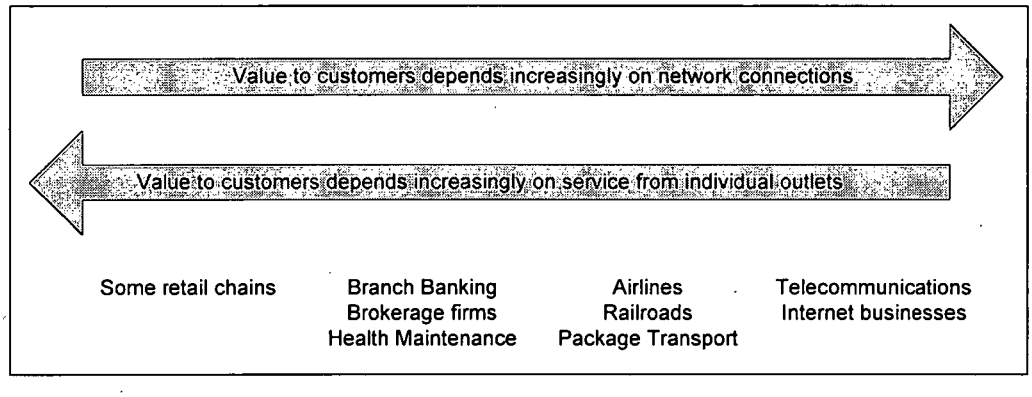

Figure 17: Spectrum of Network-Based Businesses

(Coyne et al. 1998:99)

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6.2 The Telecommunications Value Chain

The previous section described the nature of the business of a telecommunications company. The following two sections will consider the functions performed by the telecommunications company. The functions performed by a telecommunications company to is not only to provide a service to their customers, but also to survive. This section will consider the organization as a whole and discuss the organization by considering the various functions of the entire organization. The next section will focus on the life cycle of a service (or product) and consider the stages that it undergoes in its life cycle.

In describing the steps to building a data warehouse for a telecommunications company, Mattison (1997) proposes the value chain as seen in Figure 18. Each of these value-adding activities will be described in more detail followed by a discussion of the value chain.

1. Creation (new product development and exploitation): This activity describes the activities that companies perform to develop new products and secure new market segments
2. Acquisition (acquiring the "right" to do business): Companies need not have the creation activities. These are usually found in smaller firms attempting to capture markets with new innovative ideas (it must be said that AT&T must be the exception to the rule here). "The one thing that telecommunications companies must do, however, before anything else, is to acquire the right to service certain geographical or legal areas and work to maintain that right" (Mattison, 1997:54).
3. Network infrastructure planning and development (creating the "phone system"): This activity describes the actual constructing of the network, done by planning and installation processes.
4. Network infrastructure maintenance (maintaining the "phone system"): Once the system is up and running, it needs to stay that way for the remainder of its lifetime.
5. Provisioning (setting up customer services): This is the activity of setting up the customer's profile. It is also this area that is receiving allot of attention in terms of automation. Here the models of the TeleManagement Forum are most applicable (discussed in a later section).
6. Activation (activating customer services): This activity is the actual activation of the line, in contrast to the previous activity of simply setting up the line, here again the models of the TeleManagement Forum become very important in automating the process.
7. Service Order Processing: "In some large telecommunications companies the processes of activation, provisioning and network maintenance become such a large and complicated set of tasks that a special form, called the service order, is created. The service order becomes the standardized form that documents and drives the process of getting work done" (Mattison, 1997:58).
8. Billing (tracking service and invoicing the customer): The billing function is seen as the most critical activity, secondary only to the actual service to the customer. This activity relies on all the

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foregoing functions. In the development of an information system, Mattison (1997:58) has the following to say about the billing system: "There is no telecommunications company in existence that does not have at the heart of its operation a large, complex billing system, and this system usually serves as the main source of information for all other business side processes and people."

9. Marketing (identifying prospects/channels, advertising): Marketing is an important function, and even more so when competition is involved.
10. Credit Management: Although this can be seen as a subset of the finance activity, this function is so important in some companies, that it actually has to be seen as an entity on its own.
11. Customer Service (keeping the customer happy): The importance of customer service is important in any business, but may even be more so for a telecommunications company as they are in essence selling a service and nothing else.
12. Operations (network and business): this refers to umbrella groups, combining some of the functions already discussed.
13. Sales (establish and maintaining customer relationships): Here the idea that keeping a customer, costs less than recruiting a new one applies. Heskett et al (1997) propose that the costs associated with converting non-customers to customers may be five times as high as the costs associated with improving customer relationships with existing customers.

In considering all these functions, it is clear that some activities are not that important to deserve special attention as is done here, these include activities like operations, credit management, sales and service order processing. This is not to say that they are not important, they could rather be considered as part of the other activities.

This value chain has more value as an indicator of all the components that make up the telecommunications company. The use of a value chain here, is misleading as it may imply that these activities occur sequentially, while they do not. The following section will elaborate on this.

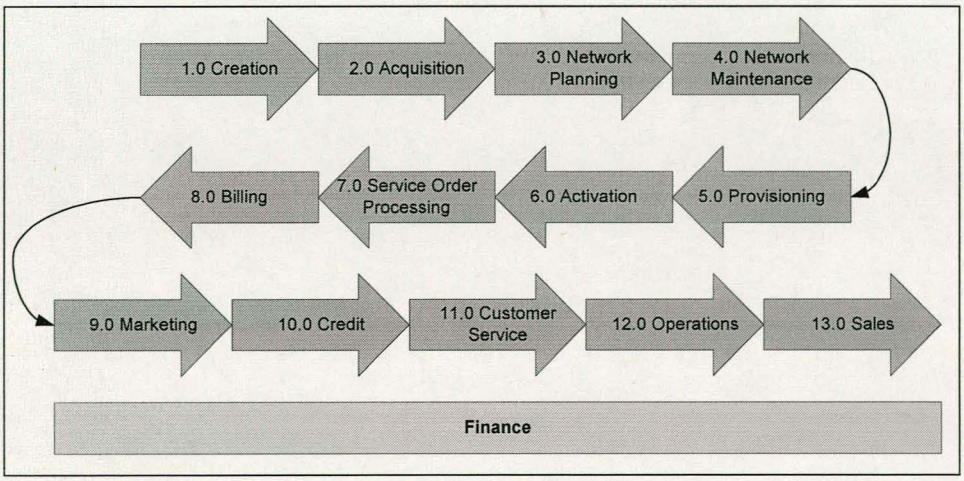

Figure 18: Telecommunications Value Chain

(Mattison, 1997:63)

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The value of considering this model is that it gives a complete picture of all the dimensions of a telecommunications company.

6.3 Service Life Cycle

Ward (1998) considers the different stages that a service within a telecommunications company goes through. The model proposed by Ward can be elaborated upon by adding a dissolution stage.

The dissolution stage is added, as every product or service will be replaced at some point in time. It has now become essential to keep this in mind when planning and installing any service within a company.

This model uses similar terms and names as Figure 18, although they are in fact used slightly different. It is thus necessary to discuss each process again.

1. Sales/acquisition addresses all activities involved in acquiring new customers and new business
2. Order entry/order handling are tasks associated with processing a customer request for service into a firm order.
3. Provisioning describes all the design and layout work related to implementing a new service.
4. "Installation incorporates all the physical work associated with installing and activating the service to the customer location, as well as any work performed remotely or in advance of the actual service turn-up" (Ward, 1998:99).
5. Billing encompasses all activities to generate a customer invoice.
6. Network management and trouble handling describes all activities that maintain the network and ensures that the network meets the standards placed upon it.
7. Fulfillment includes any post sale and post installation customer activities, such as training, etc.
8. Dissolution describes the activities associated with recovering the service from operation and disposing of the equipment used.

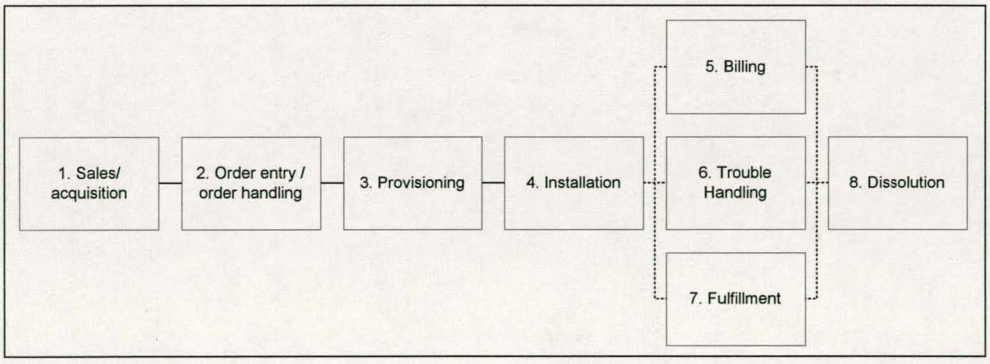

Figure 19: Service Life Cycle

(adapted from Ward, 1998. p104)

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This model introduces a few new concepts. The previous could be seen as all activities that take place within the telecommunications company. The model presented in Figure 19 focuses on the service (or product) itself. The concept of the parallel processes is also very important. This will become more apparent when in the discussions that follow.

It should be said now that the Supply Chain of the telecommunications company lies within its installation process. The definition given for the installation process should be understood, as it is the basis for the sections that follow. The value of Figure 18 is that any functions not belonging to point 3, Network (infrastructure) Planning (and installation) are beyond the scope of this thesis.

6.4 Setting the Boundaries for this Project

"Installation incorporates all the physical work associated with installing and activating the service to the customer location, as well as any work performed remotely or in advance of the actual service turn-up" (Ward, 1998:99).

To better illustrate this definition, it is useful to consider it in terms of a manufacturing company, using the terms *make to stock* and *make to order*.

Make to stock products are intended to be shipped from finished goods or "off the shelf", are completed prior to receipt of a customer order, and are generally produced in accordance with a sales forecast (SCC, 1998:1).

A *make to order* environment is one in which products are completed after receipt of a customer order and are built or configured only in response to a customer order (SCC, 1998:1).

The provision of service to the customer can be seen as a *make to order* environment. The company cannot provide a service that the customer does not demand. This process is not that simple however. The manufacturing (construction) project times of the telecommunications infrastructure is of such a nature that it cannot create a service on the demand of the customer. An exchange or any service for that matter is not installed overnight. For this reason the company must build capacity. When the customer then requires a service, the service is provided from this capacity. This can be seen as a *make to stock* environment followed by a *make to order* environment (see Figure 20).

The domain of this thesis is the make to stock portion of the installation. Translating this into a telecommunications network, this thesis will consider all activities that provide network capacity. Customers are then given service from this network in the form of lines from the exchange, or cell phones from a cellular tower. These activities are beyond the scope of this study, although they too may well be modeled using the model being developed.

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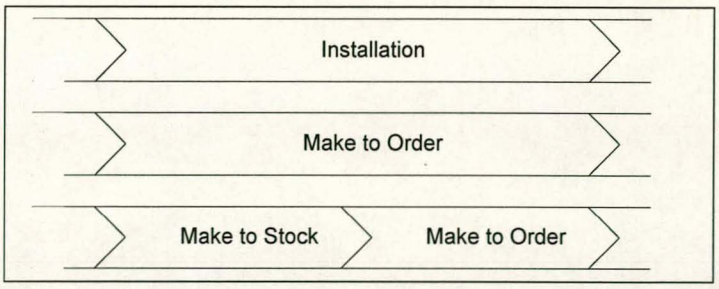

Figure 20: Nature of the Installation Process

The focus of this study is to describe the building of capacity (by developing a model that will be able to describe it). Although it was shown that the function has been described as a make to stock environment in terms of the final customer (person receiving service), this thesis will consider a different customer. The customer now becomes the person ordering the work on the network. The customer is now someone within the company that has identified areas for improvement in the current network. With the customer defined in this context, the building of capacity now becomes a make to order process.

6.5 Other Supply Chains

It must be questioned why boundaries are put on the model in the first place. It is the author's opinion that it would be possible to model the other processes of the telecommunications company, but that they would be better modeled by using a more appropriate model than Supply Chains. It has already been illustrated (in Figure 19) that the billing, maintenance and fulfillment processes run concurrently when the service is in its operational stage of its life cycle. A Supply Chain would not be able to capture this complex concurrent interaction of the processes. These processes that interact concurrently can be seen as infostructure. "Infostructure deals with information – the elements, the structure, and the process by which that information is handled" (Ward, 1998). Infrastructure in turn deals with the physical network. Models have been created to model the infostructure of telecommunications companies. These models are created by the TeleManagement Forum. Figure 21 shows the processes covered by the forum and also how they are related. Complex flow diagrams have been set up for all processes within a telecommunications company. These diagrams are then used to firstly document, but also eventually automate the processes.

Other functions like the access network (the network elements from the exchange to the customers premises) may also be modeled by the proposed model (the make to order portion of Figure 20). This is, however, not part of this thesis. The focus here is to show that the model is applicable to the installation of the network up to the exchange (building of capacity or make to stock portion of Figure 20).

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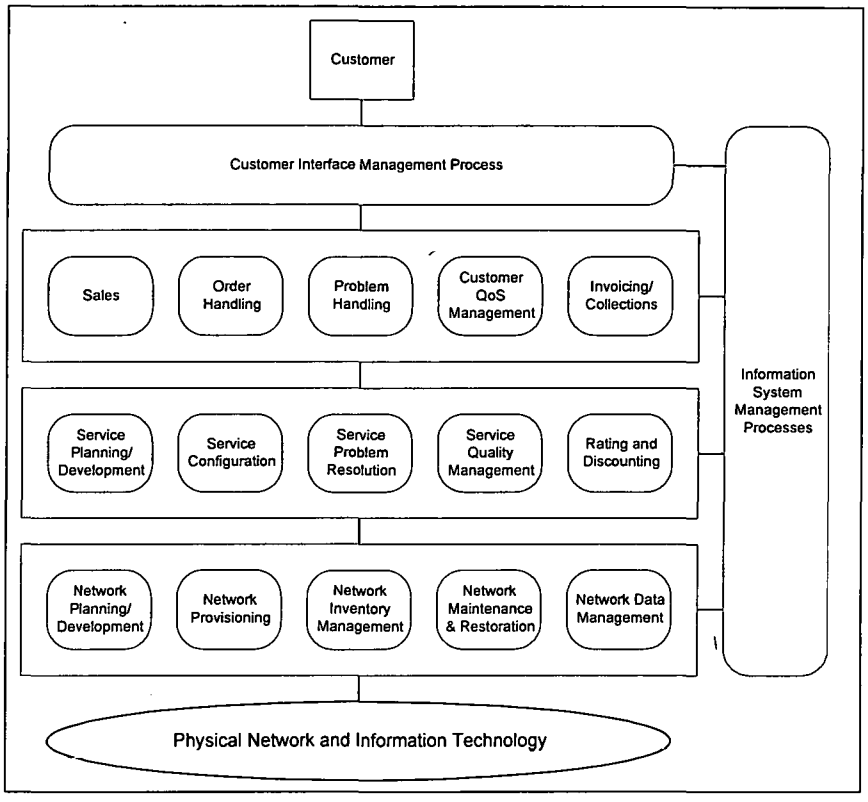

Figure 21: Telecom Operations Map

(TeleManagement Forum, 1999:15)

Another function that has a Supply Chain, is the maintenance function. The maintenance function would require equipment to replace the faulty equipment. This is not modeled in this case, as the question here would not be how inventory or the flow thereof is managed, but rather, how much is needed to keep the network running within acceptable levels of quality of service. The challenge here is to use techniques like simulation to determine inventory levels rather than considering the Supply Chain.

6.6 Conclusions

This section has shown that many activities in the telecommunications company are moving toward automation. The provision of infrastructure is still an element that cannot be automated. It will always remain important.

There is very little literature to suggest that telecommunications companies in other countries are looking into their Supply Chains. This may be because most telecommunication companies are not trying to expand their networks at the rate that the South African industry is attempting to. This is not to say that there aren't countries rapidly expanding their networks, but the situations in these countries may be different.

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This chapter has given an overview of the telecommunications industry from which the domain of the thesis has been defined. With the domain defined, it is necessary to describe the environment in which these systems operate. This is done by considering the South African telecommunications industry. This analysis of the environment is done in the following chapter.

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Chapter 7

The South African Telecommunications Industry Overview

The previous chapter focused on the telecommunications company and eventually defined the domain of this thesis. This chapter will describe the state of the telecommunications industry within South Africa. This is necessary for two reasons:

The telecommunications industry has seen some major changes over the past few years. Technology is changing the market at dramatic rates, the biggest driver of change being the merger or narrowing of the boundaries between data and voice communications. South Africa has also gone through changes in terms of regulation. The country's sole telecommunications provider has gained two strategic equity partners, in the form of Southern Bell Communications and Telekom Malaysia. The market is currently highly regulated with Telkom as the sole telecommunications provider, but this is set to change by the year 2002 when competition will be allowed into the market.

The industry has also seen the introduction of two cellular providers in the form of Vodacom and MTN and there are talks of a third cellular service provider license being awarded by December 1999.

The effect of these changes is that the industry is in a state of transition. To describe any situation within this project as the set practices and daily routine would be wrong. The situations described here are snap shots of the industry as it is migrating from the "As-Is" to its "To-Be" state. It is thus necessary to describe where the industry has come from, and also where it will be within the next five years.

The second reason for describing the industry is to show the value of considering the Supply Chain of the telecommunications company. There is very little use in identifying, designing, and managing a Supply Chain if the company could achieve better performance results by investing the same amount of time and energy in an other area. The value of Supply Chain Management to a telecommunications company within South Africa should be illustrated.

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The discussion of the telecommunications industry will be done by partially using Porter's (1980:4) framework describing the five forces driving industry competition. These forces are potential entrants, industry competitors, suppliers, buyers and substitutes (see Figure 22).

The model is by no means used here as the best model for describing the industry. The idea is rather to describe a topic as complex and large as the telecommunications industry, using a structured framework. The discussions will consider only the "new entrants" dimension of the model, as this is the main driver of change to the South African telecommunications industry.

The chapter will be concluded with a brief look at the value of pursuing Supply Chain Management within the industry just described.

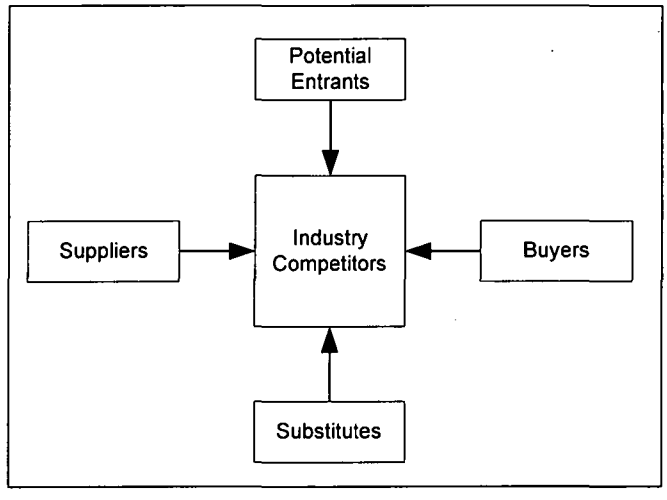

Figure 22: Forces Driving Industry Competition

(Porter, 1980:4)

7.1 Potential Entrants

"New entrants to an industry bring new capacity, the desire to gain market share, and often substantial resources. Prices can be bid down or incumbents' cost inflated as a result, reducing profitability. Companies diversifying through acquisition into an industry from, other markets often use their resources to cause a shake-up, ... Thus acquisition into an industry with intent to build market position should probably be viewed as entry even though no entirely new entity is created. The threat of entry into an industry depends on the barriers to entry that are present, coupled with the reaction from existing competitors that the entrant can expect. If barriers are high and/or the newcomer can expect sharp retaliation from entrenched competitors, the threat of entry is low" (Porter, 1980).

Although written in 1980 and for any industry in general, this piece can almost be seen as prophetic for the South African telecommunications industry. All these issues have or are likely to take place within the next few years.

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Porter suggests six major barriers to entry. These barriers to entry will now be discussed in more detail for the South African telecommunications industry.

Economies of Scale

Economies of scale refer to the decline in unit cost of a product as the absolute volume increases. The threat of economy of scale is traditionally that an entrant may come in at a great risk as the established companies produce large volumes of products, allowing them to produce products at lower prices.

The telecommunications industry in South Africa has the exact reverse of this scenario. It is true that a network has to be provided regardless of whether the company has one or one thousand customers. The cost of building a network is thus fixed. The greater the utilization of the available capacity, the less the fixed cost per customer. This is consistent with the views of economies of scale.

Consider the situation of a large capacity network between two cities. The only additional cost per customer is the connection to the network "hubs" in each of the cities. This can be broken down even further: a company may run a network only between two office complexes. The cost of a connection to the "hub" is even less. Now consider this type of network and the person in the rural regions. To connect these remote customers requires long runs of cable and equipment, as the population density is much less than in the office complexes for example. This makes connecting only certain customers much more profitable.

The nature of these customers is also a problem. The corporate customer in general, generates a higher revenue than the customer in the rural area. The result is that the corporate customer is a much more profitable customer, as the connection cost is lower and the revenue generated is higher.

New entrants to the market will in all likelihood focus on these customers, and ignore the non-profitable customers. This would mean that the majority of South Africa will not receive telecommunications services, a promise that the current government has made to its voters. The result is a regulated market. The South African Telecommunications Regulatory Authority (SATRA) is in charge of regulating and controlling the current telecommunications industry. As part of Telkom's right to a period of exclusivity, Telkom has to provide service to all segments of the country.

The result is a high cost of installation. The company is in essence cross subsidizing the installation of new services. Money generated from profitable customers is used to fund the installations to non-profitable customers. The Financial Mail (Bidoli, 1999c:67) quotes the figure of an average installation cost of $1500 per line for the African market. The result is that many customers are simply not profitable. Telkom has had great problems in bringing down this cost, and Supply Chain Management may be one approach to achieving this.

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Product Differentiation

Product differentiation refers to organizations that capture markets not only by providing superior products, but also by the name that they have built for themselves as a quality manufacturer or service provider. The idea of product differentiation will be discussed in a different context here. The discussion will focus on economy of scope.

"Economies of scope relates to the cost saving derived from manufacturing a variety of products" (Dornier, 1998:252). Although this is aimed at the manufacturing company, the same can be said for providing a variety of services to customers. Customers may switch to alternative providers if the service that they offer is better, or more suited to their needs.

The telecommunications industry has gone through a revolution in terms of the services that it can offer, with the introduction of concepts like data networks, internet, etc. Traditionally, the telecommunications network was used to transfer voice traffic. Equipment like facsimile machines and modems have been used to transfer data over a voice network, but the drive is now to have a digital network entirely. This is simply because of a shift of importance. In the past, data traffic had been negligible when compared to voice traffic, resulting in data traffic that was simply transferred over the voice network. The opposite is now true (see Figure 23).

The question must now be: What about voice communications? The answer is that voice is simply another form of data that can be transmitted over the data network. A great deal of Telkom's network upgrading and expansion efforts has been to establish this digital network, capable of providing customers with digital as well as voice services.

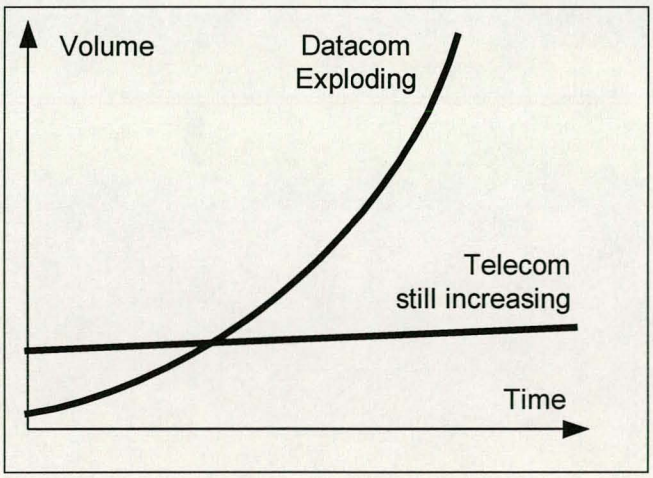

Figure 23: Data and Telephone Traffic Volumes

(Rockström and Zdebel, 1998:36)

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Capital Requirements

Capital requirements refers to the type of investment that has to be made in order to establish a business in the new market. In terms of the telecommunications company, this depends on the approach of the company. A company like Telkom, that is a fixed line operator, needs to build a physical network, requiring large amounts in capital. Any other company entering the industry with the intent on building a physical network will require great amounts of capital to compete with this scenario. Companies set to do this are the other parastatals like Eskom and Transnet. These companies have networks already established throughout the country by means of the power and rail lines. Research is going into using these networks for telecommunications networks.

A company may decide not to invest in a physical network, but rather use satellite technology for example. One service provider would set up a satellite station near a major city or business complex, and connect the subscribers to the satellite network, making the need for a fixed line network redundant. This will typically be the approach of the large multi-national companies entering the market, as these companies already have satellite networks established. They would simply enter the market, and with relatively low capital investment costs become service providers.

The negative side to this capturing of markets are the less profitable customers. Companies coming in will attempt to capture the market of only the profitable clients. Although these are sound business principles, it is questionable if it is best for the country as a whole.

Switching Costs

This is the cost incurred by switching from one provider's product to another. This is very important for the telecommunications industry. This is also something that cannot be answered at this point in time.

The problem is that changing of service provider would require a change in telephone number. Consider a person with a MTN contract. To move to say the Vodacom network would require that the person would have to change his or her number. In large companies this results in large losses as letterheads, business cards, advertisements, etc. all carry the company telephone number. Changing a number thus has many cost implications.

The solution proposed by the American Telecommunications Act of 1996 is number portability. Using this method a customer could keep his or her number, regardless of the network used. The solution is ideal, but the practical implementation is complex.

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Access to Distribution Channels

The access to distribution channels refers to the fact that established competitors may already have large faithful customers that will not want to use the facilities of a different network provider. This is not the case in the South African telecommunications industry. Recent market research by "BMI TechKnowledge shows that corporate customers do not perceive Telkom as quality provider" (Bidoli, 1999a:31). With this in mind, the company is set to loose a large section of the market when a second telecommunications provider is introduced to the industry.

Cost Disadvantages Independent of Scale

Cost disadvantages independent of scale are the advantages that the company enjoys, because it is familiar with the business and industry and enjoy superior knowledge to new entrants. The roles may be reversed in the case of the South African telecommunications industry.

Although Telkom is familiar with the country, it is not familiar with the concept of competition. The company has had the opportunity to provide a service to customers with inefficiencies in their network in the past, but in a competitive environment the organization may always change their service provider if the service quality does not meet their expectations.

To illustrate this lack of "competitive fitness", consider Telkom's performance in comparison to levels specified in the service level agreements set by SATRA in exchange for a period of exclusivity. The following paragraph is a comment on the performance with regard to these service level agreements.

"Telkom modernized a total of 518 105 existing lines during the period under review, an almost 40-fold improvement on the target of 13 000. In terms of new lines installed, Telkom added another 502 750 to its network against a target of 460 000 – effectively connecting over 1 370 new customers every day. We also took telecommunications services to communities in 920 villages, exceeding our license target of 610 by 50 percent" (Nxosana as cited by Singleton, 1999). Of the ten requirements set to the company, 2 were not met: "The two targets we missed related to the percentage of business and residential faults cleared in under 48 hours. We achieved an 85 percent and an 82 percent rating here respectively" (Nxosana as cited by Singleton, 1999). Telkom has already been fined R 3.3 million for not meeting its targets for the year ending 1998. Fines are still expected for not making its 1999 service level agreements (Die Burger:1999a).

In the paragraph above, the fines are very small when compared to the revenue generated by the company. The greatest loss is the image of the company in the eyes of the public. This gives the perception of a service provider that is incompetent. Supply Chain Management holds the potential to solve (or improve in) most of these problems.

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Government Policy

The last barrier to entry is a hot debate at this point. It has been said that Telkom has been given a period of exclusivity, provided they meet the service level agreements.

The industry has also seen attempts to try and bend the rules. Technologies like voice over the internet are gray areas and many court battles have been fought between Telkom and interim Value Added Network (VAN) providers over these issues. This adds to the image of a "bully" in the eyes of the public (Bidoli, 1999a).

The agreement made with Telkom is that no person may provide any telecommunication facilities over property boundaries. All facilities (across property boundaries) must be obtained from Telkom and no person may resell, sublet or share facilities. This leaves room for interpretation, and this is exactly what is happening (Telecommunicatons White Paper, 1995).

The biggest point of concern are the decisions that will be made with regards to introducing competition to the market. It has been indicated that issues like number portability are important and need to be addressed. Other issues include the number of providers to introduce to the market, will it be one, two or many? Will these newly introduced providers be obligated to provide services to the less profitable customers?

Much of the future of the network depends on the decisions made by SATRA. But with all these uncertainties it is clear that Telkom must continue with its strategy of building a network and providing services to as many customers as possible.

7.2 Conclusions

This chapter has considered the South African Telecommunications industry, and it was illustrated that the industry is faced with a number of changes in the near future.

The future is uncertain one for the current fixed line operator in South Africa, Telkom. The company does not have the trust of its customers as a high quality service provider. In response, Telkom has turned to improving their networks at large costs and at fast rates.

When any company has decided to grow, it must ensure at least three things:

- there is a demand for this sudden growth
- there is capital for this sudden growth
- there is enough resources for this sudden growth

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In considering these three criteria, the first one is the most controversial. Even with no demand, the company still has service level agreements to meet (set by SATRA). This means that there is no compromise on this first point. The reality is that their will always be a demand, but this is not to say that providing for the demand will be profitable.

The capital required for growth has been provided by the strategic equity partners in Telkom. The partners have expressed their commitment to making Telkom a world class telecommunications company by adopting the attitude that money is no object. Even with the availability of capital, it would be foolish to consider that the company is not concerned in spending this capital wisely.

The last point may be the greatest problem at the moment, there is either a shortage of equipment, or there are too few people to complete the work. This is confirmed by the long order lead times (that are not met by the suppliers) and the large amounts of overtime expenditures.

The last two points can definitely be improved by applying the techniques of Supply Chain design and Supply Chain Management. There is one last benefit to Supply Chain Management within any industry, but definitely to Telkom, which is very often overlooked. This is the issue of integration and communication. Focusing on the Supply Chain forces the company to consider the system as a whole and not the individual components.

As a last comment: the above discussion is not only applicable to Telkom. Any telecommunication company entering the South African market will have to build some form of network. Companies are now even setting their sites on other African markets. MTN and Vodacom have done this and there is no reason why Telkom will not follow. South Africa is in the ideal position to penetrate these markets (Bidoli, 1999d:66). In building these networks, this thesis becomes relevant as the tools presented in the chapters that follow present a structured approach to completing any installation within a telecommunications company.

The focus of the thesis from here onward, becomes more practical. The next chapter will consider some terminology that is essential for understanding the discussions that follow.

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Chapter 8

Terminology

The discussions up to now have dealt mainly with defining Supply Chain Management and discussing the telecommunications industry. The chapters that now follow use this theoretical platform to formulate a SCOR model for the telecommunications industry. This SCOR model will then be illustrated and evaluated by representing a Supply Chain within Telkom.

To complete the chapters that follow, some concepts and terminology have to be redefined. The motivation for this is not to create new concepts, but rather to point out certain concepts that may be foreign to any person not working within the telecommunications company, like parent and child projects or the network master plan. Furthermore, concepts as used in a traditional manufacturing organization are used to describe the business of a telecommunications company. It is necessary to redefine or "reframe" these concepts to become more sensible in the context that they are used.

This chapter is important if the telecommunications SCOR model is to be understood.

Revenue/Non-Revenue-Generating Assets

The fixed assets of a telecommunications company should be discussed. The company purchases equipment to provide services to its customers. These assets are usually purchased with the intent of using them for five to ten years. These are seen as fixed assets of the company: investments that the company makes now, in order to generate an income over the lifetime of the equipment. Of importance is the period of time that the asset is not generating an income. This is typically the time from the purchase of the asset, up to the point were it is generating an income. An asset that has been purchased and is not generating income is referred to as a non-revenue-generating asset.

The period that an asset is part of an installation can be seen as work in progress. Work in progress is also non-revenue-generating assets.

The period of time that an asset is a non-revenue generating asset is equivalent to the metric of cash-to-cash cycle in a traditional manufacturing company.

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The cash-to-cash cycle is discussed and illustrated in greater detail in the SCOR tutorial (Appendix C), but can be seen as the amount of time it takes from the purchase of raw material until those funds are returned. In the case of a telecommunications company, the revenue needed to recover the value of the equipment is so large that it would be of little value to measure this as it would typically take years. It is thus more sensible to measure the time until the asset starts to generate income.

The goal is to decrease the time that an asset is a non-revenue-generating asset.

Inventory

There are generally three types of items ordered within the telecommunications company (more specifically Telkom, but this is applicable to other telecommunications companies as well). The three types of items are catalogue items, non-catalogue items, and equipment.

Catalogue items are items that the entire company consumes daily (consumables). These include items like hand cleaner, toilet paper, mutton cloth, etc. They are ordered in bulk for the entire company and is distributed to a department that has very little stock of that item.

Non-catalogue items are hard to define, as they are simply the items that are not catalogue items and not equipment. Non-Catalogue items are items used within the company, that can be considered to be equipment but is not used exclusively by a telecommunications company. Non-Catalogue items are ordered, and are generally available in the regions. The process of ordering non-catalogue items is to contact a local buyer from the Telkom procurement department, who then orders from the local suppliers. If the items are not available in another region, the order is sent to head office. At this time it awaits approval. After approval it is shipped to the department. Conversations with employees have revealed that the wait for approval could typically take three to four weeks. These items are typically DC power boxes, cable, etc. and are considered to be assets.

Equipment is ordered from a list of authorized suppliers. The equipment is generally expensive and has large lead times (three to five months). These items are only produced to order and include switching equipment, transmission equipment, etc. These items are also considered to be assets.

Inventory can now be defined as catalogue items that have not been consumed and all non-revenue-generating assets. The general trend is to decrease the levels of inventory within the organization. Defining inventory in the way done here will mean that non-revenue-generating assets are not seen as fixed assets, but rather as an inventory, which should be decreased. The metric typically used here would be *inventory days of supply*. This metric should be distinguished from the metric previously mentioned, namely cash to cash cycle time. Cash to cash cycle time is the period from the point that the expense is made until it starts generating revenue (which is the definition in this thesis). Inventory

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days of supply are the number of days that inventory is carried. The two would differ if the buyer had a credit purchases contract with the supplier (which is typically the case). The ideal would be to have the equipment installed before it is paid for. There is no logic behind defining this as a performance standard, except that it would be a good performance standard to pursue and achieve.

With inventory defined, it is necessary to consider inventory in greater detail. Here the concepts of raw material inventory, work in progress inventory, and lastly finished goods inventory should be discussed in more detail.

Raw material inventory is considered to be any inventory (as defined within this thesis) that has not been issued or used within any project.

Work in progress inventory is any inventory that has been assigned to a project, of which the project is not complete.

Finished goods inventory is any inventory of which the project is complete, but is not operational yet. A project may be complete, but this is not to say that the entire project is complete. A project may consist out of a few smaller projects (children). When a child project is complete, but the other child projects are not, the items used in the entire project are inventory items. The completed child project is considered to have finished goods inventory.

Network Master Plan

To provide a coordinated effort in expanding and updating the telecommunications network infrastructure, Telkom draws up a network master plan. This is a plan of what installations to perform during the coming year.

In drawing up a master plan, a number of considerations need to be made:

- a future vision for the network
- problem areas within the current network
- installations to be performed within the following year
- traffic calculations, trends and forecasts for the coming years
- regional growth rates and new developments

With this in mind, the master plan is broken into identifiable projects, each with its own expected budget amount. This amount is a rough estimate of the project. The master plan is submitted by the end of December.

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Projects

Every installation in Telkom is considered to be a project. Some of these installations may require the services of more than one department. In this case, the entire project is referred to as a parent project. Each parent project in turn has a number of child projects.

In the case of the SDH installations (discussed in Chapter 10) the SDH installation is the parent project. To accomplish this installation, three departments are involved. These departments are part of three child projects. They all act in isolation to eventually make up a completed project.

Contingency Projects

The parent projects discussed in the previous section are initiated in one of two ways. The project can be part of a master plan project that has been identified well in advance, or it can be a contingency project.

A contingency project is any project not on the network master plan. These projects are initiated during the financial year as problems or requests arise. It could typically be because of problems in the network that have not been identified. Contingency projects are also initiated by customers of Telkom. These customers could be companies like Vodacom or MTN, requiring a network connection or the building of capacity between two points.

These projects have the potential to cause problems within Telkom at the moment. As already discussed, equipment typically have lead times of four to five months. The service level agreements with the Telkom customers are currently to fill an order within two months of that order. The result is that the equipment of master plan projects are taken and used for the contingency projects.

The result is that some projects are marooned or stranded without equipment. To meet their dead lines, equipment from other projects are taken, resulting in a snowball scenario.

8.2 Overview

With these concepts now described and clear, it is possible to consider the proposed telecommunications SCOR model (also see Appendix A). The following chapter will describe the major considerations in developing this model.

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Chapter 9

The Telecommunicatons Supply Chain Operations Reference Model

Previous chapters have considered either the concept of Supply Chain Management or the telecommunications industry. The previous chapter was used to define various terms and concepts as they are used within this thesis.

These chapters have provided the background to developing a Supply Chain Operations Reference (SCOR) model for the telecommunications industry (discussed within this chapter). It is assumed that the reader is fairly familiar with the SCOR model. It is also assumed that the reader understands the concept of Supply Chain Management and has insight into the issues of the telecommunications industry.

Before explaining the changes to the model, the reason for changing the model will first be explained. This will be followed by the working method used to change the model, discussing both the content as well as the method used to populate the model.

This is then followed by discussing the major changes to the model. The chapter will be concluded by a discussion of the application of the new model to other industries.

9.1 The Need for a New Model

Before discussing the development of the telecommunications SCOR model, it is necessary to consider why a new or different model is needed. The SCOR model has been developed with a manufacturing organization in mind. By this point it should be clear that the telecommunications industry also has a manufacturing dimension, referred to as installations. There are however differences in the use of the term *manufacture* here.

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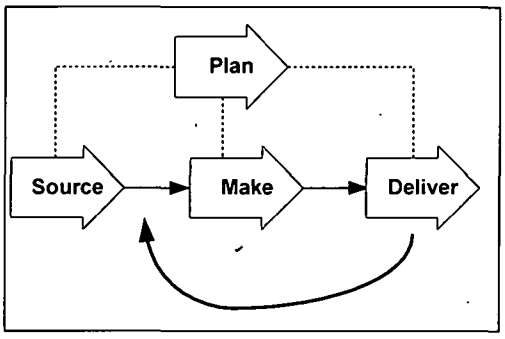

Figure 24: The Deliver Process Within the Telecommunications Company

The first and major difference is that of location and product. Manufacturing in the traditional sense refers to a product that moves through a factory while being processed, and is eventually shipped to the customer. The telecommunications company produces a product or service at the point of use (in the exchange or at the customer premises). The product does not flow through the factory, the factory (being installers) rather move around the product. In considering the SCOR model, and the description of an organization in terms of a plan, source, make, and deliver function, one can consider that the *deliver* and *make* functions now trade places (shown in Figure 24). The approach in developing the model was to include a few of the deliver functions in the source process.

The second difference is the volume of products. The traditional manufacturing functions are based upon the concepts of mass production and economies of scale. Although this is not always true, it is certainly for the most manufacturing activities. This is not the case with the telecommunications company. Here the product is one single entity at a time, an entire project is set up to deliver one single product or service, as it is a project driven environment.

There are many more differences, but these are the most important differences. These differences in turn imply different metrics in the model. It also requires different processes to be used, some processes even fall away as they are of no use. These issues will be discussed in greater detail in the sections that follow.

It is important to note that the telecommunications SCOR model is not developed to replace the original SCOR model, it has instead been created to complement the original model. The telecommunications SCOR model will thus be used in the situations that cannot be described by using the original SCOR model or that would be better described using the telecommunications SCOR model. Both models can thus be used to describe the Supply Chain. This is necessary as the telecommunications company sources its equipment from traditional manufacturing companies. The processes that follow the sourcing of this equipment do differ however (and is described in this model).

The following section will discuss the methods used to develop the telecommunications SCOR model.

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9.2 *Working Method*

In developing the telecommunications SCOR model, it was important to capture the best practices of the telecommunications company. Most of the changes in the model are based upon experiences and interviews with people within a telecommunications company. Telkom (South Africa's sole telecommunications provider) was chosen as the "model" company on which the Supply Chain Operations Reference model developed here, is based. The idea was thus to capture the current practices within the company and in this way develop a model that would address the current issues within the industry. The assumption is thus that Telkom (the company used as reference) is a fair representation of the practices that will face any telecommunications company in similar situations.

The model was developed considering the state of the industry, and also the state of the industry in near future. The goal was to develop a model that would represent these industry situations and also provide relevant and accurate best practices and benchmarking data.

This in turn helped identify problems in the current state of affairs of the company. This project is not intended to point out mistakes; it will however devote a short chapter to identifying some of the major problems identified while developing the telecommunications SCOR model.

It is still necessary to consider the method used to gather information regarding the Supply Chain of the company. This discussion will be followed with a discussion of the method used to populate the new model.

9.2.1 Gathering Information

The initial approach to gathering information was to use newly developed as well as existing questionnaires to gather information and in this way identify the characteristics of the Supply Chain within the telecommunications company. The target audience was the employees that dealt with the everyday activities of installing and ordering new equipment, as well as all the processes that precede and succeed this.

This approach had to be abandoned after it was found that the target audience did not have enough knowledge of the basic issues regarding Supply Chain Management. Knowledge here refers to knowledge of budgets for the various departments, lead times of equipment, warehousing costs, project times, etc.

A second problem was the fact that questions would be interpreted differently by different departments, due to the various environments that the employees are working in. Another problem was inconsistency of information. Many employees would provide one answer and other employees another, to the same question. A one on one interview approach would solve most of these problems.

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The method was then changed to interviews. This would require the interviewer to interpret information given, creating a problem as interviewer bias could create inaccurate information. The interview method (if conducted correctly) would result in an accurate representation of reality.

A number of departments were considered as well as various functions within each of the departments to ensure the validity of the information.

9.2.2 Populating the Model

After the information about the industry and company had been gathered, this information had to be incorporated within the model.

To populate the model in a reliable and consistent manner, a database system was used. Upon closer investigation of the SCOR model, it was found that there are a number of discrepancies and inconsistencies within the model. It was decided that these problems could be overcome if a relational database were used. This was then implemented and used to develop the telecommunications SCOR model.

This thesis will not discuss the errors in the current SCOR model. As part of this thesis a correct SCOR model was derived. This now provided a new model to base the telecommunications SCOR model on. The models can be accessed at www.bing.sun.ac.za/scm/eSCOR .

Appendix B provides detailed discussions of the database, and the design of the database.

9.3 Developing the Telecommunications SCOR Model

This section will focus on the changes and new elements of the model itself. It will start by considering the major changes to the model as a whole. The discussion then turns to discuss each of the process levels. These discussions will also include detailed decisions made in some of the process elements.

9.3.1 Model Level Changes

Figure 25 shows the process categories for the telecommunications model.

The first change is the omission of the entire deliver category. As discussed earlier in this chapter, one of the major differences between the area of traditional manufacture and that of the telecommunications company is the location. The construction of the service takes place at the point of use. There is thus no need to deliver a product or service, the material for the installation it sources, and it is used to build the service.

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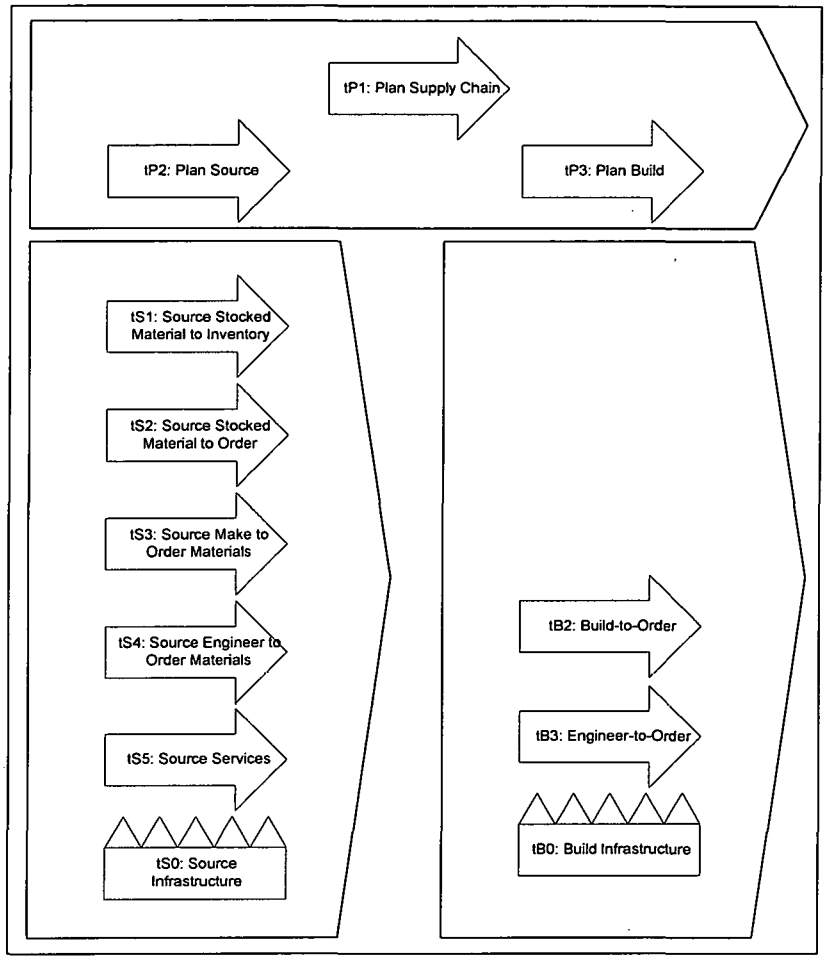

Figure 25: Telecommunications SCOR Process Categories

The Make function has become build, as that is the action performed within the telecommunications company. Although it has been said that the build or installation phase can be seen as a special case of manufacturing or make activity, it is still useful to distinguish between the two.

The next notable difference is the nomenclature used. Each term has been given the prefix *"t"*. This is to indicate that the process is part of the telecommunications SCOR model. When developing thread diagrams (as discussed in Appendix C) to model the entire Supply Chain of the telecommunications company, both the original SCOR model, and the telecommunications SCOR model will be used in the diagram. It is thus necessary to be able to use both models in the same diagrams without any confusion. This would be a problem if the names of the various processes had not been changed, as their detailed descriptions (with metrics, best practices, etc.) are different. The user needs some way of distinguishing between the processes.

Much of the original model has remained in providing the telecommunications SCOR model. The greatest changes are in removing the metrics and best practices related to mass production and general shop floor activities. Other major changes are the inputs and outputs to processes.

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In terms of metrics, it was decided to replace all "%" and "#" symbols with the word *percentage* and *number* respectively. This was done to avoid confusion in looking up terms in the glossary. This has thus been a standard set in the telecommunications SCOR model. Other (similar) changes included replacing *and* for the symbol"&", *finished goods* for FG, *work in progress* for WIP, *days of supply* for DOS, *engineering change order* for ECO, *engineer to order* for ETO and *integrated Supply Chain* for ISC. The word *total* was removed from most of the metrics. It is easy to confuse terms when looking for the term "total Supply Chain costs" and the glossary has the term listed as "Supply Chain costs". EDI was not changed, as it has almost become a term and not an acronym anymore.

The "$" symbols were not changed for the "R" symbols as the equipment purchased are in general measured in dollars and not Rand, keeping all measures standard and separate from currency fluctuations would thus result in more accurate metrics.

Sales and Marketing functions have been omitted, as these functions are not important in the context defined. Projects are planned and scheduled based upon the identified problem areas as described in the network master plan. There is thus no use for linking to sales and marketing, these functions are part of a different Supply Chain to the one defined for this project. This assumption implies that the network is planned without consulting the sales or marketing departments. This is not the case. The people in charge of drawing up the network master plan use their environment to determine the requirements within the network. This environment could include the sales and marketing departments, although this is not explicitly specified.

Engineer to order has been included in this model. The idea is that all installations that the company is familiar with, be described with a tB2 or Build-to-Order. tB3 or Engineer-to-Order will be used for first time installations, were it is critical to document and draw up new specifications for a project that has not been completed before.

This model does not accommodate work done by departments while waiting for inventory. If inventory is due to arrive late, some departments can start a project by doing preparatory work for the project and then simply installing equipment as it arrives. This is not accommodated in this model. It is assumed that the work is only started once inventory arrives. The logic to this is that the project completion is still dependent on the arrival of inventory. The project can not move on to the next phase without it being present. The assumption made in this model is simply that the starting of jobs before the arrival of inventory are the exceptions rather than the norm.

Arguably the biggest change within the model, is the inclusion of services. At the last Supply Chain World Conference in Chicago (1999), there was a call to practitioners to consider the inclusion of services into the SCOR model. The Supply Chain Council is in fact looking into this. The telecommunications SCOR model provides one solution to the problem. The issue of including

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services into the model will be discussed in more detail in one of the sections that follow (section 9.3.4).

9.3.2 Plan Processes

The tP1 process does not change much, except for the omission of the P3 process. Included into the planning of the entire Supply Chain is the process of drawing up a network master plan. The relevance and description of the network master plan has been discussed in detail in earlier chapters (see Chapter 8).

The inputs and outputs thus change because of the new way of generating orders to produce or build. The same then applies to the tP2 (old plan source) and tP3 (old plan make).

The metrics and benchmarks are similar to the original benchmarks and metrics.

9.3.3 Build Processes

The *Build* processes of the telecommunications SCOR model replace the *Make* processes. The reason for this has been discussed in a previous section.

The *make to stock* (or build to stock) has been omitted, as all building and construction is done either according to the network master plan, or according to contingency projects which are scheduled as they are ordered.

The stage *process element* (tP2.4 and tP3.5) has been included in the model, as this will be used to describe the project when it has been installed, but is not yet operational (see finished goods inventory, Chapter 8). What happens in reality is that an installation may be complete, but it is still not operational because it is part of a larger project that has to be completed. This time that the project is complete and not yet operational will be described by the stage process.

The installation or projects are finally handed over to the maintenance department, who then uses and operates the installation, from this point on it is beyond the boundaries of the Supply Chain as defined within this project.

9.3.4 Source Processes

The *source* process has had the most changes. The first change is that of splitting the S1 process into tS1 and tS2 processes. This is done as S1 considers the ordering of purchased materials. For modeling purposes, it was necessary to distinguish between products purchased to replenish inventory levels and products purchased because of a customer order.

The contents of the remaining processes are very similar to the original processes. This means that the processes need not be redefined, as it would be sufficient to simply use the origional S2, S3 and S4

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processes, as proposed by the SCOR model. The processes were, however, redefined for the telecommunications SCOR model, as the lack of changes could well be because the author does not have enough knowledge of the specific process and how they are different within the telecommunications industry. It may later be developed and discussed further by a group of experts in the field. It is thus still necessary to provide these processes as a framework for future refinements to the model.

The greatest change to the model is the inclusion of a fifth source process, tS5. This is the sourcing of a service. The use will be explained by means of an example. Say for instance, that a company (Company A) needs to build a fence. To do this it must plant poles and then erect the fence. It has decided to outsource the planting of the poles to another organization (Company B). The plan processes have been omitted to simplify the diagram (see Figure 26). Both companies still source materials, but company A sources material as well as a service. Also note that this example uses the S1 process: here there is no indication if this acquisition was as a result of an order or to replenish inventory levels. Hence the distinction and need for the tS1 and tS2 processes.

Traditionally users of the SCOR model would use S2 to indicate the ordering of purchased materials because of an order. This is not consistent with the definition of the process. S2 is defined as "The procurement and deliver of materials that are built to a specific design or configured based on the requirements of a particular customer order" (Supply Chain Council, 1998).

Indicating the nature of purchasing material with the tS1 or tS2 would not result in major changes in metrics or benchmark data, it does, however, help in improving the Supply Chain configuration when considering the Supply Chain threads.

Figure 26 shows the thread diagram for sourcing the service. Services are now sourced as would any product using the tS5 process (shown in Figure 27 and Appendix A). The process elements of the tS5 process are based upon the current practices within Telkom. This process will briefly be discussed, as it is a new addition to the model.

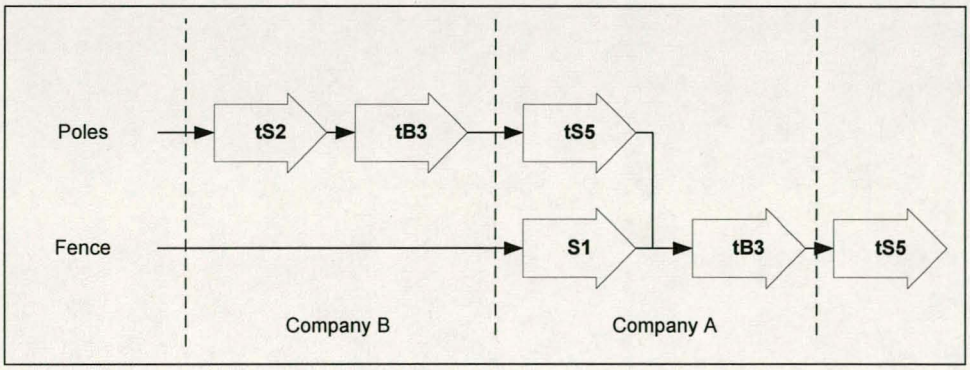

Figure 26: Services Supply Chain Thread

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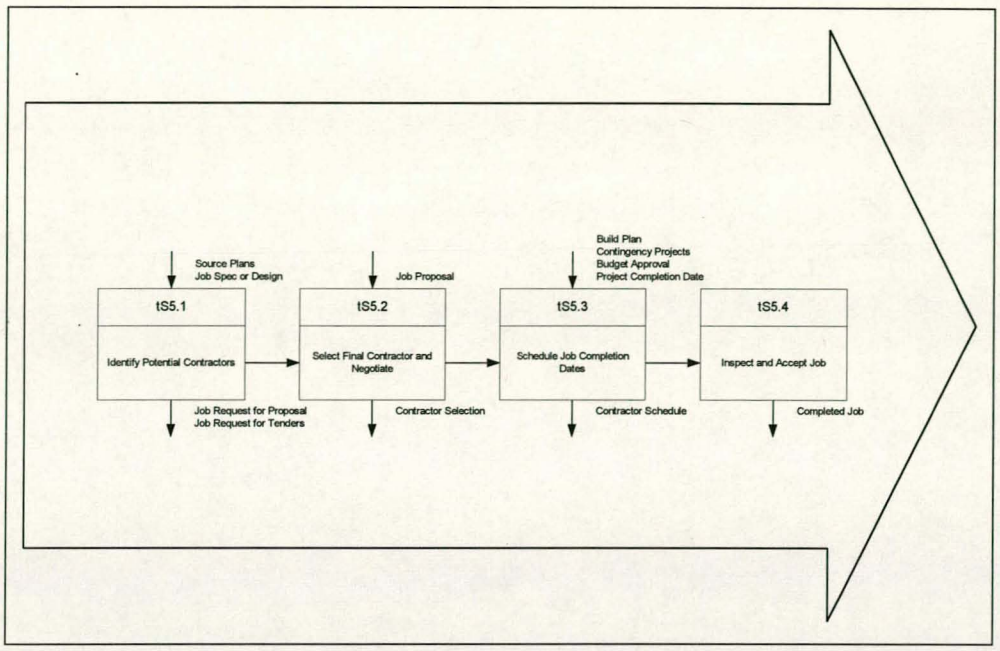

Figure 27: tS5 Process Elements

The first process is to identify the contractors that are capable of completing the project. This is based on plans and requirements of the job (job specification or design) as well as plans detailing when the project has to be completed in order to synchronize with other projects and the completion times of their projects. Tenders are then sent to the contractors that have been identified as suitable for the installation.

The contractors then submit proposals for the jobs, based upon the requirements set. From this a final contractor is chosen. The chosen contractor then becomes part of the parent project. All the child projects come together to schedule the jobs to ensure synchronization between projects.

The final process after the completion of the job, involves the inspection of the job. When thinking of the sequential nature of projects, it would make sense to place this last element after the build process. Although it does not appear to be so, it is in fact the case here as well. The processes described here are the processes of the customer receiving the job. The customer is not involved in the installation process, but follows the steps as suggested by Figure 27. From this it is clear that the SCOR thread diagram does not represent a time scale along its horizontal axis, it may rather be seen as a breakdown of ownership of the different processes.

9.4 The Application of Telecommunications SCOR to Other Industries

It is necessary to consider the application of the telecommunications SCOR model to other industries, and not only limit it to the telecommunications company. The content of the model itself is based upon practices and scenarios observed within Telkom, implying that the model is based upon a

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telecommunications company. There is however, no reason why this model is not applicable to other network-based companies (as discussed in Chapter 8).

The processes would also be able to describe the operations of developing a network of banks, railway carriers, etc. The difference may be that these organizations have different best practices. It may be beneficial to all these organizations to compare processes and best practices to understand how the other is operating their organization, and in this way develop new best practices that are applicable to all network companies.

9.5 Conclusion

This chapter has discussed the SCOR model that has been adapted for the telecommunications industry. The complete model can be found in Appendix A. The model is very similar to the original model, but now includes the ability to source services.

The great similarities found in the model once again shows that the telecommunications company does have a manufacturing dimension, and that it is very similar to the manufacturing practices of a traditional manufacturing company.

The services discussed here are simply one dimension of services. There are many other examples of services (e.g. maintenance, customer care, etc.), not described by the method proposed here. The solution provided in the telecommunications SCOR model does however, address a need to describe the sourcing of construction services. This method may be applicable to any organization that sources a construction process or activity.

The telecommunications SCOR model will next be used to describe Supply Chains that have been identified within the telecommunications company and in so doing will show the use of this model.

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Chapter 10

Case Study: SDH Feed

This chapter will consider a Supply Chain within Telkom. This Supply Chain will be used to illustrate the application of the telecommunications Supply Chain Operations Reference Model (as discussed in the previous chapter). This section will first start off by discussing the background of equipment ordering within Telkom, and how it has changed. It will then focus on the specific case study, and also the solutions as proposed by the telecommunications SCOR model.

10.1 Background

Before discussing the case study, it is useful to sketch the background of all these projects and why they are now run the way they are. As was discussed in chapter 7: The South African Telecommunications Industry Overview, the industry has acquired strategic equity partners in the form of Southern Bell and Telecom Malaysia. With the introduction of these partners, the strategy was to aggressively pursue the targets set to the company by SATRA. The approach was to remove any constraints set by finances. There would be enough money available for all projects. The result was that many departments started ordering goods in large amounts.

This would not be a problem, as the growth of the network would guarantee that any ordered goods would be consumed at some point in time. The situation is not that straightforward. The goods installed in a telecommunications company is high technology equipment. This technology has of ability to becoming redundant very quickly, and this is exactly what has happened in Telkom. Some of the equipment available in the warehouses can not be used any more, as it is too old to be used for installations, as the company does not want to install equipment that is already outdated before installation. To compound this problem, the order lead times of these items are very long. Contracts with suppliers specify that the lead times for equipment are within the regions of 3 to 4 months from the placement of the order. Once an order had been placed, it can not be cancelled.

In response to this, the company has now taken the approach of delivering equipment on demand. Budgets have to be approved and only then are the goods ordered on a per project basis. At this point

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in time, the person responsible for placing the order will first consider all goods within the warehouses and then only, if the item is not within the warehouse, it will be ordered.

The results from this flood of inventory has been

- large amounts of stock write offs
- large capital investments with no cash returns (tying up of cash)
- large logistics costs in terms of warehousing

The changes that have been made will in turn introduce a whole set of new problems, as will be discussed in a later chapter.

This brief overview has sketched the backdrop to the environment in which these projects are run and will explain why certain practices are now performed in the ways that they are. The case study as described here, describes a scenario that has already seen allot of changes and improvements in response to the lessons learned in the past.

10.2 SDH Installations

The SDH feed is a name for the installation of a Synchronous Digital Hierarchy (SDH) system. The SDH drive is part of the digitizing projects for the Telkom network. This case study will consider the Supply Chains related to the installation of SDH equipment.

To understand the Supply Chain and the nature of the environment, a bit has to be said about the actual product. In a specific region, say the Western Cape, the company will have a number of exchanges. Customers are then connected to these exchanges, referred to as switches or DSSUs. In turn these DSSUs are connected to one another. To meet the demands of traffic volume on the network, high capacity networks have to be installed between these switches. The solution that Telkom has turned to is to build an SDH network. The result is thus the SDH loops: ring type networks are installed throughout the region, connecting all the switching units to one another (see Figure 28).

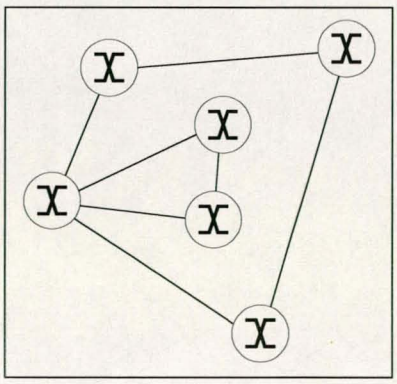

Figure 28: SDH Network Configuration

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There are four main functions involved in an SDH installation, these are: the transmission, power, construction and project management functions. The entire process of constructing a site will now briefly be discussed.

10.2.1 SDH Processes

The SDH installation is as follows:

1. The company draws up a network master plan during the year.
2. The SDH installation requires the services of more than one department. Because of this multi departmental scenario, the project management section is prompted to co-ordinate the project. The project is then managed by the project manager. A meeting is held were all the departments involved discuss all the projects identified by the master plan for the year. The projects are then scheduled considering the lead times required for equipment and resource availability. All functions are scheduled to end at roughly the same time. The SDH installation functions need not be carried out sequentially to complete the project, although it is preferred that the functions, like power, be in place before the process of transmission installations take place.
3. Projects are now left to the planners of each of the functions. There are construction planners, transmission planners and power planners involved. Each of these parties now compile detailed requirements for each of their functions. Once the plan has been compiled, it is sent to head office for project approval. At the same time the detailed project is sent to the various installers of each of the departments.
4. Once the projects are approved, the equipment is ordered. Equipment arrives at the warehouse. The installation section can then go and draw the equipment and place it in their own warehouse until it is installed.
5. When the equipment arrives, installations can start. At this point it is necessary to point out the main functions of each of the sections. The construction section installs the fibre optic cables between two switching units. The power section provides the power necessary to support the SDH equipment to be installed. The transmission section installs the actual switching equipment. It is their responsibility to ensure that the equipment gets connected to the cabling provided by construction as well as the connection to the rest of the exchange.

Only once all these functions have been completed can the project become operational and start to earn revenue. No mention was made of the computer systems that are present in all these activities. There are three computer systems: Walker, Artimas and ProjEstim. Walker is used by the finance department and tracks all costs within the company. Artimas is used to track the progression of the project when it has been started. ProjEstim is used a planning tool to estimate the requirements and expenditures of a project. These three systems are not integrated. They are in fact seen as rivals by the various departments within the company.

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The process described here will now be modeled using the newly developed model in the sections that follow.

10.2.2 As-Is Network Thread Diagram

The thread diagram (discussed in Appendix C) for the entire installation, will be developed by considering each of the departments discussed in the previous paragraph. The three departments involved are the construction-, transmission-, and power departments.

The Plan processes have been omitted from the diagrams, as they do not contribute to the actual understanding of the threads. The focus here is on the configuration of the Supply Chain and not on designing the management process like benchmarking (what Plan processes are used for).

The Supply Chain threads are mapped according to product channel. In the SCOR tutorial, it was said that there are a number of ways to distinguish between the various chains; one of these was the product channel. The focus chosen here is the type of channel used to deliver the products, as different products and equipment all use one of the three different channels.

10.2.3 Transmission Chain

The first chain considered is that of the transmission function. This department sources catalogue items, non-catalogue items and equipment. As discussed, catalogue items are items used in daily consumption. Equipment are the items that are considered to be fixed assets. They usually have long lead times, are only sourced from very specific suppliers and are generally very expensive. Non-catalogue items is best described as all items that are not catalogue or equipment items. These are items that are necessary for installations, but can be sourced locally.

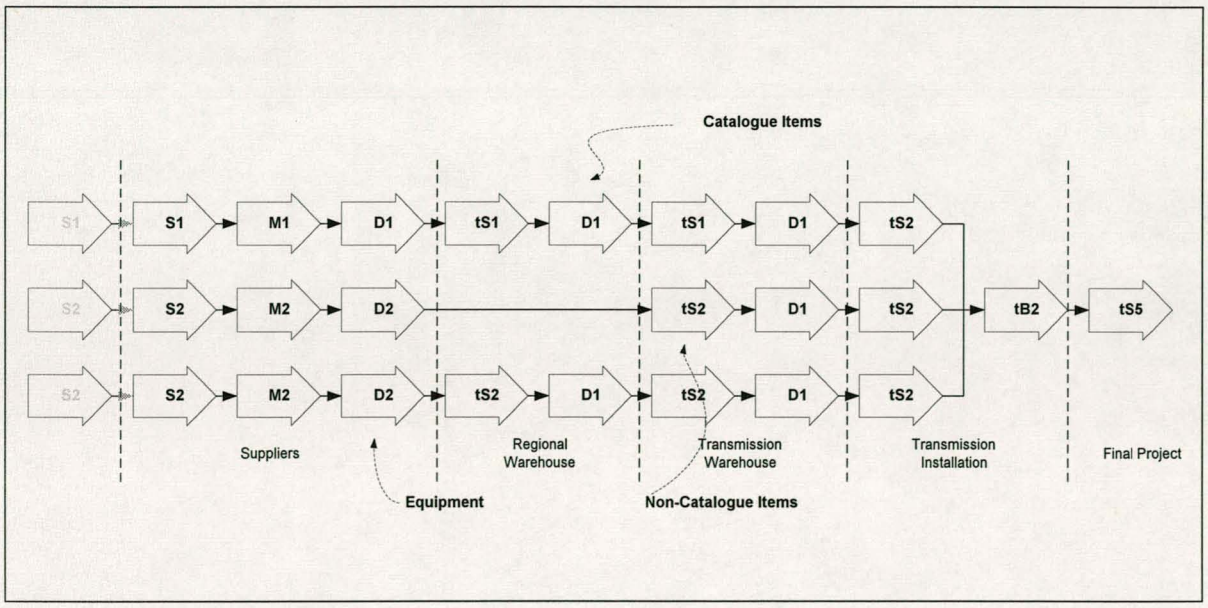

Figure 29: As-Is Transmission Supply Chain Tread Diagram

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Figure 29 shows the thread diagram for the transmission part of the SDH installation. The three product channels are also shown. The entire project is driven by a source service (tS5) process. This suggests that the transmission section has to submit a tender to receive the contract for completing the project. This is not the case at the moment, it is simply assumed that the transmission section will complete the job. The use of the process here is thus artificial. It is however, essential for the to-be model. Departments will have to apply to provide a service and must be the best of the available candidates in the future. This will force the departments to be competitive.

Each of the threads channels will now be discussed in greater detail.

Catalogue Items

Catalogue items are ordered by the installing department when their inventory levels are low. It is stored within the department at their local on-site warehouse. In the past, this warehouse was sourced by a regional warehouse which in turn was sourced by a national warehouse. This practice has now changed. The departmental warehouses are sourced by a national warehouse. The agreement is that the orders placed at the departmental warehouses will be sourced within 24 hours. This is causing some problems in the departments, as they could always see the inventory levels of these items in the regional warehouses, this in turn meant that they would be satisfied with the inventory levels and would not worry about running out of catalogue items. Although there has been a guarantee that orders will be fulfilled within 24 hours, there is very little trust in agreements like these.

The to-be scenario for the catalogue items would be to have the supplier ship directly to the departmental warehouse with a lead time agreement of 48 hours. This target is achievable. The greatest resistance to such a proposal would be that the company has no or little control over the ordering (which the current system does have). This is not the case, as the company and the supplier would work together in managing and approving orders. The idea is simply to have the suppliers keep inventory rather than the company. If the suppliers control the inventory, they have a clearer picture of how many products to manufacture to meet new demands from the telecommunications company.

Non-Catalogue Items

Non-catalogue items are ordered from a local buyer. The local buyer is a role fulfilled by the Telkom procurement section within the specific region. If the request for the item has been approved by Head Office, and it is available locally, it is shipped directly to the department. If it is not available locally, the order is passed to the national buyer, who then purchases the item. The item is then shipped to the departmental warehouse.

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The to-be scenario for non-catalogue items would be to ship it directly to the point of use. This would however require accurate forecasts of when jobs are to be started and completed. This can be achieved by using complex scheduling tools, to make sure that all projects are synchronized and on time.

Equipment

Equipment is the greatest bottleneck in the current Supply Chain. The problem is that equipment involves long order lead times. These lead times are often unpredictable and could be delayed. These delays are the greatest problems. Delays in one child project, effectively delays the entire project. The approach is currently to let each department complete their jobs to the schedule set up at the initial planning meeting. This means that one department may have completed an entire installation while others are still waiting for equipment.

The to-be scenario proposed here, may be seen as unrealistic, but it will have to be in place by the time that the company enters a competitive environment if it is to be competitive. The model proposed here suggests that no inventory should be kept at the warehouses, but that the equipment will shipped, directly to the point of use. The problem is that project dates will slip. This has to be accommodated in two ways: firstly delivery dates must slip; the suppliers must be able to delay the delivery of orders as requested by the company. The second method is to keep the goods in the exchange. The SDH equipment is installed within an exchange, which is a high security area (these two solutions will be discussed further in the following chapter).

When considering all these suggestions together, the to-be thread map as shown in Figure 30 can be created.

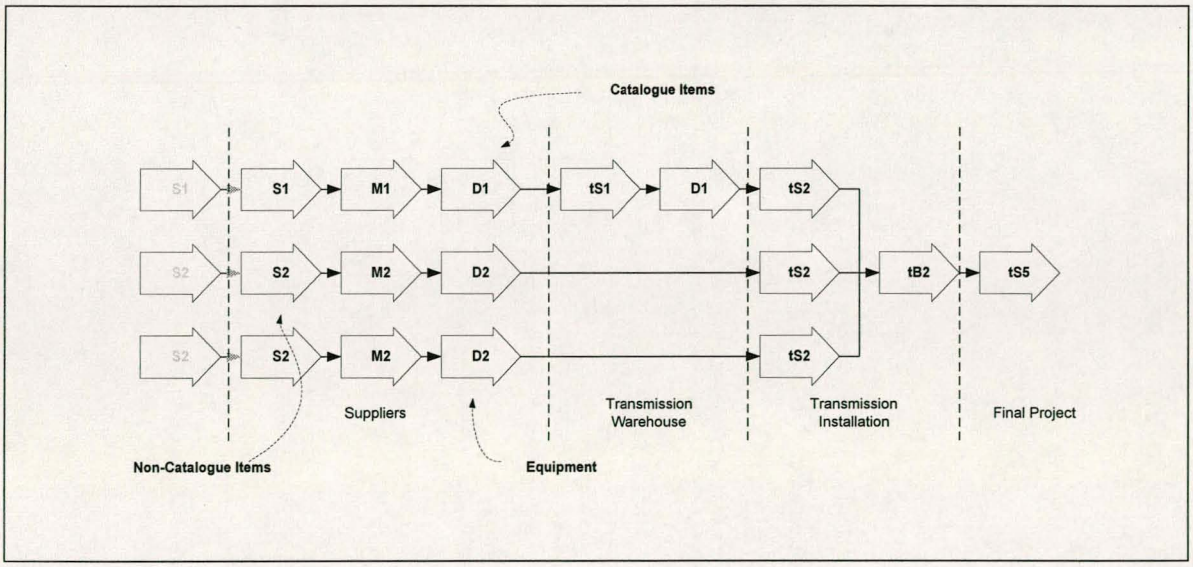

Figure 30: To-Be Transmission Supply Chain Thread Diagram

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10.2.4 Construction Chain

The construction chain differs from the chain presented for the transmission section, in that it has no sourcing of equipment (see Figure 31). Instead a new element is introduced, the sourcing of a service. The same arguments presented for the sourcing of catalogue and non-catalogue items are relevent for the construction chain. This section will elaborate on the sourcing of a service.

Contractor

Telkom is starting to outsource some of its functions to contractors. The greatest area of outsourcing is the construction department. Functions like the digging of trenches, planting of poles, etc. are not seen as activities that the company should provide. Traditionally these were done by the company, but these activities are now being outsourced.

Figure 31 shows how this outsourcing can be modeled. Outsourcing introduces a new problem in terms of the construction Supply Chain, the delay of inventory is now removed from the company itself, but the contractor should now manage the sourcing of inventory.

It is not sufficient to adopt the attitude that the function has been outsourced and it is not the company's problem anymore. A delay from the contractor would cause a delay in the entire project. It is also not acceptable to force contractors to make deadlines that may be unreasonable or inflexible. One of the central ideas to Supply Chain Management is that organizations work together to improve the entire chain and in so doing deliver a better product or service.

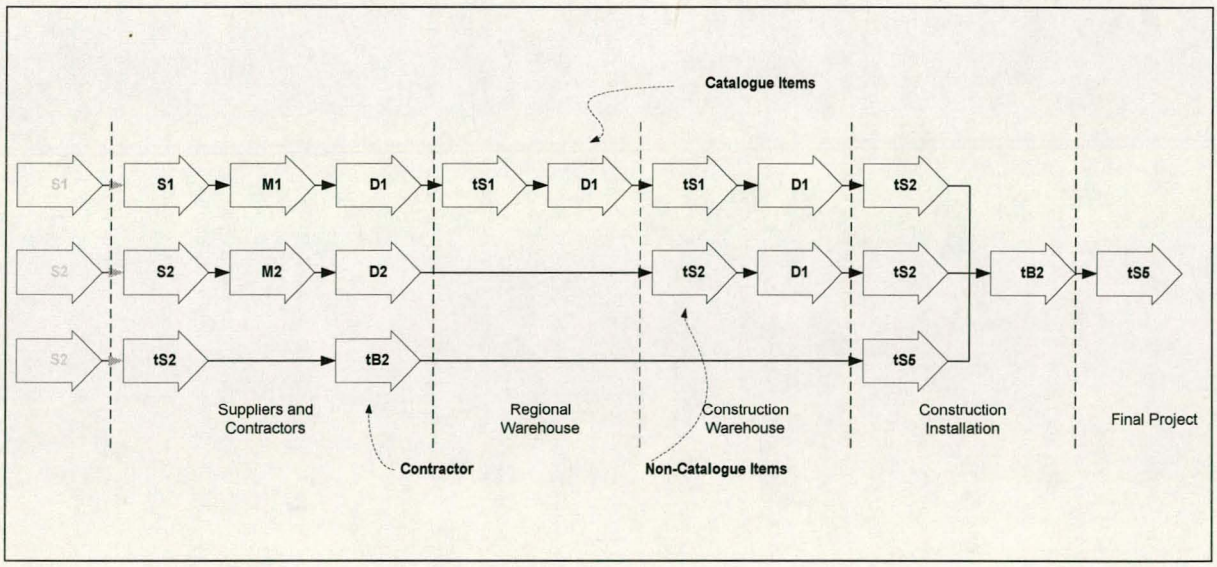

Figure 31: As-Is Construction Supply Chain Tread Diagram

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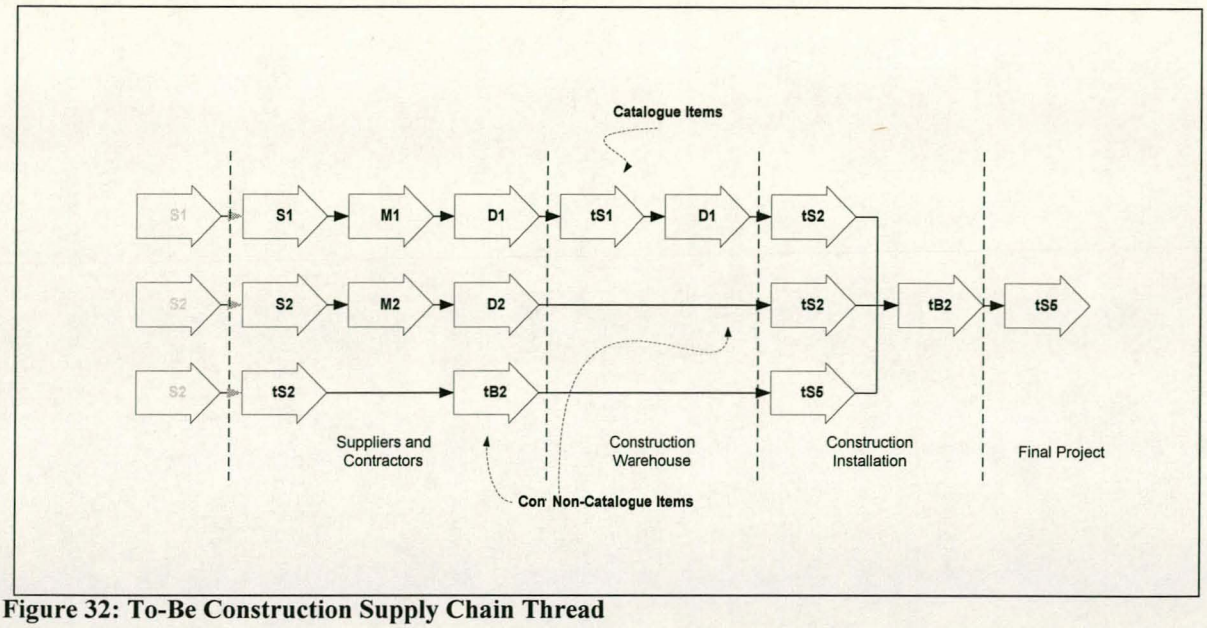

Figure 32: To-Be Construction Supply Chain Thread

10.2.5 Power

The activities of the power section are very similar to the activities already discussed. An interesting point with the power function is the sequential nature of the entire project. In the thread diagrams shown for the entire SDH chain (see Figure 32), it would appear that all projects are concurrent. The truth is that the power function is actually necessary before the installation of transmission equipment. In practice, the transmission installation can be done without power, it only needs power in the last phase when the transmission equipment needs to be tested. The result is thus that the transmission department only performs minor activities once the power is installed, hence the approach that both end simultaneously.

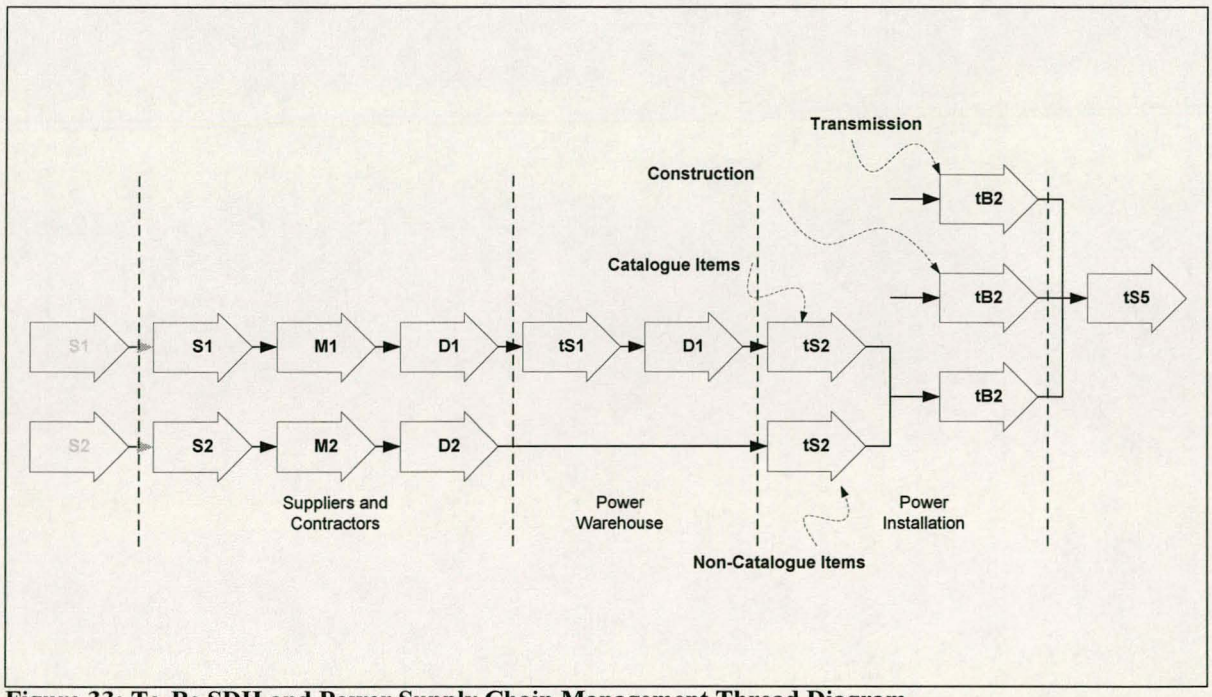

Figure 33: To-Be SDH and Power Supply Chain Management Thread Diagram

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10.3 Feasibility of Solutions

When considering the solutions proposed, the feasibility of these solutions must be evaluated. From the solutions provided, it is clear that the approach is to take a zero inventory attitude. This is not always possible or cost effective.

The first reason why there will always be inventory is because shipments from suppliers will arrive late, or some departments will be held up at some point in time, this is reality. This then results in work in progress inventory and finished goods inventory. Neither of these two reasons provide enough reason to suggest that raw material inventory should be carried. The no inventory philosophy can still be adopted; although the result may not be that (you may still have work in progress or finished goods inventory).

The second reason why inventory will be carried is due to the contingency projects. Contingency projects are not accommodated in the diagrams above, as there is no indication that inventory will be carried. It has been discussed that contingency projects have to be completed within two months of the customer order. With an equipment order lead-time of four to five months, the company will have to carry inventory. The alternative is that inventory is taken from other projects, which is a bad practice.

The solutions are thus not easily achievable, but must be achieved if Telkom is to be a globally competitive telecommunications company in the future.

10.4 Conclusions

The goal of this chapter was to illustrate the application of the developed telecommunications SCOR model. For this to be done, the model should be able to fully represent the current situation of a Supply Chain within the company.

The model was also successfully used to illustrate alternate configurations to the current Supply Chain thread. Although these changes were on a configuration level, and not a performance level, it should be clear that there is value in using the model. The part of the model not tested here, is its data (metrics, best practices, etc.), but this is not as critical as the configuration part of the model.

The greatest value of this project was in providing the structure for such a model. The information contained within it will have to be evaluated and discussed by a team of experts, but this team can now use the model structure proposed here to "house" these solutions.

The model was only proved within the boundaries of the company, and a few projects that were outsourced. There would be no value in tracing the chain further to manufacturers, as these processes

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will be described by the original SCOR model, which has been proven and is accepted to be correct for this thesis.

From this the conclusion must be made that the telecommunications SCOR model is of use and is in fact accurate, in describing projects within the telecommunications industry.

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Chapter 11

Identified Areas for Improvement

In developing the model discussed in the previous chapter, a number of obvious areas for improvements were identified. Although it is not the goal of this thesis to identify problem areas, it is useful to still discuss some problems and highlight them for later investigation.

The approach is to identify the five greatest problems identified. This is similar to the balanced scorecard approach where only the most important and significant factors are considered (Norton and Kaplan, 1996). To identify ten or twenty problems is possible, but would detract from highlighting the most important factors.

Five of the greatest problem areas will be discussed in the sections that follow.

Inventory is not an Asset

It is the general perception among employees within the company that inventory is free of costs. The employees may acknowledge that it is not a good thing, but there is a definite lack of understanding what these costs are and how significant they are.

Figure 34 lists some of the costs associated with inventory.

Inventory carrying cost:
- Tax
- Storage
- Capital
- Insurance
- Obsolescence

Ordering
- Communication
- Processing, including material handling and packaging
- Update activities, including receiving and data processing
- Inventory Control

Management

Figure 34: Costs of Inventory

(Bowersox and Closs, 1996:650)

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The perception is simply that when items are put in inventory, it is safe and cost free until it is required for use. There is thus no problems in purchasing equipment before it is needed and putting it in a warehouse.

There are reasons why employees consider inventory as discussed above. The first is simply because inventory is free. The cost of warehousing and logistics are not associated with the section, the project or the installation.

Another reason is because of the variance in material delivery dates. Although the procurement section claims that the delivery dates of suppliers are generally on time, this is not the opinion of the installers or planners. Opinions are often dismissed as they are not based upon fact. This may well be, but a person believing that the inventory will be late or will not arrive, will rather start building his or her own inventory of equipment (as is in fact happening). To compensate for the variance in delivery dates, the employees would rather have the equipment waiting in the warehouse for a month than have to wait for the inventory.

Possible solutions to this problem would be training of the employees involved in the ordering of equipment, the allocation of inventory costs to the department, storing equipment and/or accurate tracking of delivery performance, not only by the procurement section, but also by the individuals involved in the ordering of equipment.

Scheduling

In discussing the SDH installations (see section 10.2) it was said that after identifying the project, the teams meet to discuss completion or installation dates and the general scheduling of installations.

From this point forward, there is very little or no co-ordination between projects. Consider a parent project, say project A. Project A is completed once its child projects, projects B and projects C, are complete. At the initial meeting of project A, projects B and C are scheduled to both end at the same date, taking into account inventory lead times and resource availability. If the equipment of project B is delayed, project C is completed as initially agreed and project B is installed when the inventory arrives and resources are available again.

From this example it is clear that project C had equipment installed generating no revenue for the entire delay of project B. The ideal would be for project C to postpone its installation to match the completion date of B. This would require constant coordination between the various installing parties.

The answer is not that easy, however. Project C also has other projects already scheduled meaning that resources may have been committed to other projects already scheduled for the new commit date.

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On the other hand, the installers of project C may want to delay the project for other projects that would have higher priority at that point (as project A is now delayed). Negotiations can be made with suppliers to delay orders; these suppliers may even prefer this if they have too many orders. These are some of the solutions that can be explored.

To enable this complex form of scheduling, scheduling software capable of scheduling across departments and also accommodating resource constraints would be required. The scheduling system will have to track all projects for the various departments. Currently, one of the departments interviewed do have complex scheduling functionality, but it is only for the section and is a manual process. Because the scheduling is manual, it requires a large number of employees resulting in large labour costs.

Delivery to Point of Use

Delivery to the point of use is defined as the delivery of equipment to the location where the equipment will be installed. In the case of the telecommunication company, this delivery can be in a number of places. The SDH installations discussed in this thesis, are installed within a Telkom exchange. The exchange is a high security building, suitable for high technology equipment. It would thus not be a problem to store the equipment at this point for installation.

Other installations require multiple installations in the environment with no formal building structure around it. An example of this type of installation is the TDMA radio installations. Here radio networks are built instead of using copper wire to relay messages. The equipment is usually installed in the rural areas where there are no buildings; it may even be hundreds of kilometers from the nearest town. This equipment can be kept at the construction section in that region. Each town has its own Telkom construction site. Equipment can be stored at these points. If such sites are not available, storage space can always be arranged on a temporary basis at the nearest town.

There may be installations were inventory cannot be delivered to the point of installation, in this case, the equipment should be delivered to the installing section's local warehouse.

The main goal of all the solutions above was firstly to minimize, if not avoid, the use of large regional warehouses. Another goal is to minimize the use of vehicles. Many departments each have their own flat bed truck solely for transporting equipment. These trucks are necessities at the moment, as the equipment has to be transported to multiple locations. If it were already at the site, the department need not transport it.

With reference to the thread diagrams shown in the previous sections, the common objective was to remove the warehousing functions. Currently the section fetches their equipment at the warehouse and

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takes it to the local warehouse. From there equipment is taken to the installation site. In this scenario each section needs their own truck. An alternative to this would be to expand the scope of the warehousing function to include the delivery of goods. In doing this, the trucks can be taken from the sections and given to the warehousing function.

Currently the vehicle utilization (like that of the flat bed trucks), is relatively low for equipment transport. Assigning the truck to the warehouse would mean that the same truck could be used for a number of sections and in this way increase the vehicle utilization.

Accurate Cost Allocation

When inquiring with regards to the cost components of the various projects, the information was not easily available. It is essential that this information be constantly calculated and monitored. It would appear as if the approach is that the project must be completed regardless of the cost, and therefore it is not necessary to calculate the cost labor, transport or other costs that is considered fixed costs. These are in fact not fixed costs.

Even the location and building costs for the installing section, the planners section, and project management section have to be allocated. This may seem unnecessary, but is essential if accurate budgets are to be drawn up, another issue that many feel contributes to the problems in projects. The monitoring of costs may lead to the efficient management of these costs.

Techniques like activity based costing should be used here.

Constraint Based Project Planning

The company draws up a network master plan on an annual basis. This master plan has detailed information describing all the projects for the next financial year.

It would appear as if this plan is drawn up without consideration for the limited resources to complete the projects. What should happen in theory is that the master plan should be developed, described and investigated by each of the sections, if the sections then feel that they cannot meet the demand, they will report this. From here one of two paths can be followed, the resource capacity can be increased or the master plan can be scaled down. Simply setting this master plan without consideration for resource capacities results in not meeting targets, large overtime expenditures, borrowing of staff from other departments, etc.

Suggestions proposed by departments during the interviews, were to monitor the accuracy of the network master plan: to compare estimates of projects and budgets to the actual expenditures and projects completed.

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11.2 Overview

These are only some of the problems identified in completing this thesis. Other problems such as the scheduling and inventory of contingency projects have already been listed in other parts of this thesis. Focusing on the problems raised here and throughout this thesis has the potential of saving large amounts of money without large capital expenditures. These problems should be investigated for their validity and possible solutions.

The next two sections will discuss recommendations for future research and finally the conclusions that can be made from this thesis, will be discussed.

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Chapter 12

Recommendations

This thesis has relied on three primary components, these being: Industrial Engineering, Supply Chain Management and the telecommunications company.

Recommendations for the telecommunications company have been made in the previous chapter. This section will suggest future research and activities that can be made within the field of Industrial Engineering and Supply Chain Management that have been identified, in completing this theses.

12.1 Industrial Engineering

This thesis used a vast range of Industrial Engineering techniques to suggests ways in which Supply Chain Management can be of benefit for a telecommuinications company. With the industry becoming more competitive, the search will be for leaner and more competitive companies within the telecommunications industry.

One area for improvement is the warehousing function. Issues like optimal placement of warehouses, and optimum inventory levels could all be investigated. Also relevant are the optimal placement of maintenance departments, installation departments, and exchanges. The techniques like optimization and simulation will be very useful here.

These techniques can also be used to determine the amount of resources needed to provide a specified level of service. These resources include vehicles, employees, etc.

12.2 Supply Chain Management

A considerate amount of research is still going into Supply Chain Management. There are a number of issues that need to be investigated further:

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The first issue enjoying great attention is the integration of services into the concept of Supply Chain Management. This thesis has explored only one dimension of services and its relationship to Supply Chain Management, but there are many other areas to explore.

More research is also needed on the differences of the Supply Chains depending on the industry that is being considered. It is widely accepted that Supply Chains differ depending on the industry. These differences need to be studied and understood in order to manage these chains.

12.3 Overview

This chapter has briefly suggested a few more areas that may prove to be valuable for future research.

The next chapter also explores future actions, in addition to considering the conclusions made from this thesis project.

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Chapter 13

Conclusions

The goal of this thesis was to develop a model that will enable a telecommunications company to model its Supply Chain.

By considering the case study (Chapter 10), it is clear that this goal was in fact achieved. The case study also showed that using the model could illustrate and suggest improvements to the current Supply Chain.

The next stage will now be to assemble a team to review the contents of the current model, and also to develop it further. The model will then have to be implemented to validate its functionality and use.

With the industry in its current state, it is important that any value added network provider in South Africa, and especially Telkom, becomes competitive. This can only be done if all processes are accurately monitored and managed. Supply Chain Management is the ideal tool to provide this management, spanning across many functions within the company, with no regard for functional boundaries. It focuses on the flow of the final product, the project in the case of this thesis, rather than focusing on each department in isolation.

The applicability of this thesis to other parts of the telecommunications company such as the building of the infrastructure up to the customer premises should be investigated. Another area for investigation is the application of this model to other network companies like railways, internet companies, etc. Although many of the practices are based upon practices observed within Telkom, the processes should be very similar for other network companies.

Considering the activities described by the Supply Chain and Supply Chain Management, together with the model's ability to represent the activities of the telecommunications company, it should be clear that there is indeed value in exploring the Supply Chain of a telecommunications company. It may even be the practice that will distinguish the industry competitors from the industry leaders.

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Chapter 14

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Appendix A

teleSCOR

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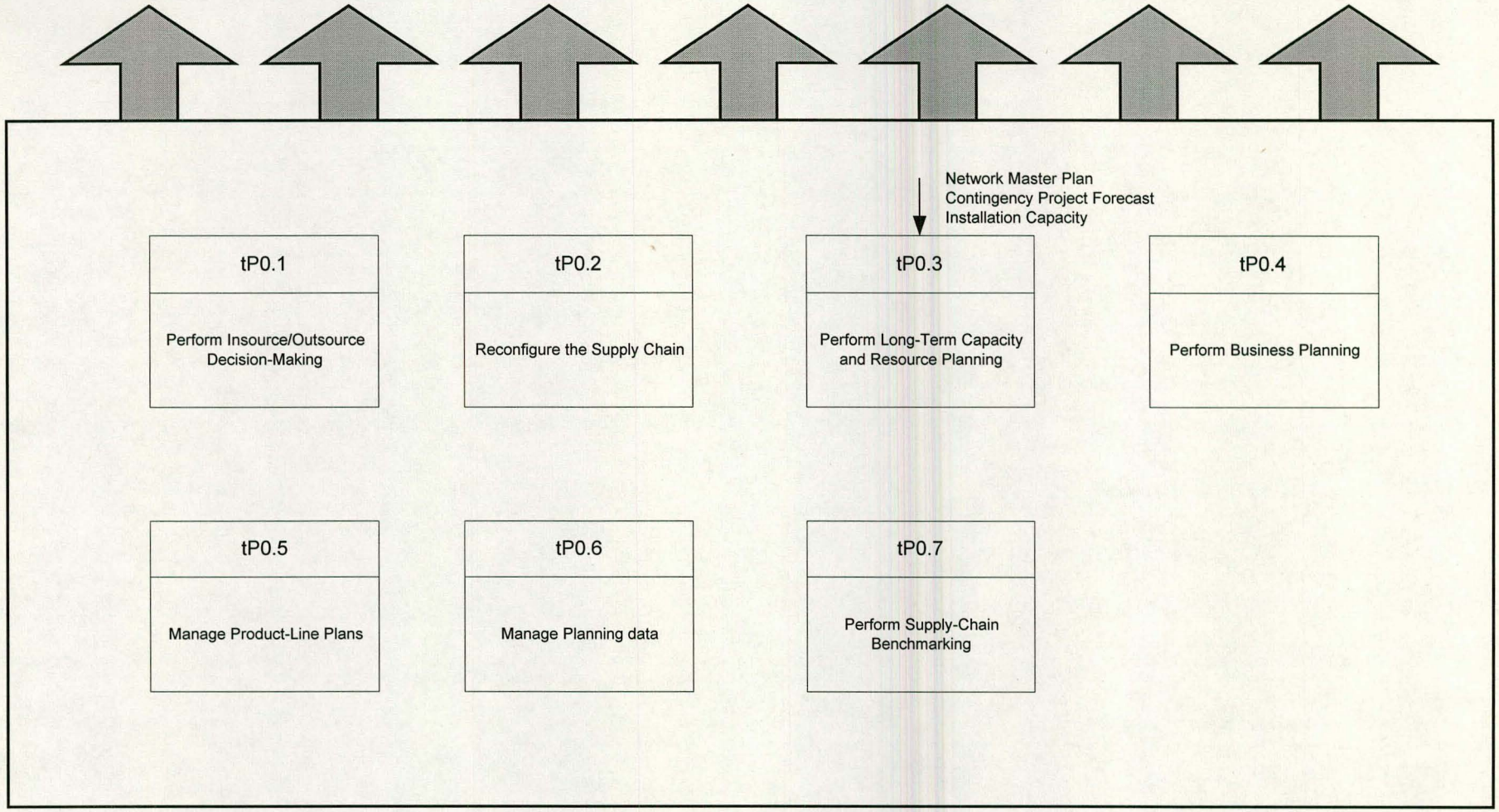

tP0: Plan Infrastructure

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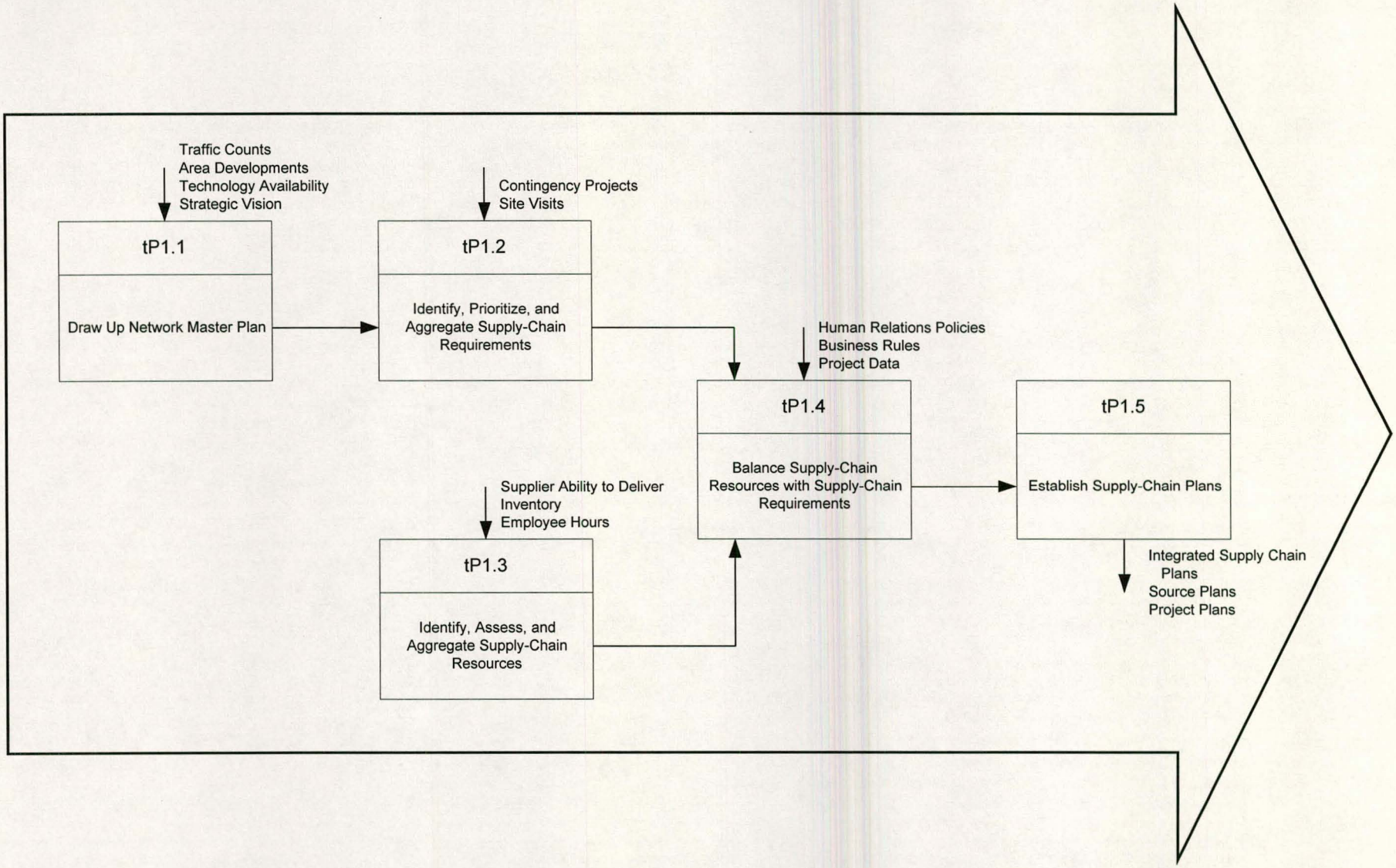

tP1: Plan Supply Chain

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Process Category: **Plan Supply Chain**	**Process Number:** tP1
Process Category Definition	
The development and establishment of courses of action over specified time periods that represent a projected appropriation of Supply Chain resources to meet Supply Chain requirements.	
Performance Attributes	**Metric**
Cycle Time	Cumulative Source/Build Cycle Time Replan Cycle Time Cash-to-cash Cycle Time
Cost	Order Management Costs Inventory Carrying Costs Value-Added Productivity Inventory obsolescence
Service/Quality	Forecast Accuracy Delivery to Customer Request Date
Assets	Return on Assets Capacity Utilization Total Inventory Days of Supply
Best Practices	**Software Features Required**
Re-balancing of full-stream supply/demand on a weekly basis, including Source-Build resources including capacity and schedules of functional departments, contractors and suppliers.	*None Identified*
Capability to run "simulated" full-stream supply/demand balancing for "what-if" scenarios	Supply Chain modeling and visualization system
A change in the supply delivery date signal instantaneously "reconfigures" the build plans for each function	Event-driven Supply Chain replanning
Responsiveness and flexibility are emphasized by developing expertise in making business processes reprogrammable, reconfigurable and continuously changeable	*None Identified*
Supply Chain is designed to have supply flexibility equal to demand volatility	*None Identified*
On-line visibility of all Supply Chain demand requirements and resources, both currently available and committed (pegged)	*None Identified*
Tools support balanced decision making (e.g., trade-off between service level and inventory investment)	*None Identified*
All functions and organizations understand their impact on supply/demand balancing, including project management, functional departments, customer, suppliers, materials management, and contractors	*None Identified*

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Process Category: **Draw Up Network Master Plan**	**Process Number:** tP1.1
Process Category Definition	
The development of a Network Strategy over the next five years and a detailed Plan of action for the next year.	
Performance Attributes	**Metric**
Cycle Time	Estimated Project Times to Actual Project Times to Actual Project Times Master Plan Cycle time
Cost	Estimated Project Costs to Actual Project Costs Master Planning Costs
Service/Quality	Forecast Accuracy Number of Contingency Projects
Assets	Return on Assets Capacity Utilization
Best Practices	**Software Features Required**
Plan is drawn up with consideration and participation of all relevant functional departments, contractors and suppliers.	*None Identified*
Plan is drawn up with consideration for build capacity	*None Identified*
Plan is drawn up with consideration for SLA agreements set with regulatory authority.	*None Identified*
Plan is drawn up with knowledge of technological advances in the line of business.	*None Identified*
Plan is drawn up with knowledge of developments in the region and also specifically the area in which installation is to occur.	*None Identified*
Projects are determined while considering the effects of other projects already specified.	*None Identified*

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Process Element: Identify, prioritize, and aggregate Supply Chain requirements	**Process Element Number:** tP1.2
Process Element Definition	
The process of identifying, prioritizing, and considering, as a whole with constituent parts, all sources of demand in the Supply Chain of a product or service.	
Performance Attributes	Metric
Cycle Time	Forecast Cycle Time Replan Cycle Time
Cost	*None Identified*
Service/Quality	Forecast Accuracy Contingency Forecast Accuracy
Assets	*None Identified*
Best Practices	**Software Features Required**
Relationships with customers are developed to gain more accurate visibility into actual demand via their forecasts, product promotions, etc.	*None Identified*
Joint Service Agreements with customers defining the level of "flexibility" or resource upside available within stated leadtimes and agreed upon conditions	*None Identified*
Joint Service Agreement enables customer and supplier to share risk on resources committed to increase flexibility (e.g. purchase longest-lead materials as buffer to reduce time fences)	*None Identified*
Requirements are represented as a rolling time-phased blend of scheduled backlog, projects identified, contingency projects identified.	*None Identified*
"Push-based" forecasts are replaced with customer replenishment or "pull-based" signals	*None Identified*
Systems support accurate on-line visibility of full-stream demand requirements and priorities	*None Identified*
The demand plan is updated frequently to reflect actual consumption or customer forecast information	*None Identified*

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Process Element: Identify, prioritize, and aggregate Supply Chain resources	**Process Element Number:** tP1.3
Process Element Definition	
The process of identifying, evaluating, and considering, as a whole with constituent parts, all things that add value in the Supply Chain of an installation	
Performance Attributes	**Metric**
Cycle Time	Actual to Theoretical Installation Times
Cost	Resource Variability Costs Overtime Costs
Service/Quality	Delivery to Customer Request Date
Assets	Inventory cycle-counting accuracy Capacity Utilization
Best Practices	**Software Features Required**
All resources from across the Supply Chain are identified, assessed, and aggregated into a full-stream representation of resources (an entity's own, suppliers, and customers resources of inventory, capacity, etc.)	*None Identified*
EDI links integrating supplier and contractor resource information (inventory, capacity availability, etc.) with own resources	*None Identified*
Joint Service Agreements with suppliers and contractors defining the level of "flexibility" or resource upside available to Source within stated leadtimes and agreed upon conditions	*None Identified*
Supply Chain is designed so supply flexibility equals demand volatility	*None Identified*
Systems support accurate on-line visibility of full-stream resources	*None Identified*
Lead-times reflect "worst we can do"	*None Identified*
Effective inventory policies categorize 100% of total inventory (active, usable, excess, obsolete) and take appropriate action	*None Identified*

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Process Element: Balance Supply Chain resources with Supply Chain requirements	**Process Element Number:** tP1.4
Process Element Definition	
The process of developing a time-phased course of action that commits Supply Chain resources to meet Supply Chain requirements.	
Performance Attributes	**Metric**
Cycle Time	Replan cycle time
Cost	Supply Chain finance and planning costs
Service/Quality	Delivery to customer request date
Assets	Capacity utilization Total inventory Days of Supply
Best Practices	**Software Features Required**
Supply/demand balancing drives for optimal combination of customer service (e.g. on-time delivery or fill-rate) and resource investment	*None Identified*
Clearly defined expectations between Project Manager and Functional teams in terms of time fence policies (e.g. frozen window, +/- percent deviations at various agreed points in the future)	*None Identified*
Flexibility around nominal volumes and mix is agreed at planning meeting and supported by specific flexibility agreements • JSA terms and conditions are established to support 80-90% of the volume under "normal" conditions • Exceptions, or violations, to the JSA are systematically identified and managed by a process owner	*None Identified*
Planned project dates are reviewed weekly and new schedules are put in place on a weekly basis (BIC = daily) • Open demand is automatically aggregated by product family and compared to previous forecast • Variances greater than an established level are flagged for analysis and validation by a project manager • Costs of rescheduling are calculated based upon loss in resource capacity and inventory handling • Revenue projections and potential supply/capacity adjustments are automatically distributed to senior management and all functional departments involved.	*None Identified*

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Process Element: Establish Supply Chain plans	**Process Element Number:** tP1.5
Process Element Definition	
The establishment of courses of action over specified time periods that represent a projected appropriation of Supply Chain resources to meet Supply Chain requirements.	
Performance Attributes	**Metric**
Cycle Time	Replan cycle time
Cost	*None Identified*
Service/Quality	Plan stability
Assets	*None Identified*
Best Practices	**Software Features Required**
All functions and organizations understand their impact on supply/demand balancing, including project management, functional departments, customer, suppliers, materials management, and contractors	*None Identified*
Plans which do not violate business rules are communicated openly and cross-functionally for execution	*None Identified*
Plans which violate business rules (e.g. Joint Service Agreements) are addressed cross-functionally, considering total business impacts (revenue, cost, quality, customer service, etc.)	*None Identified*
To address conditions which cannot be adequately satisfied during the current planning period, each functional area develops prioritized recommendations for the subsequent planning period	*None Identified*
Specific changes to the plan are agreed to cross-functionally, according to defined business rules (e.g. lowest cost, lowest lateness, etc.)	*None Identified*

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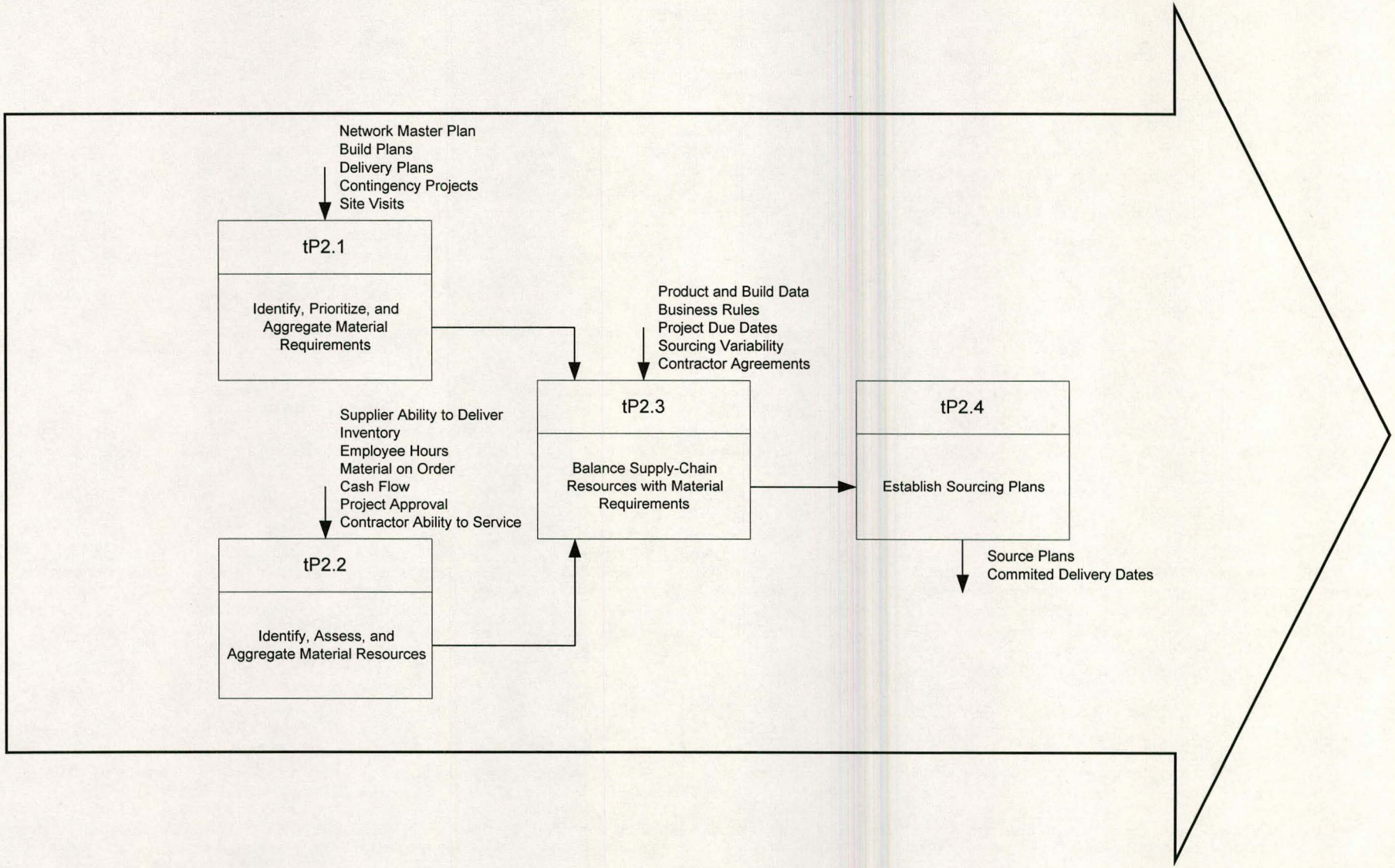

tP2: Plan Source

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Process Category: Plan Source	**Process Number:** tP2
Process Category Definition	
The development and establishment of courses of action over specified time periods that represent a projected appropriation of material resources and contractor services to meet Supply Chain requirements.	
Performance Attributes	**Metric**
Cycle Time	Cumulative Source Cycle Time Source Flexibility Source cycle time
Cost	Inventory carrying costs Number of Supply Sources Raw Material Shrinkage Commodity Management Profile
Service/Quality	Supplier/Contractor Delivery Performance to Customer Request Date Supplier Fill Rate Contractor Service Level
Assets	Raw Material Inventory Days of Supply
Best Practices	**Software Features Required**
EDI links integrate supplier resource information (inventory, capacity availability, etc.) with own resources	Inter-company resource planning with EDI/Internet communication
Joint Service Agreements with suppliers define the levels of "flexibility" or resource upside available within stated leadtimes and agreed upon conditions	*None Identified*
Distinct and consistent linkages exist to ensure disruptions and opportunities in material resources are quickly and accurately communicated and acted upon	Bi-directional EDI or Internet procurement to customer service linkage
All key participants in the Supply Chain, including strategic partners, have full visibility of the status of projects (e.g. approved, planned, completed, etc.)	*None Identified*
Joint Service Agreements with contractors define the levels of "flexibility" or resource upside available within stated leadtimes and agreed upon conditions and Contractor Service levels.	*None Identified*
Joint Service Agreements with suppliers allow the delayed delivery of products and materials ordered.	*None Identified*

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Process Element Name: Identify, prioritize, and aggregate material requirements	**Process Element Number:** tP2.1
Process Element Definition	
The process of identifying, prioritizing, and considering, as a whole with constituent parts, all sources of demand for material in the Supply Chain of an Installations.	
Performance Attributes	**Metric**
Cycle Time	Forecast Cycle Time Project Plan Cycle Time
Cost	Project Plan Costs
Service/Quality	Forecast Accuracy Material Requirement Accuracy
Assets	*None Identified*
Best Practices	**Software Features Required**
The demand plan is updated frequently to reflect actual consumption or customer forecast information	*None Identified*
Capacity and supply constraints are balanced against demand during the planning cycle • Network Master Plan reflects management of capacity and/or supply constraints • Customers, operations, and management agree to limits of short term flexibility	*None Identified*

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Process Element Name: Identify, assess, and aggregate material resources	**Process Element Number:** tP2.2
Process Element Definition	
The process of identifying, evaluating, and considering, as a whole with constituent parts, all material used to add value in the Supply Chain of a product or contractor services.	
Performance Attributes	**Metric**
Cycle Time	*None Identified*
Cost	Number of Supply Sources Commodity Management Profile Inventory on Hand
Service/Quality	Inventory Accuracy
Assets	Raw Material Inventory Days of Supply
Best Practices	**Software Features Required**
Capacity and supply constraints identified during Network Master Plan process are balanced against demand during the planning cycle	*None Identified*
Inventory is planned at the part level, based on supply and demand variability. • Inventory performance is measured at the dollar and unit levels • Inventory targets are reviewed and adjusted frequently • Inventory obsolescence is reviewed at the part number level	*None Identified*

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Process Element Name: Balance material resources with material requirements	**Process Element Number:** tP2.3
Process Element Definition	
The process of developing a time-phased course of action that commits material resources to meet material requirements.	
Performance Attributes	**Metric**
Cycle Time	Replan cycle Time Source Flexibility
Cost	Material planning costs
Service/Quality	Supplier Delivery Performance to Customer Request Date
Assets	Inventory days of supply
Best Practices	**Software Features Required**
Suppliers share responsibility for balancing supply and demand through Joint Service Agreements	*None Identified*

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Process Element Name: Establish souring plans	**Process Element Number:** P2.4
Process Element Definition	
The establishment of courses of action over specified time periods that represent a projected appropriation of supply resources to meet sourcing plan requirements.	
Performance Attributes	**Metric**
Cycle Time	Source cycle time
Cost	Number of Supply Sources Commodity Management Profile
Service/Quality	Supplier Delivery Performance to Customer Request Date Supplier Fill Rate
Assets	Raw Material Inventory Days of Supply
Best Practices	**Software Features Required**
EDI is used to provide real-time demand information and handle routine transactions	*None Identified*
Blanket purchase orders cover period requirements	*None Identified*
Suppliers are aware of project delays	*None Identified*
Suppliers base due dates on latest delivery date of all projects	*None Identified*

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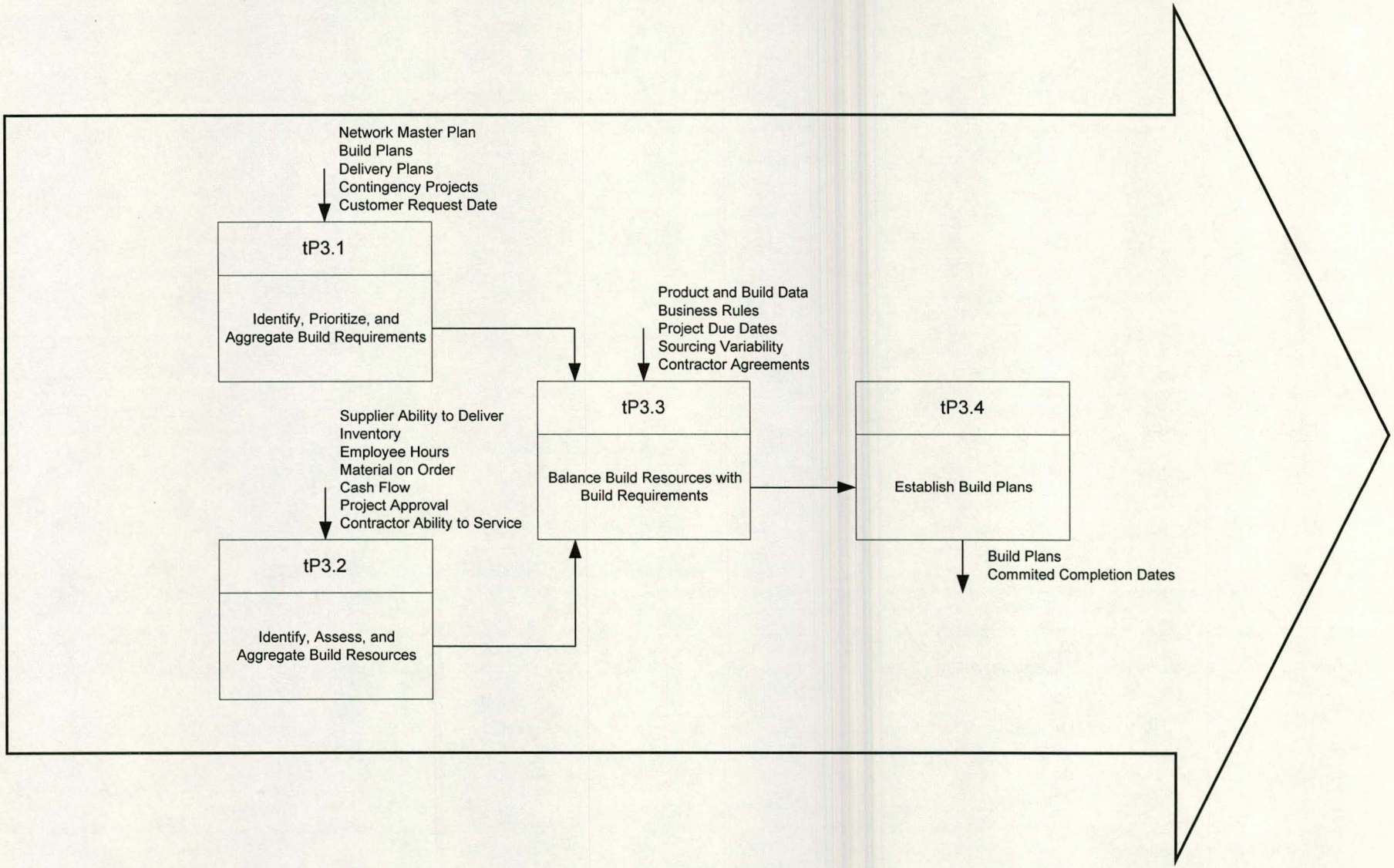

tP3: Plan Build

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Process Element Name: Plan Build	**Process Element Number:** tP3
Process Element Definition	
The development and establishment of courses of action over specified time periods that represent a projected appropriation of production resources to meet installation requirements.	
Performance Attributes	**Metric**
Cycle Time	Cumulative Build Cycle Time Shortest Build Cycle Time to Scheduled Cycle Time Scheduled Cycle Time to Actual Cycle Time Build flexibility Number of End Installations
Cost	Inventory Carrying Costs Work in Process Shrinkage Material Overhead Cost Per Dollar of Material Expenditure Overtime Expenditure
Service/Quality	Build plan adherence Shortest Build Cycle Time to Scheduled Cycle Time Scheduled Cycle Time to Actual Cycle Time
Assets	Work in Process Inventory Days of Supply Inventory Obsolescence
Best Practices	**Software Features Required**
Distinct and consistent linkages exist to ensure disruptions and opportunities in build resources are quickly and accurately communicated and responded to	*None Identified*
Delays in one build function is considered in scheduling other projects	*None Identified*

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Process Element Name: Identify, prioritize, and aggregate build requirements	**Process Element Number:** tP3.1
Process Element Definition	
The process of identifying, prioritizing, and considering as a whole with constituent parts, all sources of demand in the production of a product or service.	
Performance Attributes	**Metric**
Cycle Time	Shortest Build Cycle Time to Scheduled Cycle Time Scheduled Cycle Time to Actual Cycle Time
Cost	*None Identified*
Service/Quality	Forecast Accuracy
Assets	*None Identified*
Best Practices	**Software Features Required**
Consideration of supplier's material availability in company's supply resources (including supplier's production plans and capability, inventory, and delivery plans)	Internet linkage to supplier quoting, planning, configuration and customer service applications
Consideration of contractors service availability in company's supply resources (including supplier's production plans and capability, inventory, and delivery plans)	Internet linkage to supplier quoting, planning, configuration and customer service applications

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Process Element Name: Identify, assess, and aggregate build resources	**Process Element Number:** tP3.2
Process Element Definition	
The process of identifying, evaluating, and considering, as a whole with constituent parts, all things that add value in the production of a product.	
Performance Attributes	**Metric**
Cycle Time	*None Identified*
Cost	*None Identified*
Service/Quality	*None Identified*
Assets	*None Identified*
Best Practices	**Software Features Required**
Inventory targets are reviewed and adjusted frequently	*None Identified*
Inventory obsolescence is reviewed at the part number level	*None Identified*

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Process Element Name: Balance build resources with build requirements	**Process Element Number:** tP3.3
Process Element Definition	
The process of developing a time-phased course of action that commits production resources to meet production requirements.	
Performance Attributes	**Metric**
Cycle Time	Cumulative Build Cycle Time Build Flexibility
Cost	Overtime expenditure Staff Borrowed
Service/Quality	Project Lateness
Assets	Work in Process Inventory Days of Supply Inventory Obsolescence
Best Practices	**Software Features Required**
Inventory targets are reviewed and adjusted frequently	*None Identified*

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Process Element Name: Establish Build Plans	**Process Element Number:** tP3.4
Process Element Definition	
The establishment of courses of action over specified time periods that represent a projected appropriation of supply resources to meet production plan requirements.	
Performance Attributes	**Metric**
Cycle Time	Cumulative Build Cycle Time
Cost	Work in Process Inventory Carrying Costs
Service/Quality	Build plan adherence Shortest Build Cycle Time to Scheduled Cycle Time Scheduled Cycle Time to Actual Cycle Time
Assets	Work in Process Inventory Days of Supply Inventory Obsolescence.
Best Practices	**Software Features Required**
Contingency Projects get priority Status	*None Identified*
No Material is taken from other projects to complete a project	*None Identified*

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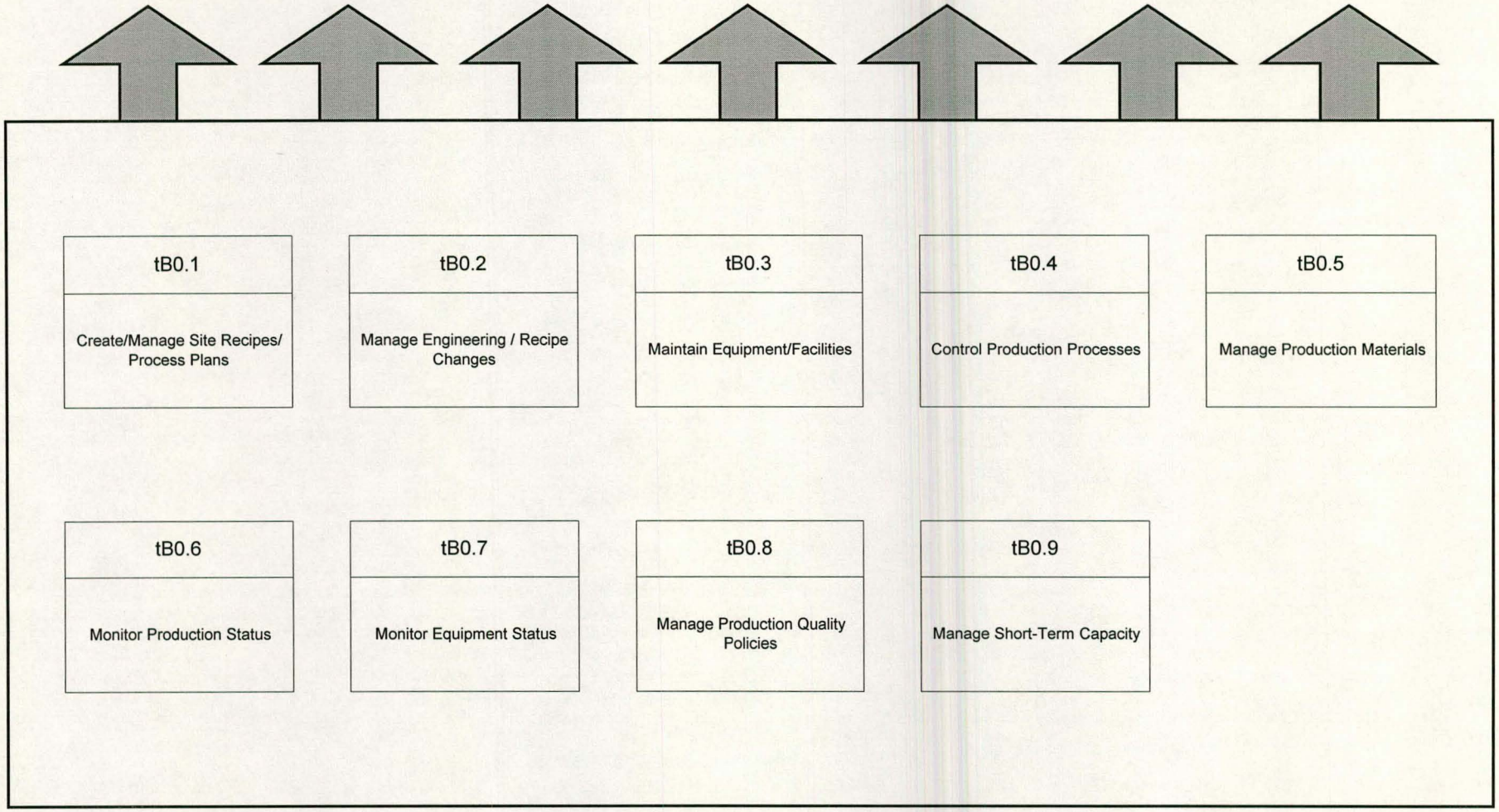

tB0: Build Infrastructure

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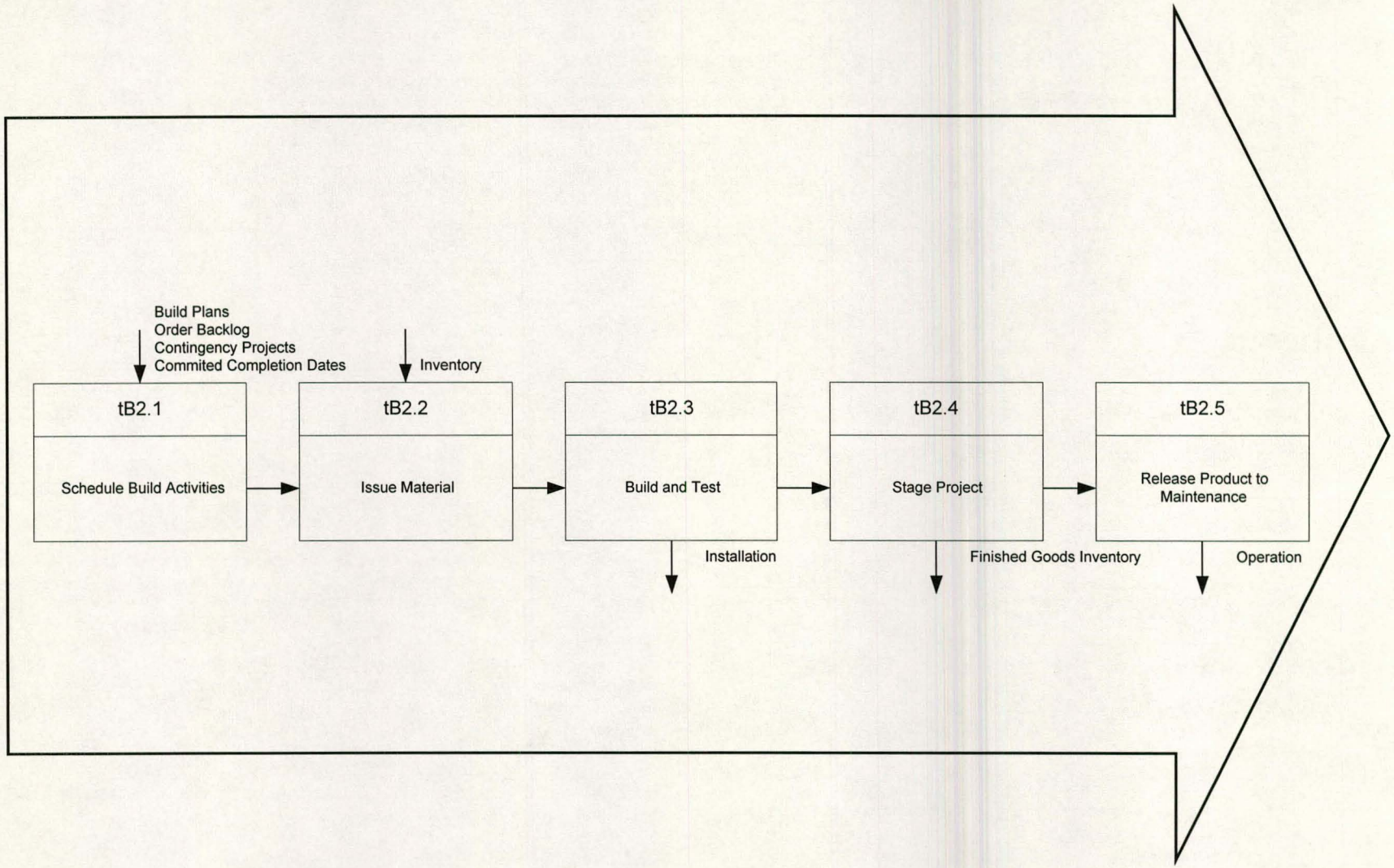

tB2: Build-to-order

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Process Category: **Build-to-Order**	**Process Number:** tB2
Process Category Definition	
The process of build in a build to order environment is the adding of value to the network by installing equipment. A make to build environment is one in which projects are completed after receipt of a customer order and are built or configured only in response to a customer order.	
Performance Attributes	**Representative Metrics**
Cycle Time	Replan Cycle Time Child Project Installation Time
Cost	Value-added productivity Average section-wide salary Section Cost per hour Indirect to direct headcount ratio Overhead cost Child Project Cost
Service/Quality	Performance to customer request date Performance to commit date Yield
Assets	Asset Turns Capacity utilization Inventory Aging
Best Practices	**Software Feature Required**
Organization to enhance flexibility: Few job classifications, self-directed work force, flat management structure, cross-functional work teams.	***None identified***
Avoid juggling orders. Juggle orders only when inventory delivery is delayed or other child projects are delayed.	***None identified***
Posted performance results	***None identified***
Accurate and approved work instructions/ process plans	***None identified***
Paperless Project tracking	***None identified***
Link individual performance to organizational and divisional goals	***None identified***
Provide continuous formal training to employees	*None identified*
Implement employee involvement programs	*None identified*

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Process Element: Scheduling Build Activities	**Process Element:** tB2.1
Process Element Definition:	
Given plans for the manufacture of specific installations, the scheduling of the operations to be preformed in accordance with these plans. Scheduling includes sequencing, and due date commitments of other child projects.	
Performance Attributes	**Representative Metrics**
Cycle Time	Responsiveness lead time Schedule cycle time Schedule interval
Cost	Work in Process inventory Days of Supply Equipment losses Schedule resource costs Section level order management costs
Service/Quality	Installation flexibility Percentage of orders scheduled to customer request date Schedule achievement
Assets	*Capacity utilization*
Best Practices	**Software Feature Required**
Schedule reflects current plant status (equipment availability, other jobs and resource availability) on line	Schedule undated by on line reporting and status systems and re-sequence activities
Schedule includes preventative maintenance program	*None Identified*
Maintain data integrity and system accuracy by ensuring 99%+ production data, inventory levels, and schedule requirements	Detail production scheduling model that synchronizes Plan and Build activities
Cross Training/certification	Human Resource/certification support
Demand pull mechanisms	*None Identified*
Scheduling is based on latest completion date of all child projects.	*None Identified*
Work in Process inventory is minimized	*None Identified*

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Process Element: Issue material	**Process Element Number:** tB2.2
Process Element Definition	
The selection and physical movement of materials (e.g., raw materials, fabricated components, equipment, manufactured subassemblies, required ingredients or intermediate formulations) from a stocking location (e.g., stockroom, a location on the production floor, a supplier) to a specific point of use location. Issuing material includes the corresponding system transaction.	
Performance Attributes	**Metric**
Cycle Time	Material requisition cycle time Percentage of parts received at point of use
Cost	Inventory obsolescence
Service/Quality	Inventory accuracy
Assets	Cash-to-cash cycle time
Best Practices	**Software Features Required**
Strategic safety stock of selected materials, items, or subassemblies to decouple equipment issuance cycle time from supplier lead time	*None Identified*
Electronic equipment demand transactions	Automated process control and/or barcode data collection
Complete lot history	*None Identified*
Supplier delivery to production process at point of use	*None Identified*

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Process Element: Build and Test	**Process Element Number:** tB2.3
Process Element Definition	
The series of activities performed upon equipment to integrate them to form a fully functioning system and the processes associated with the validation of the installation performance to ensure conformance to defined specifications and requirements.	
Performance Attributes	**Metric**
Cycle Time	Shortest Build Cycle Time to Scheduled Cycle Time Scheduled Cycle Time to Actual Cycle Time
Cost	Value-added productivity Child project employment Asset turns
Service/Quality	Scrap expense Quality levels In-process failure rates Yield
Assets	Capacity utilization
Best Practices	**Software Features Required**
Just-in-Time/demand flow techniques	*None Identified*
Authorize each operation to assess the quality of the previous operations	*None Identified*
Paperless production control	*None Identified*
Accurate and approved process plans/specifications	*None Identified*
Reduce chances of installer error	*None Identified*
Reduce non-value added paperwork while still measuring process metrics	*None Identified*
Reduce non-value added activities, including equipment transportation, etc.	*None Identified*
Maintain accurate project history information	*None Identified*

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Process Element: Stage Product	**Process Element Number:** tB2.4
Process Element Definition	
After completion, the Child Project awaits the completion of the entire project before it can be released.	
Performance Attributes	**Metric**
Cycle Time	Build to release cycle time
Cost	Inventory aging Inventory Spoiled
Service/Quality	*None Identified*
Assets	Finished Goods Inventory Days of Supply
Best Practices	**Software Features Required**
Schedule all child projects to end simultaneously	*None Identified*
Minimise Parent project Build Cycle Time	*None Identified*

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Process Element: Release product to Maintenance	**Process Element Number:** tB2.5
Process Element Definition	
Activities associated with post-production documentation, testing, or certification required prior to hand over of child project to maintenance.	
Performance Attributes	**Metric**
Cycle Time	Test time Error Correction Time
Cost	*None Identified*
Service/Quality	Percentage release errors
Assets	Finished Goods Inventory Days of Supply
Best Practices	**Software Features Required**
None Identified	*None Identified*

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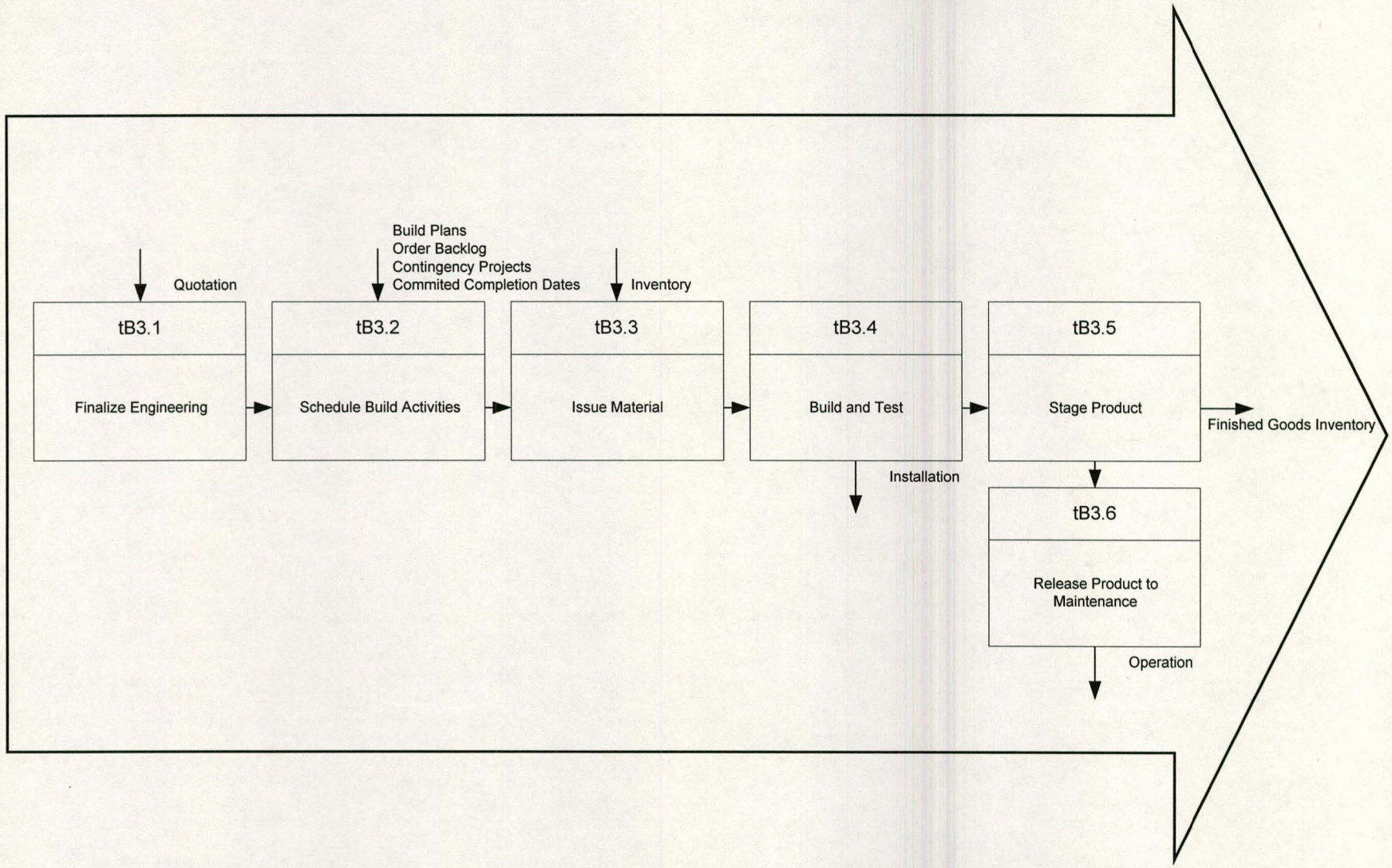

tB3: Engineer-to-order

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Process Category: Engineer to Order	**Process Number:** tB3
Process Category Definition	
The process of build in a build to order environment is the adding of value to the network by installing equipment. While Build to Order includes standard products built only in response to a customer order or products configured in response to a customer order, Engineer to Order includes custom products that are designed, developed, and manufactured in response to a specific customer request. This would typically be the first time installation of a specific type of equipment.	
Performance Attributes	**Metric**
Cycle Time	Order fulfillment cycle time Number of Engineering Change Orders
Cost	Value-added productivity Average section-wide salary Engineering Change Order cost Overhead cost
Service/Quality	Performance to customer request date Performance to commit date
Assets	Asset turns Capacity utilization Inventory aging
Best Practices	**Software Features Required**
Organize to enhance flexibility: few job classifications, self-directed work force, flat management structure, cross-functional work teams	Support for modular skills inventory with links to training databases, compensations systems, and operator instructions
Strict FIFO adherence - avoid juggling orders	*None Identified*
Posted performance results	*None Identified*
Paperless order tracking	Electronic dispatch and data collection at work center
Provide continuous formal training to employees	*None Identified*

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Process Element: Finalize Engineering	**Process Element Number:** tB3.1
Process Element Definition	
Engineering activities required after acceptance of order, but before installation starts. May include generation and delivery of final drawings, specifications, formulas, part programs, etc. In general, the last step in the completion of any preliminary engineering work done as part of the quotation process.	
Performance Attributes	**Metric**
Cycle Time	Number of ECOs Deliver to commit date Order fulfillment cycle time
Cost	Engineering Change Order cost
Service/Quality	Capacity utilization
Assets	*None Identified*
Best Practices	**Software Features Required**
None Identified	*None Identified*

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Process Element: Schedule Manufacturing Activities	**Process Element Number:** tB3.2
Process Element Definition	
Given plans for the manufacture of specific installations, the scheduling of the operations to be performed in accordance with these plans. Scheduling includes sequencing, and due date commitments of other child projects.	
Performance Attributes	**Metric**
Cycle Time	Responsiveness lead time
Cost	Inventory Days of Supply Section level order management costs
Service/Quality	Build flexibility Percentage of orders scheduled to customer request date Schedule achievement
Assets	Cross training
Best Practices	**Software Features Required**
Use knowledge from other similar projects, current project gets preference	*None Identified*
Schedule reflects current plant status (equipment, jobs, and other resources on-line)	On-line reporting from operations
Schedule includes preventive maintenance program	Interface to maintenance management system
Maximize data integrity and system accuracy by ensuring 99%+ accuracy of BOM configuration, inventory levels, and schedule requirements	*None Identified*
Design/upgrade production equipment to maximize flexibility and avoid project stoppages	*None Identified*
Cross-training/Certification	*None Identified*

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Process Element: Issue material	**Process Element Number:** tB3.3
Process Element Definition	
The physical movement of materials (e.g., raw materials, fabricated components, manufactured subassemblies, required ingredients or intermediate formulations) from a stocking location (e.g., stockroom, a location on the production floor, a supplier) to a specific point of use location. Issuing material includes the corresponding system transaction.	
Performance Attributes	**Metric**
Cycle Time	Material requisition cycle time Percentage of parts received at point of use Receiving and put away cycle time
Cost	Inventory obsolescence
Service/Quality	Inventory accuracy
Assets	Cash-to-cash cycle time
Best Practices	**Software Features Required**
Supplier delivery to production line at point-of-use	EDI link to supplier's sales order and inventory systems
Strategic safety stock of selected materials or subassemblies to decouple material issuance cycle time from supplier lead time'	*None Identified*

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Process Element: Build and Test	**Process Element Number:** tB3.4
Process Element Definition	
The series of activities performed upon equipment to integrate them to form a fully functioning system and the processes associated with the validation of the installation performance to ensure conformance to defined specifications and requirements.	
Performance Attributes	**Metric**
Cycle Time	Shortest Build Cycle Time to Scheduled Cycle Time Scheduled Cycle Time to Actual Cycle Time
Cost	Child Project employment Asset turns Value-Added Productivity
Service/Quality	Scrap expense Quality levels In-process failure rates Yield
Assets	Yield variability Capacity utilization
Best Practices	**Software Features Required**
Just-in-time demand flow techniques	*None Identified*
Authorize each operation to assess the quality of the previous operations and prevent operator-introduced errors	*None Identified*
Paperless production control	*None Identified*
Reduce non-value added paperwork while still measuring process metrics	*None Identified*
Reduce non-value added activities, including equipment transportation	*None Identified*
Link individual performance to organizational and divisional goals	*None Identified*
Provide continuous formal training to employees	*None Identified*
Implement employee involvement program	*None Identified*
Maintain accurate project history information	*None Identified*

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Process Element: Stage Product	**Process Element Number:** tB3.5
Process Element Definition	
After completion, the Child Project awaits the completion of the entire project before it can be released.	
Performance Attributes	**Metric**
Cycle Time	Build to release cycle time
Cost	Inventory Aging Inventory Spoiled
Service/Quality	*None Identified*
Assets	Finished Goods Inventory Days of Supply
Best Practices	**Software Features Required**
Schedule all Child Projects to end simultaneously	*None Identified*
Minimize Parent Project Build Cycle Time	*None Identified*

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Process Element: Release product to Maintenance	**Process Element Number:** tB3.6
Process Element Definition	
Activities associated with post-production documentation, testing, or certification required prior to hand over of child project to maintenance.	
Performance Attributes	**Metric**
Cycle Time	Test time Error Correction Time
Cost	*None Identified*
Service/Quality	Percentage release errors
Assets	Finished Goods Inventory Days of Supply
Best Practices	**Software Features Required**
None Identified	*None Identified*

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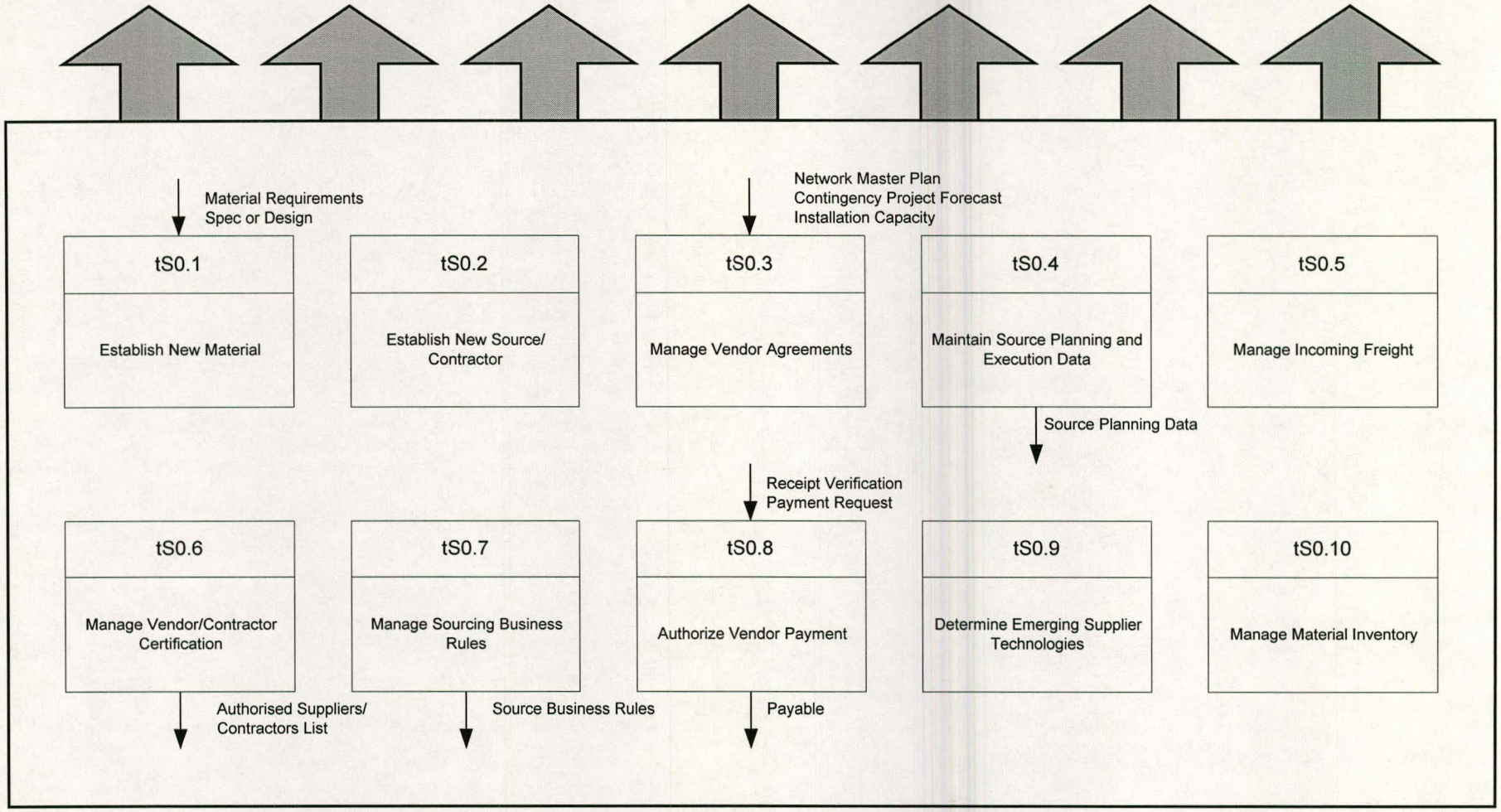

tS0: Source Infrastructure

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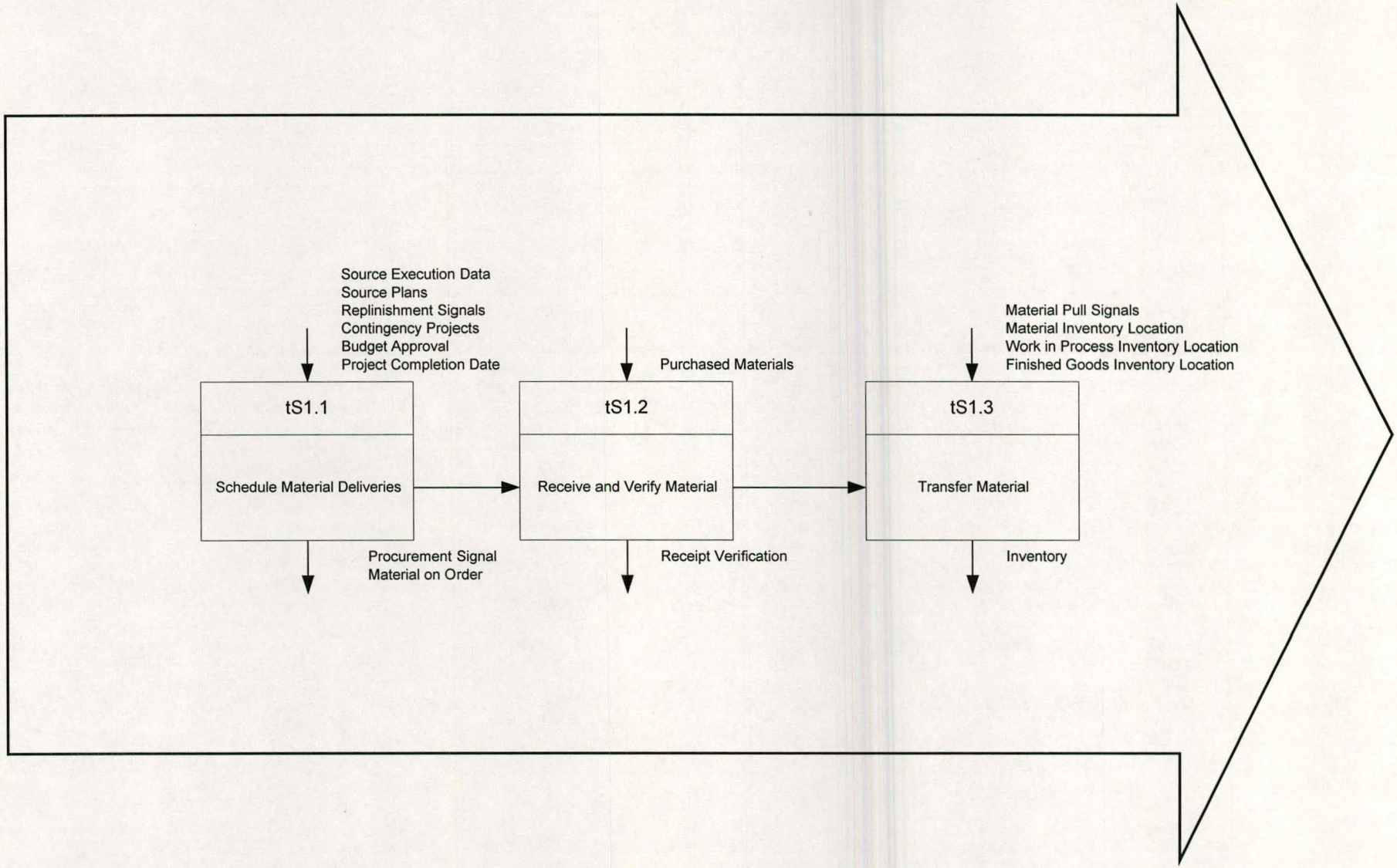

tS1: Source Stocked Material to Inventory

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Process Category: Source Stocked Materials to Inventory	**Process Number:** tS1
Process Category Definition	
The procurement, delivery, receipt and transfer of raw material items, and subassemblies to replenish inventory levels. This is used for items that the company orders to keep provide from stock.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time
Cost	Material Acquisition Costs
Service/Quality	Percentage defective
Assets	Inventory Days of Supply
Best Practices	**Software Features Required**
Joint Service Agreements	*None Identified*
Special Rates as Preferred Supplier	*None identified*
Automated pull signals are used to notify suppliers of the need to deliver material	*None identified*

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Process Element: Schedule Material Deliveries	**Process Number:** tS1.1
Process Element Definition	
Scheduling and managing the execution of the individual deliveries of material against an existing contract or purchase order. The requirements for material releases are determined based on the detailed sourcing plan or other types of material pull signals.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time Percentage of EDI Transactions
Cost	Materials Management as a Percentage of Materials Acquisitions Costs Average section-wide salary
Service/Quality	Percentage defective
Assets	Inventory material days of supply (Days of Supply)
Best Practices	**Software Features Required**
Utilize EDI transactions to reduce cycle time and costs	EDI interface for 830, 850, 856 and 862 transactions
VMI agreements allow suppliers to manage (replenish) inventory	Vendor managed inventories with scheduling interfaces to external vendor systems
Automated pull signals are used to notify suppliers of the need to deliver material	*None identified*
Consignment agreements are used to reduce assets and cycle time while increasing the availability of critical items	Consignment inventory management
Advanced ship notices allow for tight synchronization between source and build processes	Blanket order support with scheduling interfaces to external vendor systems

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Process Element: Receive and Verify Materials	**Process Number:** tS1.2
Process Element Definition	
The receipt and acceptance of material deliveries. This includes all of the activities associated with receiving, verifying and accepting material deliveries.	
Performance Attributes	**Metric**
Cycle Time	Source Cycle Time
Cost	Receiving costs as a Percentage of Material Acquisition Costs Average section-wide salary
Service/Quality	Supplier On Time Delivery Performance over Percentage defective
Assets	*None identified*
Best Practices	**Software Features Required**
Supplier certification programs are used to reduce (skip lot) or eliminate receiving inspection	Skip lot/sampling inspection logic
Bar coding is used to minimize handling time and maximize data accuracy	Bar code interface for data collection devices Generate bar coded receiving documents
Deliveries are balanced throughout each working day and throughout the week	*None identified*
Supplier delivers directly to point of use	*None identified*

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Process Element: Transfer Material	**Process Number:** tS1.3
Process Element Definition	
The transfer of accepted material to the appropriate stocking location within the Supply Chain. This includes all of the activities associated with repackaging, staging, transferring and stocking material.	
Performance Attributes	**Metric**
Cycle Time	Order receive to Stock Available Cycle Time
Cost	Receiving and material storage costs as a Percentage of Material Acquisition Costs Transport Cost
Service/Quality	*None Identified*
Assets	Transportation Utilization
Best Practices	**Software Features Required**
Drive deliveries directly to stock or point-of-use in manufacturing to reduce costs and cycle time	Pay on receipt Specify delivery location and time (to the minute) Specify delivery sequence

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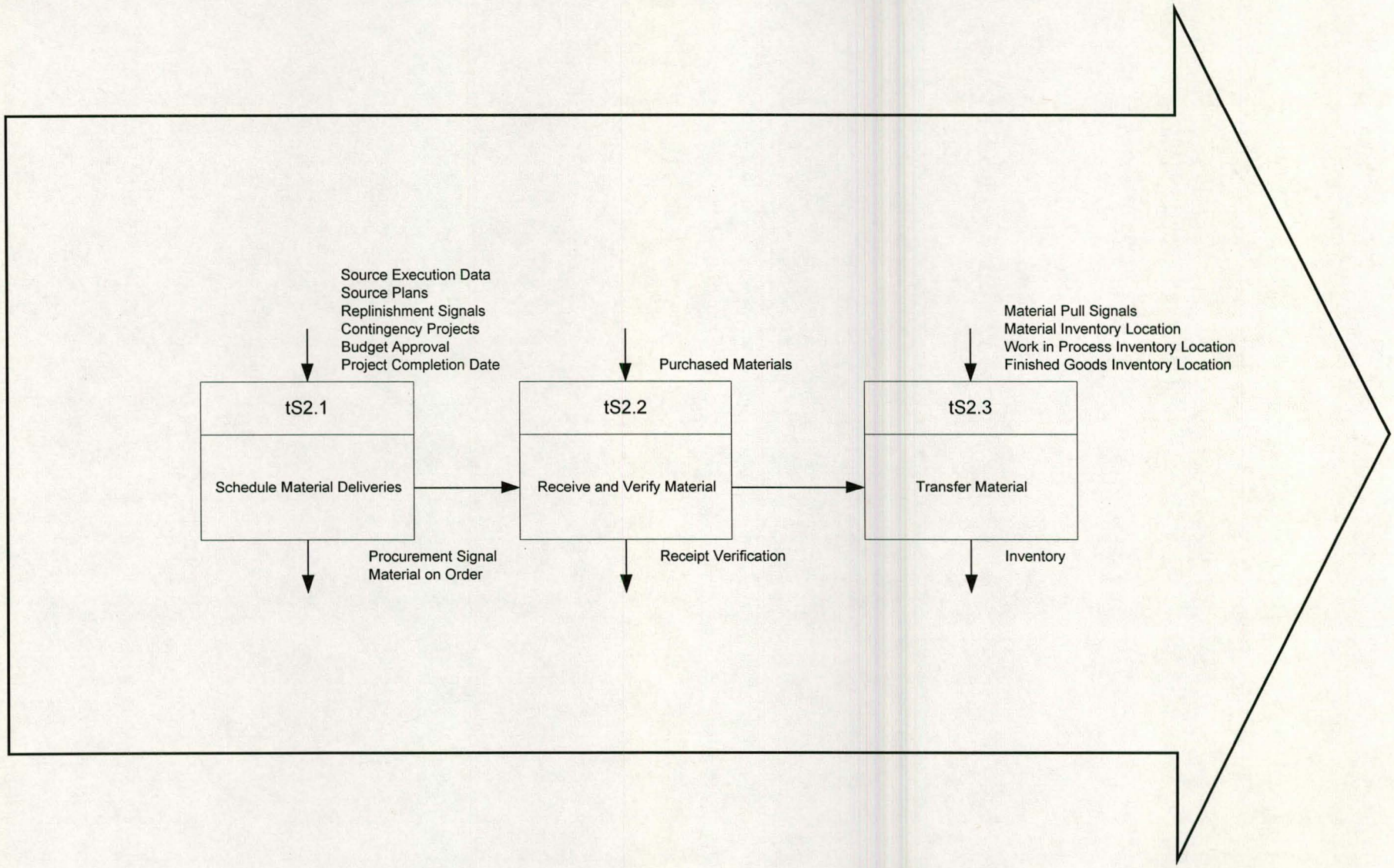

tS2: Source Stocked Material to Order

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Process Category: Source Stocked Materials to Order	**Process Number:** tS2
Process Category Definition	
The procurement, delivery, receipt and transfer of raw material items, and subassemblies for a specific order. This is used for items ordered for specific projects.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time
Cost	Material Acquisition Costs
Service/Quality	Percentage defective
Assets	Inventory Days of Supply
Best Practices	**Software Features Required**
Joint Service Agreements	*None Identified*
Materials are dedicated to a project and should not be borrowed to other projects or installations	*None identified*

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Process Element: Schedule Material Deliveries	**Process Number:** tS2.1
Process Element Definition	
Scheduling and managing the execution of the individual deliveries of material against an existing contract or purchase order. The requirements for material releases are determined based on the detailed sourcing plan.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time Percentage of EDI Transactions
Cost	Materials Management as a Percentage of Materials Acquisitions Costs Average section-wide salary
Service/Quality	Percentage defective
Assets	Inventory material days of supply (Days of Supply)
Best Practices	**Software Features Required**
Utilize EDI transactions to reduce cycle time and costs	EDI interface for 830, 850, 856 and 862 transactions
Automated pull signals are used to notify suppliers of the need to deliver material	*None identified*
Consignment agreements are used to reduce assets and cycle time while increasing the availability of critical items	Consignment inventory management
Advanced ship notices allow for tight synchronization between source and build processes	Blanket order support with scheduling interfaces to external vendor systems

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Process Element: Receive and Verify Materials	**Process Number:** tS2.2
Process Element Definition	
The receipt and acceptance of material deliveries. This includes all of the activities associated with receiving, verifying and accepting material deliveries.	
Performance Attributes	**Metric**
Cycle Time	Source Cycle Time
Cost	Receiving costs as a Percentage of Material Acquisition Costs Average section-wide salary
Service/Quality	Supplier On Time Delivery Performance over Percentage defective
Assets	*None identified*
Best Practices	**Software Features Required**
Supplier certification programs are used to reduce (skip lot) or eliminate receiving inspection	Skip lot/sampling inspection logic
Bar coding is used to minimize handling time and maximize data accuracy	Bar code interface for data collection devices Generate bar coded receiving documents
Deliveries are balanced throughout each working day and throughout the week	*None identified*
Supplier delivers directly to point of use	*None identified*
Material Ordering is done in Coordination with other Child Projects	*None identified*

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Process Element: Transfer Material	**Process Number:** tS2.3
Process Element Definition	
The transfer of accepted material to the appropriate stocking location within the Supply Chain. This includes all of the activities associated with repackaging, staging, transferring and stocking material.	
Performance Attributes	**Metric**
Cycle Time	Order receive to Stock Available Cycle Time
Cost	Receiving and material storage costs as a Percentage of Material Acquisition Costs Transport Cost
Service/Quality	*None Identified*
Assets	Transportation Utilization
Best Practices	**Software Features Required**
Drive deliveries directly to stock or point-of-use in manufacturing to reduce costs and cycle time	Pay on receipt Specify delivery location and time (to the minute) Specify delivery sequence
Inventory is shipped as needed in project time line	*None identified*

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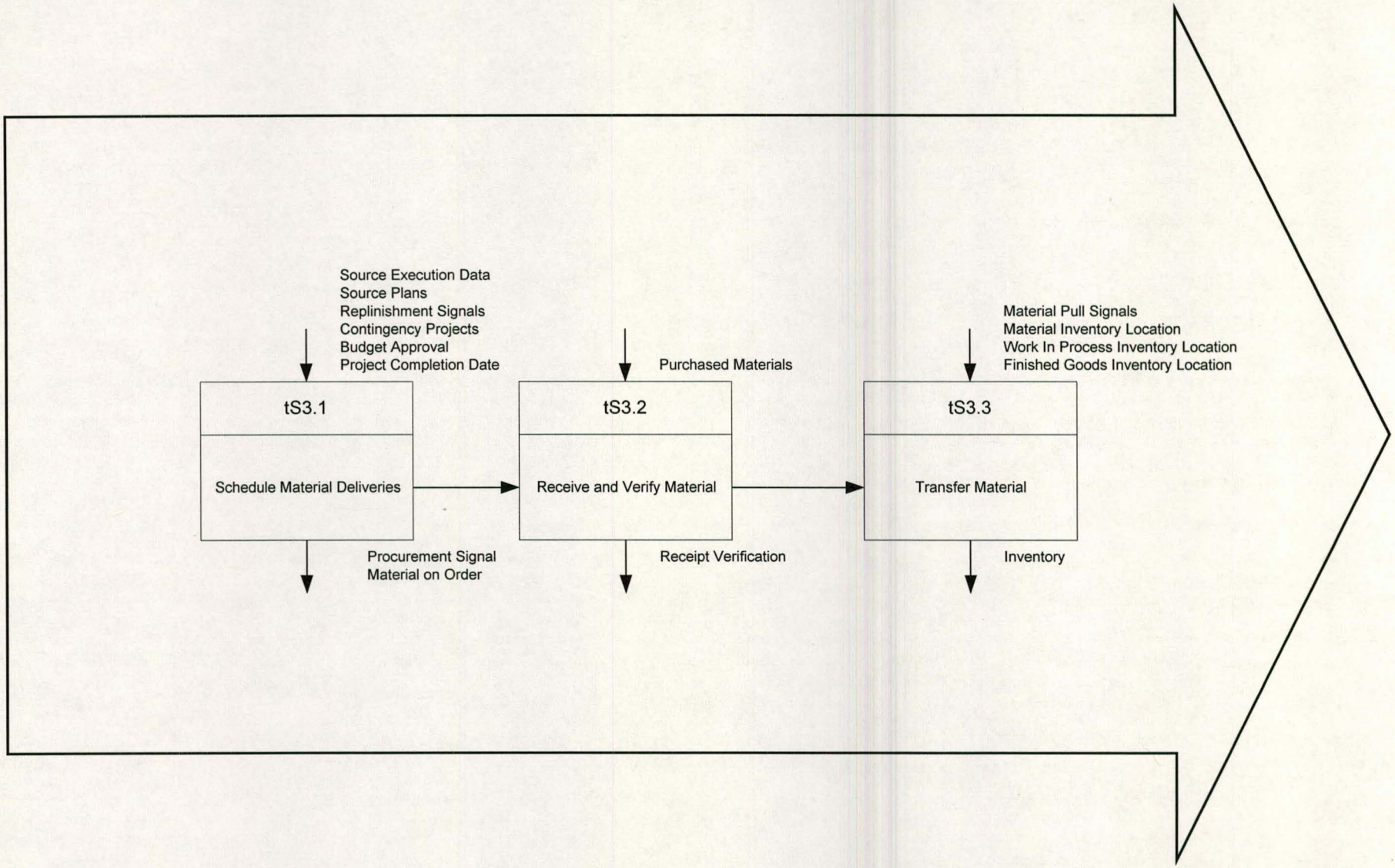

tS3: Source Make to Order Materials

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Process Category: **Source Make to Order Materials**	**Process Number:** tS3
Process Category Definition	
The procurement and deliver of materials that are built to a specific design or configured based on the requirements of a particular customer order.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time
Cost	Material Acquisition Costs
Service/Quality	None
Assets	Inventory Days of Supply
Best Practices	**Software Features Required**
Joint Service Agreements	*None Identified*
Automated Statistical Process Control (SPC)	*None Identified*

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Process Element: Schedule Material Deliveries	**Process Number:** tS3.1
Process Element Definition	
Scheduling and managing the execution of the individual deliveries of material against the contract. The requirements for material deliveries are determined based on the detailed sourcing plan. This includes all aspects of managing the contract schedule including prototypes and qualifications.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time Percentage of EDI Transactions
Cost	Materials Management as a Percentage of Materials Acquisitions Costs
Service/Quality	*None Identified*
Assets	Inventory material days of supply (Days of Supply)
Best Practices	**Software Features Required**
Utilize EDI transactions to reduce cycle time and costs	EDI interface for 830, 850, 856 and 862 transactions
VMI agreements allow suppliers to manage (replenish) inventory	Vendor managed inventories with scheduling interfaces to external vendor systems
Consignment agreements are used to reduce assets and cycle time while increasing the availability of critical items	Consignment inventory management
Advanced ship notices allow for tight synchronization between source and make processes	Blanket order support with scheduling interfaces to external vendor systems

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Process Element: Receive and Verify Materials	**Process Number:** tS3.2
Process Element Definition	
The receipt and acceptance of material deliveries against the contract requirements. This includes all of the activities associated with receiving, qualifying, verifying, and accepting material deliveries.	
Performance Attributes	**Metric**
Cycle Time	Source Cycle Time
Cost	Receiving costs as a Percentage of Material Acquisition Costs
Service/Quality	Supplier On Time Delivery Performance over Percentage defective
Assets	*None Identified*
Best Practices	**Software Features Required**
Supplier certification programs are used to reduce (skip lot) or eliminate receiving inspection	Skip lot/sampling inspection logic
Bar coding is used to minimize handling time and maximize data accuracy	Bar code interface for data collection devices Generate bar coded receiving documents
Deliveries are balanced throughout each working day and throughout the week	*None Identified*
Supplier delivers directly to point of use	*None Identified*

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Process Element: Transfer Material	**Process Number:** tS3.3
Process Element Definition	
The transfer of accepted material to the appropriate stocking location within the Supply Chain. This includes all of the activities associated with repackaging, staging, transferring, and stocking material.	
Performance Attributes	**Metric**
Cycle Time	*None identified*
Cost	Receiving and material storage costs as a Percentage of Material Acquisition Costs
Service/Quality	*None identified*
Assets	*None identified*
Best Practices	**Software Features Required**
Drive deliveries directly to stock or point-of-use in manufacturing to reduce costs and cycle time	Pay on receipt Specify delivery location and time (to the minute) Specify delivery sequence

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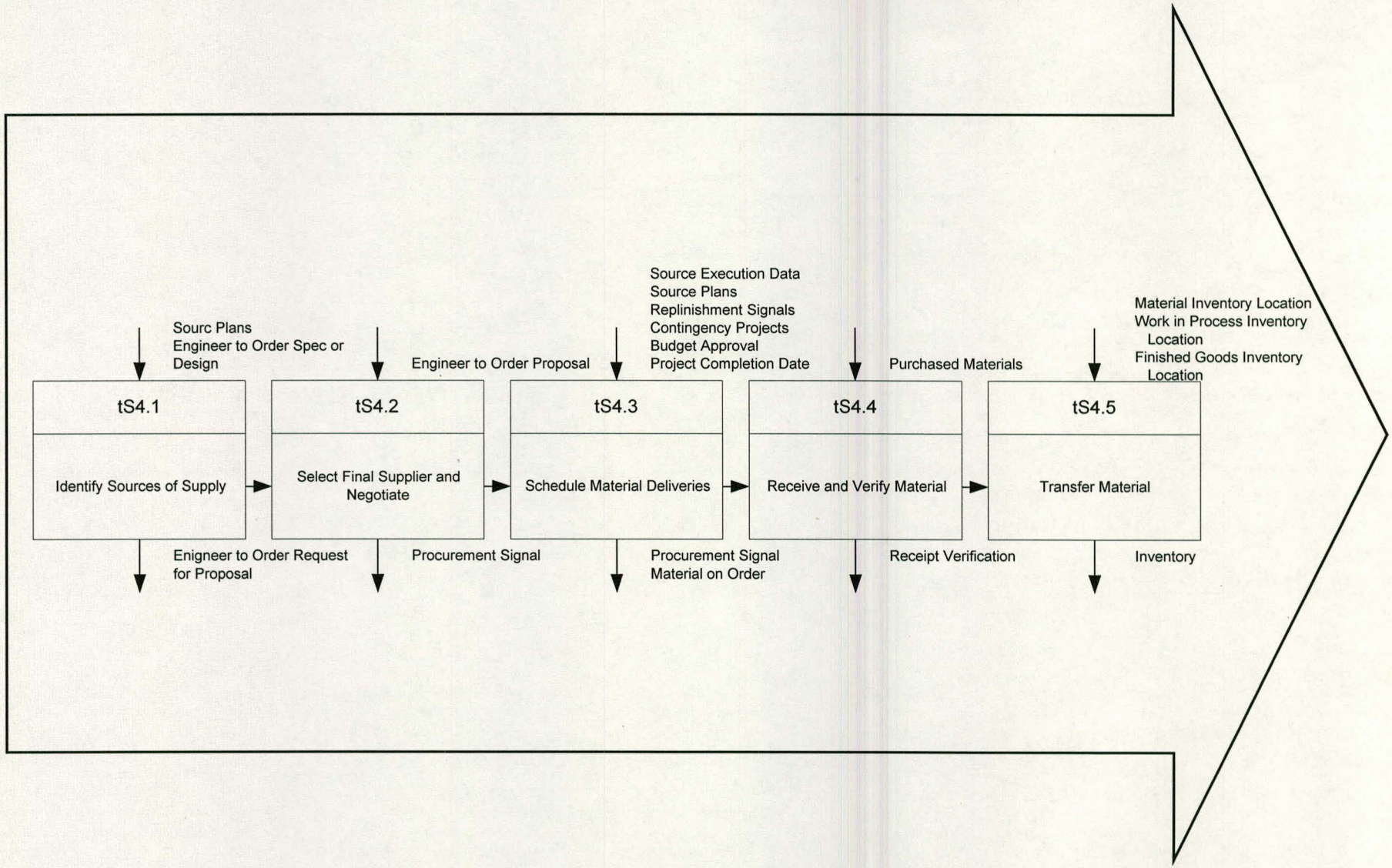

tS4: Source Engineer to Order Materials

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Process Category: Source Engineer to Order Materials	**Process Number:** tS4
Process Category Definition	
The negotiation, procurement and delivery of engineer-to-order assemblies that are designed and built based on the requirements or specifications of a particular customer order or contract.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time
Cost	Material Acquisition Costs
Service/Quality	Percentage defective
Assets	Inventory Days of Supply
Best Practices	**Software Features Required**
Joint Service Agreements	*None Identified*

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Process Element: Identify Sources of Supply	**Process Number:** tS4.1
Process Element Definition	
The identification of potential suppliers capable of designing and delivering material that will meet all of the required product specifications.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time Purchased Material by Geography
Cost	Material Process Engineering as a Percentage of Material Acquisition Costs
Service/Quality	*None Identified*
Assets	*None Identified*
Best Practices	**Software Features Required**
Product Data Management and Electronic Document Management are used to manage technical documents and requirements for engineer to order materials	*None Identified*
Electronic data interchange is used to send technical information to and from potential suppliers	*None Identified*
On line RFQ processes linked into the document management process reduces cycle time and material management costs	*None Identified*
Concurrent engineering is used to tightly link sourcing into the product development process	*None Identified*
Supplier development programs are used to get local suppliers to invest in developing new technologies	*None Identified*
Consider Black Empowerment Strategies When Identifying Suppliers	*None Identified*

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Process Element: Select Final Supplier(s) and Negotiate	**Process Number:** tS4.2
Process Element Definition	
The identification of the final supplier(s) based on the evaluation of RFQ's, supplier qualifications and the generation of a contract defining the costs and terms and conditions of material availability.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time
Cost	Materials Management as a Percentage of Materials Acquisitions Costs
Service/Quality	*None Identified*
Assets	Inventory material days of supply (Days of Supply)
Best Practices	**Software Features Required**
Electronic data interchange is used to send RFQ's and technical information to and from potential suppliers	*None Identified*
On line RFQ processes linked into the document management process reduces cycle time and material management costs	*None Identified*
Supplier certification programs can reduce the cycle time for certifying existing suppliers to provide new technologies	*None Identified*
Utilize concurrent engineering with suppliers to allow them to provide engineering and product performance test data	*None Identified*
On line document management and automated vendor approval processes can reduce the cycle time and costs associated with managing supplier evaluations	*None Identified*
Consider Black Empowerment Strategies When Selecting Suppliers	*None Identified*

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Process Element: Schedule Material Deliveries	**Process Number:** tS4.3
Process Element Definition	
Scheduling and managing the execution of the individual deliveries of material against the contract. The requirements for material deliveries are determined based on the detailed sourcing plan. This includes all aspects of managing the contract schedule including prototypes and qualifications.	
Performance Attributes	**Metric**
Cycle Time	Source Lead Time Percentage of EDI Transactions
Cost	Materials Management as a Percentage of Materials Acquisitions Costs
Service/Quality	*None Identified*
Assets	Inventory material days of supply (Days of Supply)
Best Practices	**Software Features Required**
Utilize EDI transactions to reduce cycle time and costs	EDI interface for 830, 850, 856 and 862 transactions
VMI agreements allow suppliers to manage (replenish) inventory	Vendor managed inventories with scheduling interfaces to external vendor systems
Consignment agreements are used to reduce assets and cycle time while increasing the availability of critical items	Consignment inventory management
Advanced ship notices allow for tight synchronization between source and make processes	Blanket order support with scheduling interfaces to external vendor systems

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Process Element: Receive and Verify Materials	**Process Number:** tS4.4
Process Element Definition	
The receipt and acceptance of material deliveries against the contract requirements. This includes all of the activities associated with receiving, qualifying, verifying, and accepting material deliveries.	
Performance Attributes	**Metric**
Cycle Time	Source Cycle Time
Cost	Receiving costs as a Percentage of Material Acquisition Costs
Service/Quality	Supplier On Time Delivery Performance over Percentage defective
Assets	*None Identified*
Best Practices	**Software Features Required**
Supplier certification programs are used to reduce (skip lot) or eliminate receiving inspection	Skip lot/sampling inspection logic
Deliveries are balanced throughout each working day and throughout the week	*None Identified*
Supplier delivers directly to point of use	*None Identified*

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Process Element: Transfer Material	**Process Number:** tS4.5
Process Element Definition	
The transfer of accepted material to the appropriate stocking location within the Supply Chain. This includes all of the activities associated with repackaging, staging, transferring, and stocking material.	
Performance Attributes	**Metric**
Cycle Time	*None Identified*
Cost	Receiving and material storage costs as a Percentage of Material Acquisition Costs
Service/Quality	*None Identified*
Assets	*None Identified*
Best Practices	**Software Features Required**
Utilize EDI transactions to reduce cycle time and costs	EDI interface for 830, 850, 856, and 862 transactions
Drive deliveries directly to stock or point-of-use in manufacturing to reduce costs and cycle time	Pay on receipt Specify delivery location and time (to the minute) Specify delivery sequence

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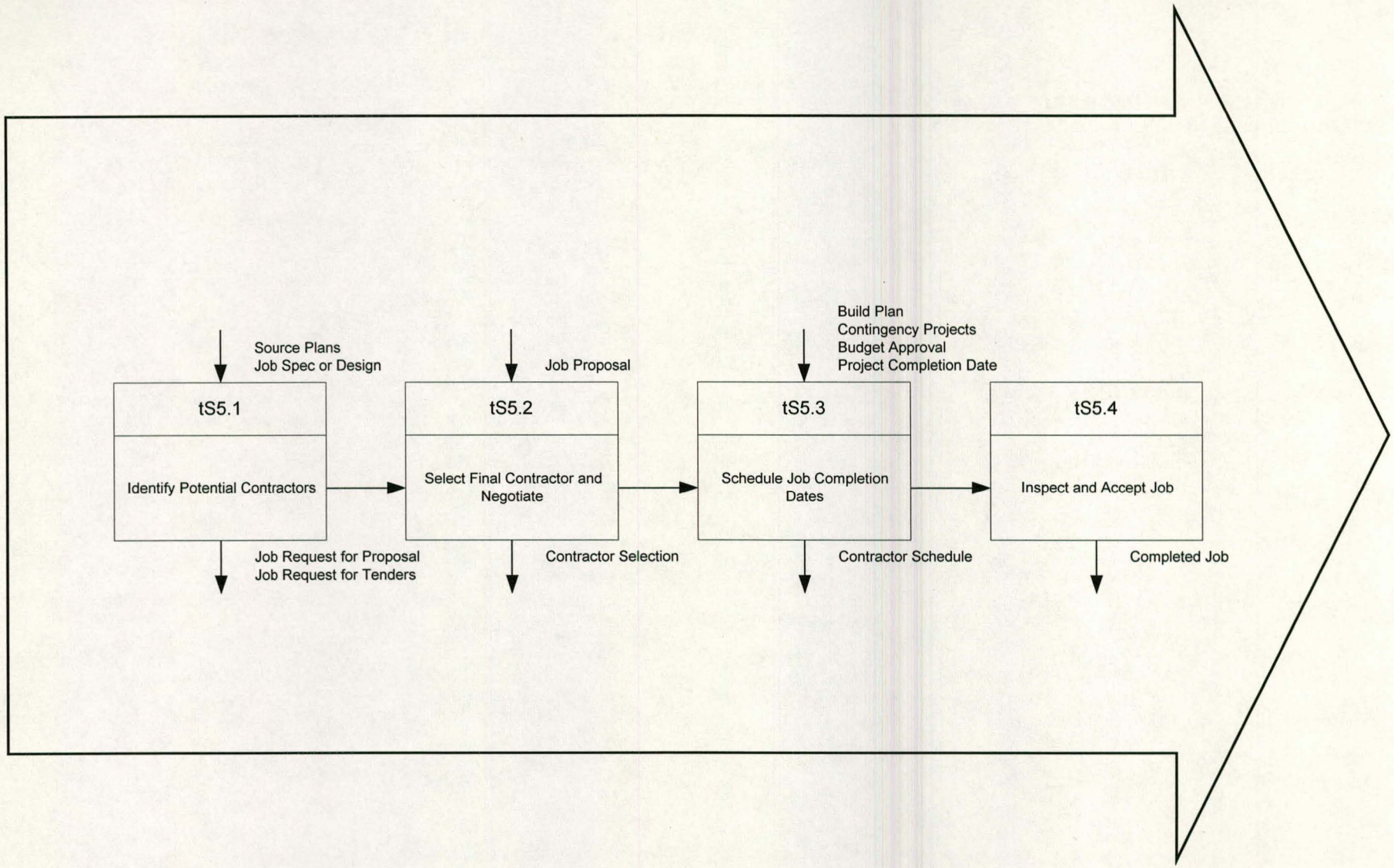

tS5: Source Services

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Process Category: Source Services	**Process Number:** tS5
Process Category Definition	
The selection , negotiation and completion of services that are completed based on the requirements or specifications of a particular job specification in completion of an installation or project.	
Performance Attributes	**Metric**
Cycle Time	Service Lead Time Job Time
Cost	Tender Cost
Service/Quality	On time Completion of Accepted Job
Assets	*None Identified*
Best Practices	**Software Features Required**
Joint Service Agreements	*None Identified*
Preference to Previously disadvantaged contractors.	*None Identified*
Consider Specific Accreditations for Suppliers (ISO 14000, ISO 9000, etc.)	*None Identified*

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Process Element: Identify Potential Contractors	**Process Number:** tS5.1
Process Element Definition	
The identification of potential contractors capable of completing and delivering the job as specified in the job specifications.	
Performance Attributes	**Metric**
Cycle Time	Service Lead Time Service Contractors by Geography
Cost	Tender Preparation Cost
Service/Quality	*None Identified*
Assets	*None Identified*
Best Practices	**Software Features Required**
Electronic Document Management are used to manage technical documents and requirements for job specifications	*None Identified*
Electronic data interchange is used to send technical information to and from potential contractors	*None Identified*
Supplier development programs are used to get local contractors to deliver required services	*None Identified*
Consider Black Empowerment Strategies When Identifying Suppliers	*None Identified*
Consider Specific Accreditations for Suppliers (ISO 14000, ISO 9000, etc.)	*None Identified*

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Process Element: Select Final Contractor and Negotiate	**Process Number:** tS5.2
Process Element Definition	
The identification of the final contractors based on the evaluation of Tender, contractor qualifications, Contractor history and the generation of a contract defining the costs and terms and conditions to complete job.	
Performance Attributes	**Metric**
Cycle Time	Service Lead Time
Cost	Contractor Selection Cost
Service/Quality	Number of Tenders Submitted Number of Tenders Meeting Requirements
Assets	*None Identified*
Best Practices	**Software Features Required**
Electronic data interchange is used to send tenders and technical information to and from potential contractors	*None Identified*
On line tender processes linked into the document management process reduces selection time	*None Identified*
Contractor certification programs can reduce the cycle time for certifying existing contractors to provide new technologies	*None Identified*
On line document management and automated vendor approval processes can reduce the cycle time and costs associated with managing contractor evaluations	*None Identified*
Consider Black Empowerment Strategies When Selecting Contractors	*None Identified*
Consider Specific Accreditations for Suppliers (ISO 14000, ISO 9000, etc.)	*None Identified*

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Process Element: Schedule Job Completion Dates	**Process Number:** tS5.3
Process Element Definition	
Schedule and Manage the Job to meet required completion dates of the installation or project.	
Performance Attributes	**Metric**
Cycle Time	Service Lead Time Percentage of EDI Transactions Scheduling Cycle Time
Cost	*None Identified*
Service/Quality	Flexibility
Assets	*None Identified*
Best Practices	**Software Features Required**
None Identified	*None Identified*

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Process Element: Inspect and Accept Job	**Process Number:** tS5.4
Process Element Definition	
The processes associated with the validation of the job to ensure conformance to defined specifications and requirements.	
Performance Attributes	**Metric**
Cycle Time	Source Cycle Time
Cost	Inspection Cost
Service/Quality	Contractor On Time Delivery Performance
Assets	*None Identified*
Best Practices	**Software Features Required**
Supplier certification programs are used to reduce (skip lot) or eliminate receiving inspection	*None Identified*
Record Contractor Performance to Build Contractor History Record.	*None Identified*

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Glossary

Process Catergory	Definition
Build-to-Order	The process of build in a build to order environment is the adding of value to the network by installing equipment. A make to buil environment is one in which projects are completed after receipt of a customer order and are built or configured only in response to a custome order.
Engineer to Order	The process of build in a build to order environment is the adding of value to the network by installing equipment. While Build to Order includes standard products built only in response to a customer order or products configured in response to a customer order, Engineer to Order includes custom products that are designed, developed, and manufactured in response to a specific customer request. This would typically be the first time installation of a specific type of equipment.
Plan Build	The development and establishment of courses of action over specified time periods that represent a projected appropriation of production resources to meet production requirements.
Plan Infrastructure	Make/buy decisions, Supply Chain configuration, long-term capacity and resource planning, business planning, product phase-in/phase-out, manufacturing ramp-up, end-of-life management, product-line management
Plan Source	The development and establishment of courses of action over specified time periods that represent a projected appropriation of material resources and contractor services to meet Supply Chain requirements.
Plan Supply Chain	The development and establishment of courses of action over specifie time periods that represent a projected appropriation of Supply Chain resources to meet Supply Chain requirements.
Source Engineer to Order Materials	The negotiation, procurement and delivery of engineer-to-order assemblies that are designed and built based on the requirements or specifications of a particular customer order or contract.
Source Infrastructure	Vendor certification and feedback, sourcing quality, in-bound freight, component engineering, vendor contracts, initiate vendor payments
Source Make to Order Materials	The procurement and deliver of materials that are built to a specific design or configured based on the requirements of a particular customer order.
Source Services	The selection , negotiation and completion of services that are completed based on the requirements or specifications of a particular jo specification in completion of an installation or project.
Source Stocked Materials to Inventory	The procurement, delivery, receipt and transfer of raw material items, and subassemblies to replenish inventory levels. This is used for items that the company orders to keep provide from stock.
Source Stocked Materials to Order	The procurement, delivery, receipt and transfer of raw material items, and subassemblies for a specific order. This is used for items ordered for

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	specific projects.

Process Element	Definition
Authorize Vendor Payment	Authorize Vendor Payment
Balance build resources with Build requirements	The process of developing a time-phased course of action that commits production resources to meet production requirements.
Balance material resources with material requirements	The process of developing a time-phased course of action that commits material resources to meet material requirements.
Balance Supply Chain resources with Supply Chain requirements	The process of developing a time-phased course of action that commits Supply Chain resources to meet Supply Chain requirements.
Build and Test	The series of activities performed upon equipment to integrate them to form a fully functioning system and the processes associated with the validation of the installation performance to ensure conformance to defined specifications and requirements.
Build and Test	The series of activities performed upon equipment to integrate them to form a fully functioning system and the processes associated with the validation of the installation performance to ensure conformance to defined specifications and requirements.
Control Production Processes	Control Production Processes
Create/Manage Site Recipes/Process Plans	Create/Manage Site Recipes/Process Plans
Determine Emerging Supplier Technologies	Determine Emerging Supplier Technologies
Draw Up Network Master Plan	The development of a Network Strategy over the next five years and a detailed Plan of action for the next year.
Establish Build Plans	The establishment of courses of action over specified time periods that represent a projected appropriation of supply resources to meet production plan requirements.
Establish New Material	Establish New Material
Establish New Source/Contractor	Establish New Source/Contractor
Establish souring plans	The establishment of courses of action over specified time periods that represent a projected appropriation of supply resources to meet sourcing plan requirements.
Establish Supply Chain plans	The establishment of courses of action over specified time periods that represent a projected appropriation of Supply Chain resources to meet Supply Chain requirements.
Finalize Engineering	Engineering activities required after acceptance of order, but before installation starts. May include generation and delivery of final drawings, specifications, formulas, part programs, etc. In general, the last step in the completion of any preliminary engineering work done as part of the

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	quotation process.
Identify Potential Contractors	The identification of potential contractors capable of completing and delivering the job as specified in the job specifications.
Identify Sources of Supply	The identification of potential suppliers capable of designing and delivering material that will meet all of the required product specifications.
Identify, assess, and aggregate build resources	The process of identifying, evaluating, and considering, as a whole with constituent parts, all things that add value in the production of a product.
Identify, assess, and aggregate material resources	The process of identifying, evaluating, and considering, as a whole with constituent parts, all material used to add value in the Supply Chain of a product or contractor services.
Identify, prioritize, and aggregate build requirements	The process of identifying, prioritizing, and considering as a whole with constituent parts, all sources of demand in the production of a product or service.
Identify, prioritize, and aggregate material requirements	The process of identifying, prioritizing, and considering, as a whole with constituent parts, all sources of demand for material in the Supply Chain of an Installations.
Identify, prioritize, and aggregate Supply Chain requirements	The process of identifying, prioritizing, and considering, as a whole with constituent parts, all sources of demand in the Supply Chain of a product or service.
Identify, prioritize, and aggregate Supply Chain resources	The process of identifying, evaluating, and considering, as a whole with constituent parts, all things that add value in the Supply Chain of an installation
Inspect and Accept Job	The processes associated with the validation of the job to ensure conformance to defined specifications and requirements.
Issue material	The selection and physical movement of materials (e.g., raw materials, fabricated components, equipment, manufactured subassemblies, required ingredients or intermediate formulations) from a stocking location (e.g., stockroom, a location on the production floor, a supplier) to a specific point of use location. Issuing material includes the corresponding system transaction.
Maintain Equipment/Facilities	Maintain Equipment/Facilities
Maintain Source Planning and Execution Data	Maintain Source Planning and Execution Data
Manage Engineering/Recipe Changes	Manage Engineering/Recipe Changes
Manage Incoming Freigth	Manage Incoming Freigth
Manage Material Inventory	Manage Material Inventory
Manage Planning Data	Manage Planning Data
Manage Production Materials	Manage Production Materials
Manage Production Quality Policies	Manage Production Quality Policies

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Manage Product-Line Plans	Manage Product-Line Plans
Manage Short-Term Capacity	Manage Short-Term Capacity
Manage Sourcing Business Rules	Manage Sourcing Business Rules
Manage Vendor Agreements	Manage Vendor Agreements
Manage Vendor/Contractor Certification	Manage Vendor/Contractor Certification
Monitor Equipment Status	Monitor Equipment Status
Monitor Production Status	Monitor Production Status
Perform Business Planning	Perform Business Planning
Perform Insource/Oursource Decision-Making	The act of deciding whether or not to complete a project self or outsource the project to a contractor
Perform Long-Term Capacity and Resource Planning	Perform Long-Term Capacity and Resource Planning
Perform Supply Chain Benchmarking	Perform Supply Chain Benchmarking
Receive & Verify Materials	The receipt and acceptance of material deliveries against the contract requirements. This includes all of the activities associated with receiving, qualifying, verifying, and accepting material deliveries.
Reconfigure the Supply Chain	Reconfigure the Supply Chain
Release product to Maintenance	Activities associated with post-production documentation, testing, or certification required prior to hand over of child project to maintenance.
Schedule Job Completion Dates	Schedule and Manage the Job to meet required completion dates of the installation or project.
Schedule Material Deliveries	Scheduling and managing the execution of the individual deliveries of material against the contract. The requirements for material deliveries are determined based on the detailed sourcing plan. This includes all aspects of managing the contract schedule including prototypes an qualifications.
Scheduling Build Activities	Given plans for the manufacture of specific installations, the schedulin of the operations to be preformed in accordance with these plans. Scheduling includes sequencing, and due date commitments of other child projects.
Select Final Contractor and Negotiate	The identification of the final contractors based on the evaluation of Tender, contractor qualifications, Contractor history and the generation of a contract defining the costs and terms and conditions to complete job.
Select Final Supplier(s) and Negotiate	The identification of the final supplier(s) based on the evaluation of RFQ's, supplier qualifications and the generation of a contract defining the costs and terms and conditions of material availability.
Stage Product	After completion, the Child Project awaits the completion of the entire project before it can be released.

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Transfer Material	The transfer of accepted material to the appropriate stocking location within the Supply Chain. This includes all of the activities associated with repackaging, staging, transferring, and stocking material.

Metric	**Definition**
Actual to Theoretical Installation Times	The ratio of the measured time required to complete a given project divided by the shortest possible time required to complete a given output based on the rated efficiency of the labor operations.
Asset Turns	Average time that assets remain within the section/company
Average section-wide salary	Total payroll for salaried employees divided by total headcount
Build flexibility	The time is typically takes to implement a sustainable unplanned increase in end product supply of 20% if each of the factors shown below was the only constraint: 1)Internal manufacturing capacity 2)Direct labor availability 3)Constraining processes 4)Key components/materials availability 5)Direct labor availability
Build Plan Adherence	Build plan adherence is calculated as the number of activities completed as planned: It is measured as the number of days varied from the pla generated in the previous month.
Build to release cycle time	The time taken from the start of the installation until the installation is handed over to the next section.
Capacity Utilization	A measure of how intensively resources are being used to complete installations. Some factors that should be considered are internal Human Resource Capacity, constraining processes, vehicle Usage, direct labor availability and key components/materials availability.
Cash-to-cash Cycle Time	Cash to cash cycle time is the period from the point that the expense is made to purchase equipment until it starts generating revenue
Child Project Cost	The total amount of money required to complete the child project
Child Project Employment	Total number of employees required to complete the chiuld project
Child Project Installation Time	The average time required to complete the specific child project
Commodity Management Profile	Number of distinct part numbers (purchased commodities) sourced within the following areas: 200 kms, Own country, Own continent, Off-shore.
Contingency Forecast Accuracy	Forecast accuracy of number of equipment required for contingency projects.Forecast Accuracy = (Forecast Sum - Sum of Variance)/Forecast Sum; Where:Forecast Sum = The sum of the units or dollarsforecasted to be shipped in each month based upon the forecast generated three months prior.Sum of Variances = The sum of the absolute values, at th forecasted line item level, of the differences between each month's forecast as defined above and actual demand for the same month.
Contractor On Time Delivery Performance	The percentage of projects that are fulfilled on or before the original customer requested date (contractors performance measured by the customer).

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Contractor Selection Cost	All costs needed to select contractors. This includes interview time, adiminstrative costs, tender cost.
Contractor Service Level	Number of times that contractors are called back to correct errors in project
Cross training	The providing of training or experience in several different areas (e.g., training an employee on several types of projects rather than one). Cross-training provides backup workers in case the primary installer is unavailable.
Cumulative Build Cycle Time	The cumulative external and internal lead time to complete a project (if you start with inventory on-hand).
Cumulative Source Cycle Time	The cumulative external and internal lead time to source equipment for a project (if you start with no inventory on-hand, no parts on-order, and no prior forecasts existing with suppliers), in calendar days.
Cumulative Source/Build Cycle Time	The cumulative external and internal lead time to complete a project (if you start with no inventory on-hand, no parts on-order, and no prior forecasts existing with suppliers), in calendar days.
Deliver to commit date	The date of project completion to the date commited by the installing section
Delivery to Customer Request Date	The project completion date compared to the date requested by th customer
Engineering Change Order cost	Costs incurred from revisions to a blueprint or design released by engineering to modify or correct an installetion The request for the change can be from a customer or from quality control or another department.
Equipment losses	Equipment ordered for a project that can not be used
Error Correction Time	The time taken to rectify any errors made in the installation (in calender days)
Estimated Project Costs to Actual Project Costs	The total project costs over the budgeted project costs
Estimated Project Times to Actual Project Times	The total project time over the predicted project times
Finished Goods Inventory Days Of Supply	The number of days elapsed after the completion of the child project until the project becoimes oiperational
Forecast Accuracy	Forecast accuracy of budgets and requirements for projects.Forecast Accuracy = (Forecast Sum - Sum of Variance)/Forecast Sum; Where:Forecast Sum = The sum of the units or dollarsforecasted to b shipped in each month based upon the forecast generated three months prior.Sum of Variances = The sum of the absolute values, at th forecasted line item level, of the differences between each month's forecast as defined above and actual demand for the same month.
Forecast Cycle Time	The time between forecast regenerations that reflect true changes in marketplace demand for shippable end-products. Only true "bottoms-up" forecasts are counted: for example, if weekly or monthly updates to the

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	forecast only recalendarize or shift dates for the forecast to avoid changing the annual dollar-based forecast, they should not be considered true forecast regenerations.
Indirect to direct headcount ratio	Ratio of total number of employees required to support installation in general without being related to a specific project, indirect labor, to the total number of employees that is specifically applied to the installation or used in the performance of the service, direct labor.
In-process failure rates	The number of times that errrors have to be corrected on installations (comebacks of installation crew)
Inspection Cost	All costs associated with the inspection of a project or child project. This includes labour, certification, equipment cost, calibration costs, etc.
Installation flexibility	The time is typically takes to implement a sustainable unplanned increase in end product supply of 20% if each of the factors shown below was the only constraint: 1)Internal installation capacity 2)Direct labor availability 3)Constraining processes 4)Key components/materials availability 5)Direct labor availability
Inventory Accuracy	The absolute value of the sum of the variance between physical inventory and perpetual inventory
Inventory Aging	The percentage of total gross inventory (based on value) covered by expected demand within specific time buckets.
Inventory Carrying Costs	Inventory Carrying Costs are the sum of opportunity cost, shrinkage, insurance and taxes, total obsolescence for raw material, WIP, and finished goods inventory, channel obsolescence and field sample obsolescence.
Inventory cycle-counting accuracy	The absolute value of the sum of the variance between physical inventory and perpetual inventory
Inventory days of supply	Total gross value of inventory at standard cost before reserves for excess and obsolescence. Only includes inventory on company books, future liabilities should not be included. 5 point annual average of the sum of all gross inventories (raw materials & WIP, plant FG, field FG, field samples, other) ÷ (COGS ÷ 365).
Inventory Obsolescence	The annual obsolete and scrap reserves taken for inventory obsolescence expressed as a percentage of annual average gross inventory value.
Inventory on Hand	The value of inventory held by the company
Inventory Spoiled	The percentage of inventory that is spoiled after the project has been completed, but has not yet become operational
Job Time	The total time that an installation or project is scheduled to take
Master Plan Cycle time	The number of days it takes to draw up the network Master Plan
Master Planning Costs	All costs associated in drawing up a master plan, including administrative costs, man hours used, travel costs
Material Acquisition Costs	Material acquisition costs include costs incurred for isntalation materials: sum of materials management and planning, supplier quality engineering, inbound freight and duties, receiving and material storage, incoming

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	inspection, material process engineering and tooling costs.
Material Overhead Cost Per Dollar of Material Expenditure	Total Material carrying costs which include all capital cost, storage cost, and risk costs divided by the total cost of acquiring the material.
Material planning costs	Costs associated with any actions perfromed to eventually order material or equipment
Material Process Engineering as a Percentage of Material Acquisition Costs	Material Process Engineering – Cost associated with tasks required to document and communicate material specification, as well as reviews to improve the use of the purchased item expressed as a percentage of material acquisition costs.
Material Requirement Accuracy	The cost incurred in purhasing material devided by the actual costs pf purchased materials for a specific project
Material requisition cycle time	The total amount of time required to convert the identification of capacity needs for key material resources to the receipt of those resources.
Material Shrinkage	The costs associated with breakage, pilferage, and deterioration o material inventories.
Materials Management as a Percentage of Materials Acquisitions Costs	Material (Commodity) Management and Planning – All costs associated with supplier sourcing, contract negotiation and qualification and the preparation, placement, and tracking of a Purchase Order expressed as a percentage of material acquisition costs. This category includes all costs related to buyer/planners.
Number of Contingency Projects	The number of contingency project orders received in previous financial year
Number of End Installations	The total number of different installation types provided bythe dsection
Number of Engineering Change Orders	Total number of revisions to a blueprint or design released by engineering to modify or correct a installation, engineering change orders (Engineering Change Order). The request for the change can be from a customer or from production quality control or another department.
Number of Supply Sources	Total number of internal and external direct production material suppliers used.
Number of Tenders Meeting Requirements	The total number of tenders that have been submitted for approval that actually meet the requirements set by the tender as a percentage of the total number of applications
Number of Tenders Submitted	The total response from contractors to a request for work sent to all contractors
On time Completion of Accepted Job	The percentage of jobs that are completed by the time specified at th time of acceptance
Order fulfillment cycle time	The average actual lead times consistently achieved, from Customer Signature/ Authorization to Order Receipt, Order Receipt to Order Entry Complete, Order Entry Complete to Start-Build, Start Build to Order Ready for Shipment, Order Ready for Shipment to Customer Receipt o Order, and Customer Receipt of Order to Installation Complete.
Order Management Costs	The aggregation of the following cost elements (contained in this glossary): 1)Create Customer Order Costs 2) Order Entry an

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	Maintenance Costs 3) Contract/Program and Channel Management Costs 4) Installation Planning Costs 5) Order Fulfillment Costs 6) Distribution Costs 7) Transportation Costs 8) Installation Costs 9) Customer Invoicing/Accounting Costs
Order receive to Stock Available Cycle Time	The time taken from the submission of an order until equipment and material arrives at the section
Overhead cost	Costs incurred in the operation of a business that cannot be directl related to the individual projects. These costs, such as light, heat, supervision, and maintenance, are grouped in several pools an distributed to projects by some standard allocation method such as direct labor hours, direct labor dollars, or direct materials dollars.
Overtime Costs	The average number of overtime hours claimed devided by nemuber fo people claiming overtime
Overtime Expenditure	Ther total amount spent on overtime payments
Percentage defective	The percentage of time ainstalltion is considered unacceptable against standard criteria. The # of unacceptable projects divided by the total number of projects completed during a fixed time window.
Percentage of EDI Transactions	Percentage of orders submitted via electronic data interchange, EDI.
Percentage of orders scheduled to customer request date	The percentage of orders whose delivery is scheduled to within an agreed to time frame of the customer's requested delivery date.
Percentage of parts received at point of use	The percentage of material receipts that are delivered directly to the installtion site or a consolidation point with no inspection or minor visual/paperwork inspection only.
Percentage release errors	Percentage of projects handed over to the next section with errors over the number of the total number of projects scheduled during a financial year
Performance to commit date	The percentage of projects completed by the scheduled completion time
Performance to customer request date	The completion date of projects compared to the date requested by the customer
Plan stability	The frequency with which a plan is changed, outside regularly scheduled intervals
Project Lateness	The average number of days that a project is completed after the commit date (only projects that are late are used in this calculation)
Project Plan Costs	The costs associated with drawing up the planning specifiocations for a project, this includes calculating the costs per employee, travel cost, administrative costs, etc.
Project Plan Cycle Time	The average number of days required to complete the project plan
Purchased Material by Geography	Number of the materials or equipment that are sourced in within the following areas: 200 miles, Own country, Own continent, Off-shore.
Quality levels	Specified quality specifications set by the suppliers/other departments, receiving customers
Receiving and material storage costs as a	Receiving and Material Storage – All costs associated with taking

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Percentage of Material Acquisition Costs	possession of and storing material. Includes warehouse space and management, material receiving and stocking, processing work orders, pricing, and internal material movement. This does not include incoming inspection.
Receiving and put away cycle time	The total amount of time required to move materials from an inbound location to an internal storage location.
Receiving costs as a Percentage of Material Acquisition Costs	All costs associated with taking possession of material expressed as a percentage of material acquisition costs. This does not include inspection.
Replan Cycle Time	The time taken from the identification of a error in the project plan until the project plan is resubmitted for a project
Resource Variability Costs	Costs associated with the variance in resoure availibility. This could include a shortage of vehicles, employees on sick leave, employees o strike, etc.
Responsiveness lead time	Minimizing elapsed time, including all delays, to receive a customer order and complete the project, including inventory lead times
Return on Assets	A financial measure of the relative income-producing value of an asset. It is calculated as net income divided by total assets.
Schedule achievement	Schedule achievement is calculated as the number of times that the project schedule is met and is calculated by considering the absolute variance of completion date in days to the scheduled date
Schedule cycle time	The amount of time required to schedule or reschedule all projects with considerations of the contraints and schedules of other departments that are child projects to the parent projects
Schedule interval	The interval with which projects are rescheduled
Schedule resource costs	The costs associated with scheduling and rescheduling. These costs include computer software costs, people costs, etc.
Scheduled Cycle Time to Actual Cycle Time	The scheduled time needed to complete a project relative to the actual time required to complete a project
Scrap expense	Expenses incurred from material that cannot be used in a project,but cannot be used in other projects either
Section Cost per hour	The costs of keeping a section running on a daily basis. This includes cost like water, electricity, adiministrative costs, floor space costs, indirect labor, cleaning costs, etc.
Section level order management costs	The aggregation of the following cost elements for which installation is central focal point of orders : 1)Create Customer Order Costs 2) Order Entry and Maintenance Costs 3) Contract/Program and Channel Management Costs 4) Installation Planning Costs 5) Order Fulfillment Costs 6) Distribution Costs 7) Transportation Costs 8) Installation Costs 9)Customer Invoicing/Accounting Costs
Service Contractors by Geography	Number of the contractors that are sourced in within the following areas: 200 miles, Own country, Own continent, Off-shore.
Service Lead Time	Shortest time that a contractor can start work after the acceptance to

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	complete a project
Shortest Build Cycle Time to Scheduled Cycle Time	The shortage possible time in which a project can be completed in theory relative to the time that the project has been scheduled for
Source Cycle Time	The time required for a supplier to complete a single cycle, beginning with the receipt of an order and ending with the fulfillment of that order.
Source Flexibility	The ability of the supplier to expedite or delay the delivery of equipment ordered. This is measured by the number of days notice the supplier requires to change the delivery date
Source Lead Time	The time required from the ordering of equipment or materials until the materials arrive if no inventory is kept by the supplier
Staff Borrowed	The number of man hours used of staff from other sections in order t complete project dead lines
Supplier Delivery Performance to Customer Request Date	The percentage of orders that are fulfilled on or before the original customer requested date (suppliers performance measured by th customer).
Supplier Fill Rate	The percentage of time a supplier completes a commitment to a customer to ship or deliver an order within 24 hours.
Supplier On Time Delivery Performance over Percentage defective	The percentage of orders that are fulfilled on or before the original customer requested date relative to the number of products that have to be returned because of defects
Supplier/Contractor Delivery Performance to Customer Request Date	The percentage of orders/projects that are fulfilled on or before the original customer requested date (suppliers performance measured by the customer).
Supply Chain finance and planning costs	Costs associated with paying invoices, auditing physical counts, performing inventory accounting, and collecting accounts receivable. (Does not include customer invoicing/accounting costs.)
Tender Cost	All costs associated with drawing up and sending out a tender for project completion, contacting contractors, etc.
Tender Preparation Cost	All costs associated with drawing up a tender
Test Time	The time required to check if equipment is ready for operation
Total Service Time	Time required by contractor to complete a project
Total Source Lead Time	Total source lead time is the cumulative lead time required to source 95% of the dollar value of materials from internal and external suppliers.
Transport Cost	Describes all costs associated with transfering equipment, materials or resources to complete an installation (this includes material shipment up to final point of intsallation and daily travel of employees to installation site)
Transportation Utilization	The number of hours of use of transportation resources realtive to the hours available for use
Value-Added Productivity	Value added per employee is calculated as total product revenue less total material purchases ÷ total employment (in full-time equivalents). (aka

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	economic value added)
Work in Process Inventory Carrying Costs	Costs associated to ensure that work in progress is protected and secure while installation is in progress. (this includes security protection, insurance, special covers, etc.)
Work In Progress Inventory Days Of Supply	The number of days after equipment is issued to a section for a specific project until the project is completed and becomes finsihed goods
Work In Progress Shrinkage	The costs associated with breakage, pilferage, and deterioration of WIP inventories. The loss of any material, part, and/or assembly that is being worked on or is waiting to be processed within the operations system.
Yield	The ratio of usable output from a process to its input.
Yield variability	The condition that occurs when the output of a process is not consistently repeatable either in quantity, quality, or combination of these.

Input	**Definition**
Area Developments	Developments in terms of population or construction in areas served by the company. This includes developments like industrial areas, resedential areas, shopping centers, office complexes, etc
Budget Approval	The approval of the estimated costs and expenditures of a project by head office and/or the finance department
Build Plans	Build plans describe the schedule and also the specifications that are involved in completing the build phase of a project
Business Rules	Rules And authoritative direction for conduct or customary course of action within a commercial enterprise.
Cash Flow	The Flow of Cash within the business. This is the amount of cash available for spending.
Commited Completion Dates	The date that the installing section has agreed to be completed by. This date takes into account other projects, inventory arrivals, etc.
Contingency Project Forecast	A forecast of all the contingency projects to occur during the next financial year/month
Contingency Projects	Projects that have not been included in the Network Master plan, these projects are usually orderd by customers external to the company
Contractor Ability to Service	The ability of the contractor to provide the required service by the time requested
Contractor Agreements	Agreements made with the supplier specifying service lead times, costs, payment terms, quality of service, etc
Customer Request Date	The date for the completion of a project as requested by the customer
Delivery Plans	Plans describing the arrival of equipment or material as well as the location of this arrival

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Employee Hours	The number of employee hours required or available for the completion of a project
Engineer to Order Proposal	A proposal specifying the proposed price, quality, product, lead time etc for the completion of a project by the suppliers
Engineer to Order Spec or Design	A design or specification detailing the requirements of products to be sourced sent out to the suppliers for quotations
Finished Goods Inventory location	The storage location of finished goods. For installations this will be the site where installations are to be performed.
Human Resource policies	Policies detailing the company's view to appointment and day to day management of employees within the company
Installation Capacity	The total availability of resources that are used for installations, this includes vehicle hours, man hours, equipment availability, etc.
Inventory	Material or equipment ordered by the company that is not yet operational. This includes catalogue, non-catalogue and equipment. Note that equipment onlyu becomes a fixed asset as soon as it is operational.
Job Proposal	proposals provided by contractors to complete jobs, price, lead time, quality specs etc.
Job Spec or Design	A specification sent out to contractors that details the requirements of a proposed project. This is then used to submit a proposal from the contractor
Material Inventory Location	The location where inventory is kept. This include all stages of inventory until the equipment becomes operational for a project
Material on Order	Material that has been ordered, but has not arrived at the company premises yet.
Material Pull Signals	This occurs when a project is started and material is pulled from the stoirage location as needed. This initiated by the installating section
Material Requirements	The materials needed to complete the project being planned
Network Master Plan	A plan detailing the projects that are to be completed wihtin a financial year to meet the vision for the network as identified by the company
Order Backlog	Orders that have not yet been completed, because of various reasons (resource shortage, late equipment arrivals, etc)
Payment Request	A request to receive payment for products delivered or services received
Product and Build Data	Data describing the product and installation to be completed. This includes performance specifications of the installation, operating specifications, etc.
Project Approval	The approval of the project to be completed.
Project Completion Date	The date by which the project is or will be completed
Project Data	Information pertaining to the project, eg completion dates, costs, ownership, etc.

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Project Due Dates	A delivery date agreed upon by the installing section and the customer
Purchased Materials	Materials that have been purchased for the completion of the projects
Quotation	The estimated cost of a product or project to be completed
Receipt Verification	The confirmation that a product or service has been received
Replenishment Signals	The indication that inventory has to be replenished. This is found with catalogue items and also also equipment identified as required for a project
Site Visits	Visits made to the point of installation to determine the requirments for the completion of the project. This includes planning, installation project management etc visits
Source Execution Data	Data indicating the ordering of equipment in order to receive equipment at the required delivery date
Source Plans	Plans detailing the estimated or expected delivery date of equipment and materials to the company
Sourcing Variability	The measure of the deviation of the actual delivery date to the expected delivery date
Spec or Design	A specification or design detailing the required product or service required for the completion of a project.
Strategic Vision	The vision of the company in terms of the position of its network, this includes the nature of its market, the market it intends to capture, movements of competitors, industry developments, etc.
Supplier Ability to Deliver	The ability of the supplier to deliver products by the requested date
Technology Availability	The availibility of technology to fill a need identified within industry
Traffic Counts	Counts showing the nature of constomer traffic on the current netowrk
Work in Process Inventory Location	The location where work in process is kept, in the case of installations, this is either the section itself or the final installation point

Output	**Definition**
Authorised Suppliers/Contractors List	A List of all suppliuers and contractors that have been approved by th company for business
Build Plans	Build plans describe the schedule and also the specifications that are involved in completing the build phase of a project
Commited Delivery Dates	The date that the supplier has agreed to be completed by.
Committed Completion Date	The date that the installing section has agreed to be completed by. This date takes into account other projects, inventory arrivals, etc.
Completed Job	A job that has been completed and can be handed over to the next stage of

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	the project
Contractor Schedule	A schedule indicating the start, completion and handover of projects to the next stage
Contractor Selection	The selection of the contractor best suited to complete the job, this could be witrh regard to money, time, quality, contract etc.
Engineer to Order Request for Proposal	Requests sent out to contractors for the delivery of equipment identified by the company to be completed in order to complete parent projects
Finished Goods inventory	Equipment and projects that have been completed, but that has not yet become operational
Installation	Any part of a project that requires the placement and arrangement of equipment to complete the project and bring equipment to an operational state meeting the lade down requirements
Integrated Supply Chain Plans	Courses of action over specified time periods that represent a projected appropriation of total Supply Chain resources to meet total Supply Chain demand requirements.
Inventory	Material or equipment ordered by the company that is not yet operational. This includes catalogue, non-catalogue and equipment. Note that equipment onlyu becomes a fixed asset as soon as it is operational.
Job Request for Proposal	Requests sent out to contractors for the completion of projects identifie by the company to be completed in order to complete parent projects
Job Request for Tenders	Requests sent out to contractors for the completion of projects identifie by the company to be completed in order to complete parent projects
Material on Order	Material that has been ordered, but has not arrived at the company premises yet.
Operation	A product that is generating revenue or enabling other installations to generate revenue
Payable	A serice or product that can and will be paid
Procurement Signal	The indication that inventory has to be replenished. This is found with catalogue items and also also equipment identified as required for a project
Project Plans	Plans indicating the progression of the project, the avrious phases, roleplayers, cost etc.
Receipt Verification	The confirmation that a product or service has been received
Source Business Rules	Rules and authoritative direction for conduct or customary course o action within a commercial enterprise.
Source Planning Data	Plans detailing the estimated or expected delivery date of equipment and materials to the company
Source Plans	Plans detailing the estimated or expected delivery date of equipment and materials to the company

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Appendix B

Database Design

The objective of this project was to develop a SCOR model specifically for the telecommunications company. This model is based on the original SCOR model. Upon closer investigation of the SCOR model, it was found that the model had a number of flaws. The flaws were not in the content itself, but in the way that it was presented.

This would pose a serious problem, as the model is the framework of this project. The SCOR model had to be re-evaluated and checked for consistency. At closer inspection of the mistakes and problems, it was discovered that they had occurred because of the growth of the model.

The SCOR model changes yearly after committees evaluate the content of the model. The model is then updated. The model has great value in that it is linked between steps. This also means that a change in one point of the model will result in changes in other points. With a static Microsoft Word document model (as is currently being used) these changes have to be made manually to ensure consistency. It is the author's opinion that a relational database could solve this problem.

This chapter describes the design and implementation of such a database. It is arguably impossible to design a fail-safe system. The assumption is made that the user is familiar with the system when adding, editing or deleting information. The database system does, however, decrease the chances for errors due to neglect.

When reading this chapter it is assumed that the reader has at least read the SCOR Overview chapter (it would be preferred if the reader had completed the SCOR tutorial).

B.1 Current Problems

Before continuing to describe the proposed solution, it is necessary to consider the problems encountered with the model.

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The first problem is that of consistency. A useful feature of the SCOR model is that it defines all the terms used. When used daily, terms start to take on different meanings as people use them. This together with the fact that industries use terms in different contexts makes a definition of terms essential.

The SCOR model accommodates this by providing a very complete glossary. In turn, each of the glossary terms refers to a specific process. Here lies the first problem. If a new process element is added, it is assigned a number according to its sequential position in the process category. This means that all the other process element numbers may have to change. The result is that all the glossary term references have to be changed, which is a tedious manual process.

The second problem is better explained by means of example. Some process elements refer to the term "Performance to Scheduled Commit Date". Upon considering the glossary, it was found that the term is not present, but there is a term "Delivery performance to Scheduled Commit Date" which was the same thing, although it would take time to search for it.

These problems are small and trivial, and fortunately the model is still small enough to browse through the entire glossary and try to find the mistake. This does however result in unnecessary problems. At times, terms, that to the reader seems to be the same, are in fact not. This searching exercise should thus be eliminated from the model.

A relational database will be able to solve these problems. The design of such a database will now be discussed. In order to do this, the nature of the model first needs to be discussed.

B.2 SCOR Modeling Framework

In order to create a database, it is necessary to describe the SCOR model itself, in essence, creating a model of the model. Any model consists out of model constructs. "A modeling construct (or simply construct) is a primitive of a modeling language, the syntax and semantics of which must be precisely defined. Formal description techniques are defined by constructs having good syntax and semantics" (Vernadat, 1996:24). The model constructs in the SCOR model are the processes. These processes are in turn arranged according to three levels of hierarchy. These levels are the Process level, the Configuration level, and the Process Element level. Each of the levels have different characteristics.

The Process level has only four constructs: Plan, Source, Make and Deliver. These are the main categories for further processes.

The Configuration level contains 17 constructs. Each of these constructs have best practices, software features and metrics associated with them.

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The Process Element level contains 119 constructs. As with the configuration level constructs, the constructs are associated with best practices, metrics and software features. These constructs also have inputs and outputs.

B.3 Database Requirements

In developing a database for the SCOR model, a number of requirements had to be met. These requirements will now be discussed briefly:

1. The model must be able to describe the current SCOR model without any less functionality. That is, the model should not loose any of its features and functionality because it was transferred to an electronic format.
2. The model must be flexible. The basic structure of the model is fixed, but there should be room for further expansion of the model. This became evident when considering the SCOR model for the petrochemical industry, as proposed by Botha (1998). This model was based upon the SCOR model, but had added attributes to some of the processes. This was necessary for the application of the model. The structure of the database should not inhibit this expansion.
3. The model must be easy to use. If the electronic version of the model was more difficult to use, it would be of no value as the user would more than likely revert to the Microsoft Word document version.
4. The model must simplify the process of adding, editing or deleting information. It must also be consistent and decrease the chances of errors.
5. The model must be web-based. This is more a feature than a requirement, although it would be more valuable if the model is easily accessible over the world wide web.

There are more requirements, but these mentioned above are the main requirements for this database.

B.4 Model Structure

The Extended Entity Relationship of the model is given in Figure 35. The following sections will discuss the logic and assumptions made to arrive at this model. The current design also has some advantages, but also has drawbacks. These will be highlighted in the sections that follow.

B.4.1 tConstructs

The tConstructs table describes all the processes within the model. The first assumption made here is that all processes are identical. As discussed in the previous section, processes falling in the various levels (Process, Configuration or Element) each have different attributes. The assumption is simply

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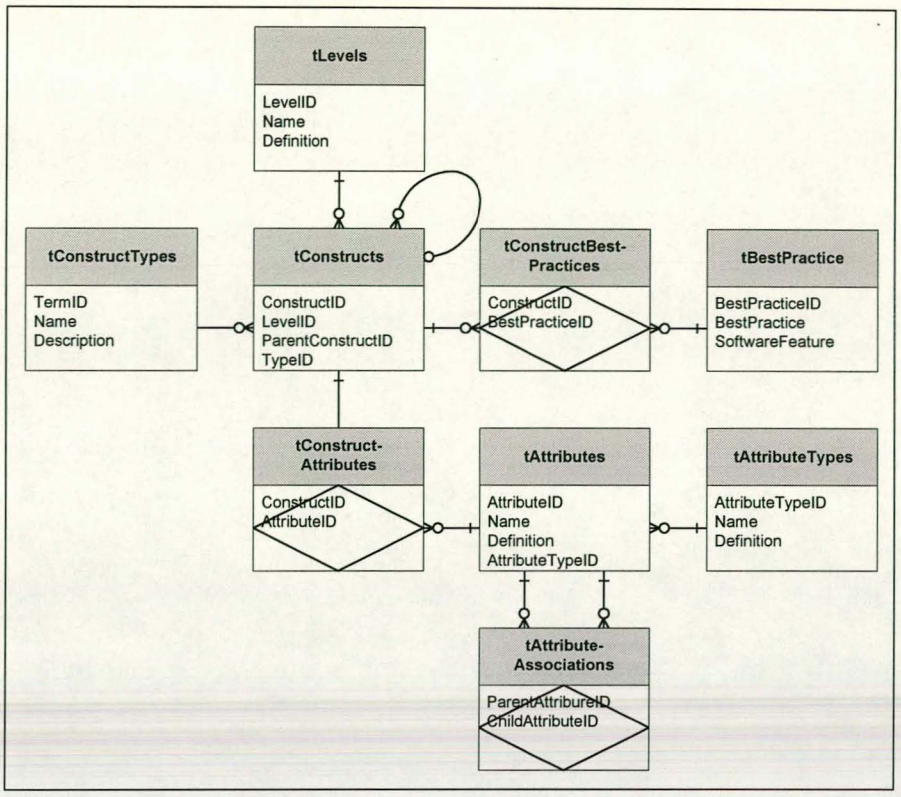

Figure 35: SCOR Database Extended Entity Relationship Diagram

that the attributes need only be attached to the process if it is necessary. If the user has the need to attach inputs to a construct in the Configuration level, this is possible, although it is not necessary.

Constructs also have a form of hierarchy. A construct may thus have a parent construct, and may also have children, but this is optional. This is represented by the loop in the top right corner of the tConstructs entity of Figure 35. A construct **may** have **a** parent construct. A parent construct **may** have **one or more** child constructs.

The generic use of the term *construct* here allows the user to create as many levels as desired, as long as integrity is maintained with the hierarchical relationships of these constructs.

The ID's for the tables are the original ID's used in the SCOR model (P1, S1.1, etc.). These were used, as it would be useful to users already familiar with the SCOR model, but also because these ID's are unique.

One functionality not built into this structure is that of the constructs not being related if they are at the same level, that is, the relationship of P1.3 following P1.1 cannot be shown. It was decided that adding this functionality would provide greater opportunity for errors and problems than it would add value. It is however possible if a number of validation processes are created.

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B.4.2 tLevels

The tLevels table is not essential for the use of the model. With the inclusion of the hierarchy approach as discussed in the previous section, this becomes redundant. It is still included, as it may be useful for someone who is familiar with the traditional SCOR model.

This function also provides a potential for errors. A person may define a level that is hierarchically, say four levels from the top level, a level that is intended for processes in a different level. The database simply uses this level as a label. It will result in erroneous data, but the database will still function.

B.4.3 tConstructTypes

The tConstructTypes table contains names and definitions for each of the constructs. It was not made part of the actual tConstructs table, as the names and definitions are repeated many times. The M2.2 process element and the M3.3 process element both have the name "Issue Material" with the same definition.

The M2.2 and M3.3 constructs are still defined independently, as their attributes (Metrics, Best Practices, etc.) are different. Defining them as one construct and simply associating them to different parents would mean that they are exactly the same, even the attributes, which is not so.

If at some point in time, the definitions for the terms change for either of the models, a new term can be created. Sharing one term does have the advantage that if the term itself changes for both constructs, it is only changed in one place, ensuring integrity.

The glossary of terms will eventually be built from these terms and definition, the definitions will be consistent and the relationships will also be correct.

B.4.4 tAttributes (and tAttributeTypes; tAttributeAssociations)

Each of the constructs may have an attribute. Attributes are typically, inputs, outputs, metrics, etc. These are the attribute types that are contained in the tAttributeTypes table. Each attribute is once again defined. These attributes are then associated with the construct. When changing an attribute, it need only be changed at one point to ensure consistency.

Attributes can also be related to other attributes. This is required frequently with the metrics. **Each** metric can be classified into **one or more** of four possible performance attributes. **Each** performance attribute **can** be associated to **many** metrics. The relationship method followed here is different to the

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one considered with the tConstructs table as the tConstructs table had a one to many relationship. Here the relationship is many to many.

This allows for many problems as it would be possible to associate attribute A to be, B to C and C to A. If a system displaying the step were to display every attribute with all their relationships, this would result in an infinite loop. The display of constructs currently in use does not require this functionality, but it is necessary to keep this point in mind when populating and using the database.

The nature of the attributes table allows the user to define new attribute types, and attach the attributes to constructs. One may decide to add keywords to the construct. The user would simply define a new attribute type, *Keywords* and then define keywords and associate them to the constructs. This makes the database flexible, as new types of attributes can be attached without changing the structure of the database.

B.4.5 tBestPractices

The tBestPractices table attaches best practices to each construct. In turn each Best Practice is associated with a software feature. This could have been included as an attribute, but the approach taken in this design is that best practices and software features have a one to one relationship. Practically this would mean that the user would have to define a software feature for every best practice. These two attributes would then have to associated. This would have resulted in allot of unnecessary work. The best practices are part of the model structure, it would thus be valid to include it as an entity on its own. When the user now enters a best practice, a software feature is entered at the same time.

The drawback to this approach is the assumption of a one to one relationship between software features and best practices. Upon investigating the model, it is found that the same software features are used for many different best practices. This is simply because the features specified are too general. Specifying that a certain best practice is supported by an ERP system is of very little use. The software features have to be very specific to be of real use, thus the assumption of a one to one relationship.

B.5 Displaying the Model

The model is displayed using the world wide web. The process of adding information is not provided in a web-based platform, as it is felt that it could lead to a corruption of the database if anyone could enter information. Information is thus added to the database itself using Microsoft Access.

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This section will describe how the web-based platform is used to display the model. Suggestions for improvement will also be made in this section.

1. The model can be accessed by going to the following URL: www.bing.sun.ac.za/scm
2. Click on the word eSCOR.
3. Click on the word SCOR. Note that any of the other models can also be accessed at this point in time.

A drop down is available with all the levels that are currently in the database. This is for the experienced user that is familiar with the model and would like to go directly to a specific level. The database will be demonstrated by drilling down the model.

4. Select the **Model** level and click the *submit* button. The user can also view the glossary at this point.

In this Model, top construct has been defined SCOR and is assigned the level, model. This was simply done to provide one parent construct to all the other constructs.

5. Select the **SCOR** option and click the *submit* button.
6. The SCOR construct is now displayed. The user can now drill down the model, or go up one level. Select the **Plan** option and click the *submit* button.
7. Select the **P1** option and click the *submit* button.

All the elements of the P1 process category are now displayed. Note that the attributes also have a second column. This column is for attributes attached to attributes, as with the performance attributes attached to the metrics. The constraint here is that only one level of associated attributes are displayed, that is, if there were attributes associated to performance attributes, it would not have been displayed.

8. Select the **P1.1** option and click the *submit* button.

All the elements of the P1.1 process element category are now displayed. Also note that inputs have also been added, as P1.1 has inputs. Now go back to the initial screen described in step 4.

9. Click on the word **Glossary**

A screen is displayed with all the available attribute types and processes. Each attribute type has a check box. To display all attributes of a specific attribute type, check the box next to it.

10. Check all the boxes and click the *submit* button.

A list of all the attributes and processes along with their definitions are displayed.

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B.5.1 Suggestions for Improvement

It is easy to underestimate the value of graphical representation when working with models. The pictures of the model are invaluable. It would be useful if a picture could be attached to each process. When the process is displayed, a relevant image of the process is displayed.

Another useful feature would be the ability to have maintenance functions, like adding editing and deleting on the web-based format, as long as the required security is provided. This would become especially useful when using the model over a company intranet, and a number of team members that are geographically removed work together on a Supply Chain Management project, as would typically be the case.

The glossary currently displays all terms in the database. It would be useful for the user to select a specific term that he/she would like to view.

The SCOR case study was discussed in Appendix C. Having the SCOR model in a database format, would make the process of designing (or redesigning) a Supply Chain much simpler. It would be of great use if the database was used as part of the tutorial.

B.6 Conclusions

It was shown that the database has been implemented successfully. Successfully here means that all requirements have been met.

The design of the database is of such a nature that it is easy to change the structure of the database, while ensuring integrity, and also without any further programming. The current interfaces to the database have been developed in such a way that any addition in the structure can be accommodated.

With this database now in place, it is easier to create other models using the SCOR model as partial model.

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Appendix C

SCOR Tutorial

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Chapter C1

Introduction and Overview

C1.1 Introduction

The SCOR model is used to model Supply Chains. The problem is that the SCOR models functionality may be lost if the user does not understand the uses of the model. Understanding this, the Supply Chain Council has set up a SCOR workshop in which the model is explained.

The biggest problem with this is the fact that the model still remains relatively inaccessible to people not in the United States. This tutorial will attempt to bridge this gap. This tutorial is closely based on the workshop presented by the Supply Chain Council. It is by no means intended to replace the workshop. It should rather be seen as a second best alternative. The idea is that someone could read through the case study without any formal instruction and still understand the model.

The case study's material is adapted from the material presented at the workshop. The figures are all the same, except for a few minor exceptions. The main differences are the background sketch and environment.

There are also differences in the interpretation of the data given. Some of the calculations are done differently, and others are skipped entirely.

The course follows a pattern of first describing the As-Is scenario and then tries to determine the current performance metrics. Next, the desired performance metrics are calculated. These metrics are then translated to a physical To-Be network design. Lastly mention is made of further uses of the model is made in terms of process elements.

The tutorial starts off with an overview of the SCOR model, describing the model in very broad terms followed by the case study. This is the first version of the case study. It will still be refined as it is presented to people. Further versions will also include estimations of the time that each model should take. This documented should be completed with the SCOR model documentation.

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Chapter C2

Supply Chain Operations Reference Model Overview

The Supply Chain Operations Reference (SCOR) model is used to describe, measure and evaluate Supply Chain configurations. It was developed by the Supply Chain Council (SCC) to provide a standard "language" for Supply Chain practitioners to use when describing their Supply Chains.

There was a need for an industry standard as different companies had to find a way of communicating their Supply Chain to their suppliers and customers. This led to the development of the SCOR model. It should be noted that the model is by no means perfect or complete. It is a very new model, and work is constantly being done to evaluate and improve it.

The Supply Chain Council was formed in 1996 by Pittiglio Rabin Todd & McGrath (PRTM) and AMR Research. The SCC initially included 69 voluntary members. This figure has now grown to 400 members, with most of these members being companies (Supply Chain Council, 1999a:8). The council boasts with a growth figure of 30 members per month. This information is significant, as it is an indication of the acceptance of the council and also the SCOR model as the industry standard in Supply Chain Management. Even more interesting is the regional breakdown of the membership. The SCC was initially supported by members from the United States. This has started to change. Chapters in Europe (55 members) and Japan (40 members) have now formed and the first Supply Chain world conference in Europe is scheduled for September 1999.

This section will provide an overview to the model. The overview is based upon the SCOR model overview presentation presented at each of the Supply Chain world conferences as well as a SCOR model overview published, and distributed to all council members.

The overview will only illustrate the basic functionality of the model.

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C2.1 The Uses of SCOR

The opening statement of this chapter described SCOR as a "process reference model designed for effective communication among Supply Chain partners" (Supply Chain Council, 1999b:24). This illustrates that the model has three dimensions: it is used to describe, measure and evaluate.

The model is used to describe virtually any Supply Chain using standard process definitions. Standard SCOR metrics enable the easy measurement and benchmarking of the Supply Chain's performance. This makes the model a useful tool in configuring and reconfiguring a companies Supply Chain.

C2.2 What is a Process Reference Model?

"Process reference models integrate the well-known concepts of business process reengineering, benchmarking and process measurement into a cross-functional framework" (Supply Chain Council, 1999b:2).

The process reference model, once complete contains standard descriptions of management processes,

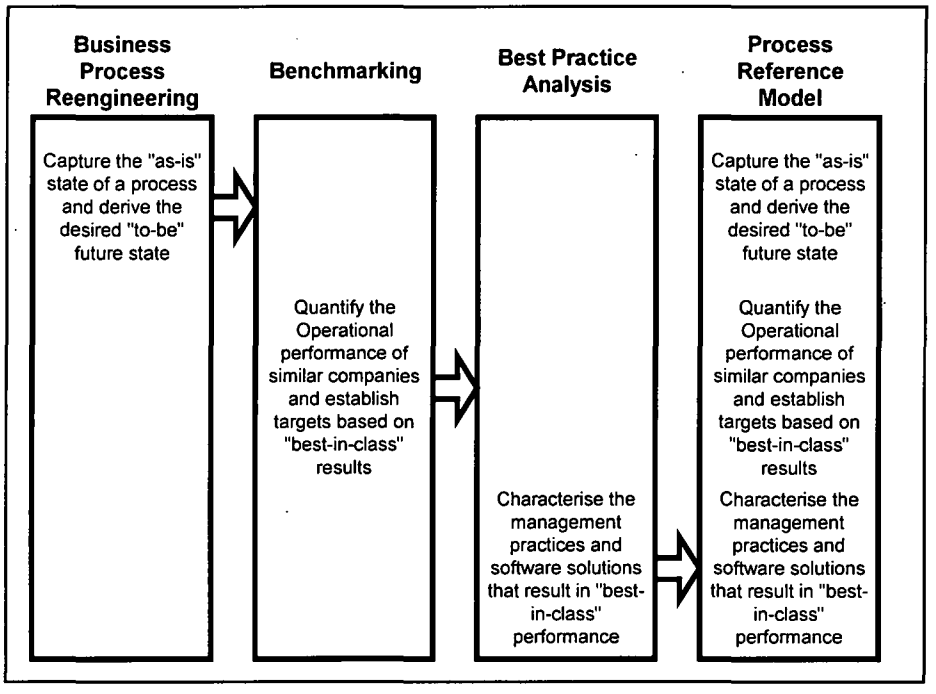

Figure 36: Process Reference Model

(Supply Chain Council, 1999b:2)

a framework of relationships among standard processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and standard alignment to software features and functionality.

This is also a high level description of the outputs of a complete SCOR implementation. These are however only the tangible outputs. A great benefit of using such a model, is in fact the process of

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creating your own model. Creating the model requires an understanding of the processes being modeled, an understanding that the practitioner may have had before, but not in the detail that is required to efficiently manage those processes.

C2.3 Boundaries of the SCOR Model

The principles and techniques described by the field of Supply Chain Management are not complex, in fact, they seem rather obvious and intuitive. The problem arises when implementing these ideas. The environment in which it is applied is filled with complexities and interdependencies. A small change at one point may have an effect on a later process.

With these complexities in mind, the SCC has set boundaries to their model. The most important function of the model is that it must be able to describe the entire Supply Chain, from the supplier's supplier to the customer's customer. The SCOR model spans:

- All customer interactions, from order entry through paid invoice.
- All physical material transactions, from the supplier's supplier to your customer's customer, including: equipment, supplies, spare parts, bulk product, software, etc.
- All market interactions, from understanding of aggregate demand to the fulfillment of each order.

SCOR does not include:

- Sales administration processes.
- Technology development processes.
- Product and proces design and development processes.
- Post-delivery customer support operations including technical support processes (SCC, 1999b:4).

Links to processes not included in the scope of the model, like product development, are noted within the model. The SCOR model is based on four distinct management processes. These processes are plan, source, make and deliver. All decisions made within the Supply Chain are aggregated to one of these processes. Some models have added more processes, for instance a store process. In the SCOR model the store function has been included with the deliver process. The number of aggregations are not important, it is more important for the model to be able to explain and represent a Supply Chain, and this is possible with the four processes as defined.

The various model processes will now be discussed in more detail.

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C2.3.1 The Scope of the SCOR Processes

The Plan process is used to describe demand and supply planning. It is defined as the "Processes that balance aggregate demand and supply to develop a course of action which best meets the established business rules" (SCC, 1999b:8). The planning here refers to daily operational planning as well as long term strategic planning. Operational planning decisions include: the assessment of supply resources, aggregation and prioritization of demand requirements, planning of inventory, distribution requirements, production, material, and rough-cut capacity for all products and all channels. Strategic decisions described by the Plan process are: make/buy decisions, Supply Chain configuration, long term capacity and resource planning, business planning, product phase-in/phase-out, manufacturing ramp-up, and end-of-life management, product-line management. The process also describes the management of the planning infrastructure. The Infrastructure elements are those elements that are needed to support the various processes, in this case planning processes. The Plan process is the process used most often in designing and managing the Supply Chain.

The Source processes are used to describe sourcing or material acquisition. It is defined as "Processes that procure goods and services to meet planned or actual demand" (SCC, 1999b:8). The sourcing operations described how to obtain, receive, inspect, hold, and issue material. As with the Plan process, the Source process also describes the management of the source Infrastructure element. The Source Infrastructure describes vendor certification and feedback, sourcing quality, in-bound freight, component engineering, vendor contracts, and the initiation of vendor payments.

The Make process describes production execution. It is defined as "Processes that transform goods to a finished state to meet planned or actual demand" (SCC, 1999b:8). The Make process is used to describe the elements of: request and receive material, manufacture and test products, package, hold and/or release products. The Make process also has Infrastructure elements. These elements are: engineering changes, facilities and equipment, production status, production quality, shop scheduling or sequencing, and short-term capacity.

The final process, the Deliver process describes order management, warehouse management and transportation and installation management. It is defined as "Processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management, and distribution management" (SCC, 1999b:8). Elements relating to order management include: enter and maintain orders, generate quotations, configure product, create and maintain customer database, manage allocations, maintain product or price database, manage accounts receivable, credits, collections and invoicing. The Warehouse management elements include: pick, pack and configure products, create customer specific packaging or labeling, consolidate orders, ship products. Transportation and installation management elements are divided into the elements needed to get the product to the customer premises, and then to actually install the product at this premises.

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These elements are: manage traffic, manage freight, manage product import/export, schedule installation activities, perform installation and verify performance. The Infrastructure elements for the deliver process describe the management of: channel business rules, order rules, delivery inventories, and delivery quantity.

C2.4 The SCOR Model Structure

The SCOR model is divided into 3 levels of detail (see Figure 11). In the previous section, reference was made to the SCOR processes: Plan, Source, Make and Deliver. Reference was also made to the process elements; which are elements that make up a process. The processes and process elements all fit in different levels in the model. These levels will now be discussed in more detail.

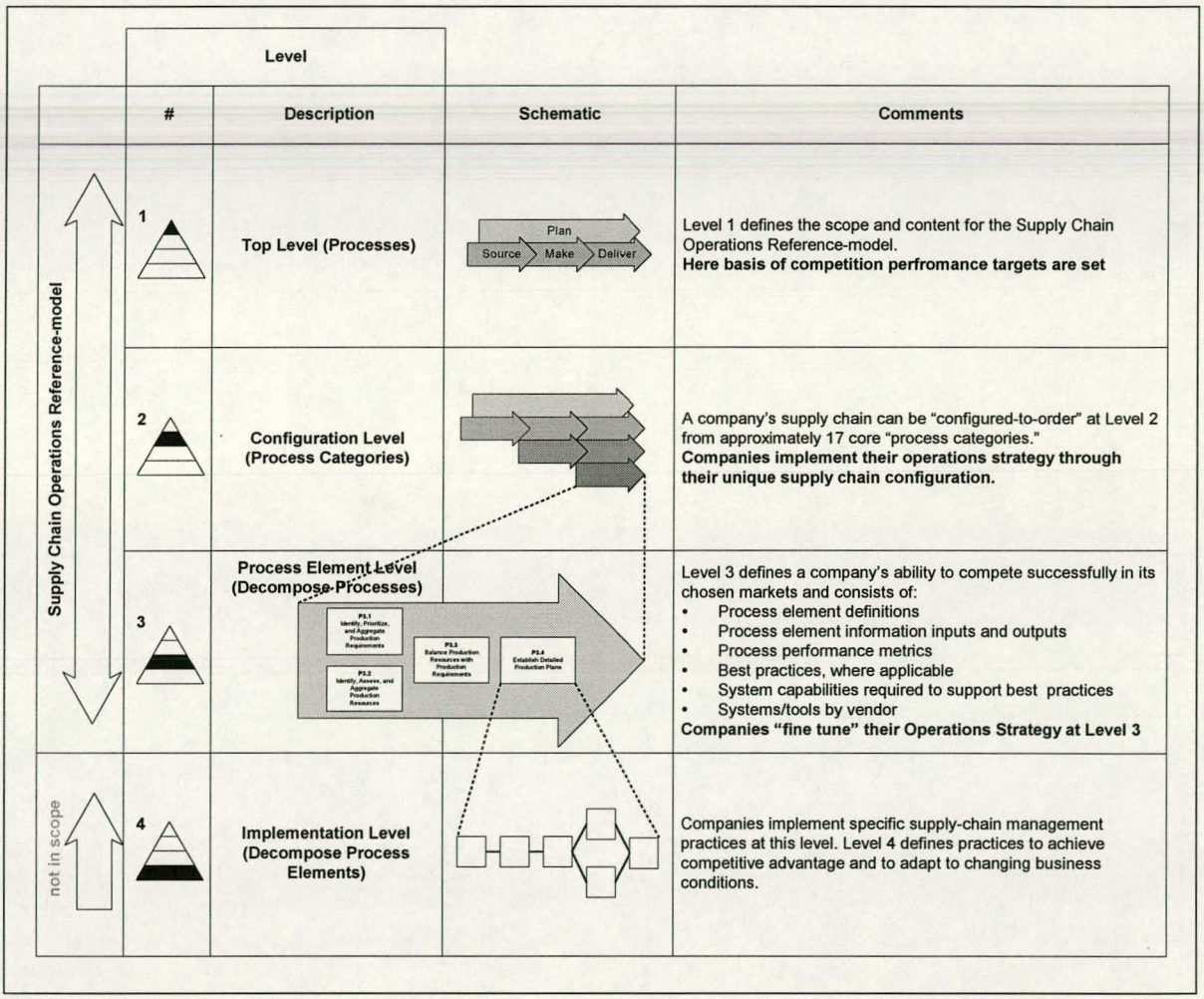

Figure 37: SCOR Model Structure

(Supply Chain Council, 1999a:14)

C2.4.1 Top Level (Level 1)

Level one defines the scope and content for the SCOR model. This is done by grouping processes into one of 4 categories: plan, source, make, or deliver. Definitions for each of these processes were given in section 5.3.1. The outputs of the top level are the global performance metrics for the Supply Chain.

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These metrics are the metrics that the company sees as important for their Supply Chain. It is important to note that the metrics have not been assigned or attributed to any process or function. These are simply global metrics (see Figure 12).

C2.4.2 Configuration Level (Level 2)

In level one, processes were categorized into one of four processes. In level two, each of these processes is further described in three dimensions, called process types. The three process types are planning, execution, and infrastructure.

Planning is defined as "a process that aligns expected resources to meet expected demand requirements" (SCC, 1999b:9). The planning processes balance aggregated demand and supply, consider consistent planning horizon, occur at regular, periodic intervals, and can contribute to the Supply Chain response time.

Execution is defined as "a process triggered by planned or actual demand that changes the state of material goods" (SCC, 1999b:9). The execution processes generally involve scheduling or sequencing, transforming goods, and moving goods to the next process. The execution processes can contribute to the order fulfillment cycle time.

	Customer-Facing		Internal-Facing	
SCOR Level 1 Supply Chain Management	Delivery Performance/ Quality	Flexibility & Responsiveness	Cost	Assets
Delivery performance	✓			
Order fulfillment performance	✓			
Fill rate				
Perfect order fulfillment				
Order fulfillment lead time	✓			
Supply chain response time		✓		
Production flexibility		✓		
Total logistics management cost			✓	
Value-added productivity			✓	
Warranty cost of returns processing cost			✓	
Cash-to-cash cycle time				✓
Inventory days of supply				✓
Asset turns				✓

Figure 38: Level 1 Performance Metrics

(Supply Chain Council, 1999b:9)

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		SCOR Process				
		Plan	Source	Make	Deliver	
Process Type	Planning	P1	P2	P3	P4	Process Category
	Execution		S1-S3	M1-M3	D1-D3	
	Infrastructure	P0	S0	M0	D0	

Figure 39: SCOR "Configuration" Toolkit

(Supply Chain Council, 1999b:8)

Infrastructure is defined as "a process that prepares, maintains, or manages information or relationships on which planning and execution processes rely."

Figure 13 shows the relationships of the processes and process types. The result is the process categories. The process categories are used as building blocks to map and configure their Supply Chains. There are 17 process categories in total. Figure 13 shows the numbering convention used in the model. All Plan processes are assigned the label *P*, source processes are assigned a label *S*, Make processes *M* and lastly Deliver processes are labeled *D*. Each of these groups consist out of a number of process categories, hence the numerical suffix to each process label. The S1 –Source Stocked Product process element will be discussed as an example in section 5.4.3.

To illustrate the use of these categories, consider a scenario were a Company A is supplying products

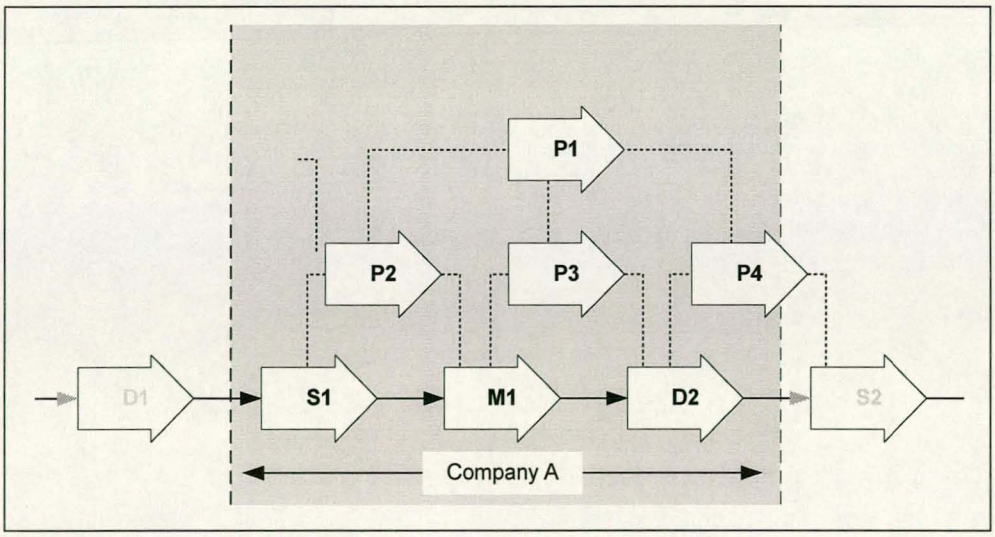

Figure 40: Supply Chain Example – *Company A*

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to a distributor. The company has a policy of only purchasing standard components that are freely available. The customer has a number of choices in configuring the product. The company manufactures the product according to this order. Figure 14 shows the SCOR representation of the scenario just described.

This now provides a departure point for analyzing and reconfiguring the Supply Chain if the company finds that the Supply Chain is not performing as desired, or even when searching for areas for improvement.

C2.4.3 Process Element Level (Level 3)

The next step is the process element level. Here the process category defined in level two is decomposed. This level consists out of process element definitions, process element information inputs and outputs, process performance metrics, best practices (where applicable), system capabilities required to support best practices, and systems or tools. Each of these items have been defined for each element. An element is a sub component of a process category (discussed in section 5.4.2). Figure 15 shows the level three S1: Source stocked material process category. The diagram shows each of the process elements performed in this category. It also shows the process flow (sequence of elements), the inputs, and the outputs to the elements.

Figure 16 shows the process element definition, and performance metrics. These metrics are not necessarily applicable for the context it is used in, they are simply the suggested metrics. The final choice of metrics is left to the discretion of the user of the tool. Figure 16 also shows the recommended best practices and software features for the specific element. As with the metrics, these best practices and software features are simply suggestions, the final choice is left to the user.

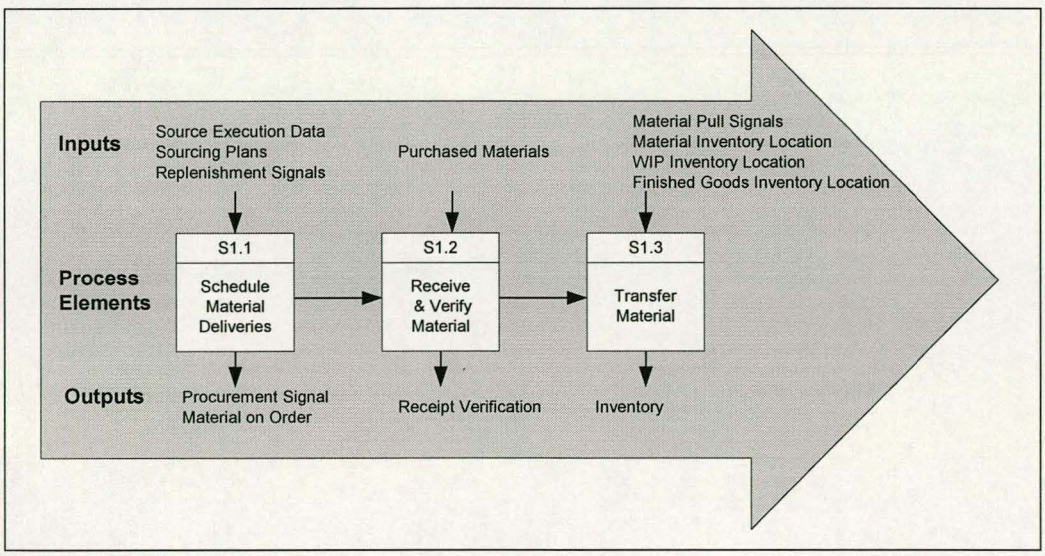

Figure 41: Level 3 Example - *S1 Source Stocked Product*

(Supply Chain Council, 1998)

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Process Element: Schedule Material Deliveries — Process Number: S1.1

Process Element Definition

Scheduling and managing the execution of the individual deliveries of material against an existing contract or purchase order. The requirements for material releases are determined based on the detailed sourcing plan or other types of material pull signals.

Performance Attributes	Metric
Cycle Time	Total Source Lead Time
Cost	Materials management as a % of Material Acquisition Costs
Service Quality	% Deffective
Assets	Raw Materials Days of Supply (DOS)

Best Practices	Software Features Required
Utilise EDI transactions to reduce cycle time and costs	EDI interface for 830, 850, 856, and 862 transactions.
VMI agreements allow suppliers to manage (replenish) inventory	Vendor managed inventories with scheduling interfaces to external vendor systems
Mechanical (Kanban) pull signals are used to notify suppliers of the need to deliver material	Electronic Kanban support
Consignment agreements are used to reduce assets and cycle time while increasing the availability of critical items	Consignment inventory management
Advanced ship notices allow for tight synchronisation between source and make processes	Blanket order support with scheduling interfaces to external vendor systems

Figure 42: Element Definition, Standard Performance Metrics, Best Practices, and Software Features
(Supply Chain Council, 1998:42)

C2.4.4 Implementation Level (Level 4)

The implementation level is not in the scope of the model. At this point the person using the model will start to look into the actual processes involved in completing the process elements described in the previous level. It now becomes a reengineering exercise, with the focus on describing and improving that specific process element.

C2.5 Summary

This section introduced the SCOR model. It was shown that the model allows the user to represent the entire Supply Chain in a standardized form. It also provides guidelines regarding best practices, metrics, etc.

It was shown that the model has the ability to describe the Supply Chain in various levels of detail and also aggregating the detailed levels back to a global view of the chain. It is the author's opinion that this, coupled with the ability to move through the model horisontally is what makes the model of great value to anyone working with the Supply Chain of any company.

This chapter did not attempt to suggest how the model is to be used. The aim was rather to explain each of the dimensions of the model. There is in fact no "correct method" for using the SCOR model.

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The Supply Chain Council does have suggestions in using the model, but these are simply suggestions. In fact, various lecturers presenting the SCOR workshop have different ways of applying the model. Any method is acceptable, as long as it can fulfill the needs of the users of the tool.

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Chapter C3

The Case Study

Read through the following case study of *Umboniso* Company. Take about 20 minutes to go through it. Don't worry about being to thorough, you can always come back to it later. For now you should just try to get a feel for what is happening in the case study.

Umboniso (Xhosa word for example) is a company based in South Africa and is the supplier of two electronic devices to the South African market.

The two product lines are the *ubudala* (Xhosa word for old) product and the *entsha* (Xhosa word for new) product.

The *ubudala* product is a mature product. *Umboniso* has been the manufacturer of this product for a number of years, and has achieved great success and also market share with this product in the past. There are now several similar products with similar features on the market.

The *entsha* product is a new product released by *Umboniso* to continue their leadership in the market.

Umboniso has one manufacturing plant located in the Port Elizabeth area. The facility does not have the capacity to produce both products and meet the forecast demand. *Umboniso* has thus chosen to outsource the manufacture of the *ubudala* (mature) product to a manufacturer in East Asia.

The *entsha* (new) product is manufactured at the Port Elizabeth plant. It sources some of the components of the product from a manufacturer in East Asia. It also sources the casings of the products from a supplier in Botswana. This was done as it was felt that the casing did not require special skills to manufacture. The process of producing the product was a monotonous process, and could easily be done by unskilled labourers. The costs of labour were lower in Botswana than in South Africa.

The products are distributed to regional warehouses in Cape Town, Durban, Johannesburg, and Pretoria. The warehouses then supply distributors who in turn sell the products to the customers for the

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mature product line. *Umboniso* has decided to cut the costs of the "middle man" with their new product. The new product is shipped directly to the customer. Here the product is sent to the customer via the distribution center.

The company has now, after six months in the financial year, done a forecast of the year end results. The company was not satisfied with the projected results. It was felt that Supply Chain Management may be the key to identifying the problems in the company.

C3.1.1 Manufacturing

- *Umboniso* has one manufacturing facility located in Port Elizabeth
- The *ubudala* product line has been outsourced to an OEM in East Asia.
- The *enstha* product line is manufactured at the Port Elizabeth manufacturing plant. The product consists out of a number of components that are easily available and sourced locally. Two of the components are sourced from other locations. The first is a casing manufactured in Botswana. The other component is an electronic circuit board manufactured by an OEM in East Asia. The manufacturing plant keeps stock of the components as well as the finished goods.

C3.1.2 Distribution

- In the case of the mature product line, customers purchase products from the distributors. The distributors order stock to replenish their stock when predetermined reorder levels are reached.
- The manufacturing facility manufactures products based upon forecast data for the specific distribution center. Manual orders can be placed if the forecast amount is not enough to meet the required stock levels in the warehouses. The finished products are transported to the various warehouses by rail. Orders are kept until containers are filled before shipping to the warehouses to aggregate the cost per product. Shipment (this includes the loading and off loading) of a container usually takes 48 hours.
- The distribution centers require the fulfillment of orders within 48 hours.
- The warehouses expect manual orders to be filled within 7 days.

C3.1.3 Sourcing

- The company orders the entire mature product from an OEM manufacturer. The manufacturer supplies the company according to forecast demands set by the company. Manual orders can be placed when the order differs from the forecast amount. The OEM can manufacture a product within 30 days of receiving an order. The actual manufacture takes much less time, but the manufacturer also manufactures for other companies and requires its orders to be scheduled and fixed a month in advance.

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- The ownership of the product moves to *Umboniso* as soon as the product leaves the port of the OEM supplier in East Asia. The product spends 70 days at sea in shipping the product to the factory in Port Elizabeth. The components then take 7 days to pass the customs in the harbor. Orders are not shipped until an entire container is not filled. This applies to both the Mature product and the electronic component of the New product.
- The New product also requires a component from Botswana. The Botswana factory produces the casings upon receiving orders from *Umboniso*. These casings are then transported by truck to the Port Elizabeth factory. The products take 7 days to clear at customs and another two days to be transported across country.

C3.1.4 Market

The products are of such a nature that a customer would purchase either a new product or a mature product. The value of the New product lies in its availability, features and quality. Price is a secondary consideration in this product. Very few products that are produced locally can compete with the New product. There are similar products available in Europe and America.

The Mature product competes on price and the reputation of the product. The previous success of the product may be a distinguishing factor when choosing the product. There are a number of similar products on the market. Distributors value low priced products, high inventory turns and minimal logistics costs.

The company is rated as one of the top five companies in its industry.

C3.2 SWOT Analysis

C3.2.1 Strengths

- The Mature line does have a price advantage over other products in the market.
- The reputation of *Umboniso* after the success of its previous product has created the perception of a company with quality products
- The New product is a product with superior functionality above the other products on the market.

C3.2.2 Weaknesses

- The company is loosing its reputation after customers have returned with complaints of bad quality products in the New line.
- *Umboniso* is not always making the order deadlines as specified. Orders that are filled are not always complete.
- *Umboniso* cannot respond to market fluctuations in a reasonable amount of time.
- *Umboniso* has not invested in Marketing via the Internet which is becoming more popular in this industry.

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C3.2.3 Oppertunities

- The New product line has the potential to become the leading product if its quality and availability can be increased.
- The Mature line can easily dominate the market if its availability can be increased. The product has outstripped the forecast demand of the company.

C3.2.4 Threats

- Competitors in the New product group are gaining market share by means of their e-commerce initiatives. Customers who need the product in a short period of time have no problem in paying the extra amounts of fast shipments and the other customers have no problems in waiting for 30 days.
- The profits of the mature line are to low to warrant the company to continue providing the product. The profit margins must either be increased or it should be dropped al together.

C3.2.5 Discussion

After further investigation of the SWOT analysis, the following was found. The suppliers in Botswana were producing products that did not always meet the specifications set by *Umboniso*. Customers would return the product within a week of purchase. At this point *Umboniso* would supply the customer with a new product. The manufacturer of the casings did have a return policy. Any faulty products should be returned. If it cannot be repaired, it would be replaced. The entire process of disassembling the product, shipping the casing to Botswana and back again, and then reassembling the product took two months.

This also caused problems in the inventory levels of the factory. The faulty products were replaced with products that were manufactured according to the forecast for following periods. This resulted in manual orders being placed. The total shipment times caused the company to be unresponsive to the new demand resulting in stock outs of finished goods. This shortage of finished goods was short lived, because when the components finally arrived, the replaced faulty components had also arrived resulting in too much stock on hand. (The components sent for repair is listed as inventory when it is sent for repair). The inventory levels were thus fluctuating and hard to predict.

Upon further investigation it was found that the problem in Botswana was that there was a shortage of schooled employees. Although the labour force was cheap, it was also proving to unreliable.

C3.3 Critical Success Factors

- Make the supply of the Mature product profitable.
- Increase the quality and availability of the New product line.
- Maintain image as leader in the industry.
- Overall revenue growth for the year at 10 %.

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C3.4 Financial Statements

Extract from Income Statement

		Last Year		Current Year Projection
		R(million)		*R(million)*
Revenue		1000		1000
COGS		600		540
Net Operating Expenses		270		395
Order Management	*50*		*113*	
Material Acquisition	*20*		*32*	
Selling Expenses	*50*		*62*	
Administrative Costs	*50*		*88*	
R&D Costs	*100*		*100*	
Operating Income		130		65

Extract from Balance Sheet

	Last Year	Current Year Projection
	R(million)	*R(million)*
Accounts Payable	22	22
Accounts Receivable	146	292
Inventory	88	176

C3.5 Notes

- The increase in logistics costs is attributable to the increase in shipments of components from other countries. It is assumed that the cost of transporting the goods to the warehouses has remained constant.
- The projected revenue growth is R100M below the projected growth of 10 %
- The decrease in price of COGS is attributable to the fact that the OEM is manufacturing the product at a more competitive price.
- Increased administrative costs is accounted for by the implementation of a new information system to handle the large number of orders that need to be processed. The old information system had to be replaced by a new one that could communicate with the suppliers in other countries. The investment on the information system is estimated to be R30M

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- The inventory amount doubled because of the problems in supplying the new product. The goods transported by ship are also the property of the company and is indicated as inventory.

C3.6 Service Performance

- 1000 customer orders are placed at the regional warehouses per week
  - 800 are for mature products
  - 200 are for new products
- 890 orders were delivered by the committed to delivery date
  - 100 were delivered as partial fulfillments
    - 50 for the mature product
    - 50 for the new product
- 790 orders were delivered in full be the committed to delivery date
  - 690 for mature
  - 100 for the new
- All orders are treated as stock items. Items having no stock are expedited.
- For items having stock, the line filtrate is 63% NEW and 89% mature
- *Umboniso*'s order fulfillment lead-time performance includes
  - Customer authorization to order receipt-1day
  - Order receipt to order entry-1 day
  - Order entry to start build-1day
  - Start build to order ready for shipment-2days
  - Order ready for shipment to customer receipt-2days
- For expedites add
  - Make cycle-30days
  - Shipping Cycle OEM - 70+7days
  - Shipping Cycle OEM (Botswana) - 7 + 2days
- Of the 790 orders delivered on time and in full, 200 orders were either in question for shipping damage or something wrong on the packing slip or mismatch between the invoice and purchase order.
  - 100 new
  - 100 mature
- It takes 45 days to increase or decrease production capacity 20% without cost penalty for both products. The OEM supplier follows the lead-time agreed to in the supplier agreement (120 days)
- The value added per employee is calculated to be R122k

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- The direct costs of faulty products to the company cannot be calculated directly, as no materials are lost, there are however costs involved in transporting the product are lumped in the operational expenses.

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Chapter C4

SCOR Methodology: Applied in Four Steps

As discusses in the overview, the model can be divided into four steps. This is then the order in which an implementation is done. Figure 43 gives a breakdown of the actual process that a practitioner would go through when implementing the model. This figure will be referred to throughout the rest of this tutorial. The first important thing to note is that you need not complete a level before moving on to the

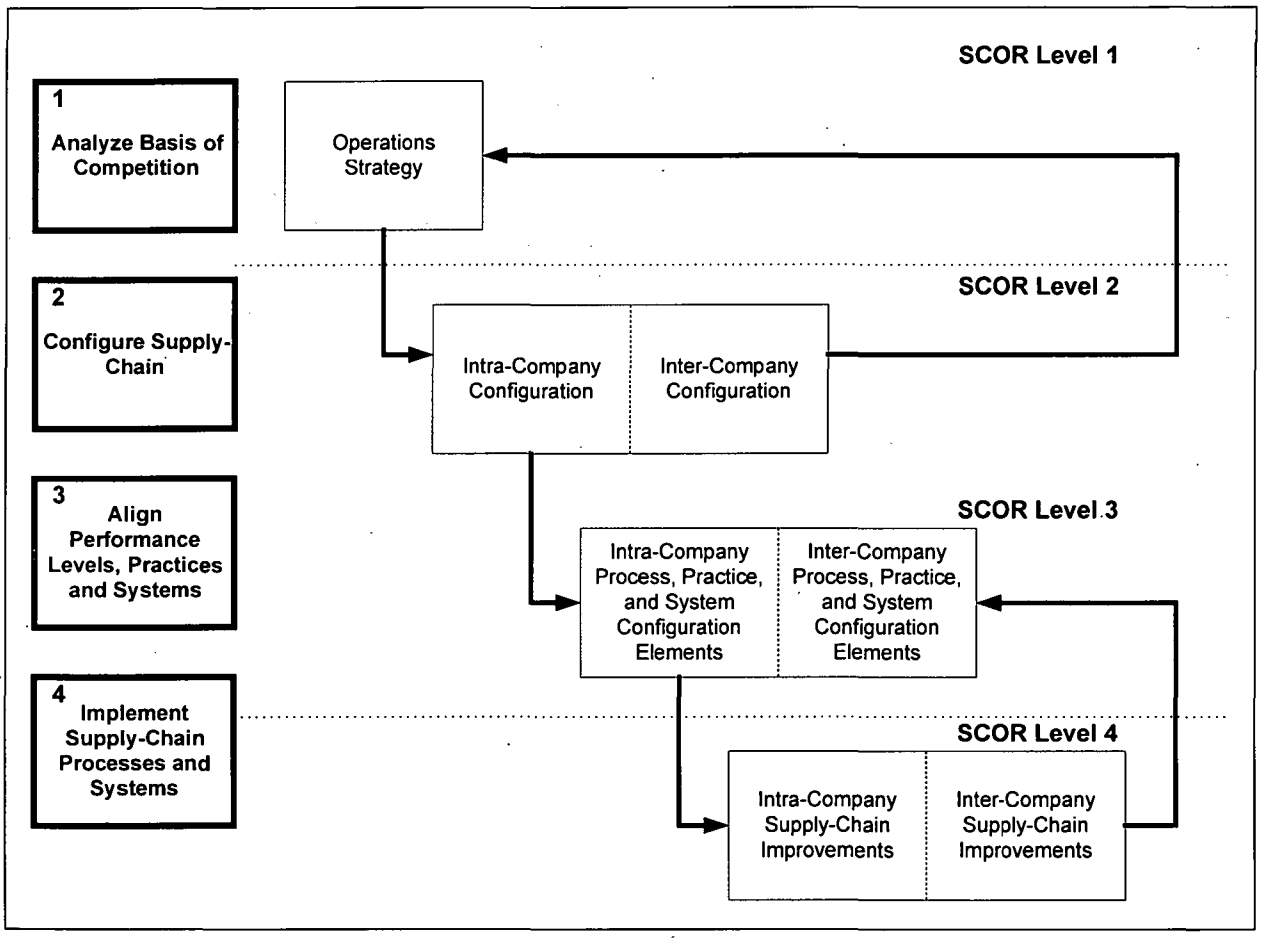

Figure 43: SCOR Methodology: Applied in Four Steps

(Supply Chain Council, 1999)

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next. The figure does give an idea of how the steps are related.

The rest of this chapter will discuss this figure in more detail. Level 1 is the analysis of the basis of competition. There are a number of ways in which this can be done. The SCOR model does this by identifying the key performance metrics for the entire Supply Chain. Here you should attempt to first identify the Supply Chain to be modeled, decide how the company intends to compete, identify the performance metrics at a corporate level, etc.

The next level is the configuration of the Supply Chain. At this level the goal is to give a as-is and to-be representation of the Supply Chain. The focus is on the actual flow of material. Note that the mapping here is of both the Supply Chain of the company and that of its partners.

The third level is a look into the practices and metrics that support the configuration given in the previous level. The focus here is information flow and workflow. Here information specific to the various tasks must be gathered.

The last level is the actual implementation of Supply Chain processes and systems. This is beyond the scope of the SCOR model, but a typical example will be given.

Considering the four steps as a whole it is important to note that the process is iterative. A change in a lower level may lead to changes in higher levels. This tutorial will move along the stages in general, although there may be times that two steps may be grouped. An indication of the current step will be given throughout the document with the following symbols:

Level 1

Level 2

Level 3

Level 4

The tutorial will consist out of discussions and then a point where the user will be required to provide their solution. As the model builds upon decisions made in previous steps, the model will follow one trail of solutions. This is not to say that the solutions suggested by the user are wrong, it is simply impossible to cater for all solutions. The user is thus encouraged to provide their own solutions but continue with the tutorial using the solutions that have been suggested.

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Chapter C5

Kicking Off

By now you have read the case study, and seen that *Umboniso* has a few problems with their Supply Chain. Off hand you can make a number of suggestions to correct the problem, but for now the focus is on going through the steps as prescribed by the SCOR model.

First you need to consider what the Supply Chain is. Supply Chains are defined in one of two ways.:The first and very obvious form of defining the Supply Chain, is by considering the product. Each product has its own flow and thus its own Supply Chain. The next method is by defining the Supply Chain in terms of the customer channels. The general trend is to distinguish between various customers. Customers are not all equal. With this differentiation in mind, each customer group may require a different Supply Chain.

For this case study we will choose the Supply Chains with regard to the products. Here *Umboniso* has two products, and thus two Supply Chains.

The rest of the tutorial will be discussed by first using the Mature product line as an example. The reader will then be required to complete the task for the New line.

The choice of the Supply Chain was in level 1. The next step is to move to a level two activity, to model the as-is Supply Chain.

C5.1 The As-Is Supply Chain for the Mature Product Line

The first step is to plot the physical locations of all the entities in the Supply Chain, these include suppliers, manufacturers, distributors, customers, etc. These entities should be plotted on a geographic map of the region. After the entities have been placed, the material flows and relationships between the various items should be shown.

Lastly the SCOR level 2 processes should be identified at each location. To illustrate this, consider the processes at the warehouses. The distributor reorders as the inventory levels reach a specific reorder

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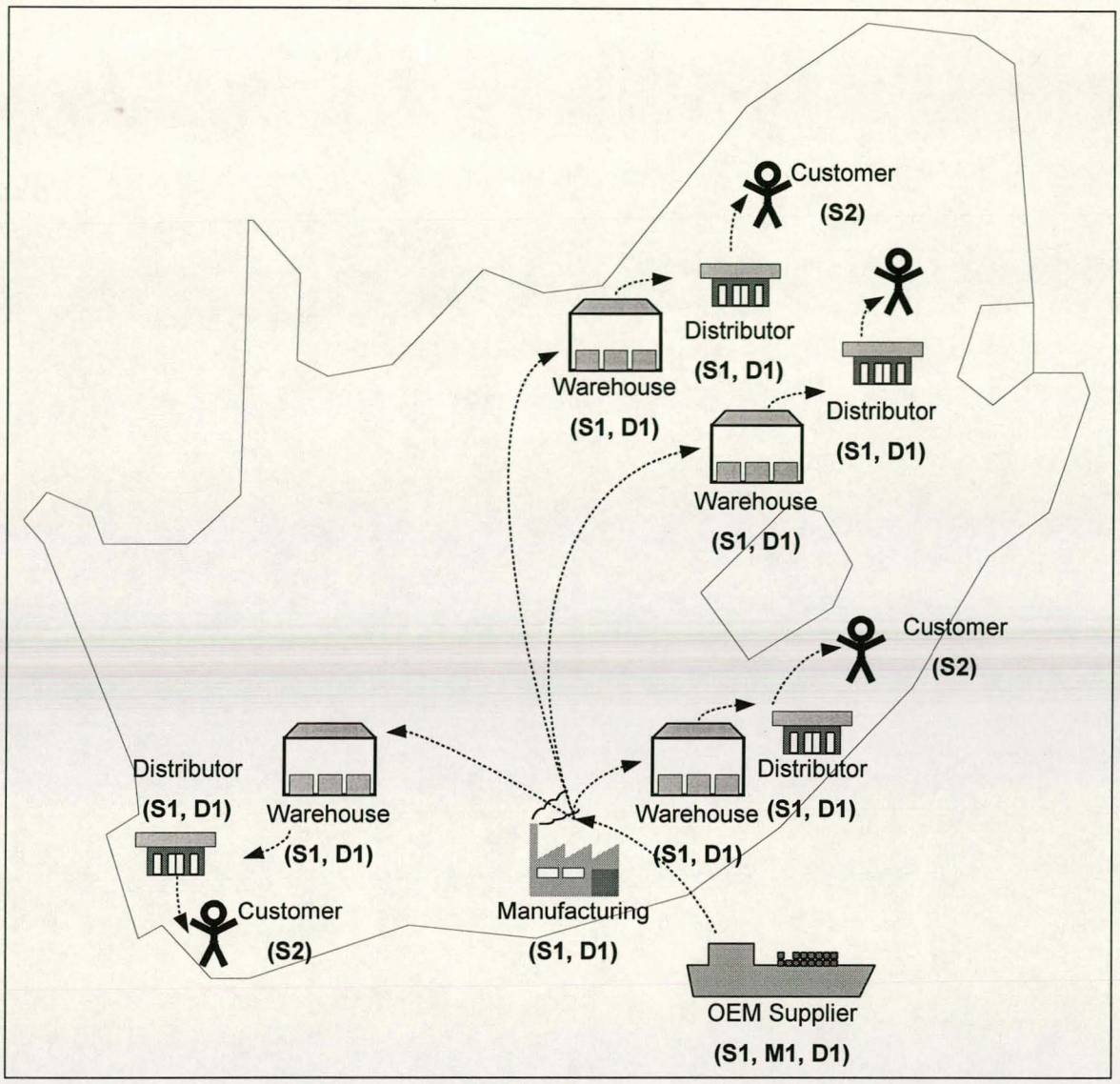

Figure 44: As-Is Supply Chain: Mature Product Line

point. The process thus has to order to stock and delivers from stock. The processes are thus S1 and D1. There are no make processes as it is a distribution center and no manufacturing takes place.

The mapping shown here usually gives rise to a number of questions. The question most often encountered is that of making the customer an S2. The problem is not as much that the customer is an S2, most people do agree with this. The customer will buy a product as they need it, consumers very rarely buys a product to keep it on the shelf. The question is however how the distributor can have a D1 one supplying a S2. Many people feel that a deliver must be followed by a source with the same number (D1 gets S1 etc.)

The exact convention is not important, what is important that the use of the symbols and processes are consistent. Also important are the lists of all the processes. You can go and look up which processes are available in the SCOR "repository" along with their definitions in the model (see Figure 45).

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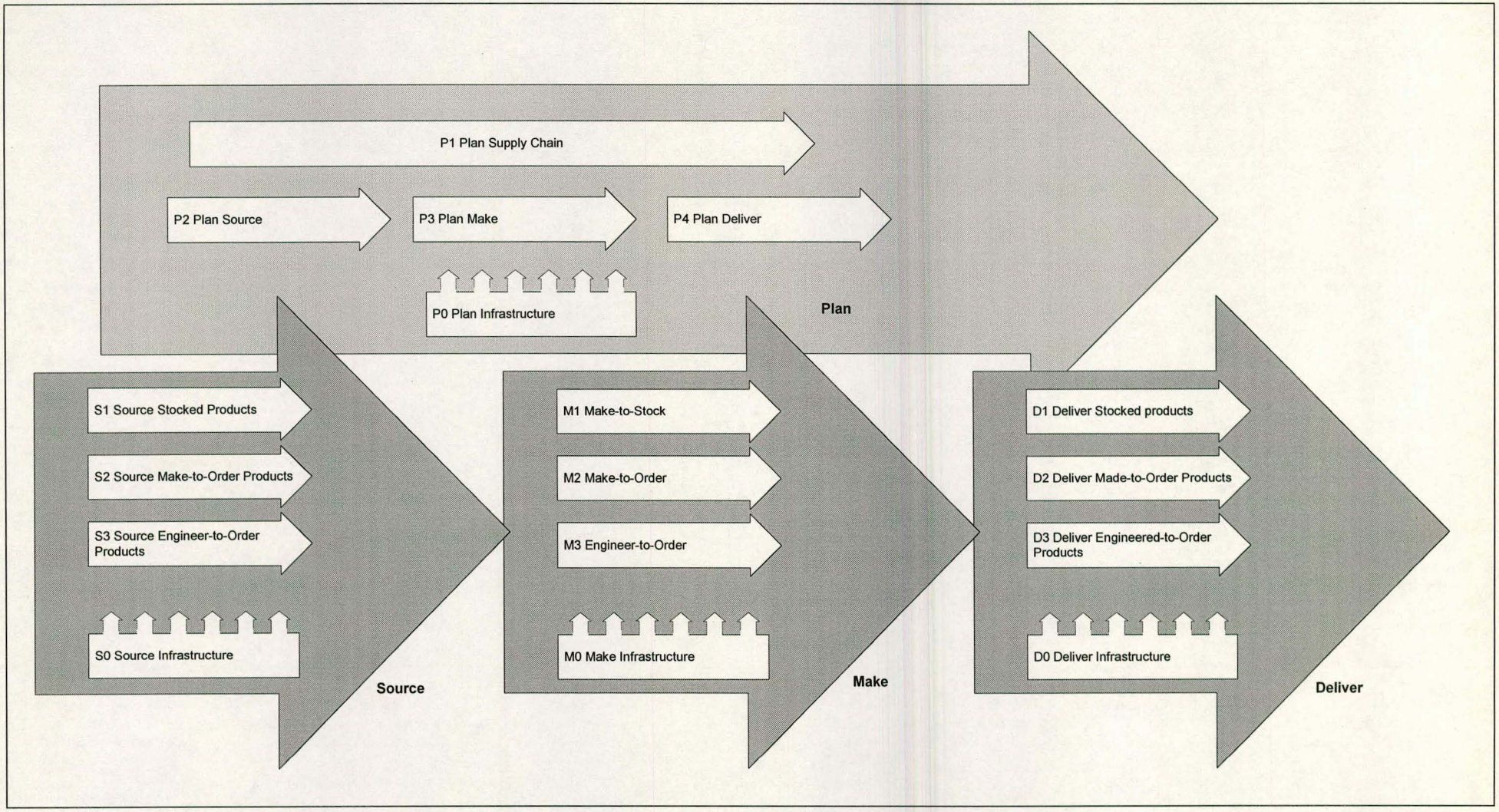

Figure 45: Process Elements

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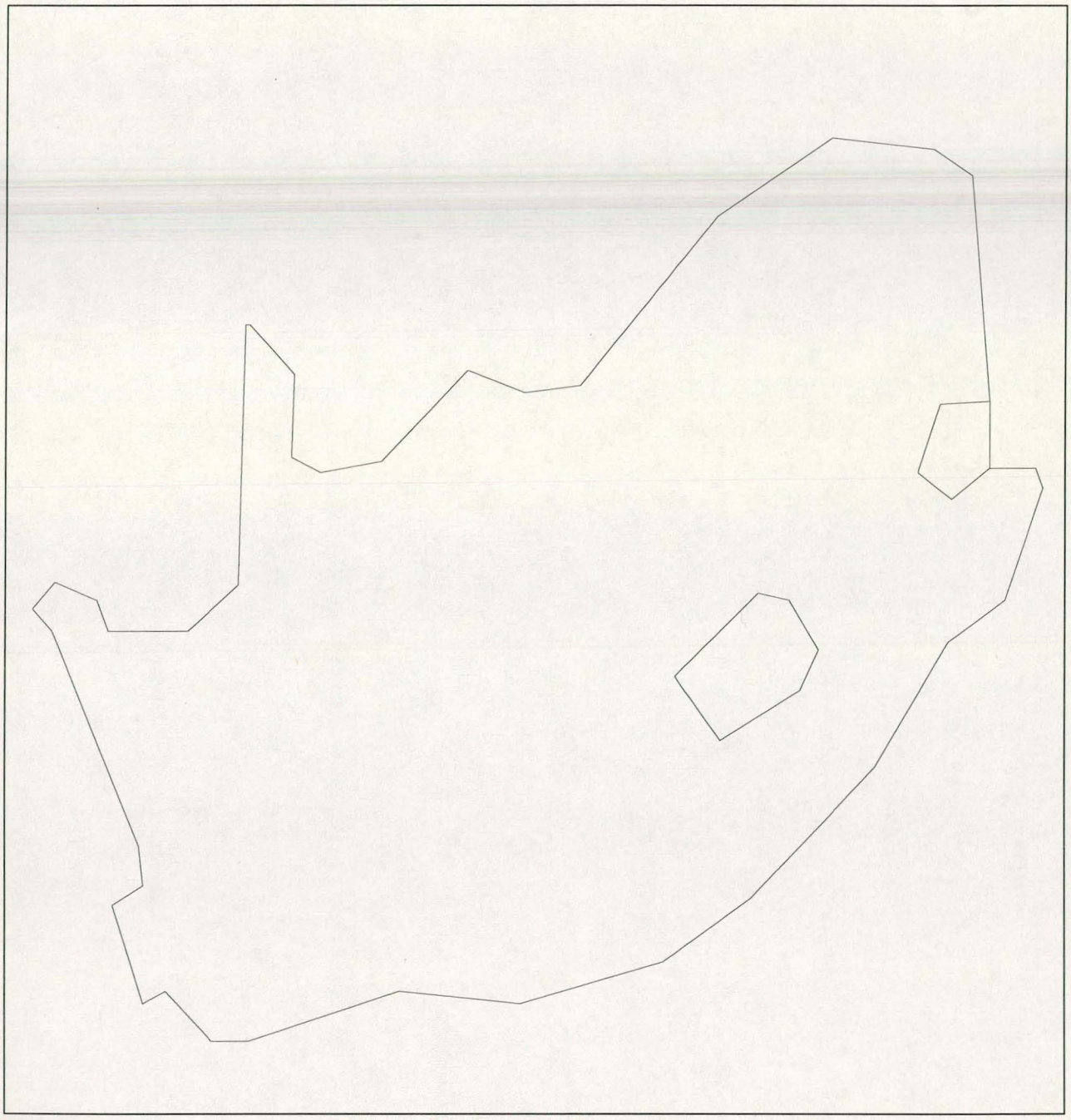
C5.2 Exercise 1

Now complete the following steps for the New Product Line on the map provided below

1. Draw the physical locations of all the entities involved in the New product cupply chain
2. Draw the flow of materials between the various entities
3. Add the SCOR level two process identifiers (S1, M1, D1, etc.) to the physical locations

Note that you have no interest in showing the inter- and intra- company borders in this diagram, the idea is simply to draw the Supply Chain as a whole at this point in time.



Excercise 1

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Chapter C6

Configuring the Supply Chain

This chapter continues from the previous one. Now that you have plotted the Supply Chain it needs to be mapped into a diagram that better illustrates the sequential progression as the product flows through the chain.

In this mapping, each of the execution processes identified in the geographical representation is drawn in a sequential order and represented with an arrow.

Figure 46 shows how these processes have been plotted. Now that the execution processes have been draw, planning processes have to be drawn for each of these processes. This is done by placing the planning processes for each of the execution level processes above the execution processes. Not that the planning process of the execution process is linked to the next process that follows.

Lastly a thread of planning processes is grouped with a plan 1 process. Here a thread could be defined as the processes between and including a sequence of supply and demand processes.

A few interesting issues now arise when considering this. The first is the Plan 1 processes. These processes can also be used to group the plan 1 processes of various threads. It is thus felt that the contents of the process is of such a nature that it actually describes other plan 1 processes. The activities of two companies coming together to discuss how there Supply Chains are performing will thus be discussed with the plan 1 process.

Another interesting point is that of a thread and the source deliver blocks. In theory, the ideal would be that the source and deliver blocks become one, companies do not need to source or deliver anymore, they are in fact a seamless or virtual organisation. This is ignored for this tutorial.

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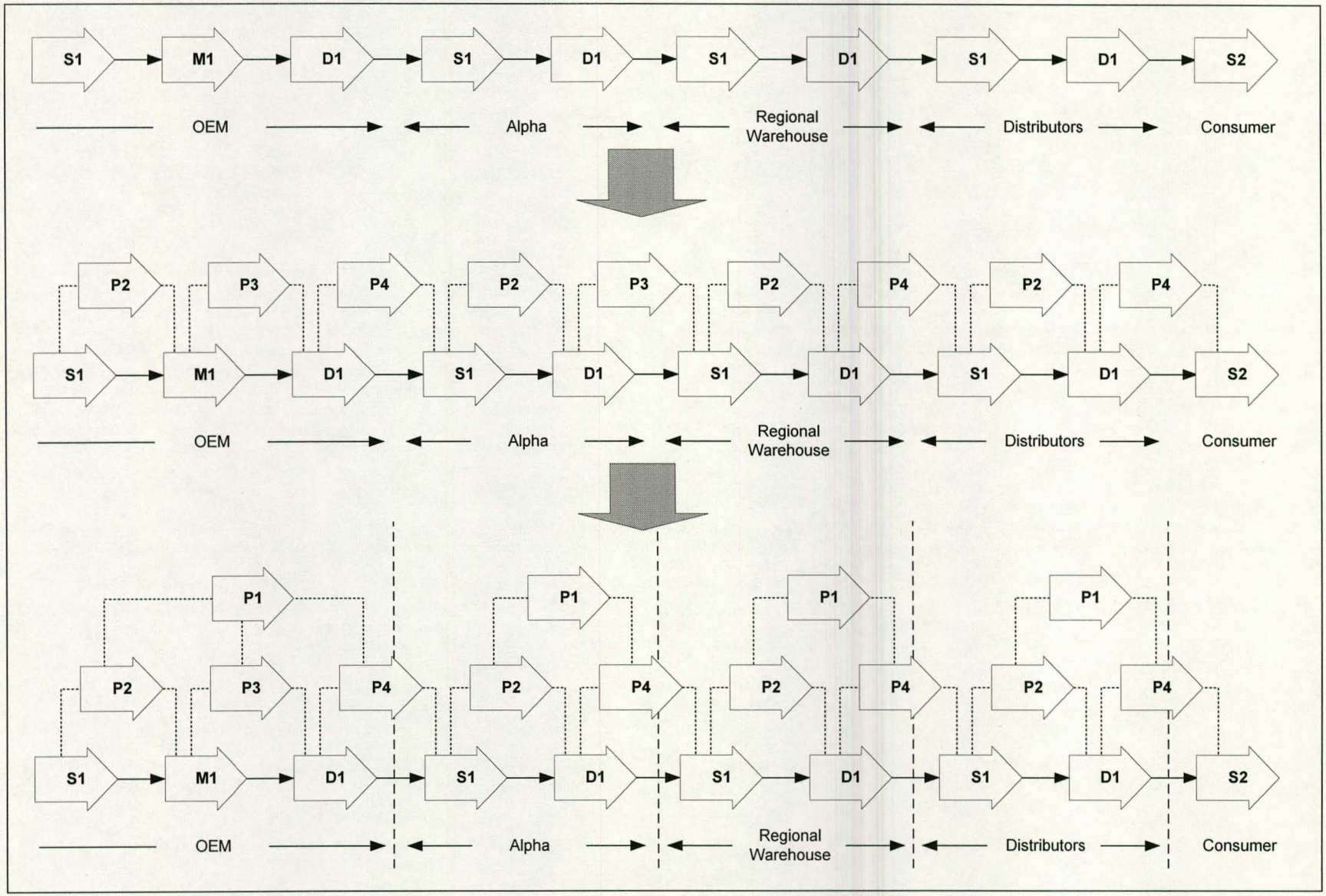

Figure 46: Process and Execution Elements

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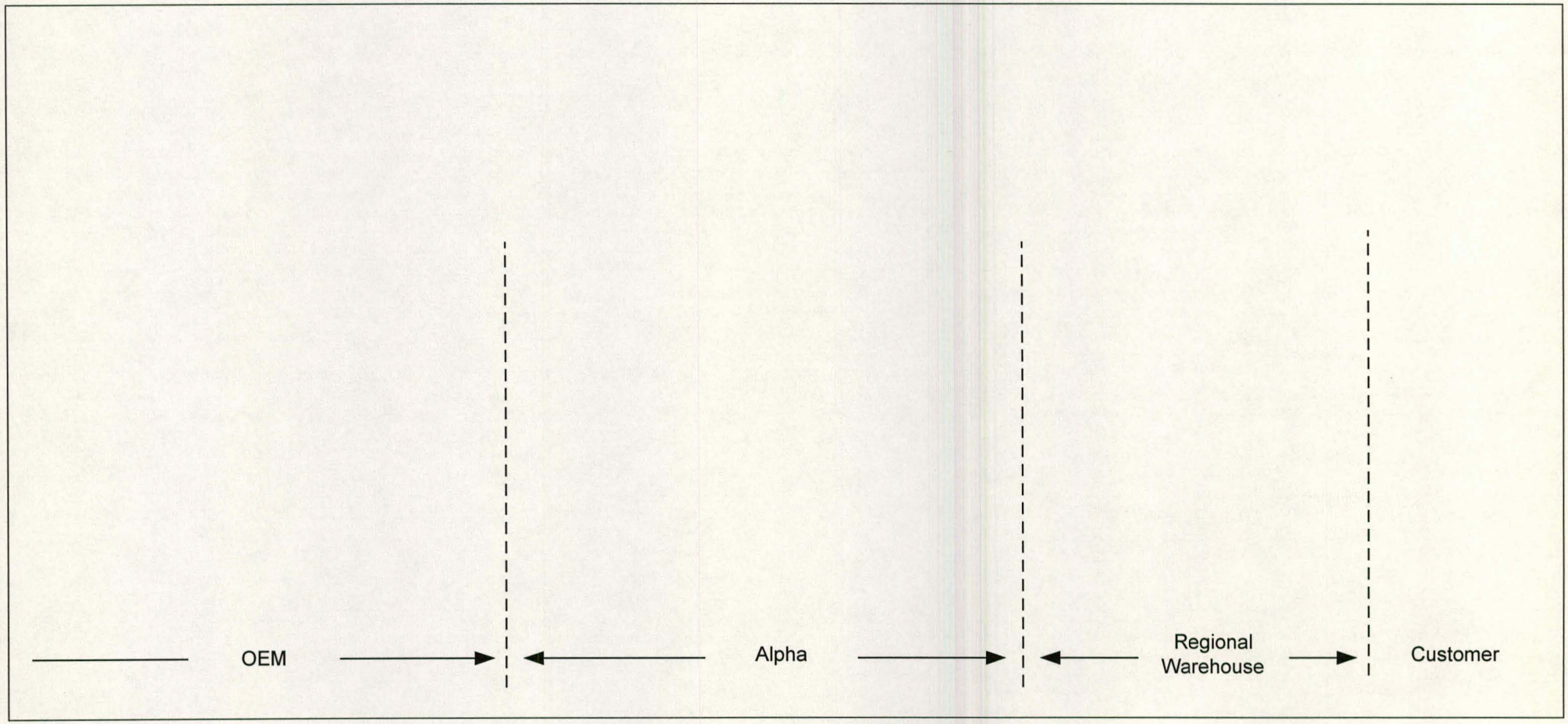
C6.1 Exercise 2

1. Plot the execution processes
2. Plot the plan processes of the execution processes
3. Plot the Plan 1 processes



Excercise 2

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Chapter C7

Performance Metrics

The reader will be forgiven for thinking that the only use of the previous two exercises was to draw the Supply Chain, because that is exactly what was done. You will also notice that you should now have a good idea of how the Supply Chain operates and what elements are involved.

Now that the Supply Chain that is being considered has been defined, the analysis of this Supply Chain can now be done. For this we once again move to level one of the SCOR model. Here we focus on the level one performance metrics shown in Figure 47.

These are the metrics that are important when considering the Supply Chain as a whole. As was seen in the previous section, a P1 plan process is assigned to each thread. For this example we will focus on *Umboniso*'s thread.

At this point the idea is that the company obtains benchmarking data. The benchmarking exercise is not part of this tutorial although it should be said that benchmarking results can be obtained at reasonable prices when the company participates in benchmarking exercises.

	Customer-Facing		Internal-Facing	
SCOR Level 1 Supply Chain Management	Delivery Performance/ Quality	Flexibility & Responsiveness	Cost	Assets
Delivery performance	✓			
Order fulfillment performance	✓			
Fill rate				
Perfect order fulfillment				
Order fulfillment lead time	✓			
Supply chain response time		✓		
Production flexibility		✓		
Total logistics management cost			✓	
Value-added productivity			✓	
Warranty cost of returns processing cost			✓	
Cash-to-cash cycle time				✓
Inventory days of supply				✓
Asset turns				✓

Figure 47: Level 1 Performance Metrics

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	Supply Chain Scorecard v 3.0					
	Overview Metrics	SCOR Level 1 Metrics	Actual	Parity	Advantage	Superior
External	Delivery Performance/. Quality	Delivery Performance to Commit Date	86%	85%	90%	95%
		Fill Rates	89%	94%	96%	98%
		Perfect Order Fulfillment	74%	80%	85%	90%
		Order Fulfillment Lead times	7 days	7 days	5 days	3 days
	Flexibility & Responsiveness	Production Flexibility	45 days	30 days	25 days	20 days
Internal	Cost	Total Logistics Management Costs	19%	13%	8%	3%
		Value Added Productivity	R122K	R156K	R306K	R460K
		Warranty Cost or Returns Processing Cost	N/A	N/A	N/A	N/A
	Assets	Cash-to-cash Cycle Time	211	80 days	46 days	28 days
		Inventory Days of Supply	119 days	55 days	38 days	22 days
		Asset Turns	2.2 turns	8 turns	12 turns	19 turns

Figure 48: Level 1 Benchmark Results

Figure 48 shows how these benchmarking results have been added for the Mature product range. At first glance this table might seem intimidating. There are a number of calculations and terms used, but what are they exactly.

The first issue to clear up would be the terms used. The SCOR model also includes a glossary. All metrics, Process elements and inputs and outputs (discussed later) are given in this glossary. Take for example the cash to cash cycle time. The SCOR glossary defines this as: *Cash-to-cash cycle time = inventory days of supply + days sales outstanding – average payment period for materials (time it takes for a dollar to flow back into a company after its been spent for raw materials).*

From this the cash to cash cycle can be calculated. The same then applies for all of the metrics. If your specific company has defined their metrics in a different way, it is still fine, simply make sure that there is consistency in the use of the metric and that you don't have people working with different definitions to the same metric.

Each of the calculations will now be discussed in more detail. Remember to constantly refer to your SCOR model to identify what is meant with each of the metrics.

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The first metric is the **delivery performance to commit date**. This is defined as *the percentage of orders that are fulfilled on or before the original scheduled or committed date.* In the case of the mature product there were 800 orders for the product. Only 690 had been received in full. The delivery performance to commit date is thus

$$\frac{\text{number of orders delivered on time and in full}}{\text{total number of orders}} = \frac{690}{800} = 86{,}25\% \approx 86\%$$

The next metric is the **Fill Rates** defined as *the percentage of ship-from-stock orders shipped within 24 hours of order receipt.* This figure is given to be 89%.

The third metric is **Perfect Order Fulfillment**. *A "perfect order" is defined as an order that meets all of the following standards: 1) Delivered complete; all items on order are delivered in the quantities requested; 2)delivered on time to customer's request date, using your customer's definition of on-time delivery 3)documentation supporting the order including packing slips, bills of lading, invoices, etc., is complete and accurate. A Perfect condition is defined as faultlessly installed (as applicable), correct configuration, customer-ready, no damage.* Perfect order fulfillment is calculated by dividing the total orders shipped on time and in full less the orders with faulty documentation less the orders with shipping damage by the the total number of orders. For the mature product the perfect order fulfillment is

$$\frac{\begin{array}{c}\text{total orderds shipped n time and infull}\\ \text{- orders with faulty documentation}\\ \text{- orders with shipping damage}\end{array}}{\text{total number of orders}} = \frac{590}{800} = 73{,}75\% \approx 74\%$$

Order fulfillment lead times is defined as *the average actual lead times consistently achieved, from Customer Signature/ Authorization to Order Receipt, Order Receipt to Order Entry Complete, Order Entry Complete to Start-Build, Start Build to Order Ready for Shipment, Order Ready for Shipment to Customer Receipt of Order, and Customer Receipt of Order to Installation Complete.* In the case of the mature product there is no manufacturing, but the other time measures are still valid for order entry and processing. The **order fulfillment lead-time** is thus 5 days (= 1 + 1 + 1 + 2).

Production Flexibility has two definitions. There is the upside flexibility, which is defined as *the time required to achieve a sustained increase in volume by 20%.* These is also the downside flexibility which is defined as the *percentage order reduction sustainable at 30 days prior to delivery with no inventory or cost penalties.* In the case of the mature we have to calculate the time for the manufacturer to ship the product to us along with the 30 day production ramp up. The flexibility is thus 30 + 7 + 70 = 107 days

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Total logistics costs *are the sum of Supply Chain related MIS, Finance and Planning, Inventory Carrying, Material Acquisition, and Order Management costs.* This amount can also be expressed as a percentage of turnover. Here the costs of the New and Mature products are mixed, and may be hard to distinguish between. It is possible to split costs according to volume of products sold etc., but for this case study, the amounts will be kept the same in calculations for both new and mature products. The total logistics cost is thus

$$\frac{30+14+113+32}{1000} = \frac{189}{1000} = 18{,}9\% \approx 19\%$$

Value Added Employee Productivity *is calculated as total product revenue less total material purchases ÷ total employment (in full-time equivalents).* The use and relevance of this measure will not be discussed in this document. It is however useful to note that this metric is gaining more and more attention in industry. An alternative calculation for value added per employee is wages + interest + profit + tax + depreciation + (change in Non Cash components:woking capital). The figure is given at R122k for *Umboniso.*

The **Warranty costs** *include materials, labor and problem diagnosis for product defects. Umboniso* does not have any direct losses because of warranty, so it can be ignored.

Inventory Days of Supply *is the total gross value of inventory at standard cost before reserves for excess and obsolescence. This only includes inventory on company books, future liabilities should not be included. 5 point annual average of the sum of all gross inventories (raw materials & WIP, plant FG, field FG, field samples, other) ÷ (COGS ÷ 365).* Once again it should be said that the metric could be calculated for each of the products if the various amounts for the products had been given. An estimation of this amount could be made by assigning the amount to the product based upon the relative sales of the products.

$$\frac{\text{Total gross value of inventory}}{\text{Cost of Goods Sold}} \times 365 = \frac{176}{546} \times 365 = 117{,}66 \approx 118 \textit{days}$$

This figure is an indicator of the amount of time that inventory spends within our company

Cash-to-Cash Cycle Time *is the inventory days of supply + days sales outstanding – average payment period for materials (time it takes for a dollar to flow back into a company after its been spent for raw materials).* This is an indicator of the amount of time that it takes from the point that a company spends its cash to the point that it gets the cash back.

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$$\left(\frac{\text{Total gross value of inventory}}{\text{Cost of Goods Sold}} - \frac{\text{Accaounts Payable}}{\text{Cost of Goods Sold}} + \frac{\text{Accounts Receivable}}{\text{Revenue}}\right) \times 365 = \left(\frac{176}{540} - \frac{22}{540} + \frac{292}{1000}\right) \times 365$$
$$= 210{,}69$$
$$\approx 211 days$$

The last metric is **Net Asset Turns.** Net asset turns gives an indication gives an indication of how good the assets available to the company are utilised. It is calculated as *Total gross product revenue ÷ Total net assets.* This case study does not provide figures regarding the fixed assets of the company. The measure is thus only for working capital, but so is the benchmarking data provided in the SCORe card.

$$\frac{\text{Revenue}}{\text{Inventory + Acounts Receivable - Acounts Payable}} = \frac{1000}{292 + 176 - 22} = 2.24 \approx 2.2 turns$$

It is now your turn to calculate the various performance figures of each of the Level 1 metrics. The answers to each of the metrics are given in each of the blocks. The correct answers are not as important as the process of getting to the right answers, so make sure that the correct method is understood.

Remember that your SCOR model has all the definitions that you need to calculate the metrics.

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C7.1 Exercise 3

Delivery Performance to Commit Date	
	50%

Order fulfillment performance: Fill Rate	
	63%

Order fulfillment performance: Lead Time	
	7 days

Perfect order fulfillment	
	0%

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Production Flexibility	
	45 days

Total Logistics Management Costs	
	19%

Warranty Costs	
	-

Value Added Productivity	
	122k

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Inventory Days of Supply	
	118 days

Cash-to-cash Cycle Time	
	211 days

Net Asset Turns (Working Capital)	
	2.2 turns

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You can now complete the following SCOR card of the New product Line metrics. The answers to the above calculations have been inserted into the card.

Supply Chain Scorecard v 3.0

	Overview Metrics	SCOR Level 1 Metrics	Actual	Parity	Advantage	Superior
External	Delivery Performance/ Quality	Delivery Performance to Commit Date	50%	85%	90%	95%
		Fill Rates	63%	94%	96%	98%
		Perfect Order Fulfillment	0%	80%	85%	90%
		Order Fulfillment Lead times	7 days	7 days	5 days	3 days
	Flexibility & Responsiveness	Production Flexibility	45 days	30 days	25 days	20 days
Internal	Cost	Total Logistics Management Costs	19%	13%	8%	3%
		Value Added Productivity	R122K	R156K	R306K	R460K
		Warranty Cost or Returns Processing Cost	N/A	N/A	N/A	N/A
	Assets	Cash-to-cash Cycle Time	211	80 days	46 days	28 days
		Inventory Days of Supply	119 days	55 days	38 days	22 days
		Asset Turns	2.2 turns	8 turns	12 turns	19 turns

Excercise 3

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Chapter C8

Performance Attributes

Now you have completed the calculation of all the level 1 performance metrics, the most important metrics need to be identified. At this point in time the metrics should be linked to the strategy of the company. Here the reader should keep the case study presented in mind. You are in fact considering the importance of the various factors that determine the success of the product lines.

At this point you should rate the various level 1 performance attributes. It is suggested that you rate the attributes by choosing one to be an attribute that has to be superior in comparison to that of the competition for the product, one that is at the advantage level and lastly two that are on the parity level. This forces the user to identify only one superior attribute. The reasoning to this approach is simply that it is very difficult to be the best at everything. This is a debatable argument, but does have face value. Very few companies can focus on all aspects of the Supply Chain and bring them all to a superior level; the idea is rather to apply incremental change.

Here the choice of the correct phase is greatly dependent on the opinion of the person performing the analysis and how they see their strategies. Most people feel that asset utilisation is the most important thing with a Mature product. Reliability and quality are merely attributes that require parity with the levels of competitors as the product is now mass-produced and is similar to many other products on the market.

A different person may feel that they could still differentiate from the market by still providing superior quality and reliability and this is then the most important factor. Which answer is correct? Both, it depends on what the strategy of the company, of the team and of the individual is.

Now that the various levels of competition for the performance attributes have been identified, the need to be translated to physical performance levels. Here we refer back to the benchmarking data obtained earlier. The task is now to identify those performance metrics that will result in the performance attribute levels as chosen above.

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Performance Attribute	
Reliability/Quality	○
Flexibility/Responsiveness	○
COGS/Expense	●
Asset Utilisation	◉

●	Superior
◉	Advantage
○	Parity

Figure 49 : Gap Analysis for Mature Product

For the Mature line it was found that the performance metrics that would lead to the realisation of the targets set would be to focus on COGS/Expense. When a product is in a mature phase, its main form of differentiation is price. The company should make the product as competitive as possible, based on the price of this product. The performance attribute that should be at an advantage is the Asset Utilisation attribute. This attribute will determine the profitability of the product. In the case of the mature product it was seen that the company had problems showing a justifiable profit for the product.

Because of this diverse set of choices, the exercise will allow time for the reader to choose which attributes should be superior, advantage, and parity. The reader should then continue using the attributes provided by the tutorial.

C8.1 Exercise 4

Complete the GAP analysis for the New product line on the table given below.

Performance Attribute	
Reliability/Quality	
Flexibility/Responsiveness	
COGS/Expense	
Asset Utilisation	

●	Superior
◉	Advantage
○	Parity

Excercise 4

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C8.1.1 Exercise Discussion

Performance Attribute	
Reliability/Quality	●
Flexibility/Responsiveness	◉
COGS/Expense	○
Asset Utilisation	○

●	Superior
◉	Advantage
○	Parity

Figure 50: Gap Analysis for New Product

Figure 50 shows the various importances of the attributes that would allow the product to become competitive. The reasons for choosing these metrics should now be discussed.

Reliability and quality are the most important attributes. Customers are willing to pay higher prices, permitting the product has special features that other products do not have. The product should also be of a high quality and must clearly be a superior product in comparison to other products available.

Another important factor is the flexibility and responsiveness. Customers want the products and what it at the point in time that they develop the need for the product. It was said that there are a number of products that can compete with this product. The absence of the product would mean that the customer would rather purchase from someone else. Another important factor here is that the suppliers of similar products distribute using marketing methods like the internet etc. It is thus not hard for any customer to gain access to similar competitive products via the internet etc.

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Chapter C9

Gap Analysis Metrics

Now that the performance attributes have been chosen, it is important to translate these attributes to tangible targets for the company. Remember that these are rough estimations of the values. Calculating more exact values will add very little value to the process. The estimate should be accurate enough to use to make decisions, and the techniques shown below are usually sufficient for these needs.

For the mature product, the COGS/Expenses where found to be the attribute that the company had to be superior at. The COGS/Expenses are explained by the Cost Metrics. These cost metrics include, Total Logistics Management Cost, Warranty Cost, and Value Added per Employee.

This means that the company must attempt to have the Logistics Management Costs of 3% and value Added per Employee of R 460k as these are the levels for superior performance. Of these two metrics, it is felt that the Total Logistics Management Cost is best to try and improve upon. This requires a 16% change in the cost, this translates to a R80M saving in cost. First calculate the current metric

$$\frac{189}{1000} = 18.9\% \approx 19\%$$

Now calculate the value of the costs to for the target percentage, that is:

$$3\% = \frac{x}{1000} \Rightarrow x = 30$$

This shows that the savings would be 190 (189) – 30 = 160. But this is for a year of savings, the company is now trying to predict the savings for the next 6 months, so the savings are R80M

It may be useful to take a step back at this point and evaluate what we are doing exactly. Many people argue that this is unrealistic, how can you expect R80M of savings all of a sudden. The answer is very simple, you don't expect that kind of saving. You are basically stating the obvious here. You know that your superior competitors do have a Total Logistics Management Costs of 3% of their revenue. You also have said that this metric is important for your company to be competitive. If you thus want

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to be superior in the field of cost, you will have to bring the figure down to 3%, the costs of your company is additional information. The figure may be high because this is a case study, it may also be high because we are grouping the costs of the mature and new product lines, which ever way, the methods used here are the same for your own companies amounts.

Now to get back to the case study. For the first performance attribute, we chose to focus on only one metric. This will be the approach for the rest of the attributes as well. You may choose to use more metric, but it is suggested that you choose only one as the metrics do overlap. All of the metrics describing a certain attribute all impact on one another, changing one metric would thus impact on the other metrics. It is thus perfectly valid to choose one metric from each group.

The Asset utilisation attribute, which was found to be the attribute that should be at the advantage level, is described by the asset metrics. The metric that is felt to be the most representative here is the Cash-to-Cash cycle time. This means that the cycle time should decrease from 196 days to 46 days. Calculating the value for this improvement is more complex, because of the different choices available. The following example will illustrate. First consider the calculation of the current value:

$$\left(\frac{\text{Total gross value of inventory}}{\text{Cost of Goods Sold}} - \frac{\text{Accounts Payable}}{\text{Cost of Goods Sold}} + \frac{\text{Accounts Receivable}}{\text{Revenue}}\right) \times 365 = \left(\frac{176}{540} - \frac{22}{540} + \frac{292}{1000}\right) \times 365$$
$$= 210{,}69$$
$$\approx 211 days$$

The required value is 46 days. This means that:

$$46 = \left(\frac{\text{Total gross value of inventory}}{\text{Cost of Goods Sold}} - \frac{\text{Accounts Payable}}{\text{Cost of Goods Sold}} + \frac{\text{Accounts Receivable}}{\text{Revenue}}\right) \times 365$$
$$= \left(\frac{\text{Total gross value of inventory} + \text{Accounts Payable}}{\text{Cost of Goods Sold}} + \frac{\text{Accounts Receivable}}{\text{Revenue}}\right) \times 365$$

The problem is that changes in the Inventory or Accounts payable amounts would amounts would change the ratio in terms of the COGS and in terms of revenue if the Accounts receivable is chosen. A minimum and maximum value from improvements can be calculated. Bear in mind that the goal of 46days must always be met. Consider now if changes were made to the Inventory or accounts payable, and accounts receivable remained constant, this means that:

$$46 = \left(\frac{\text{Total gross value of inventory} - \text{Accounts Payable}}{\text{Cost of Goods Sold}} + \frac{\text{Accounts Receivable}}{\text{Revenue}}\right) \times 365$$
$$= \left(\frac{x}{540} + \frac{292}{1000}\right) \times 365 \Rightarrow x = -89.6252 \approx -90$$

The fact that you have a negative value is not a mistake, it simply means that if the days are to come down to 46days, the accounts payable will have to be R90M more than the Inventory. The difference

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is currently R154M, this would mean that R244M (154 – (-90))of cash will become available in a year, or R122M in six months. Consider the scenario of changing only the accounts receivable. Now

$$46 = \left(\frac{\text{Total gross value of inventory - Accaounts Payable}}{\text{Cost of Goods Sold}} + \frac{\text{Accounts Receivable}}{\text{Revenue}} \right) \times 365$$
$$= \left(\frac{176 - 22}{540} + \frac{x}{1000} \right) \times 365 \Rightarrow x = -159.18 \approx -160$$

The negative figure here is impossible, it is thus impossible to meet the target of 46days by changing the value of accounts payable alone. You can now go and calculate a lower limit of accounts receivable, and then see how much the inventory and accounts payable must decrease to meet the target value, but that is purely academic. Here you should simply decide were you intend to cut back (inventory accounts payable, accounts receivable or a combination of the lot. The main motivation given here was free cash. Bear in mind that this also means less loans and also money for investment in other activities like machines etc. The solutions given above seen unattainable, but bear in mind that they are the extremes calculated when keeping one metric constant and changing the rest. This is hardly likely, it is more likely to have a scenario were all three variables have changed. One such solution is an accounts payable of R50M, an accounts receivable of R82M and an inventory amount of R84M.

The attributes that are left to be at the parity level are Reliability or Quality and Flexibility and Responsiveness. To determine the value of Reliability and Quality, the Fill Rates Metric is chosen. We see that the metric is very nearly at the correct level. It is also not easy to attribute a value to the improvements of this metric. At this point it becomes a game of trying to "guestimate" a reasonable answer. Suppose that we could in fact account for the lost sales by increasing our fill rates (which is a reasonable assumption). We also assume that for the mature product line Reliability or Quality are simply at the parity level, meaning that the R100M lost sales would have been realised had the parity level metric been met. This is one approach to quantifying the savings. This is not accurate in this case however. The R100M lost sales are also because of the lost sales in the New product line. At closer investigation it can be seen that the New product can be attributed all of the lost sales due to its performance.

The last attribute, the Flexibility and Responsiveness can be accounted for be the Order fulfillment lead-times. Once again it is hard to quantify this metric, although all the arguments of lost sales discussed in the previous paragraph are applicable here.

The last two paragraphs illustrated that quantifying an improvement is not easy, it is not always accurate either, but if the arguments used to calculate the values are valid you can get a reasonable estimation of the benefits. Quantification of these values are important as these will be your goals to

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work to. They are also important, as this is what management requires when forwarding suggestions for improvements.

Up to now you have drawn and mapped your Supply Chain. You then determined how the Supply Chain is performing and how that of your competitors are performing by comparing your performance to that of the competitors. The most important metrics for the specific product line were then established and lastly the value of making the improvements in the Supply Chain of the product line were quantified. This same has to be done new for the new product line.

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C9.1 Exercise 5

Choose one metric that is representative of the attributes as determined in Figure 50. It is suggested that only one metric is chosen, and that the same metrics are taken. Some of the values may become hard to calculate, but that is fine, as long as there is some form of quantification of the improvements made. Once again the answers are not as important as the method used to come to them.

Fill Rates	
	R100M

Order Fulfillment Lead-times	
	R100M

Total Logistics Management Costs	
	19%

Cash-to-Cash Cycle Time	
	Depends on Scenario Chosen

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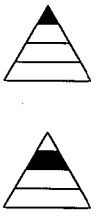
Chapter C10

Linking Metrics to the Supply Chain



In the previous sections the focus was on determining what strategy was needed to support the success of the organisation's product lines. This section will go back to the configuration of the Supply Chain determined in Chapter 6 and relate the strategies developed in the last few chapters to this configuration

In the previous chapter Fill Rates, Order Fulfillment Lead-times, Total Logistics Management Costs and Cash-to-Cash Cycle Time were chosen as the metrics that would represent the strategy of the mature product. These metrics now act as the metrics for the P1 process.

The author of this tutorial would here like to enter a personal comment. The SCOR model actually has a set of metrics defined for the P1 process, and although some do correspond to the high level metrics, they do not all appear in these metrics list. It is the authors opinion that the list of metrics should at least contain the metrics defined as level 1 metrics. There can of course be more, as the function of planning the entire Supply Chain on a daily basis would require more management techniques that the analysis of the Supply Chain.

The following process may look like a number of unnecessary steps, as they could easily have grouped into one step. This is simply so because of the relative incomplexity of the case study. A real life scenario would be much more complex, so it is suggested that the steps be followed as described.

1. Start off by identifying the plan processes and then attributing the chosen metrics to the P1 process (Figure 51).
2. Now assign the performance targets to the metrics for the P1 process (Figure 52). Note that the cash to cash figure presented is for a specific scenario of an accounts payable of R50M, an accounts receivable of R64M and an inventory amount of R100M.
3. The metrics chosen for the P1 process need to be broken down to smaller metrics that will be used to describe the P2, P3 and P4 planning processes. This seems like an impossible task. Even for a person that is very familiar with the company being discussed will find it hard to immediately

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come up with metrics to describe the Supply Chain. This is were your SCOR model becomes very helpful. Go to the P2 process in the model. Immediately the model presents a number of metrics that may be used in this case. You may also use some of the P2 process elements' metrics here. The same can now be done for P3 and P4. Choose a maximum of five metrics (Figure 53).

4. Each of these metrics must now be assigned targets as was done for the P1 metrics. In this case, the combination of the P2, P3 and P4 metrics must result in the P1 metric. Take for example the perfect order fulfilment, which must be increased to 80 %. This metric is made up out of Supplier on Time Delivery (P2) and Faultless Invoices (P4). The result is thus 80.75% (0.85 x 0.95). The same can now be done for all the other metrics like the Cash-to-Cash cycle time. Here it may be wise to consider Cash to Cash in its three components, namely, Inventory, Accounts Payable, and Accounts Receivable.
   Inventory must be decreased to R100M or to 68days. This is reflected in RM days of Supply and Finished Good Inventory. This can be divided by assigning the RM days of Supply to 60 days and Finished Good inventory to 8 days. 68 days is still very long in comparison to other companies in the industry, but the metric is being met. The reasoning behind splitting the metrics in this way is that it is felt that the time of inventory at sea is unavoidable. This thus increases this lead time. The amount of inventory that we carry can however be decreased.
   In the same way you can calculate the Days of payables and Days Sales Outstanding metrics (Figure 54).

This section illustrated how the metrics are related to the goals of lower level activities that can be applied to various parts of the Supply Chain. Bare in mind that there is reasoning to each of the decisions of how the goals are assigned. Some general strategies that could be considered for the Mature and new product lines will be discussed in the next chapter.

The reader could easily skip this chapter, although it may be interesting to understand some of the possible solutions to the current Supply Chains as they are.

For now the reader must complete the steps described above for the New product (refer to page 50).

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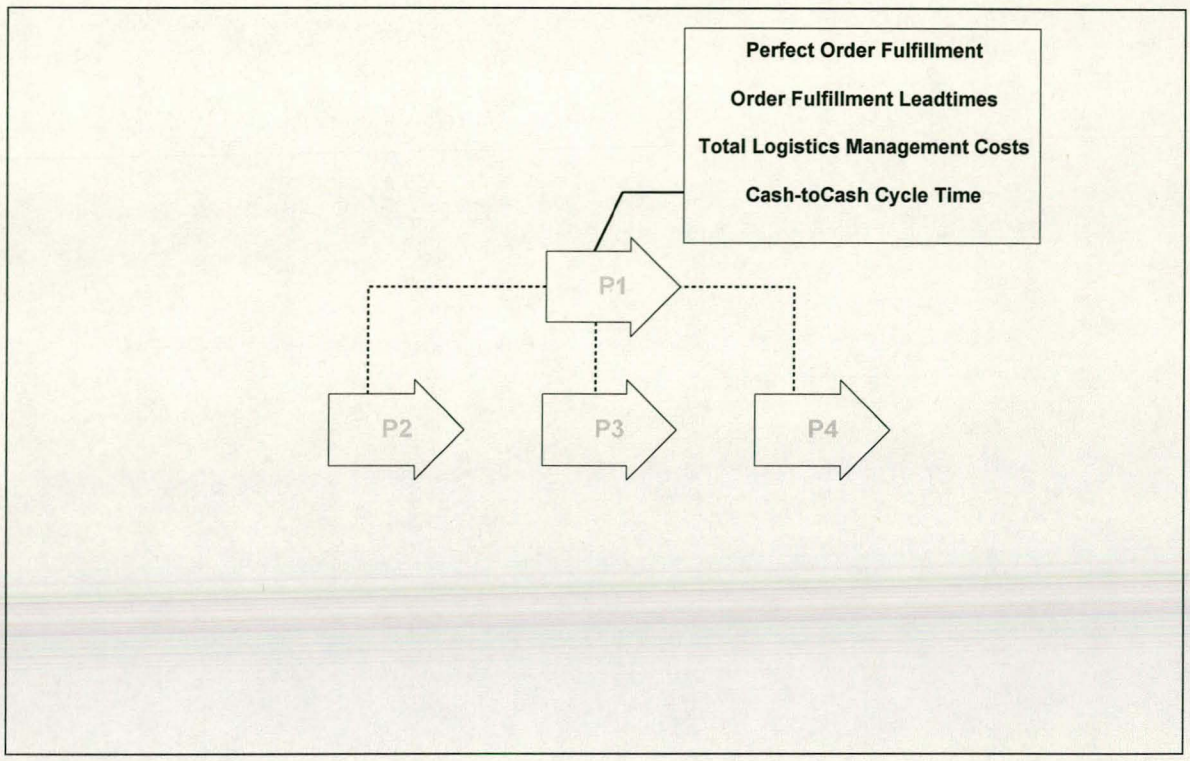

Figure 51: Identify Plan Processes and Assign Metrics

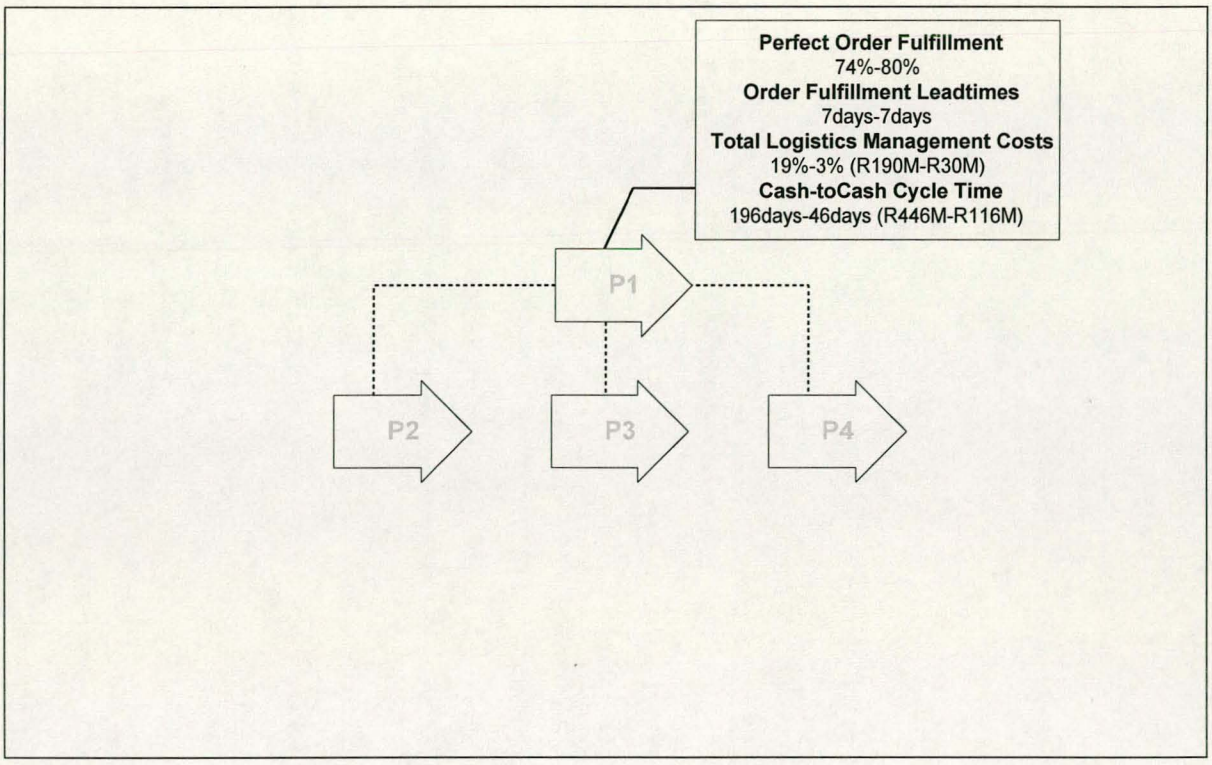

Figure 52: Assign Performance Targets to Metrics

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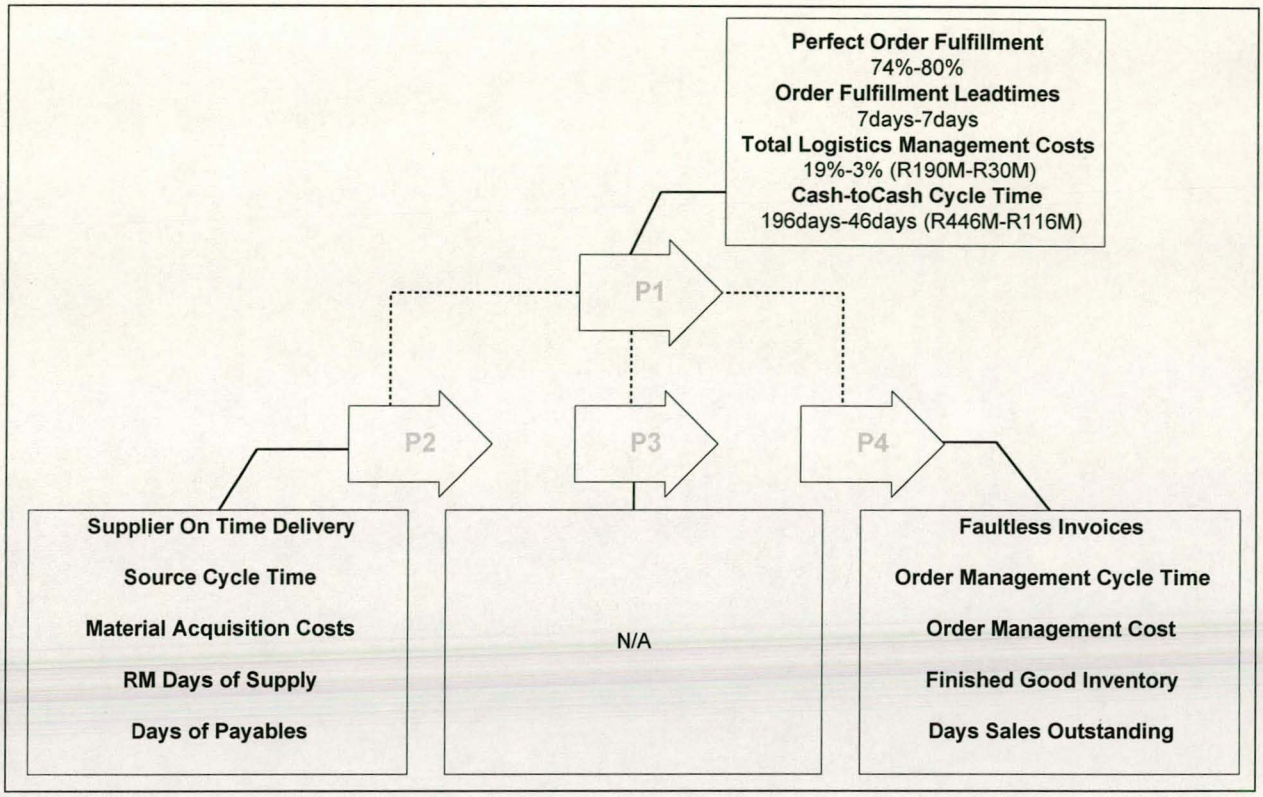

Figure 53: P2-P4 Process Metrics

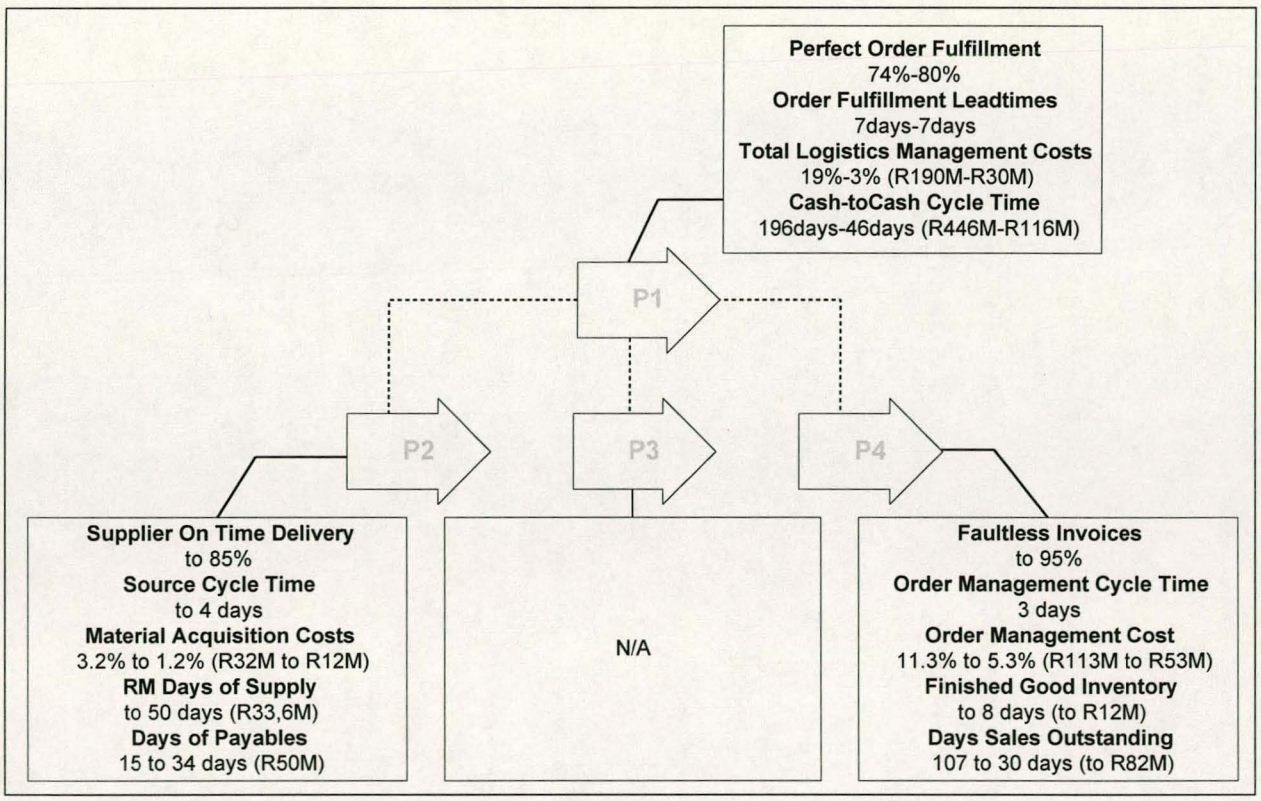

Figure 54: P2-P4 Process Metrics Targets

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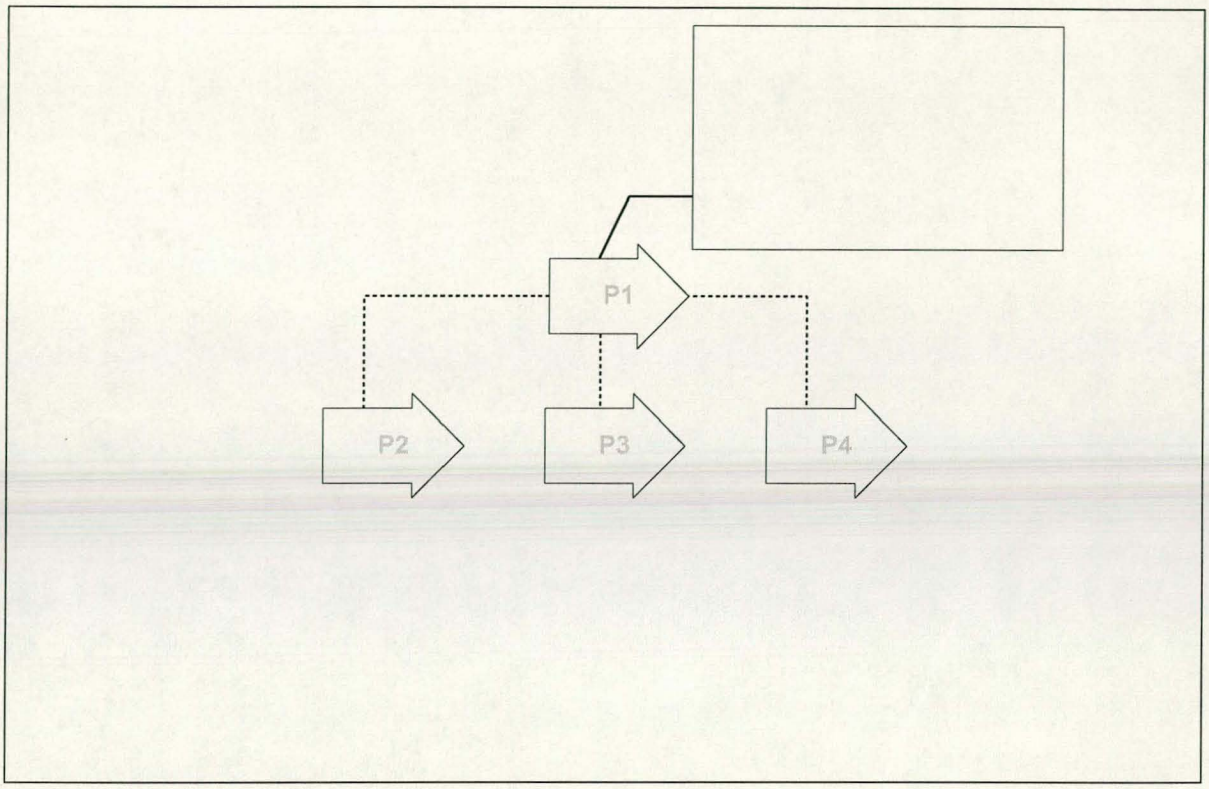
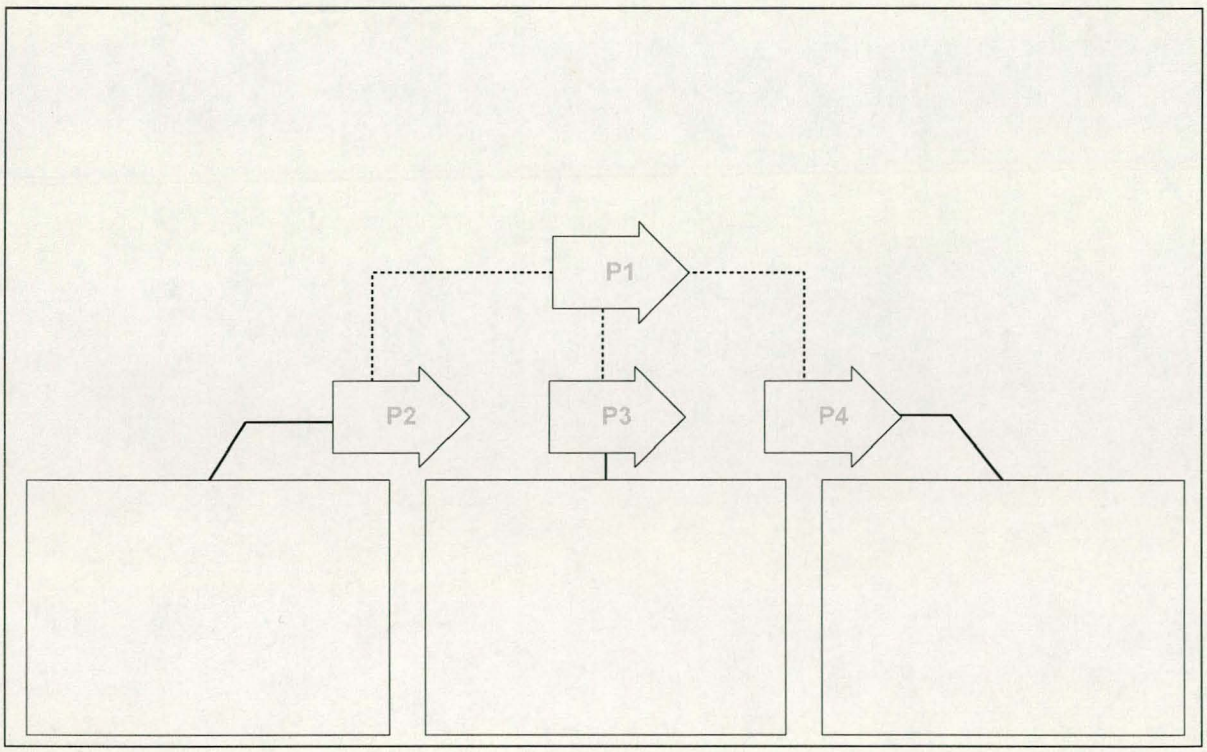
C10.1 Exercise 6

Complete the breakdown of metrics for the New product line.



Excercise 5



Excercise 6

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Chapter C11

Supply Chain Strategies

This chapter will quickly discuss some of the strategies that the company could attempt in improving their Supply Chains. These strategies are by no means the only solutions, and all suggestions or solutions do also have their problems. The section is simply meant to give suggestions to help the reader come up with other solutions.

This chapter could be skipped without any problems.

C11.1 Working Capital

We see that the Mature product is in fact selling well. The biggest problem with the mature product is that is not profitable for the company. A second problem is that the driver of the product is price, so the price can not be increased.

The biggest problem in the metrics are the long inventory and accounts receivable periods and the short accounts payable period. At the moment the debtors period is 106 days and the creditors period of 15 days. This means that we pay our accounts within 15 days on average, although we only receive money for our products after 106 days on average. This would effectively mean that it is not good business for us to increase our sales. Consider an increase in sales. This means we will have to purchase more raw materials, but we must pay for these raw materials long before we ever receive the money for this expense.

This would mean that we should increase the time that we take before paying for our raw material and decrease the time it takes our customers to pay us.

Inventory is also a problem. The inventory period is 119 days. This figure is not so high if you consider that the inventory is at sea for 70 days and the 7 days in customs. This means that the inventory stays within the company for 79 days on average. Which is still high. Now consider the

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problem with faulty casings with the New product. During all this time all the components of the product are in the possession of the company while it is waiting for repairs. There are no direct costs to the company, but this is basically inventory lying around with no use.

There are no ways to get around the problem of shipping the products by sea. Shipping the product by air would mean that the price would increase and this in turn would mean that the product's price would increase, and this is not an option as the mature product competes on price. The other option is to increase one of the other metrics. Remember that the equation for cash to cash cycle time is

$$\left(\frac{\text{Total gross value of inventory}}{\text{Cost of Goods Sold}} - \frac{\text{Accounts Payable}}{\text{Cost of Goods Sold}} + \frac{\text{Accounts Receivable}}{\text{Revenue}}\right) \times 365$$

Although the inventory period is long, the creditors period could compensate for this. This would mean that an agreement should be made with the OEM supplier for a longer period to pay, say 60 days, which is reasonable as you only receive the goods after 77 days.

C11.2 Accounts Receivable

The debtors period is very long, 106 days. At closer inspection it is seen that this is because the products are shipped incomplete or are faulty. When this happens the customers refuse to pay until the mistake has been rectified.

Umboniso had 1000 orders, shipped only 890 and had only 590 complete and without any mistakes, and none of these were New products. This figure is unacceptable.

The first problem is obvious and this is the sourcing from the manufacturer in Botswana. Although the job was said to be labour intensive, any manufacturing still requires some schooled workers. One of the metrics when measuring manufacturing is in fact the ratio of engineers to blue collar workers. This is the problem in this case. The company could now decide to move the plant to South Africa and produce the products locally, but this may cause the price to rise. An option would be to automate the process. Processes that are monotonous like is the case here, can be automated. This would of course mean job losses, but the company may argue that they are not South African jobs. Which decision to make is up to the company and their attitude towards job creation. They may even decide to send a number of engineers to the plant in Botswana as part of supplier education.

Another problem is the number of products that are delivered with the incorrect or paperwork. This can be changed by using EDI systems. It is not always possible to know what is available, so the best would be to open the SCOR model at the deliver process element. Here you can look at all the best practices associated with delivery of products. A possible solution may be e*lectronic generation and download of shipping documents.* Here again the model gives you a good idea of what to do.

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C11.3 Network Design

A network redesign is also possible. Here he configurations of the networks become very handy (Chapter 6). The process elements that seem to add very little value are the threads that have only Source and Deliver processes. For the mature line this would be *Umboniso* itself and the Warehouse and Distributor. For the New line it is the Warehouse and the Distributor. Could any of these be omitted?

In the case of the mature line, you can not skip the distributor. In fact, you could skip the distributor, but this would mean that you would have to market the product directly to the public, and for a mature product this may result in too many expenses. It is thus advisable to keep the distributor. The factory itself only serves as a warehouse for the mature product, a point before the product is sent to the various warehouses. It is also a point were the products go through quality inspection before it is moved on. One cannot help but question the value of the warehouses. It is simply a buffer to ensure that the distributor receives products in time. The distances in this case study are so small, that the distributor could in fact be sourced from the factory. The factory would thus act as one large warehouse for all the distributors. The same could apply to the New line. The company could thus do away with its warehouses all together. This would also decrease the amount of inventory kept.

C11.4 E-Commerce

It is the global trend to become what has been called a "dot com" company. Becoming active in electronic commerce is a prerequisite into to days environment. We are now even finding the first examples of companies that have had considerable losses because of their competition marketing products over the Internet. Here we think of companies like Compaq and Dell. *Umboniso* is faced with this same dilemma. The New product seems the ideal product to be marketed over the internet. It has now commitment to any distributors, as it ships directly to the customer.

Cost is also not such a great problem as the New product does not compete on price. This is also the ideal time to become active on the internet for future products to come.

E-Commerce could also be the companies answer to communicating with its suppliers. By using the internet, other companies could see what the status of the company is and act accordingly.

C11.5 Conclusion

This chapter was a short discussion of some solutions to the company's problems. Ideas were basically thrown around to simply show how a simple problem could be filled with complexities. It also showed how a problem in one area could impact on a whole range of others.

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The major decision made from here is the decision to remove the warehouses from the network. Also, the manufacturer in Botswana has been left there, although the company has decided to support them with engineers. In return for this, the creditors period has been increased.

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Chapter C12

To-Be Supply Chain

The most important conclusion made in the previous chapter is that the warehouses could be removed for both the product lines. This means that the configuration diagrams need to be redrawn for the mature and the new line.

This now works in the opposite order to mapping the as-is configuration. First processes are mapped in their threads, this is then followed by a geographical mapping from the thread diagram.

The thread diagram for the mature product can be seen in Figure 55. The geographical diagram for the To-Be Mature Product line can be seen in Figure 56.

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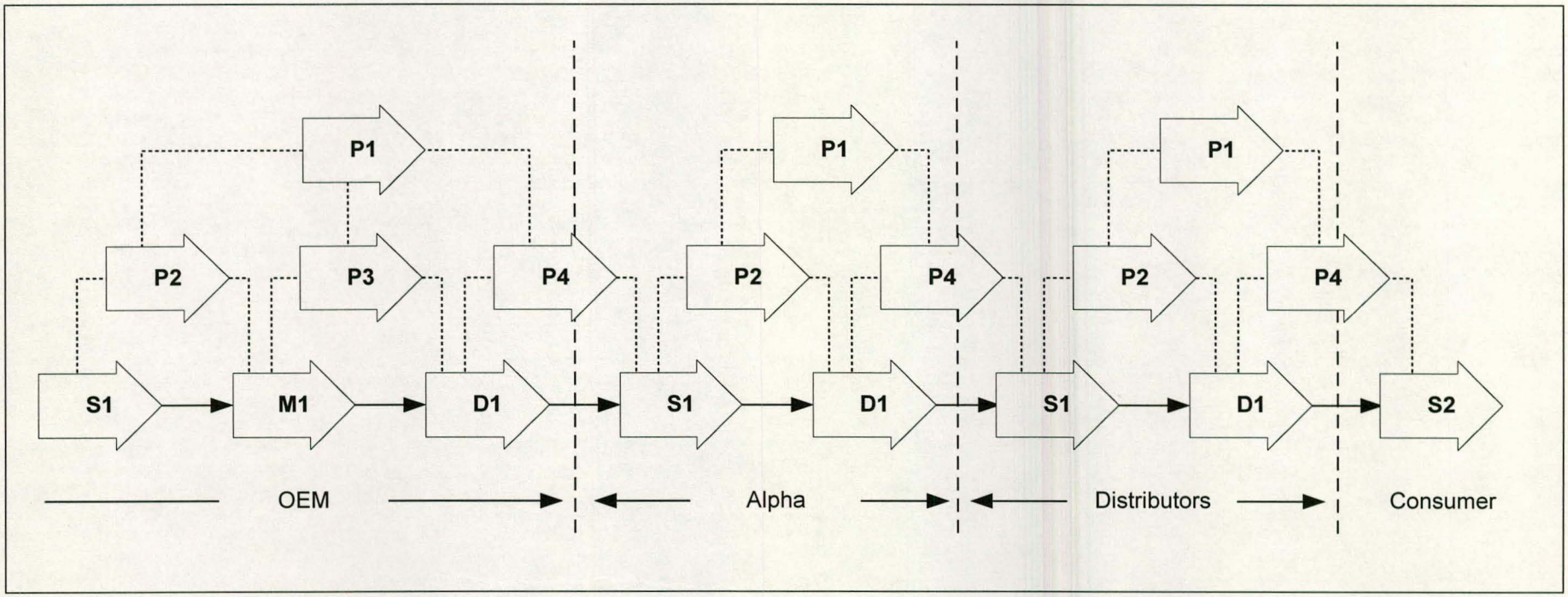

Figure 55: To-Be Pocess Configuration

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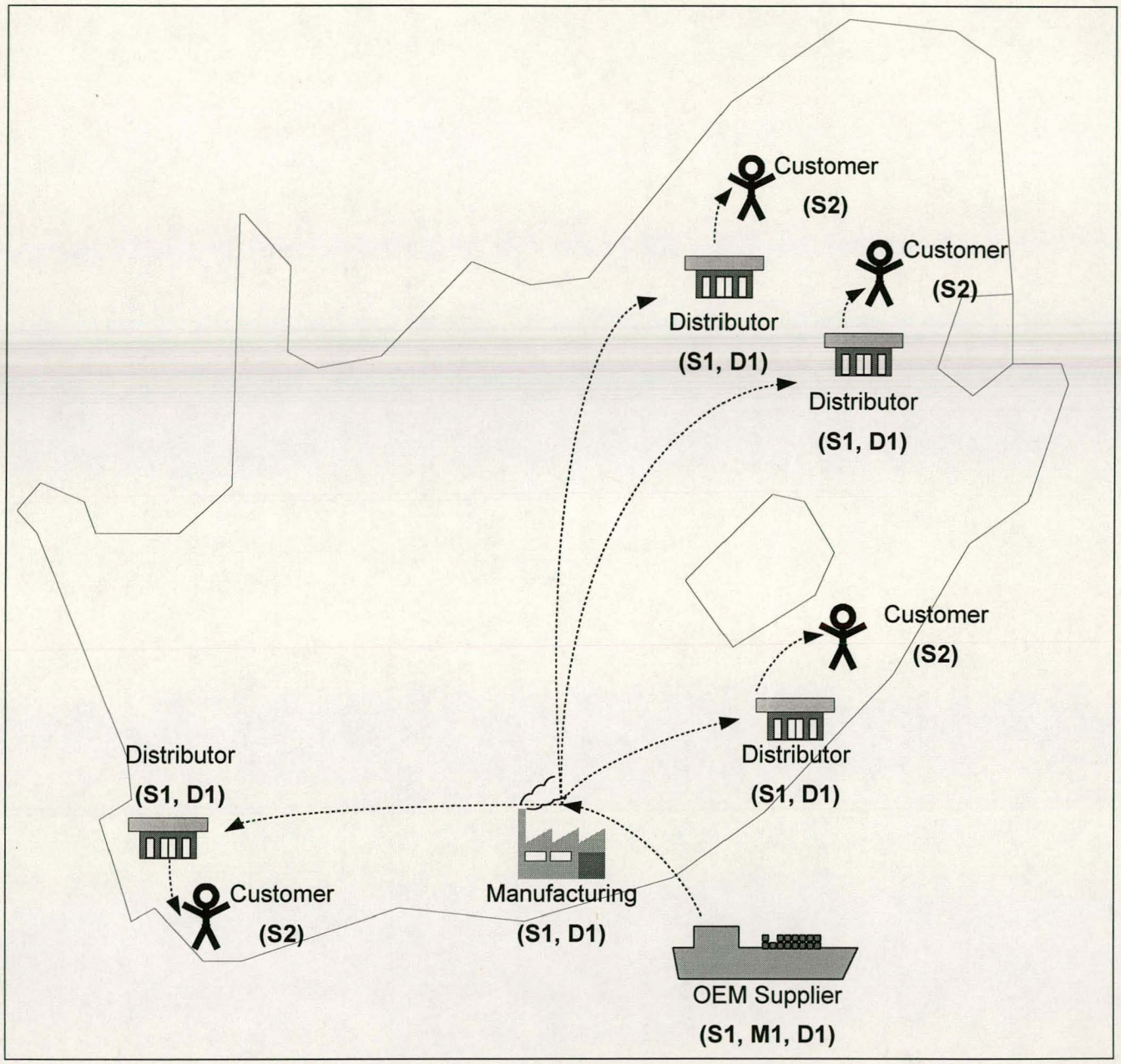

Figure 56: To-Be Mature Geographical Map

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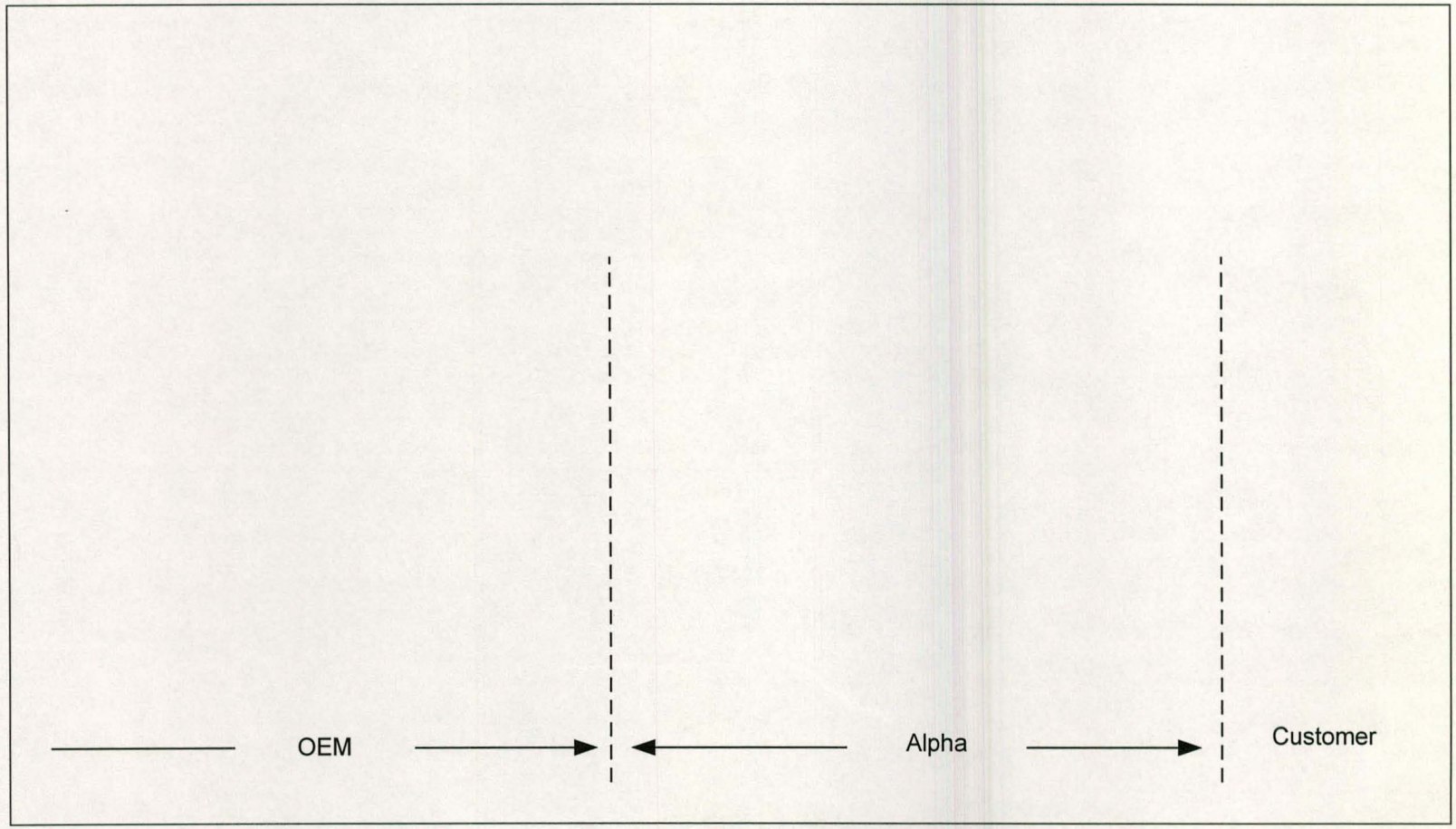
C12.1 Exercise 7

5. Plot the execution processes
6. Plot the plan processes of the execution processes
7. Plot the Plan 1 processes



Excercise 7

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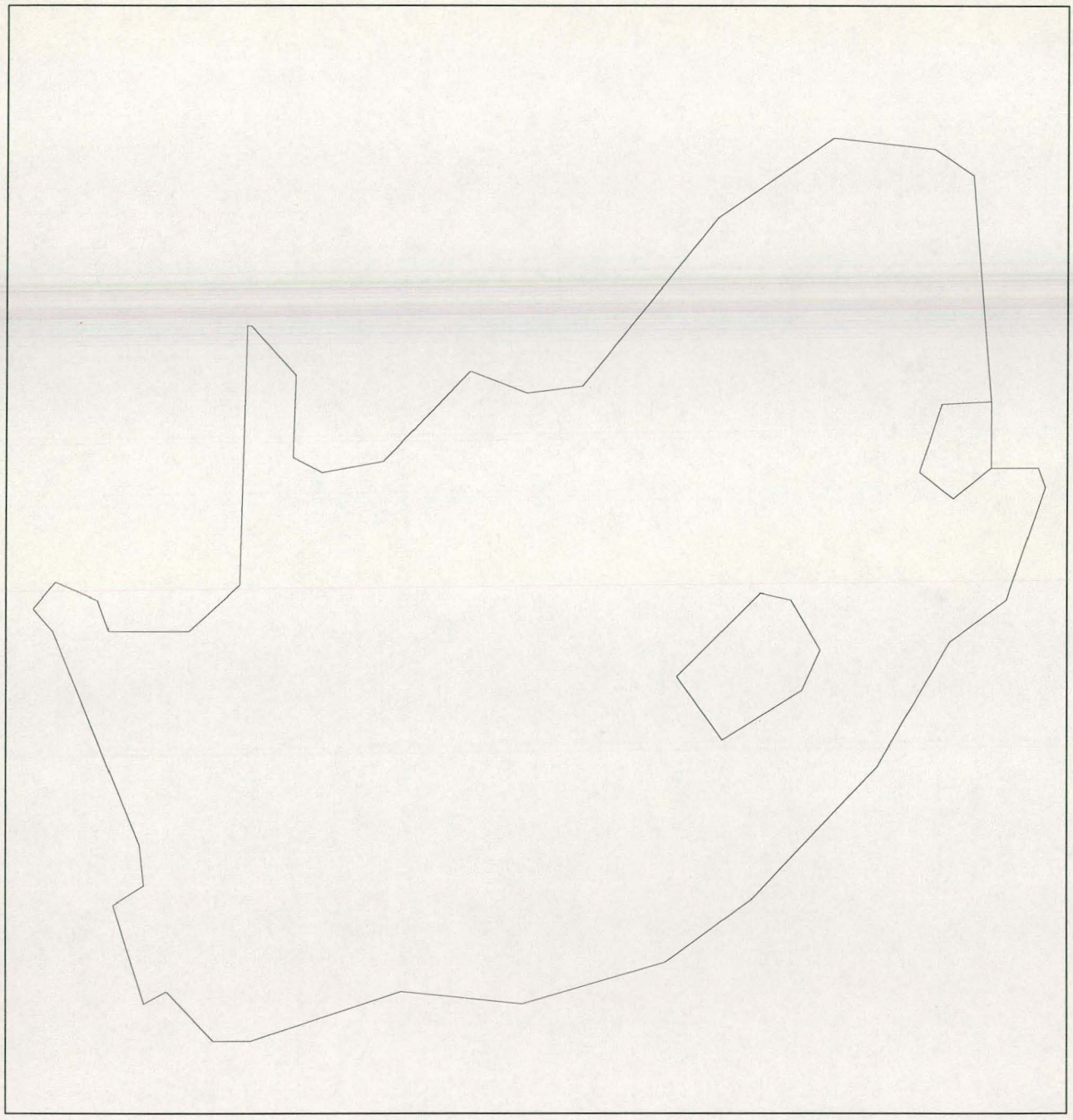
Now complete the following steps for the New Product Line on the map provided below

8. Draw the physical locations of all the entities involved in the New product cupply chain
9. Draw the flow of materials between the various entities
10. Add the SCOR level two process identifiers (S1, M1, D1, etc.) to the physical locations



Excercise 8

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Chapter C13

Process Elements

The issue not introduced yet in this model is that of the process elements, or level three of the SCOR model. The reason is simply that the use of these elements are greatly up to the user of the model. The process elements start to describe the main activities of each process. Note that the word start was used here, as it does not give the exact activities that you have to perform. It is rather a reference to activities that are suggested. These elements are of great value; it helps by providing a reference of the main processes that need to be performed. These are generic and are applicable to most businesses. The use of activities are left entirely to the discretion of the user of the model.

The Supply Chain Council use these elements in elaborate swim lane diagrams were elements are assigned to various parties within and outside the company. In this way you can start to model how information is flowing as well. At this point the modeling moves beyond that of just the product, it starts to focus on the processes that supports the flow of products.

This is not discussed within this tutorial as it is the author's opinion that the use of these activities should be left to the preferences of the practitioner investigating the Supply Chain. This tutorial will merely illustrate how it could be used, or rather what it is.

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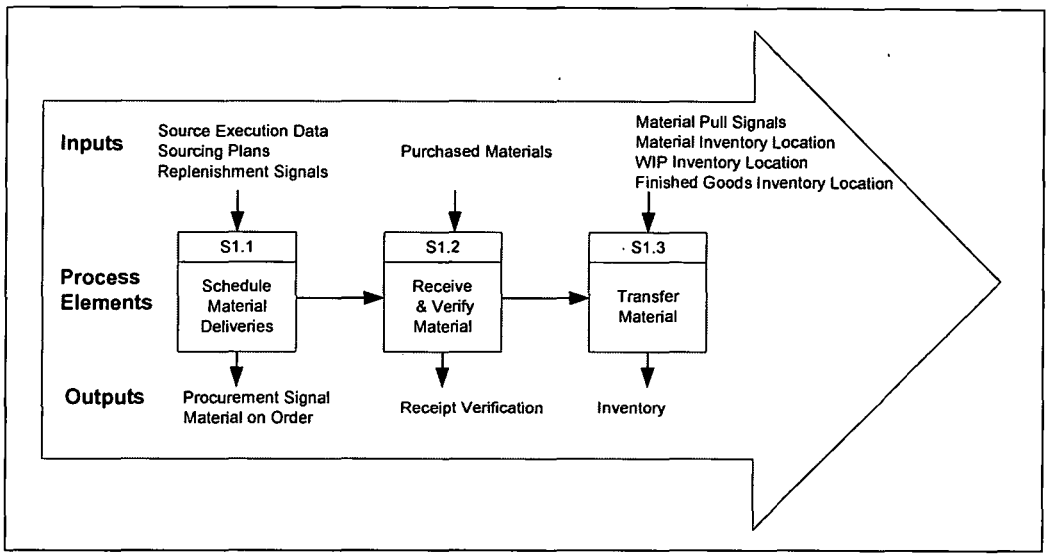

Figure 57 : Process S1

Figure 57 shows the process elements of process S1. It shows the process elements, the inputs and the outputs to the process elements. This then gives an idea of what should be done when a S1 process is mapped in the geographical diagrams.

In the case study, *Umboniso* is very dependent on the their suppliers. The company could thus look into the suggested practices of the of the process elements. First the model suggests to look into the **Schedule Material Deliveries** element. On inspecting this element in the SCOR model, it is found that one of the metrics suggested here is the % defective ratio. This was in fact a problem in the As-Is Supply Chain and should be monitored.

The element also suggests certain best practices. These include things like, the use of Kanban pull signals to indicate that inventory should be ordered from suppliers. The element then also gives a suggestion of the software feature that is required for this best practice, in this case it is Electronic Kanban Support. This then gives the organisation an idea of what their information system should be capable of. In the case of *Umboniso*, they had just spent a large amount on their information system, but this may have been useful when selecting an information system in the first place.

This was a very brief and superficial illustration of the uses of level 3 metrics. At this point the exercise becomes an implementation. Some of the process element metrics and best practices were used while doing a breakdown of the level 1 metrics, but they are of greater use at the implementation stages. From here on, the exercise becomes a business process reengineering exercise.

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Chapter C14

Conclusion

This tutorial was a quick tour of the SCOR model. It attempted to present the use and functionality of the model. Please remember that this is not a substitute for the SCOR workshops. The workshops introduce much more information and practical cases and is highly recommended.

As can be seen, its greatest use is the fact that it is already filled with information to put any practitioner on the right track when investigating a Supply Chain. Thinking of various metrics becomes much easier when there is already a number to choose from.

Another good feature of the model is the ability to customise it. This is a reference model, and is thus only the start to a company's own model.

Lastly it should be said that the SCOR model is only a tool to aid any practitioner. The final success of the Supply Chain relies on the thought and knowledge of the practitioner. SCOR is only a modeling tool enabling various Supply Chain practitioners to speak the same language.

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Chapter C15

References

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Appendix CA

Solutions to Excercises

This section contains solutions to the excercises. These are not the correct answers, they are simply the suggested answers. The answer number refers to the number beneath each figure.

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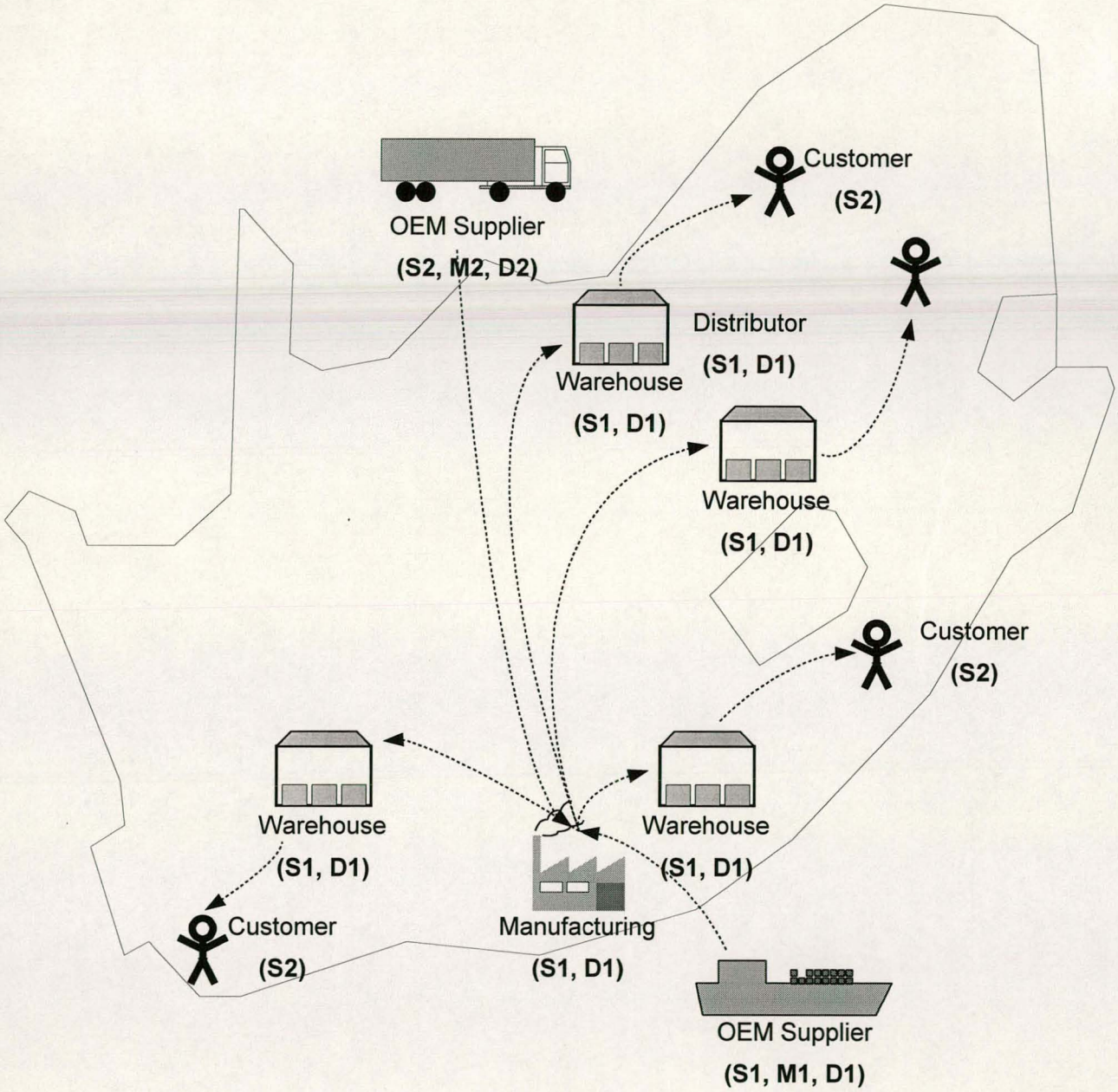

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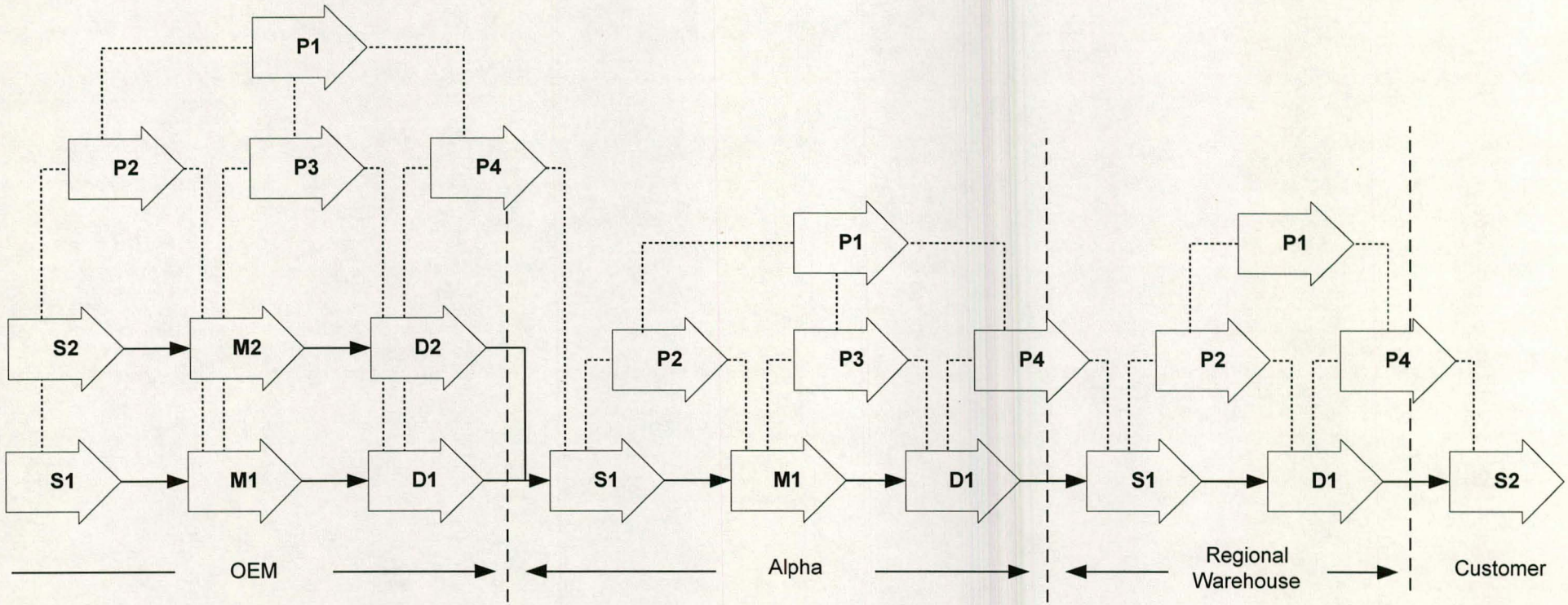

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Supply Chain Scorecard v 3.0

	Overview Metrics	SCOR Level 1 Metrics	Actual	Parity	Advantage	Superior
External	Delivery Performance/ Quality	Delivery Performance to Commit Date	50%	85%	90%	95%
		Fill Rates	63%	94%	96%	98%
		Perfect Order Fulfillment	0%	80%	85%	90%
		Order Fulfillment Lead times	7 days	7 days	5 days	3 days
	Flexibility & Responsiveness	Production Flexibility	45 days	30 days	25 days	20 days
Internal	Cost	Total Logistics Management Costs	19%	13%	8%	3%
		Value Added Productivity	R122K	R156K	R306K	R460K
		Warranty Cost or Returns Processing Cost	N/A	N/A	N/A	N/A
	Assets	Cash-to-cash Cycle Time	211	80 days	46 days	28 days
		Inventory Days of Supply	119 days	55 days	38 days	22 days
		Asset Turns	2.2 turns	8 turns	12 turns	19 turns

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Performance Attribute	
Reliability/Quality	●
Flexibility/Responsiveness	◉
COGS/Expense	○
Asset Utilisation	○

●	Superior
◉	Advantage
○	Parity

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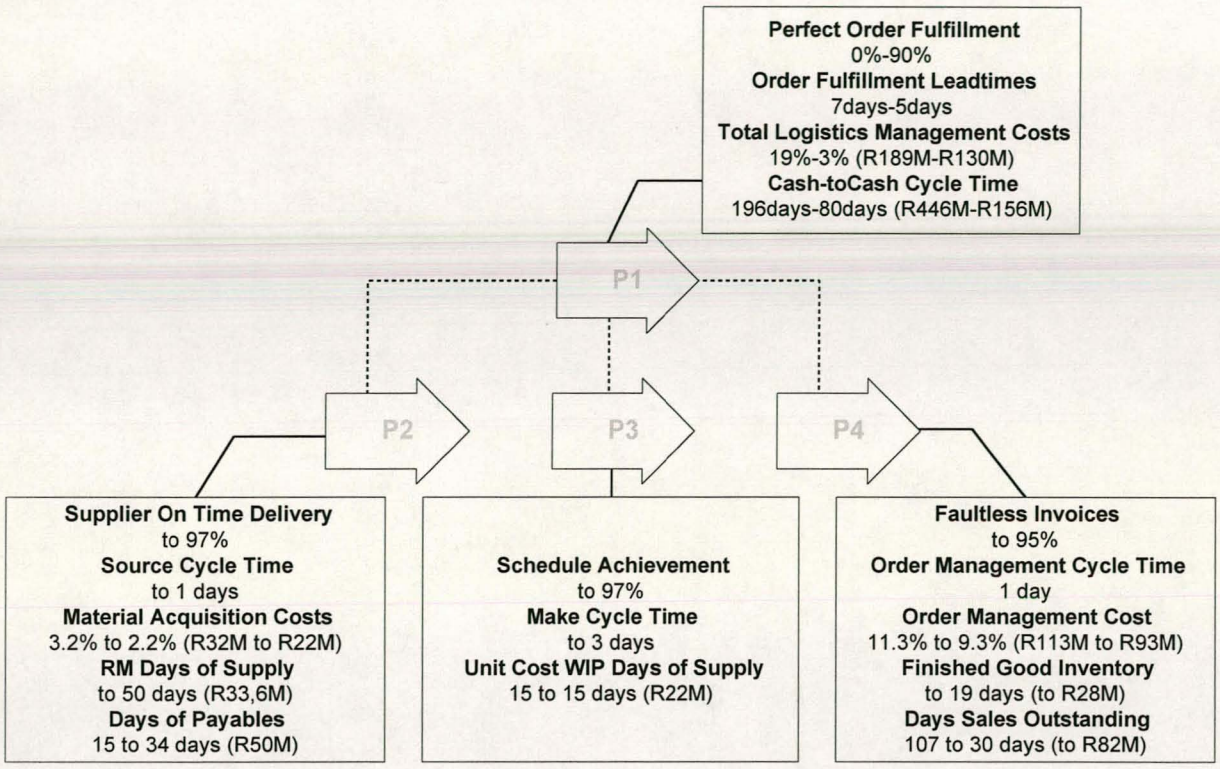

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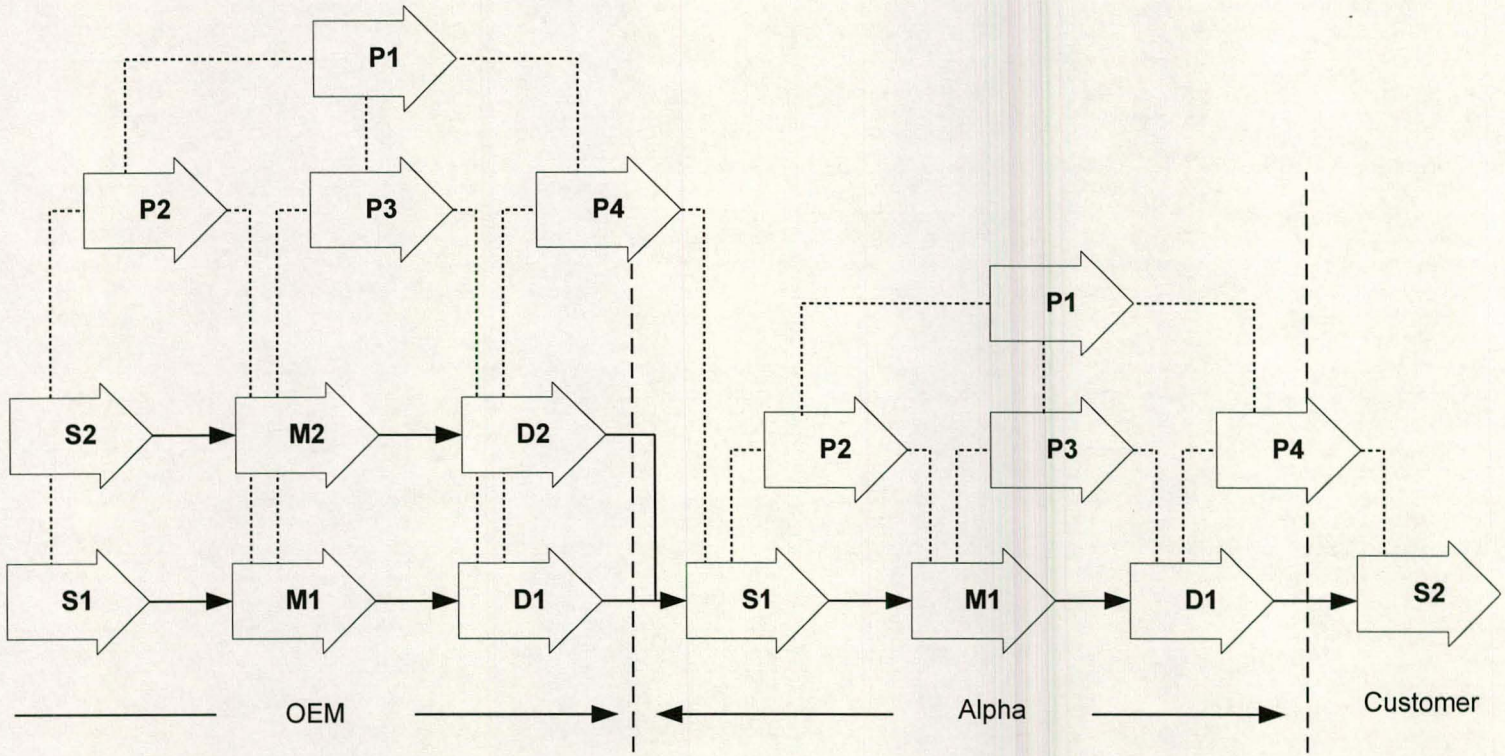
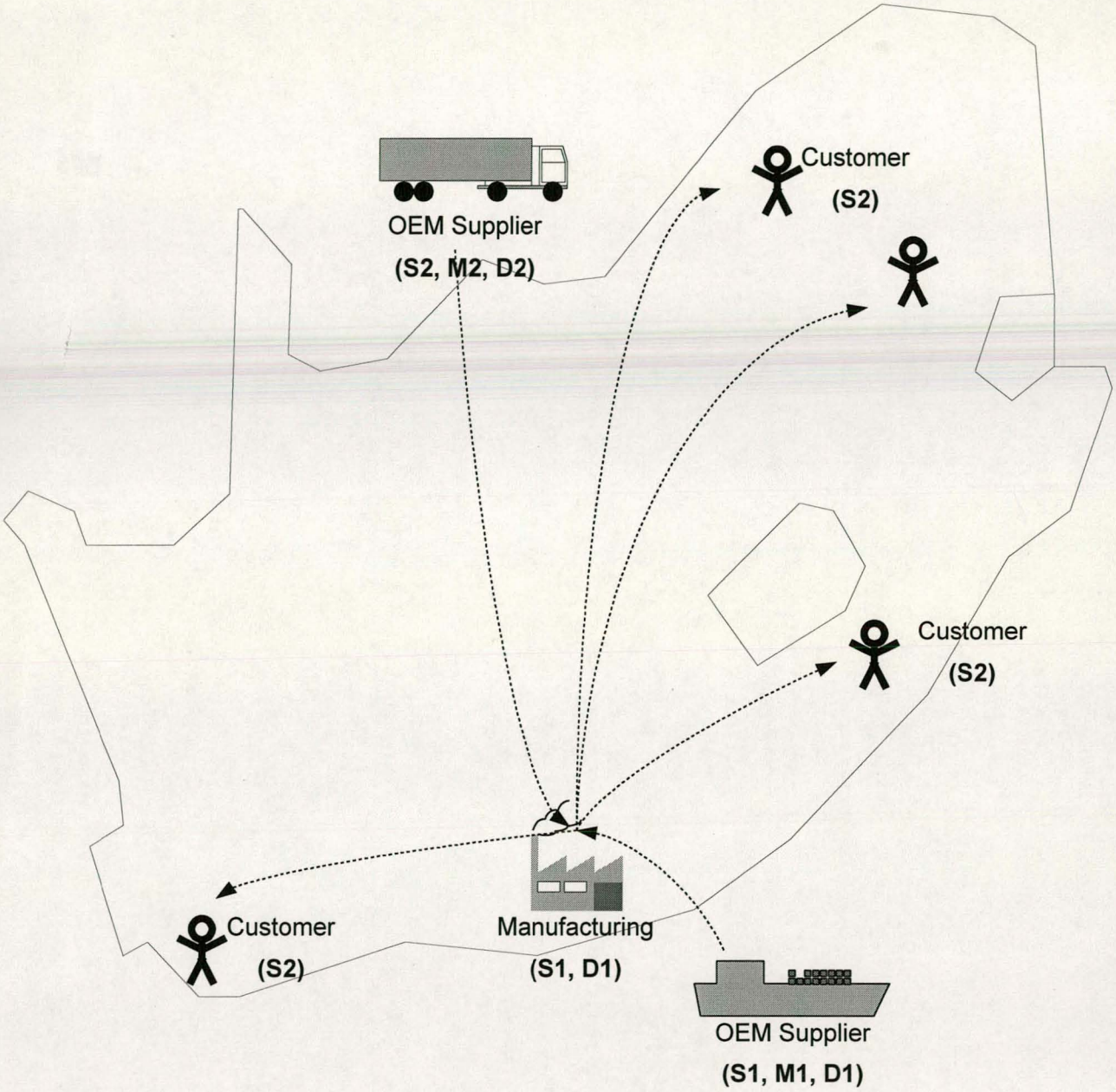
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