Design of a warehouse SCOR model to align supply chain activities

by

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Executive Summary

Growth is an essential part of a business. It is a dynamic process and has an impact on the functions and the functional interdependencies of a business. The transition to a higher business level should be as “smooth” as possible. (Rigwa, Venter,2005)

Sasol Wax is the leader in producing and marketing wax products. Wax produce are used in various final products like candles and rubber to name only two. Sasol Wax is planning for an estimate of 20% growth over the next 5 years. The nature of the business requires a great deal of infrastructure to facilitate the growth.

Supply Chain Development assists other business units within Sasol with their growth and expansion from a supply chain view point. They also align all the supply chain processes of each business unit with the greater Sasol supply chain strategy.

These two very different businesses units meet in a unique way. Supply Chain Development support Sasol Wax to develop a supply chain process that could relate to the greater Sasol business.

Warehousing is an essential and expensive part of any company. The planning, resources and requirements that are used in a warehouse scenario should be aligned to fit the product and company. Warehousing is an important part of the supply chain and it is important to align the warehouse with the rest of the supply chain.

The focus of this project is to support the warehouse developments for this project. The warehouse is an essential part of the supply chain should be aligned with the supply chain.

To support the appropriate development of the warehouse, the basics of the SCOR model is used and formed into a new model specifically for the use in the warehouse environment. The warehouse SCOR model uses the building block such as plan, receive, store, deliver and enable to describe the warehouse processes and operations.

The Fisher-Tropsch Wax Expansion Project (FTWEP) provides an opportunity to develop a model that could assist in the planning of a warehouse. Using this model will assist in developing a warehouse system that will be aligned with the rest of the supply chain and will operate optimally.

This generic model could then be applied to the Fisher-Tropsch Wax Expansion Project (FTWEP) to assist in the warehouse planning, operations, requirements and resources. The warehouse SCOR model also describes the best practices for a warehouse and the key performance indicators for the planning of a warehouse.

Concluding the report is a process map of the execution of the project up until this stage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Introduction

The great thing in the world is not so much where we stand, as in what direction we are moving. (Oliver Wendell Holmes)

The warehouse function in industry is very important as it creates a time utility for raw materials or finished products. The warehouse is a point in the logistical system where the raw material or finished goods are stored for periods of time. A warehouse also has value adding property such as the ability to accommodate product mixing, cross docking, protection against contingencies and customer service.

Warehousing is an integral part any supply chain. It is an important logistical link between the business and it suppliers or customers. The warehouse also is an expensive part of a supply chain. It is important to align the warehouse and it planning, operations, resources and requirements with the other activities in the supply chain.

A warehouse is a dynamic environment which changes continuously in order to meet the requirements of various influences acting on it such as; changes in products and production. The planning of a warehouse is thus a continuous process to meet the anticipated requirements. This should be done to ensure the effective utilization of a warehouse and its resources.

An opportunity to create a framework that would support the alignment of a warehouse with the rest of the supply chain has risen with the Fisher-Tropsch Wax Expansion Project (FTWEP).

Sasol Wax, (a business unit within Sasol) is the leader in the production and marketing of a range of waxes and liquid parrafins. These products is then used by customer to produce candles, rubber, chipboard, cup-coating, cosmetics, polish, hot-metal adhesives and to covert bitumen and polymers amongst other applications. The wax is produced using Sasol's proprietary Ficher-Tropsch process in Sasolburg.

In recent times they have preformed well due to the demand for their products. Due to their current success, an even greater demand for their wax products has developed. The

greater demands for wax products make it clear that growth is inevitable. This growth process provides the opportunity for the business to expand and reach new market segments.

The realization of this growth led to the start of the Fisher-Tropsch Wax Expansion Project (FTWEP). Sasol Wax is planning for approximately 20% growth over the next 5 years. A part of the FTWEP is to ensure that there are sufficient planning and infrastructure to support the supply chain segment of the project. The nature of the business needs a great deal of infrastructure to facilitate the growth in perspective to supply chain optimization, effectiveness and efficiency.

Sasol Supply Chain Development (SCD) is the custodian for all the necessary supply chain development and design work within the greater Sasol. Any project concerned with the expansion or growth regarding the supply chain needs to be clarified and signed off by Sasol SCD.

Sasol SCD takes all the supply chains within Sasol into account when developing and designing a supply chain for a particular business unit. They ensure the planning for growth is sufficient form a supply chain view and then identify where synergies may be between different supply chains within Sasol.

Thus, Sasol SCD will assist Sasol Wax in the development and design of the appropriate supply chain for the FTEWP. Part of the FTWEP development includes aligning the entire Sasol Wax supply chain according to the Supply Chain Operations Reference (SCOR) model and the planning of the appropriate warehouses that would be aligned with the supply chain and be able to facilitate the growth.

There is no elevator to success. You have to take the stairs. (Anonymous)
The FTWEP is a staircase to build a generic framework to support any warehouse in defining it planning, operations, requirements, resources and aligning it with its own supply chain. The transition of products between various entities in the supply chain and the warehouse should be as optimal and efficient as possible.

2 Background

The production of wax has been modified and improved over the last 50 years. The continuous improvement led to the high quality, purity free wax produced by this facility.

Sasol Wax is expanding their Wax producing facilities in Sasolburg with 20%. This expansion entails the conversion of an extra five million Giga Joules of natural gas into wax products per annum.

The FTWEP requires a number of facilities to accommodate the growth. Logistics is one of the critical requirements of the project and for the feasibility design. The project has a work breakdown structure. The logistics has its own work part (WP) within this structure. WP 11 focuses on the logistical requirements for the project.

2.1 Wax Production Process

Wax is produced using Sasol Fisher-Tropsch (FT) technology. Natural gas is converted into wax using two slurry bed reactors with the low temperature FT process. It is the distilled into four different waxes. They are:

- N-Paraffins
- Waxy Oil
- Paraffin Wax
- Hard Wax

These waxes then go into hydrogenation and wax oxidation. The end result is wax in one of the following forms:

- Powder
- Bulk liquid
- Flakes
- Pastilles
- Micronized powder

Figure 1 graphically explains the wax production process.

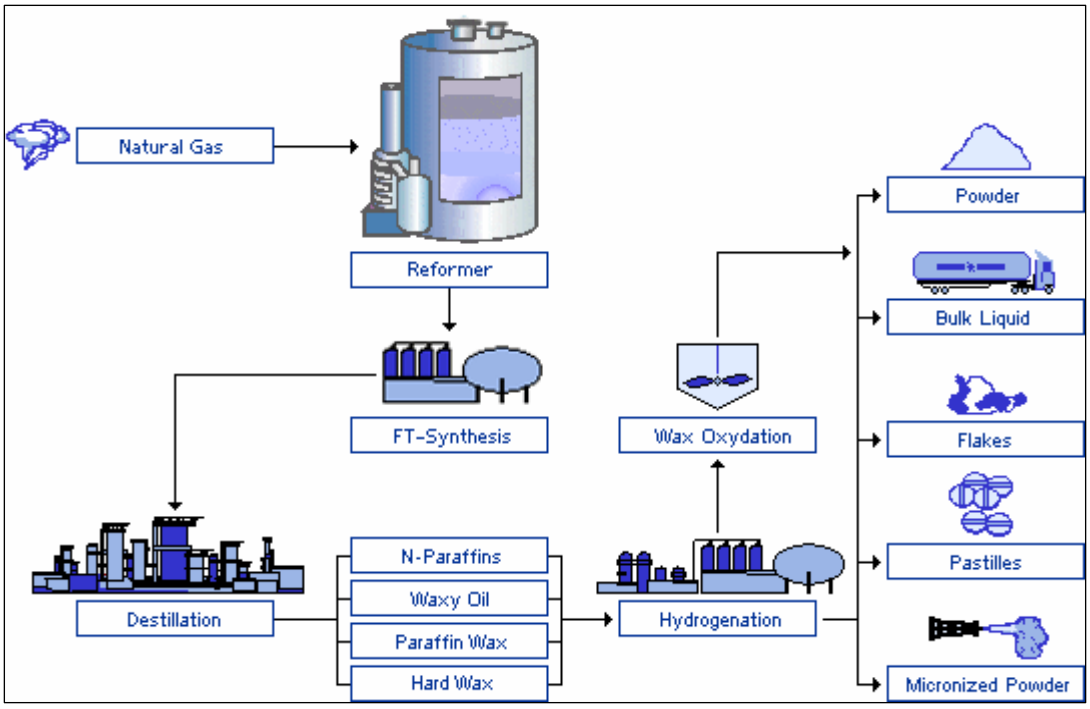

Figure 1: Wax production process

(http://www.sasolwax.com/Prodcution_Process_FT__Waxes.html)

2.2 Wax Storage Process

The wax products produced then go into the intermediate storage facility. The products are palletizes and stored here directly form the manufacturing facility. The pallets are packed according to the type of product, type of packaging and the production batch.

The manufacturing facility and the intermediate storage are located next to each other. The products are transported from manufacturing to the intermediate warehouse using forklifts. The purpose of the intermediate storage is for inspection and quality control. It also creates some buffer stock for events like shutdowns or a sudden rise demand.

The final storage facility is not located on the site and the products must be transported from the intermediate storage to the final or dispatch warehouse. The pallets are loaded onto flatbeds using a forklift. The flatbed then transport the pallets by road exiting at the West gate to the final warehouse located in Venco Park only 5 km away.

Products are then stored at the final/dispatch warehouse until it is sold to the customer. The products are dispatched from the warehouse and travel by road to Durban harbour, where it is shipped to the customer.

The warehouse facilities need to be expanded to accommodate the additional product that would be produced with the expansion. The current warehouse systems and the physical warehouses would not be able to absorb the additional product. The warehouse planning is thus a big part of the logistics work part of the FTWEP.

There are currently two alternatives for the final warehouse. They are to:

- Move the facility and build a new warehouse in the vicinity
- To upgrade the current final warehouse

Although both these options are viable, the planning of the warehouse resources, requirements and operations must still be some. The integration of the warehouse with the rest of the supply chain also needs to be planned. These plans should provide the best possible solution for the warehouse.

3 Project Scope

The main scope of the project is to deliver a business case reporting the best business solutions. These solutions should balance cost, improve efficiency and effectiveness. It should also be generic and valid over time. It includes the following:

- A framework for the collection of data concerned with the logistical study. The framework should suggest the type of information required to approach a logistical project. It should be generic and the data collected should be available to use in other instances.
- Research for the type of supply chain to be used in the FTWEP. The warehouse logistics should be aligned with the rest of the supply chain. This should be done using the Supply Chain Operations Reference (SCOR) model as a platform. A new model that could be applied specifically to warehousing should then be developed from the SCOR model that could assists in the warehouse process

design and development. This modified SCOR model will be measured against the configured SCOR model used and applied by Sasol in the warehouse environment. The requirement for the logistical study surrounding warehousing of final products should be defined with the use of the modified SCOR model.

- The storage facility design should be outlined. The layout should be optimal to support the handling of material and storage.
- Record and analyze the processes of executing the project. This will give a view on the steps in executing such a project for future references.

The project will be delivered within the limits of the scope.

4 Data and Information Collection

The fewer data needed, the better the information. And an overhead of information, that is, anything much beyond what is truly needed, leads to information blackout. It does not enrich but impoverishes. (Peter F. Drucker)

Data is raw facts about people, place and things that are important in an organization. Each fact by itself is rather meaningless. (Bently, Witten [1])

Data forms the information that is used to describe any process within a business, whether it be manufacturing or services. The information retrieved from data is then used to make important decisions regarding the business.

4.1 Information Gathering for this Project

The most common way of transferring data and information is paperwork. On paper the facts of processes or business is stated. This is also the most reliable source of information as it could be traced to a source should any enquiries occur.

Information is also retrieved visually when going on site visits and expiring the actual work environment first hand. This gives vital information regarding conceptualizing of the working environment.

The transfer of data can also be done auditory. The information gathered when talking to various individuals regarding the business may prove to be essential when starting the design and development. The individuals may vary form the project leader down to the actual production worker.

These forms of data collection were used to collect the necessary data and information with concern to this project. The information gather is then used to develop and implement in the warehouse SCOR model and the outlined warehouse design.

5 The SCOR Model

5.1 What is SCOR?

The SCOR model is an analytical model for supply chain management. It describes all the different phases included with satisfying the customers demand. It is a standardized methodology and describes the supply chain using a common language. The SCOR model identifies the supply chain performances and measure the performance using metrics. It also sets performance goals and identifies opportunities for improvement.
The building block for the SCOR model could be viewed in Figure 2.

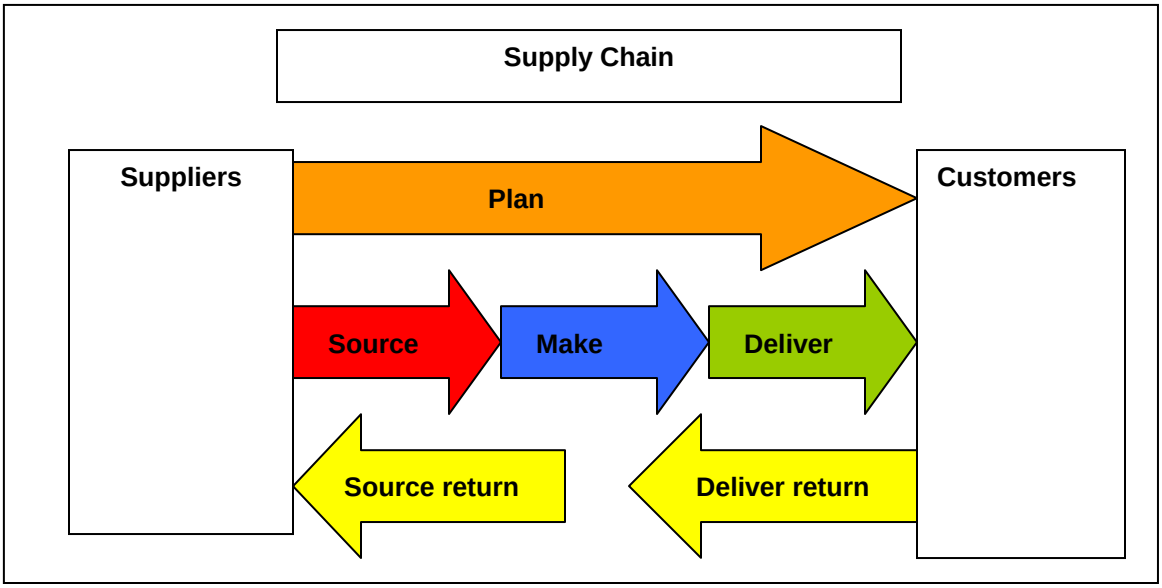

Figure 2: SCOR building blocks
(Supply Chain Council., *Supply Chain Operations Reference model*, SCOR Version 7 Overview)

SCD uses the SCOR model to align the logistical network of all the different business units and to describe the planning, management and outbound supply chain of each business unit.

5.2 A SCOR Model Designed and Developed for Warehousing

A warehouse plays a critical role in a supply chain as a supportive structure. The mission of the warehouse is to accommodate a product in any form to the next step in the supply chain. Numerous steps should be taken to accomplish this and these steps should be addressed to optimize the warehouse mission.

The SCOR model incorporates warehousing in the design of the supply chain but do not focus on the processes that are part of warehousing. Thus a modified warehouse SCOR model is presented in this project to help assist in the optimization and alignment of a warehouse in the supply chain. The SCOR principals were used to develop the warehouse SCOR model.

The warehousing process and operations could be viewed in Figure 3. This is the base from which the warehouse SCOR building blocks were developed. The warehouse SCOR model describes the warehouse activities the same way the SCOR model describes the supply chain activities. The warehouse SCOR model consists of different building block and activities.

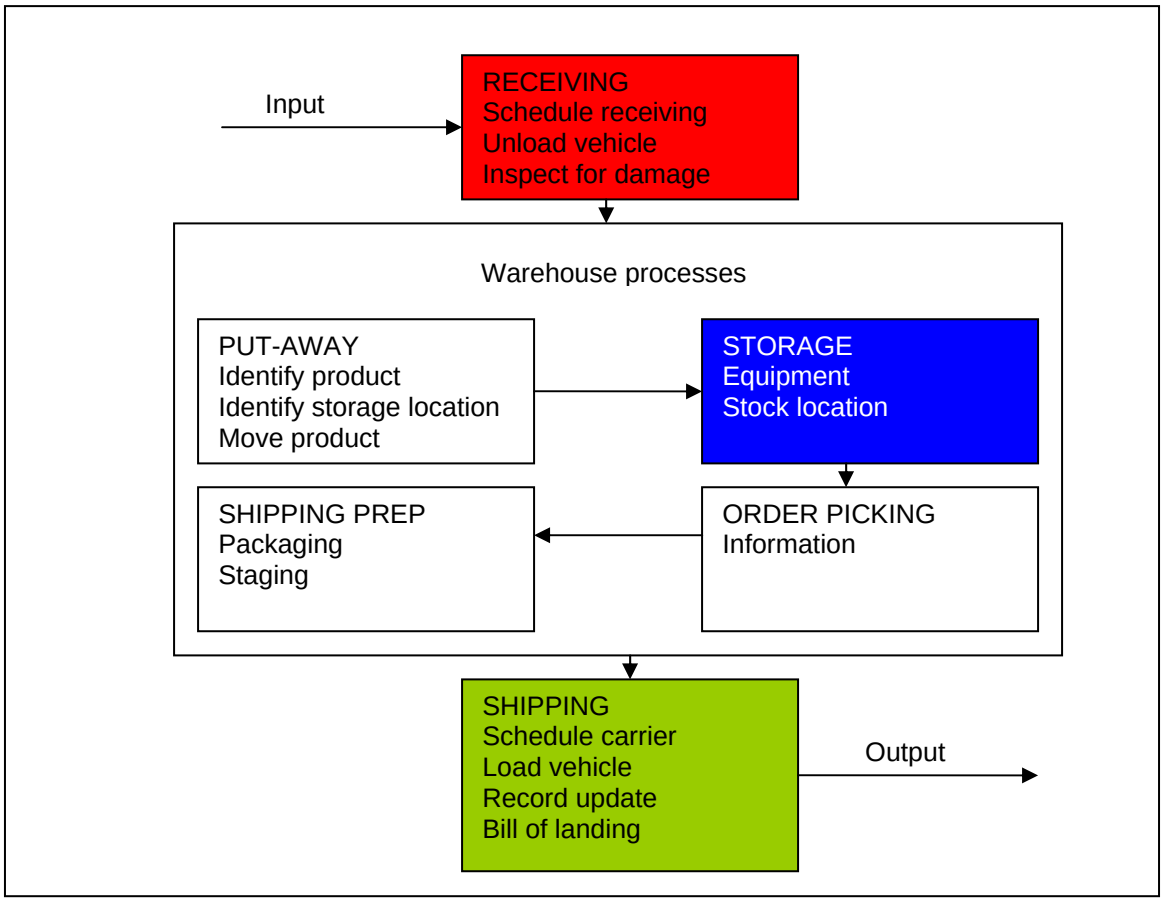

Figure 3: Warehouse process

(Bardi, Coyle, Langley 2003:300)

From warehouse operations and processes the following warehouse SCOR model building block were identified:

- Plan
- Receive
- Store
- Dispatch
- Enablements
- Return of goods received
- Goods delivered returned

Operations such as put-away, shipping preparation and order picking, which is shown in Figure 3 is not part of the basic building block of the warehouse SCOR model. These

operations are in bedded in the model to be included in receiving, storing, dispatching or the enablements.

Colour will play an important part the model to identify the various notations for these basic building blocks. The SCOR layout and interaction between these building blocks could be viewed in Figure 4. The particular warehouse SCOR layout is between the manufacturer and the customer. Another type of warehouse SCOR layout could be between the supplier and the manufacturer. The last mentioned is indicated in second in the blocks.

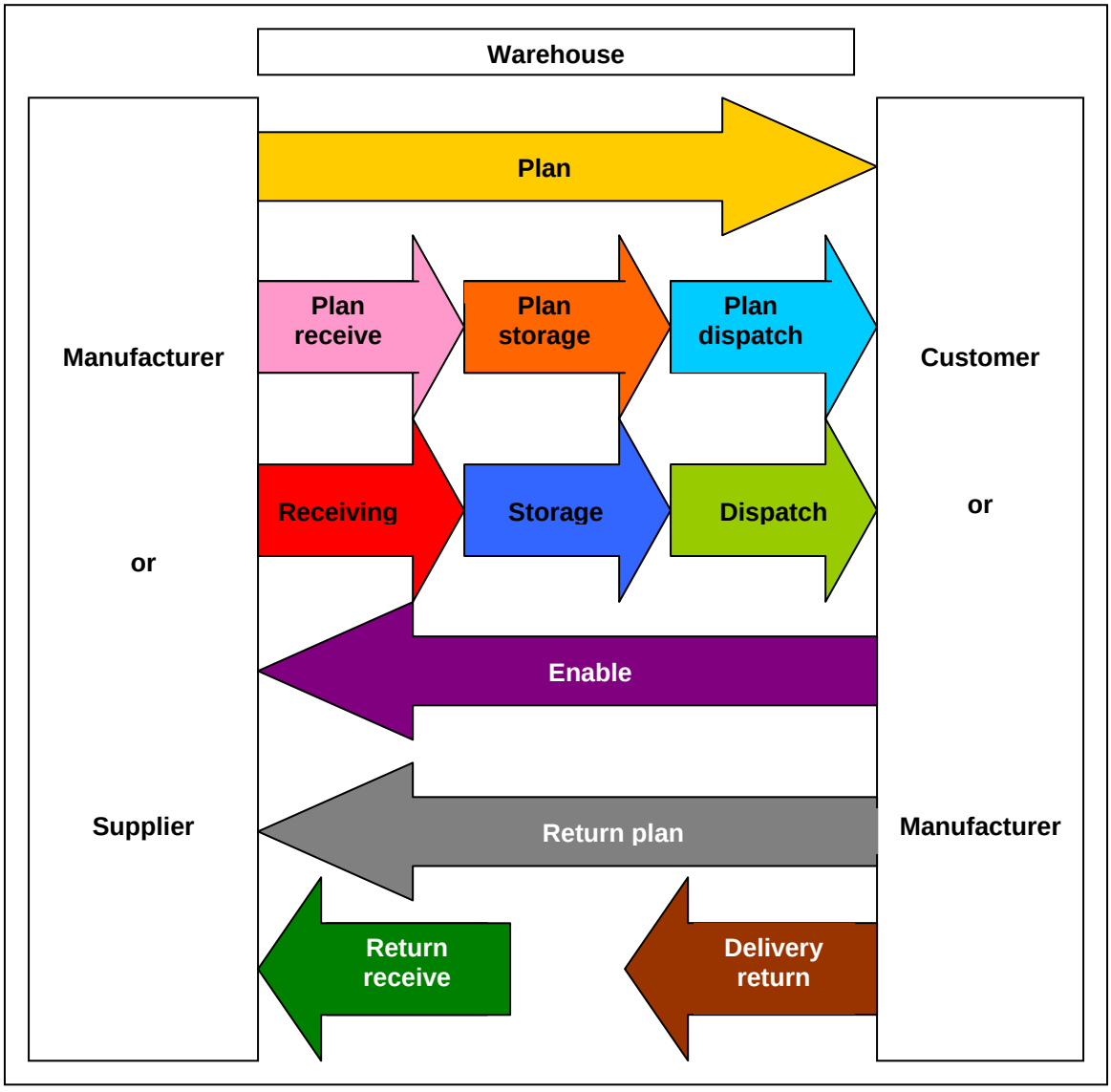

Figure 4: Modified warehouse SCOR model

5.2.1 The warehouse SCOR model definitions

The warehouse model of SCOR is presented in the following pages. The model is broken down to a process and a sub-process. These are then developed to have certain input and outputs regarding each process and sub-process. The processes and sub-process and their definitions in Tables 1, 2, 3, 4, 5, 6, 7 and 8 are:

Process	Sub process	Definition
P1 Plan warehouse supply chain		The development and establishment of actions to be taken over specified time periods that represent a projected appropriation of warehouse requirements to meet warehouse resources.
	P1.1 Identify, prioritize and aggregate warehouse supply chain requirements	The process of identifying, aggregating and prioritizing the demand for the warehousing of a product. A forecast of manufacturing and sales to depict the service necessary levels.
	P1.2 Identify, asses and aggregate warehouse supply chain resources	The process of identifying, prioritizing and aggregating all sources of the warehouse that is required to accommodate the products at the service level.
	P1.3 Balance warehouse supply chain resources with warehouse supply chain requirements	The process of identifying and measuring the gaps between the requirements and resources in order to determine how best to resolve the variance though plans or actions to optimize the warehouse.
	P1.4 Establish and communicate warehouse plans	To establish and communicate the course of action to be taken over time, representing a projected appropriation of warehouse resources to meet resource requirements.

Table 1: Planning of the warehouse definitions

Process	Sub process	Definition
P2 Plan receiving		The development and establishment of actions over time to that represent a projected appropriation of product to receive to meet warehouse demands.
	P2.1 Identify, prioritize and aggregate receiving requirements	The process of identifying, prioritizing and aggregating all products to be received at the warehouse.
	P2.2 Identify, asses and aggregate receiving resources	The process of identifying and considering all resources to be used to accommodate receiving.
	P2.3 Balance receiving resources with receiving requirements	The process of developing a course of action that commits the receiving resources to meet the receiving requirements.

	P2.4 Establish receiving plans	The establishment and communication of actions over time that represent a project appropriation of warehouse resources to meet receiving requirements.

Table 2: Planning of receiving definitions

Process	Sub process	Definition
P3 Plan storage		The development and establishment of actions over time that represent a project appropriation of storing resources to meet storage requirements.
	P3.1 Identify, prioritize and aggregate storage requirements	The process of identifying, prioritizing and aggregating all products to be stored at the warehouse.
	P3.2 Identify, asses and aggregate storage resources	The process of identifying and considering all resources to be used to accommodate storing in the facility.
	P3.3 Balance storing resources with storing requirements	The process of developing a course of action that commits the storage operations resources to meet the storage operations requirements.
	P3.4 Establish storing plans	The establishment and communication of actions over time that represent a project appropriation of warehouse resources to meet storing requirements and operations.

Table 3: Planning of storing definitions

Process	Sub process	Definition
P4 Plan delivery		The development and establishment of actions over time that represent a project appropriation of dispatch resources to meet dispatch requirements.
	P4.1 Identify, prioritize and aggregate delivery requirements	The process of identifying, prioritizing and aggregating all products to be delivered from the warehouse.
	P4.2 Identify, asses and aggregate delivery resources	The process of identifying and considering all resources to be used to accommodate delivering to customers.
	P4.3 Balance delivery resources with delivery requirements	The process of developing a course of action that commits the delivery resources to meet the delivery requirements.
	P4.4 Establish delivery plans	The establishment and communication of actions over time that represent a project appropriation of warehouse resources to meet delivering requirements.

Table 4: Planning of delivering definitions

Process	Sub process	Definition
P5 Plan return		The development and establishment of actions over time that represent a project appropriation of return resources to meet return requirements. The planning of the return of products that are reissued to customers.
	P5.1 Identify, prioritize and aggregate return requirements	The process of identifying, prioritizing and aggregating the all the requirements for the return of a product.
	P5.2 Identify, asses and aggregate return resources	The process of identifying and considering all resources to be used to accommodate the return of a product.
	P5.3 Balance return resources with return requirements	The process of developing a course of action that commits the return resources to meet the return requirements.
	P5.4 Establish return plans	The establishment and communication of actions over time that represent a project appropriation of resources to meet return requirements.

Table 5: Plan return definitions

Process	Sub process	Definition
R1 Receiving plans		The receipt of incoming finished product to be facilitated in the warehouse.
	R1.1 Schedule receiving activities	Scheduling and managing the execution of the deliveries of products from the manufacturer.
	R1.2 Receive product	The process and associated activities of receiving the product to requirements.
	R1.3 Inspection and documentation of the product	The process and actions to determine the product conformance to requirements and the generation of the appropriate documents to accommodate the product.
	R1.4 Palletize/package	The series of activities that containerize completed products for storage.

Table 6: Receiving definitions

Process	Sub process	Definition.
S1 Storage plans		To manage the process of storing products from receiving in its designated storage location for the easy retrieval following a storage strategy such as FIFO.
	S1.1 Schedule storage activities	Scheduling and managing the execution of the storage of products from receiving. The product releases are determined by its storage location.
	S1.2 Verify and update product	The identification of the product and the management of the inventory quantities.
	S1.3 Identify product storage location	The specific location of a product to be stored over time for retrieval later.

	S1.4 Transfer product	The transfer of product to the appropriate storage location.

Table 7: Storage definitions

Process	Sub process	Definitions
D1 Dispatch		The process of delivering product in a finished goods state to the receipt of a customer.
	D1.1 Process inquiry and quote	Receive and respond to general customer inquiries and requests for quotes
	D1.2 Receive, enter and validate order	Receive the orders form the customer and enter it into the order processing system. Examine order to ensure it is correct.
	D1.3 Reserve inventory and determine delivery date	Inventory and planned capacity is identified and reserved for the specific order and delivery date is committed and scheduled.
	D1.4 Consolidate orders	The process of analyzing order to determine the groupings that result in least cost/best service fulfilment and transport.
	D1.5 Build loads	Transportation modes selected and the efficient loads build.
	D1.6 Route shipments	Loads are consolidated and routed by mode and location
	D1.7 Locate product from storage	The activities such as the verifying the product, its storage location and recording the product receipt.
	D1.8 Pick and pack order	The series of activities including retrieving the orders to pick, determining inventory availability, and recording the pick. Also activities such as the sorting and combining the products and delivering of it to the shipping area for loading.
	D1.9 Load product and create shipping documents	The series of tasks including the loading onto the modes of transport and the generation of documentation to meet the need of the customer, government and carrier.
	D1.10 Ship product	The process of shipping the product to the customer site.
	D1.11 Receive and verify product by customer	The process of receiving the shipment by the customer and verifying that the order was shipped complete and the product meet the delivery terms.
	D1.12 Invoice	A signal to be sent to the financial organization that the shipping process is complete and the billing process should begin. Payment should be received from the customers.

Table 8: Delivery definitions

Process	Sub process	Definition
RR1 Return received		The process of returning defective products received by the warehouse. This includes the documentation and physical return of defective product to the manufacturers.
	RR1.1 Identify defective product	The process where the warehouse identifies and confirms defective products and applies the business rules applicable.

	RR1.2 Defective product authorization and positioning	The process of determining whether to return a product. This also includes the authorization and return obligations.
	RR1.3 Schedule removal of defective product	The process where the defective product is staged and picked up by a carrier to be returned. This also includes the administration, documentations, scheduling and shipping preparation.
	RR1.4 Return defective product	The physical handling and shipment of the defective product to return it. This also includes the contractual exchange for the defective product.

Process	Sub process	Definition
DR1 Delivery returned, defective product		The process of customers returning defective product back to the warehouse. It includes the receiving, documentation and authorization of the defective product.
	DR1.1 Authorize defective product return	The process where the customer request authorization to return defective products. The warehouse then decides whether to accept or reject this request. The decision is then communicated to the customer.
	DR1.2 Schedule defective product return	The process of negotiating the conditions of the return and the scheduling of the return shipment for the customer. Also the scheduling of the receiving of the defective product at the warehouse and information regarding the handling of the product.
	DR1.3 Receive defective product	The process where the defective product is shipped, received, verified, documented and prepared for the transfer.
	DR1.4 Transfer defective product	The process where the defective product is appropriately handled and transfer to its designation or properly disposed of.

Process	Sub process	Definition
DR2 Delivery return, excess product		The process of return excess product received by the customer back to the warehouse. The process includes the identification of the customer and excess product, authorization to return, documentation and the physical return of the product.
	DR2.1 Authorize excess product return	The process where the customer, considering business rules and contractual agreements request authorization to return excess product. The return enables should also be discussed before retuning excess product such as the exchange, transport, packaging and necessary requirements to successfully return the excess product.

	DR2.2 Schedule excess product return	The process of developing a schedule that informs the customer of how and when the excess product should be shipped. The receiving part of the warehouse also uses this schedule to determine when to expect the return of excess product.
	DR2.3 Receive excess product	The process where the excess product is received, verified, documented and prepared to be transferred to its appropriate position.
	DR2.4 Transfer excess product	The process where the excess product is transfer to its appropriate location for storage or disposal.

Table 9: Return definitions

Process	Definition
PLAN	
EP1 Manage business rules for planning process	The process of establishing, maintaining and enforcing decision support criteria for the warehouse planning which translate to rules for the conduct of business. The business rules align plan process policies with business strategy, goals and objectives.
EP2 Manage performance of warehouse	The process of measuring the warehouse performance against standards and to develop and implement a course of action to achieve the target performance levels.
EP3 Manage and plan data collection	The process of collecting, integrating and maintaining the accuracy of warehouse execution information to plan the balance of the warehouse requirements and resources at both the highest and lowest SKU planning levels.
EP4 Manage inventory	The process of establishing total warehouse inventory strategy and planning the total inventory limits or levels.
EP6 Manage transportation	The process of defining an integrated warehouse transportation strategy and maintaining the information for the transportation requirements and manage the transporters both in the warehouse and to the customers.
EP7 Manage warehouse compliance and requirements	The process of identifying and complying with regulatory documentation and process standards set by external entities when planning the warehouse.
EP8 Align warehouse plans with financial plans	The process of revising the long term warehouse capacity and resource plans with the given inputs form the strategic and business plans.
RECEIVE	
ER1 Manage receiving business rules	The process of defining requirements and establishing, maintaining and enforcing decision support in alignment with the business strategy, goals and objectives. The business strategy defines the goals for the receiving business rules that are translated guidelines and policies for conducting business with the manufacturer.
ER2 Maintain receiving data	The process of collecting, sorting and managing the configuration control of the receiving information that is required to make receiving decisions, plan the schedule and record the inventory.

ER3 Manage warehouse and manufacturer agreements	The management of the contact between the manufacturer and the receiving of the warehouse.
STORE	
ES1 Manage storage rules	The process of establishing, maintaining and enforcing rules for managing the storage in line with the strategy, goals and objectives.
ES2 Manage stage data	The process of managing, collecting, maintaining and communicating information to support the storage and the assist is the execution of storing products. The information to be managed is the products details, storage location and quantities.
ES3 Manage transport	The process of transporting the product to its storage location and the activities of the transit handling and movement.
ES4 Manage product inventory	The process of establishing and maintaining physical inventories and inventory information. This includes the inventory management, control and the physical inventories.
DISPATCH	
ED1 Manage deliver business rules	The process of defining and maintaining rules which affect the acceptance of an order, based on quantity, method of delivery, customer experience etc.
ED2 Asses deliver performance	The process of defining the requirement and monitoring the performance of the delivery of product to a customer.
ED3 Manage deliver information	The process of collecting, maintaining and communicating information to support the deliver planning and execution processes.
ED4 Manage available product inventory	The process of establishing and maintaining inventory limits and levels, product mix and stocking locations.
ED5 Manage transportation	The process of defining and maintaining the information which characterize the product, containerization, vehicle, regulations, route and rates/tariffs. Also the management of transporters.
RETURN	
ET1 Manage return business rules	The process of establishing, maintaining and enforcing the support criteria to return a product. This then translates into business rules for returning. These rules should be aligned with the overall goals, objectives and business strategy.
ET2 Asses return performance	The process of measuring the return process performance against other set performance measures for return of products.
ET3 Maintain return data	The process of collecting and maintaining the data and information that accompany the return activities.
ET4 Manage return inventory	The process of determining and planning for a return product inventory strategy, including the acceptable levels and limits of returned items. This also includes stocking locations, product mix, return models and ownership.
ET5 Manage return transportation	The process of establishing the agreement on the transportation to return products from the customer to the warehouse. This includes a transportation strategy, transportation activities and managing transportation information and performance.

ET6 Manage return regulatory, requirements and compliance	The process of identifying all regulations and rules concerned with returning a product and implementing them.

Table 10: Enabling definitions

The follow tables describe the warehouse SCOR model similarly to the SCOR model. The inputs and outputs of each sub-process are listed. The numbers and color reference of each input and output is given to link the processes together.

Example:

Input: Receiving plans (P1.2, P3.2, P4.2, P5.2, R1.1, D1.3)

This enables traceability throughout the model.

Process	Sub-Process	Input	Output
P1 Plan warehouse supply chain			
	P1.1 Identify, prioritize and aggregate warehouse supply chain requirements	• Customer • Planning data(EP3) • Warehouse forecasts (EP5) • Manage transport(EP6) • Warehouse regulations(EP7) • Revised business plan (EP8)	• Align warehouse plan and financial plan(EP8)
	P1.2 Identify, asses and aggregate warehouse supply chain resources	• Receiving plans(P2.4) • Dispatch plans(P4.4) • Storage plan(P3.4) • Planning data(EP3) • Transport(EP6) • Warehouse regulations(EP7)	
	P1.3 Balance warehouse supply chain resources with warehouse supply chain requirements	• Decision policies(EP1) • Warehouse performance(EP2) • Inventory strategy(EP4)	
	P1.4 Establish and communicate warehouse supply chain plans		• Warehouse supply chain plans (P2.1, P3.1 P4.1, P5.1) • Customer

Process	Sub-Process	Input	Output
P2 Plan Receiving			
	P2.1 Identify, prioritize, and aggregate incoming product requirements	• Establish and communicate warehouse plans(P1.4) • Storage plan(P3.4) • Delivery plan(P4.4) • Planning data(EP3)	
	P2.2 Identify, asses and aggregate incoming product resources	• Manufacturer product availability • Receiving schedule (R1.1) • Planning data(EP3)	
	P2.3 Balance incoming products resources with its requirements	• Decision policies(EP1)	
	P2.4 Establish incoming inventory storage plans		• Receiving plans (P1.2,P3.2,P4.2, P5.2, R1.1,D1.3)

Process	Sub-Process	Inputs	Outputs
P3 Plan storage			
	P3.1 Identify, prioritize and aggregate storage requirements	• Warehouse plans(P1.4) • Delivery plans(P4.4) • Planning data(EP3)	
	P3.2 Identify, asses and aggregate storage plans	• Receiving plans(P2.4) • Storage schedule(S1.1) • Inventory update(S1.2) • Inventory data(EP3) • Inventory strategy(EP4) • Inventory target levels(EP4)	
	P3.3 Balance storage resources with requirements	• Decision policies(EP1)	
	P3.4 Establish storage plans		• Storage plans(P1.2,P2.1,P4.2, P5.2, S1.1,D1.3)

Process	Sub-Process	Inputs	Outputs
P4 Plan dispatch			
	P4.1 Identify, prioritize and aggregate dispatch requirements	• Customer • Warehouse plan (P1.4) • Product order(D1.3) • Planning data(EP3)	• Business rules(EP1)
	P4.2 Identify, asses and aggregate dispatch plans	• Receiving plan(P2.4) • Storage plan(P3.4) • Identify product storage (S1.3) • Inventory update(S1.2,D1.3) • Load information(D1.5) • Planning data(EP3)	
	P4.3 Balance dispatch resources with requirements	• Return products (P5.4) • Decision policies(EP1)	
	P4.4 Establish dispatch plans		• Deliver plans(P1.2,P2.1,P3.1, P5.2, D1.3)

Process	Sub-Process	Inputs	Outputs
P5 Plan return			
	P5.1 Identify, prioritize and aggregate return requirements	• Contractual obligations • Warehouse plans (P1.4) • Planning data (EP3) • Forecasting (EP5)	
	P5.2 Identify, asses and aggregate return plans	• Return schedule (P2.4, P3.4, P4.4) • Planning data (EP3) • Inventory strategy and management (EP4) • Budget (EP8)	
	P5.3 Balance return resources with requirements	• Decision policies(EP1) • Regulatory requirements (EP6)	
	P5.4 Establish return plans		• Return plans(RR1.2, DR1.1, DR1.2, DR2.1, DR2.2) • Deliver return requirements (P4.3)

5.2.3 Receiving

Process	Sub-Process	Inputs	Outputs
R1 Receiving			
	R1.1 Schedule receiving activities	• Receiving plans(P2.4) • Information feedback(R1.3,R1.4) • Manage warehouse/manufacturer agreements(ER4) • Confirm advanced shipping notice (ASN) • Assign truck to dock location	• Scheduled receipts (S1.1,D1.7) • Receiving schedule(P2.2)
	R1.2 Receive product	• Manufacturer • Receiving business rules(ER1)	
	R1.3 Inspection and documentation of product	• Count incoming product • Manage incoming products(ER3)	• Information feedback(R1.1) • Product documents(S1.3) • Maintain product data(ER2) • Warehouse and manufacturer agreements(EP4)
	R1.4 Stage packed products for storgae		• Information feedback(R1.1)

Process	Sub-Process	Inputs	Outputs
S1 Storage plans			
	S1.1 Schedule storing activities	• Storage plan(P3.4) • Receiving schedule(R1.1) • Information feedback(S1.2,S1.3,S1.4) • Storages rules(ES1)	• Storage schedule(P3.2, D1.7)
	S1.2 Verify product	• Product documents(R1.3) • Inventory data level (ES2)	• Inventory update (P3.2, P4.2) • Information feedback(S1.1) • Inventory availability (D1.7, DR2.4)
	S1.3 Identify product storage location	• Returned excess product (DR2.4) • Storage rules(ES1) • Location data (ES2) • Manage product inventory location(ES4)	• Product inventory update(P4.2,D1.3,D1.7) • Information feedback(S1.1) • Product located for storage (S1.4)
	S1.4 Transfer product	• Product location(S1.3) • Excess product returned (DR2.4) • Transportation and material handling (ES3)	• Product location(D1.7) • Information feedback(S1.1)

Process	Sub-Process	Inputs	Outputs
D1 Dispatching			
	D1.1 Process inquiry and quote	• Customer inquiry	• Quote
	D1.2 Receive, enter and validate order	• Customer order • Customer contract • Order rules(ED1)	• Asses delivery(ED2) • Delivery data(ED3) • Transportation(ED5) • Product life cycle(ED6)
	D1.3 Reserve inventory and determine delivery date	• Receiving plans(P2.4) • Storage plans(P3.4) • Delivery plans(P4.4) • Storage location (S1.3)	• Product order (P4.1) • Product inventory status(P4.2)
	D1.4 Consolidate orders		• Daily shipment volume
	D1.5 Build loads		• Load information(P4.2)

Process	Sub-Process	Inputs	Outputs
	D1.6 Route shipments	• Carrier	
	D1.7 Receive product from storage	• Schedule receiving(R1.1) • Product availability(S1.2) • Storage schedule(S1.1) • Product location(S1.3,S1.4)	• Inventory availability (ED4) • Transport(ED5)
	D1.8 Pack order		• Pack order
	D1.9 Load product and create shipping documents	• Consolidate product • Export documentation(ED7) • Manage transport(ED5)	• Shipping documents • Special shipment defective products(RR1.4) • Government regulations(ED7)
	D1.10 Ship product		• Deliver products to customer
	D1.11 Receive and verify product by customer	• Advance shipment notice	
	D1.12 Invoice		• Payment

5.2.6 Return of product received

Process	Sub-Process	Inputs	Outputs
RR1 Return received defective product			
	RR1.1 Identify defective product	• Manage return business rules (ET1) • Return policy and requirements (ET6)	• Product data and information (RR1.3, ET3)
	RR1.2 Defective product authorization and positioning	• Return Plan (P5.4)	• Authorization to return • Inventory availability (ET4) •
	RR1.3 Schedule removal of defective product	• Contractual exchange of product • Return information (RR1.1, ET3) • Inventory return (ET4)	• Return schedule (RR1.4)
	RR1.4 Return defective product	• Load product (D1.9) • Return schedule (RR1.3) • Inventory availability (ET4) • Transport (ET5)	• Returned product • Shipment documents • Exchange for defective product

5.2.7 Products delivered returned

Process	Sub-Process	Inputs	Outputs
DR1 Delivery return defective product			
	DR1.1 Authorize defective product return	• Return plans (P5.4) • Business rules (ET1) • Return policy and regulations (ET6)	• Manage inventory information (ET3)
	DR1.2 Schedule defective product return	• Defective product return plan (P5.4)	• Return schedule (DR1.3, ET3)
	DR1.3 Receive defective product	• Return schedule (DR1.2) • Receive data (ET3) • Transportation (ET5) • Regulations (ET6)	• Receive discrepancy • Return inventory management (P5.2, ET4) • Return defective product (DR1.4)
	DR1.4 Transfer defective product	• Return inventory for transfer • Defective product (DR1.3)	• Effective products • Return inventory transfer data (ET4)

Process	Sub-Process	Inputs	Outputs
DR2 Delivery return excess product			
	DR2.1 Authorize excess product return	• Return plans (P5.4) • Business rules (ET1) • Warehouse information system (EP3)	• Manage return information (ET3)
	DR2.2 Schedule excess product return	• Excess product return plan (P5.4)	• Return schedule (DR2.3, ET3)
	DR2.3 Receive and verify products	• Retuned excess product • Inventory updated (S1.2) • Return schedule (DR 2.2) • Excess product data (ET4) • Transport (ET5) • Regulations (ET6)	• Receive discrepancy data • Return excess product (DR2.4) • Return inventory data (ET3) • Inventory update (ET4)
	DR2.4 Transfer product	• Transfer returned inventory • Excess product received (DR2.3)	• Excess product (S1.3, S1.4)

5.2.8 Enablement's of plan, receive, store and dispatch

Process	Input	Output
PLAN		
EP1 Manage business rules for planning process	• Business plan • Strategic plan • Service requirements	• Service levels(P4.1) • Decision policies(P1.3, P2.3, P3.3, P4.3, P5.3)
EP2 Manage performance of warehouse	• Continuous improvement process	• Warehouse performance(P1.3)
EP3 Manage and plan data collection	• Warehouse data	• Planning data(P1.1, P1.2, P2.1, P2.2, P3.1, P3.2, P4.1, P4.2, P5.1, P5.2)
EP5 Forecasting		• Warehouse requirements (P1.1) • Return forecast (P5.1)
EP4 Manage inventory	• Capacity constraints	• Manage inventory information • Inventory strategy (P1.3) • Inventory levels (P3.2) • Return inventory (P5.2)
EP6 Manage transportation	• Capacity constraints • Planning decision policies	• Projected capacity(P1.1) • Outsource plan(P1.2)
EP7 Manage warehouse compliance and requirements	• Warehouse layout planning • Warehouse design	• Regulatory requirements(P1.1) • Warehouse regulations (P1.2)
EP8 Align warehouse plans with financial plans	• Business plan • Strategic plan • Warehouse requirements(P1.1)	• Revised business assumptions(P1.1) • Return budget (P5.2)
RECEIVE		
ER1 Manage receiving business rules		• Receive product(R1.2)
ER2 Maintain receiving data	• Planning of receiving(R1.1) • Receiving documents(R1.3)	• Current inventory documentation
ER3 Manage incoming product	• Manufacturer	• Product inspection and documentation (R1.3)
ER4 Manage warehouse and manufacturer agreements	• Schedule receiving (R1.1) • Receiving documentation and inspection (R1.3)	• Manage the warehouse and manufacturer interface
STORE		
ES1 Manage storage rules	• Storage plan • Storage strategy	• Storage rules (S1.1)
ES2 Manage stage data	• Information needed to maintain inventory IT • Information from receiving	• Documents (S1.2) • Inventory levels and documentation (S1.3)

ES3 Manage transport	• Capacity requirements • Product location • Appropriate material handling equipment • Equipment and facilities replacement plan	• Move information and methods(S1.4)
ES4 Manage inventory and storage	• Inventory and order rules • Product mix and plans	• Product inventory location(S1.3)
DISPATCH		
ED1 Manage deliver business rules	• Manage process reports • Planning decision policies • Configuration rules	• Order rules(D1.2)
ED2 Asses deliver performance	• Delivery performance • Customer orders(D1.2)	• Manage process reports • Customer service requirements
ED3 Manage deliver information	• Customer information(D1.1,D1.2) • Validated order(D1.2)	• Customer database updated
ED4 Manage available product inventory	• Inventory rules, mix, plans • Existing inventory data(D1.7) • Customer database • Order rules	• Inventory target levels • Inventory rules • Delivery performance
ED5 Manage transportation	• Carrier • Customer service requirements • Carrier rates • Standard practice/rules • Deliver requirements • Customer order size(D1.2) • Material handling equipment (D1.7)	• Shipping parameters and documents(D1.9)
ED6 Manage product life cycle	• Order delivery time (D1.2)	
ED7 Manage import/export requirements	• Government regulations (D1.9) • Shipping history(D1.9) • Tariffs and duties	• Shipping export parameter and documentation(D1.9) • Government constraints
RETURN		
ET1 Manage return business rules		• Product identification (RR1.1, DR1.1, DR2.1)
ET2 Asses return performance	•	•
ET3 Maintain return data	• Return data (RR1.1, DR1.1, DR2.1)	• Defective product receive data (DR1.3) • Return schedule (RR1.3, DR1.2, DR2.2) • Excess product return (DR2.2, DR2.3)
ET4	• Defective or excess	• Return inventory (RR1.3, DR1.3,

Manage return inventory	product transfer • Inventory received (RR1.2)	DR2.3) • Inventory available (RR1.4)
ET5 Manage return transportation	• Inventory receive (DR1.4, DR2.3)	• Return of defective product (RR1.4) • Receive defective product (DR1.3) • Excess product handling (DR2.3)
ET6 Manage return regulatory, requirements and compliance		• Product identification (RR1.1, DR1.1, DR2.1) • Authorize return (RR1.1, DR1.1, DR2.1) • Receive defective product (DR1.3) • Receive excess product (DR2.3)

Table 11: Enablement of the process elements

A best practice for the different elements should be found and implemented. The key performance indicators for planning a warehouse could be found in Appendix A.

5.3 Data and Information Needed for the Warehouse SCOR Model

The warehouse SCOR model needs some data and information input from the warehouse operations and processes to act as input to the model.

First of all the following data should be discovered:

- Identify the type of product to be stored an its storage requirements
- The value of the product to be stored
- The current warehouse operations if any exists
- The requirement of the warehouse such as the volume, throughput and services the warehouse should offer
- Identify all alternative warehouse plans

This data would serve as input to the following:

- Warehouse strategy
- Warehouse business plan
- Contingency planning
- Distribution network planning

The information is needed to successfully plan for the warehouse which is the start of the warehouse SCOR model.
Knowledge of warehousing regulations should also be presented and noted to ensure the design and planning of the warehouse is within these rules and limits.

The data that would be required for the warehouse SCOR model may vary depending on the company. The data required for the warehouse SCOR model could be retrieved from the current warehouse management system.
The required data are the following:

- Product data
  This data has the identification of the products with their description, code, feature, weight, size, batch, storage requirements etc.
- Sales data
  The sales data consists of the history of sales for a product including the date of the sale, the sale size, customer information and delivery point etc.
- Stock data (inventory control)
  This data group should contain the stock levels and the location of the stock. The units that are reserved for known orders should also be shown in this data.
- Goods to deliver data
  Describes all the products that need to be delivered, including quantities, due dates, destinations, and delivery methods etc.
  (Waters, p228)

The data recorded and retrieved will then be uplifted into models to form the following information:

- Forecasting models
- Inventory control systems
- Economic order quantity model
- A warehouse strategy
- A warehouse business plan
- Cost of carrying inventory
- Determining stock keeping units (SKU's)

This information models is used as input at various elements in the warehouse SCOR model as can be seen in the model itself. It is also used in the decision making process.

5.4 Best Practices for Warehousing

The following are best practices identified to use in the warehouse environment. These practices could be implemented to improve and control the warehouse processes and operations.

The best practices for incoming product at receiving are the following:

- Integrate warehouse management and transportation management systems.
- View the following data for analysis; products, cost and logistics.
- Appoint scheduling for pickup and delivery of product from manufacturer.
- Measure the performance for on time delivery and completeness.
- Optimized shipment method selection based on manufacturer service requirements.
- Automated documentation.
- Automated identification of products.
- Manage and maintain data over all the products received.

The above mentioned practices feature a transport Management System and Data Maintenance Management.

Best practices for managing the inventory are the following:

- Periodic review of metrics and strategy with comparison to benchmarks
  View real-time data
- Data on current status
  Calculation of safety stock
- Inventory cycle counting
- Inventory categorization
  ABC analysis

Consideration when deciding on a storage method:

- Ease of storage
- Ease of retrieval
- Ease of location
- Security of location
- Risk of damage
- Use of cubic space
- Cost of storage equipment
- Cost of handling equipment
- Cost of the operations

(Tompkins, Smith, 1988: 540)

The location of storage for the products should also be planned and this could ultimately also influence the utilization of the storage space. There are different ways that the location of storage for products could be assigned such as:

- Random location selection
  The product is stored in any available location. This would result in the most efficient utilization of the storage space.
- Dedicated location selection
  The identification of dedicated storage location for each product.
- Zone allocation
  The identification of zones where it is suitable to store certain products. Products could then be stored anywhere within this zone.

The decision for material handling equipment could depend on various factors such as the:

- Product size
- Amount of products to be handled
- Shape of product
- Packaging of product

There exist various way that product could be moved in a warehouse such as:

- Fork lift
- Conveyors
- Automated guided vehicles
- Cranes

Best practices for finding the best route for moving products in the warehouse are:

- Short path move
  To measure and calculate the shortest path to move product to be able to store product using software.
- Reduce product handling
  Reduce handling of products through automation

The computer system of a warehouse should be able to perform the following functions:

- Update inventory record at the receiving dock, including any comment on the inspection and quality of the product received.
- Identify and store the storage location of each identified product.
- Record the orders correctly and documentation to deliver

The warehouse should have a warehouse management system (WMS).

5.5 Performance attributes and metrics

The performance attributes for the warehouse SCOR model would be the same as for the SCOR model. The performance attributes would be:

- Reliability
- Responsiveness
- Flexibility
- Cost
- Assets

The metric by which these attributes could be measured could include the following:

- Truck arrivals per day at receiving or for delivery

- Amount of product loaded or unloaded
- Time to load or unload
- Number of trucks loaded or unloaded per day
- Number of products shipped per day
- Number of products arriving per day
- Number of products stored each day
- Time taken to react on an order
- Utilization of storage space
- Labor performance
- Inventory levels
- Inventory turnovers
- Inventory accuracy
- Warehouse operating cost
- Products and equipment changes
- Business rules and regulations that would affect the operations of the warehouse

(Tompkins, Smith, 1988:552)

5.6 Implementation of the warehouse SCOR model

The warehouse SCOR model would be implemented and used by the warehouse planning team. They could use the model and roadmap to plan and executed the operations of a warehouse. The warehouse SCOR model would help ensure that the necessary requirements for a warehouse are identified the resources planned and available.

SCD (Supply Chain Development) would also use the warehouse SCOR model to ensure the warehouse or warehouses of a supply chain are aligned with the rest of the supply chain.

5.7 Sasol's SCOR Model Application

Sasol align their supply chain using the SCOR model. The supply chain that will be used for a particular application is then determined with Figure 5.

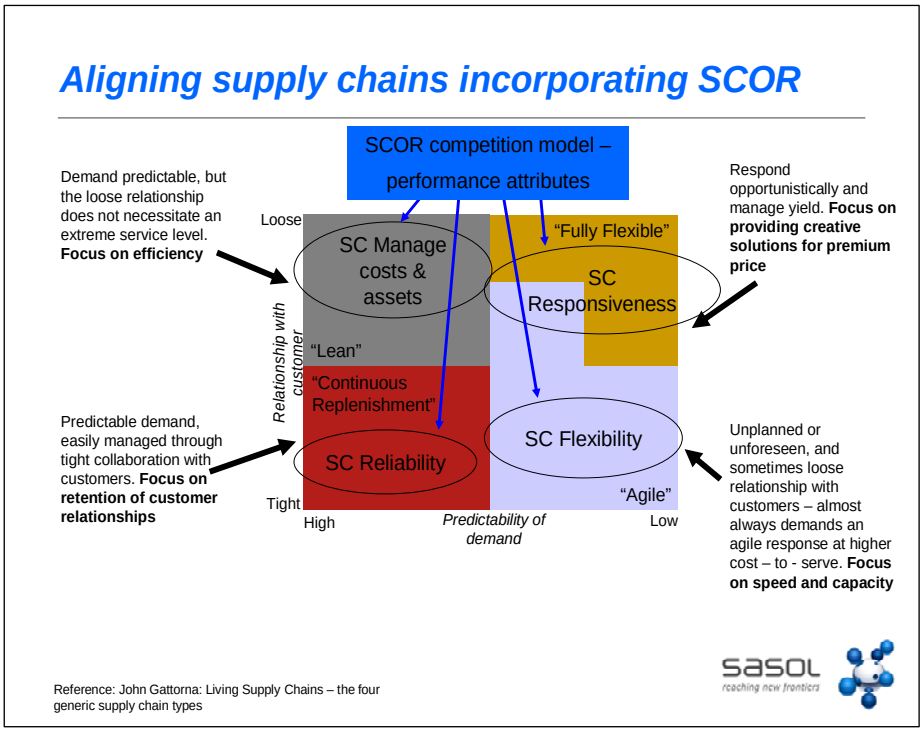

Figure 5: Aligning supply chain incorporating SCOR

The SCOR model was remodeled by Sasol to fit the particular applications in Sasol and to address only the requirements of Sasol. This was also done to model the supply chain and its processes within Sasol and to keep the model fitted to Sasol's profile. Sasol SCD used the SCOR model as base from which they developed the Sasol SCOR model. Figure 6 is the part of the Sasol SCOR model that has relevance to the warehousing facilities.

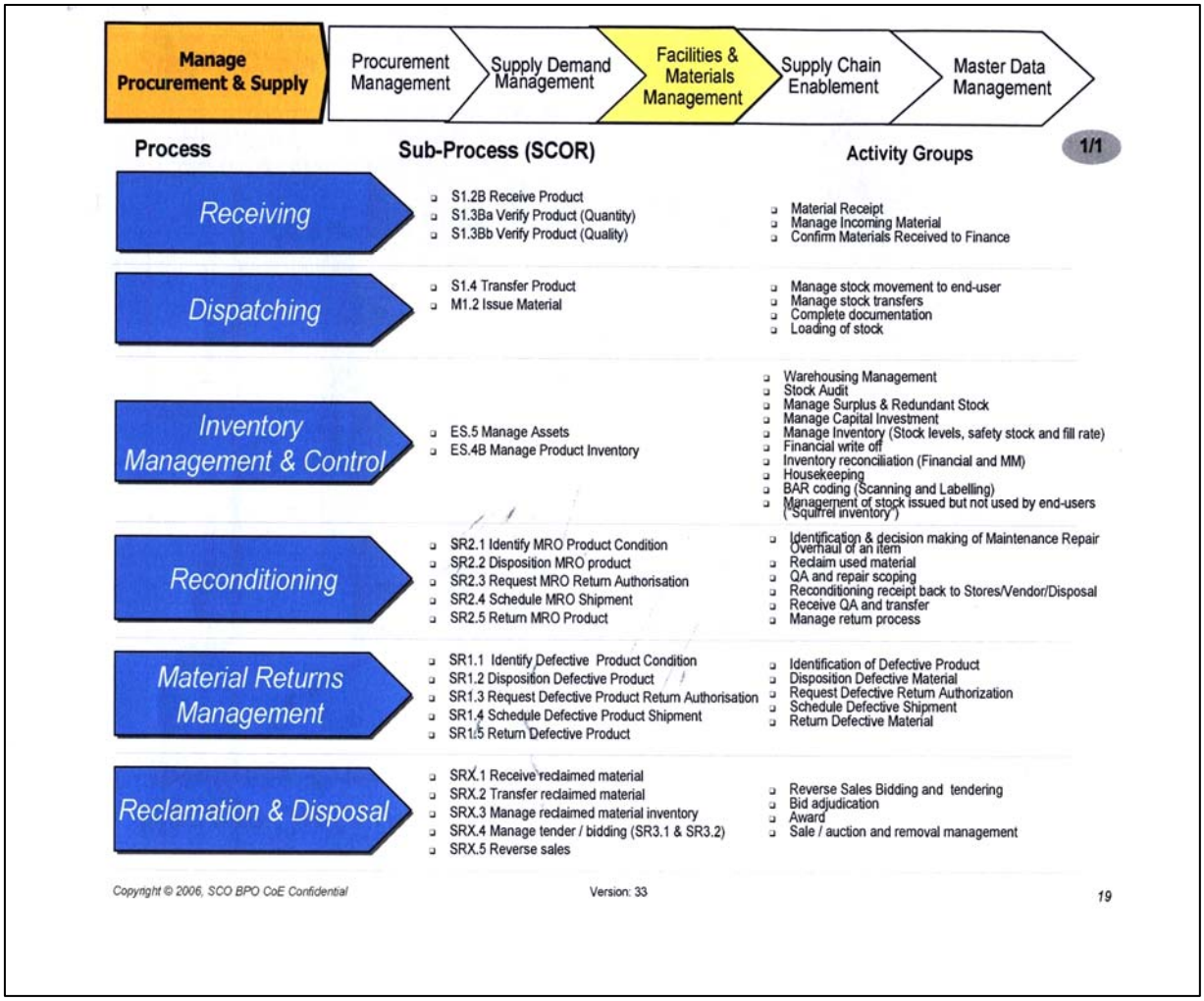

Figure 6: Sasol SCOR application

The SCOR model for facilities management incorporates a system to manage inventory. The planning for such a warehouse facility isn't clearly stated and the model focus on the return of products.

5.8 Why use the Warehouse SCOR Model?

The modified warehouse SCOR model for the FTWEP will add value to the project and to other warehousing applications within Sasol in the following ways:

- A strategy and business plan would be in place for the warehouse and the decisions could be structured and referenced to these business plans, strategies and goals.

- The model allows for a comprehensive planning for the entire warehouse and the various processes in the warehouse.
- The model could identify the warehouse requirements and the resources for the facility to be fully operational and optimized.
- It will identify and model the requirements, resources and planning for the receiving, storage and delivery of product.
- The model gives a layout of the entire warehouse processes and each step for receiving, storing and delivering. All input and output of each step is recognized and could be planned for.
- Assists in the alignment of warehouse processes with the rest of the supply chain.

The warehouse SCOR model would link the planning, operations, resources and requirements to improve the warehouse to have the necessary activities to be successful. The relationship between the planning, operations, resources and requirements could be viewed in Figure 7.

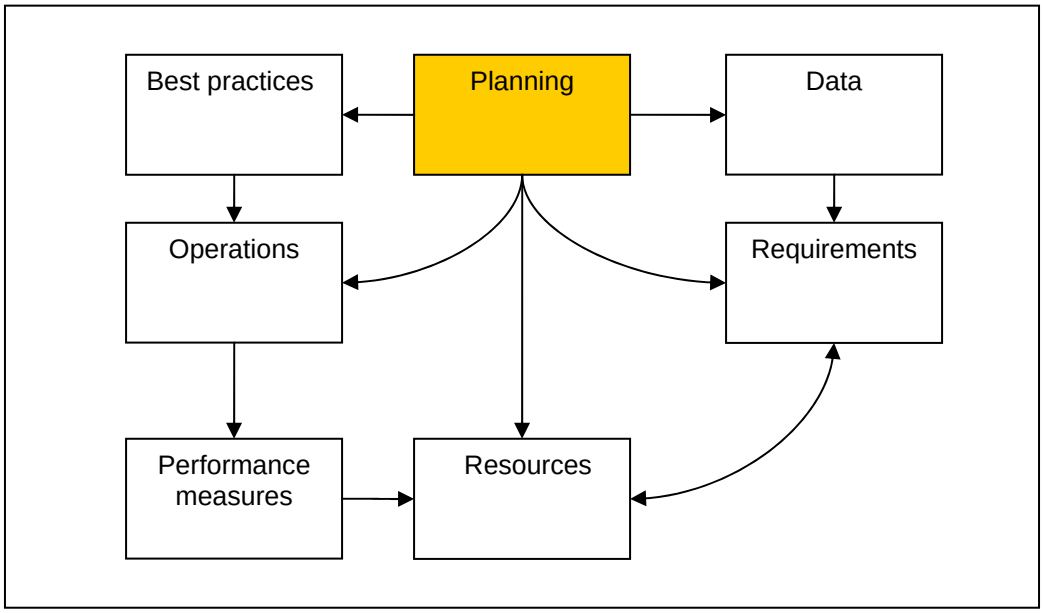

Figure 7: Improved relationships between processes

Using the warehouse SCOR model should optimize the operations of the warehouse and align the warehouse with other logistical parts in the supply chain.

The warehouse SCOR model could also be applied to the FTWEP. This will help to discover any requirements and resources that are essential to the successes of the warehouse, whether it be to build a new one or to upgrade the existing warehouse facility.

5.9 Warehouse SCOR model and the FTWEP

The warehouse SCOR model use the resources and requirements of a warehouse and meet them in such a unique way which will align with the overall supply chain strategy and objective using the SCOR model.

The warehouse SCOR model could assist the FTWEP in the development and design of their warehouses. Using this model will assist the FTWEP to take the necessary step and measures to ensure that the planning for the warehouses would be adequate to accommodate the change in the supply chain.

6 Storage Facility Layout

This is an outline for the layout of the warehouse facilities. The warehouse SCOR model also assists in the layout design by determining the amount of space that would be necessary for each of the activities.

The purpose of the intermediate storage is to store the product for a short time before it is moved to the final or dispatch warehouse. At the intermediate storage the product is inspected for quality reasons.

The products move quickly through this facility and it is thus important to plan the storage layout to be able to accommodate the flow of products. The product should be stored in such a way that the following could be achieved:

- Products is retrievable
- The material handling equipment is optimally utilized
- The loading dock should enhances quick loading and unloading

Adequate space should be available for the following activities:

- Receiving
- Staging
- Holding area
- Storage
- Dispatch

Incorporating the necessary space and planning the warehouse layout with the warehouse SCOR model should propose a layout that would be both functional and enhance the utilization of the space.

7 Project Execution

The process map the execution of the project could be viewed in Figure 7 this process map list all the step taken to complete this project.

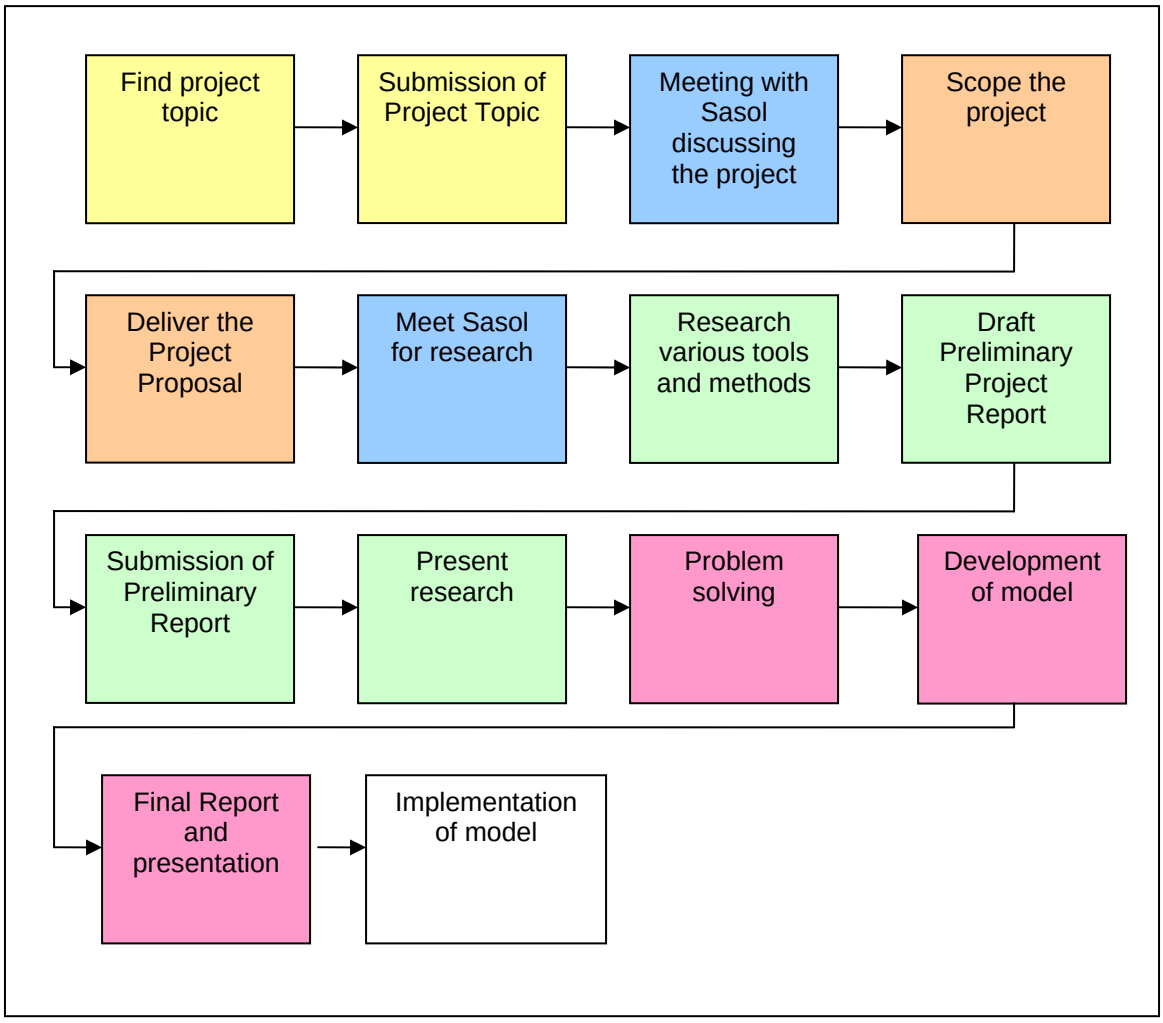

Figure 8: Project Process and Progress

The activities are shown as follow:

- Project topic activities, Yellow
- Sasol interactions, Blue
- Scope of project, Orange
- Research, Green
- Current activities, Pink

This is the first version of the warehouse SCOR model. With further development this model should be refined.

8 Conclusion

The storage of product is one of the most valuable assets in a supply chain. The warehouse is a temporary location for either raw materials or finished products. A storage facility or warehouse should thus be managed that the time a product spend in the warehouse is as short as possible and economically feasible.

The need for a warehouse model that could integrate the operations, requirements and resources of a warehouse has become inevitable. The example used in the project for this need is the FTWEP. The expansion of the production facilities and increase of production units demanded a compatible storage facility. This is the FTWEP used as a base on which the requirements and resource for a warehouse were identified.

The warehouse SCOR model assists management to plan sufficiently according to the requirements and resources of the warehouse. The warehouse SCOR model includes the operations present in a warehouse such as receiving, storage and delivery. The planning and operations of the warehouse then ties to become a complete warehouse model. The warehouse SCOR model could easily be incorporated and aligned into the supply chain and the SCOR model.

The warehouse SCOR model has been developed using FTWEP. The FTWEP benefit from the model by incorporating it in their planning, management and operations systems. Still, the warehouse SCOR model is a generic model and could be used different instances, environments and manufacturers. The warehouse SCOR model would be especially useful to manufacturers who already model their supply chain according to the SCOR model. The warehouse SCOR model would fit into the framework of the existing supply chain and could then be effortlessly aligned with the rest of the supply chain.

The great thing in the world is not so much where we stand, as in what direction we are moving. (Oliver Wendell Holmes)
The ultimate purpose of the warehouse SCOR model is to assist companies managing their warehouses, to take a step in the right direction to own successful warehouses.

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