CHAPTER 2
LITERATURE REVIEW

2.1. Supply Chain Management

2.1.1. Overview of Supply Chain Management

Supply Chain Management is a set of synchronized decision and activities utilized to efficiently integrate suppliers, manufacturers, warehouse, transporters, retailers, and customers so that the right product of service is distributed at the right quantities, to the right location and at the right time, in order to minimize system-wide costs while satisfying customer service requirements. The objective of Supply Chain is to achieve sustainable competitive advantage (Ling Li, 2007, p5)

Actually, the term of Supply Chain Management arose in the late of 1980, and come into widespread use in the 1990s, prior to that time, business used terms such as "logistics" and "operation management". Some other definitions of Supply Chain Management are:

- "The systemic, strategic coordination of traditional business function and the tactics across these business functions within a particular company and across business within the supply chain, for the purpose of improving the long-term performance of the individual companies and the supply chain as a whole."
- Supply chain management is the coordination of production, inventory, location and transportation among the participants In a supply chain to achieve the best mix of responsiveness and efficiency for the market being served.(Hugos, 2003,p4)

Different supply chain requirement often have a conflicting needs. For instance, the requirement of maintaining high levels of customer service calls for maintaining high level of inventory, but then the requirement to operate efficiently calls for reducing inventory levels. So, effective supply chain management requires simultaneous improvements in both customer service levels and company internal operating efficiency.

In order to improve and achieve effective supply chain, company must take decision individually or collectively regarding their action in five major supply chain drivers. These five drivers concepts are depict with the figure below: (Hugos, 2003, p5-6).

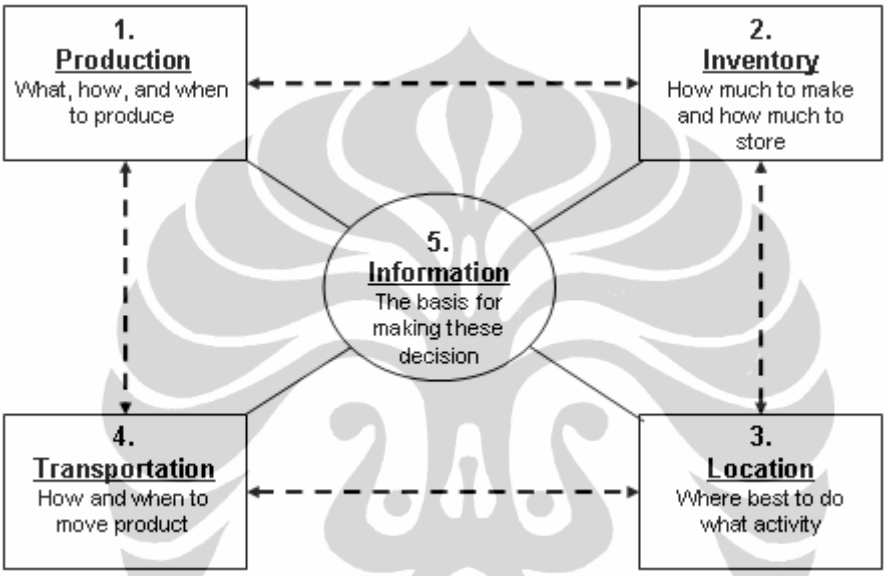

Figure 2-1 Framework of the Five Major Supply Chain Drivers

Source: Michael Hugos, 2003, Essential of Supply Chain Management, p5-6

1. Production.

   What product does the market want? How much of which product should be produced and by when? This activity includes the creation of master production schedules that take into account plant capacities, workload balancing, quality control, and equipment maintenance.

2. Inventory.

   What inventory should be stocked at each stage in supply chain? How much inventory should be held as raw materials, semi-finished, or finished goods? The primary purpose of inventory is to act as buffer against uncertainty in the supply chain. However, holding inventory can be expensive, so what are the optimal inventory levels and reorder points?

3. Location.

   Where should facilities for production and inventory storage be located? Where are the most cost efficient locations for the production and for storage of inventory? Should existing facilities be used or new ones built? Once these decisions are made they determine the possible paths available for products to flow through for delivery to the final customer.

4. Transportation.

   How should inventory be moved from one supply chain location to another?

5. Information.

   How much data should be collected and how much information should be shared? Timely and accurate information holds the promise of better coordination and better decision making.

The right combination of responsiveness and efficiency in each of these drivers allows a supply chain to increase throughput while simultaneously reducing inventory and operating expense.

2.1.2. Efficient Supply Chain and Responsive Supply Chain

There are two distinctive approaches to a firm's supply chain design, efficient supply chain and responsive supply chain. The table below shows the characteristic of each design.

Table 2-1 Efficient Supply Chain and Responsive Supply Chain

	Efficient Supply Chain	*Responsive Supply Chain*
Demand	Constant, based on forecasting	Fluctuate, based on customer orders
Product Life Cycle	Long	Short
Product Variety	Low	High
Contribution Margin	Low	High
Order Fulfill Lead Time	Allowed longer fulfillment lead time	Short or based on quoted due date
Supplier	Long-Term	According to product life cycle
Production	Make-to-Stock	Assemble to stock Make to order Build to order

Table 2-1 Efficient Supply Chain and Responsive Supply Chain (Cont'd)

Capacity Cushion Inventory	Low Finished goods inventory	High Parts, components, subassembly
Supply Selection	Low cost, consistent quality, and on-time delivery	Flexibility, fast-delivery, high performance design quality.

Source: Ling Li, 2007, Supply Chain Management: Concepts, Techniques and practices, USA, World Scientific Publishing, p.13

The purpose of responsive supply chain is to react quickly to market demand. This supply chain model best suites for the environment in which demand predictability is low, forecasting error is high, product life cycle is short, new product introductions are frequent and product variety is high. The purpose of an efficient supply chain is to coordinate the material flow and services to minimize inventories and maximize the efficiency of the manufacturers and service provider in the chain (Ling Li, 2007, p13).

2.2. Supply Chain Operation

2.2.1. Order Management

Order Management is the process of passing order information from customer back through the supply chain from retailers to distribution to service providers and producers. This process also includes passing information about order delivery dates, product substitutions, and back orders forward through the supply chain to customers.

Refer to (Hugos, 2003, p84-90) some guidance for effective order management are:

1. Enter the order once and only once.

   Capture the data electronically as close to its original source as possible and do not manually reenter the data as it moves through the supply chain.

2. Automate the order handling.

   Manual intervention should be minimized for routing and filling of routine orders. Exception handling should identify orders with problems that require people to get involved to fix them.

3. Make order status visible to customers and services agents.

   Let customer track their order through all the stages from entry of the order to delivery of products. Customer should be able to see order status

on demand without having to enlist the assistance of other people. When an order runs into problems, bring the order to attention of services agent who can resolve the problems.

4. Integrate order management systems with other related systems to maintain data integrity.

   Order entry systems need product descriptive data and product prices to guide the customer in making their choices. Order data is needed by other systems to update inventory status, calculate delivery schedules and generate invoices.

2.2.2. Delivery Scheduling

The delivery scheduling operation is strongly affected by the decision made concerning the modes of transportation that will be used. The delivery scheduling process works within the constraint set by transportation decisions. For most modes of transportation there are two types of delivery methods: Direct Delivery and Milk Run Delivery.

2.2.2.1. Direct Delivery

Direct Delivery is delivery made from one originating location to one receiving location. With this method of delivery, the routing is simply the matter of selecting the shortest path between the two locations. This involves decisions about the quantity to deliver and the frequency of delivery to each location. The advantages of this delivery are found in the simplicity of operations and delivery coordination.

Direct Delivery are efficient if the receiving location generates Economic Order Quantities (EOQs) that are the same size as the shipment quantity needed to make use of the transportation mode being used. For instance, if a receiving location gets deliveries by truck and its EOQ is the same size as a Truck Load (TL) then the Direct Delivery method makes sense. If the EOQ does not equal with TL quantities, then this delivery method become less efficient.

2.2.2.2.Milk Run Delivery

Milk Run Delivery is delivery that are routed to either bring product from a single originating location to multiple receiving locations or delivery that bring products from multiple originating locations to a single receiving location.

The advantage of this method of delivery are in fact that more efficient use can be made of the mode of transportation used and the cost of receiving deliveries is lower because receiving locations get fewer and larger deliveries. If the EOQs of different products needed by a receiving location are less that TL amounts, Milk Run Deliveries allow orders for different products to be combined until the resulting quantity equals TL amount. If there are many receiving location that each need smaller amounts of products, they can all be served by a single truck that starts its delivery route with TL amount of products.

There are two main techniques for routing Milk Run Deliveries, they are:

1. The Saving Matrix Technique

   This technique is the simpler techniques and can be used to assign customers to vehicles and to design routes where there are delivery time windows at receiving locations and other constraint. This technique is robust and can be modified to take into account many different constraints. It provides a reasonable good routing solution that can be put to practical use. Its weakness lies in the fact that it is often possible to find more cost effective solutions using the generalized assignment technique. This technique is best used when there are many different constraint that need to be satisfied by the delivery schedule.

2. The Generalized Assignment Technique

   This technique is more sophisticated and usually gives a better solution that Saving Matrix Technique when there are no constraints on the delivery schedule other than the carrying capacity of the delivery vehicle. The disadvantage is that it is a harder time generating good delivery schedules as more and more constraint included. This technique is best used when the delivery constraints are limited to vehicle capacity or to total travel time.

2.3. Managing Inventory in Supply Chain

2.3.1. Inventory Concept

Inventory is the stock of any item or resources used in an organization. Inventory is created when supply exceeds the demand. The purpose of inventory is to achieve economics of scale, protect suppliers from stock-out due to uneven and uncertain demand and shelter demand variation during lead-time.

Inventory is also used to improve customer service level. However, money invested in inventory is an opportunity cost to the company and its supply chain. Therefore, we need to balance the advantage and disadvantage of both low and high inventory. There are two major cost associated with inventory, they are (Ling Li, 2007, p126):

1. Holding Cost

   Inventory holding cost include storage, facilities, handling, insurance, pilferage, breakage, obsolescence, depreciation, taxes and the opportunity cost of capital.

2. Ordering or Setup Cost

   Ordering cost includes managerial and clerical costs associated with preparing the purchase. Setup cost consists of equipment setup, filling out required papers, and material handling activities.

To calculate the annual holding inventory cost, there are three pieces of data required:

1. Inventory holding cost, which is the percent of item cost. The annual cost of carrying inventory is a percentage of inventory value, including financing, devaluation, storage, theft and scrap.
2. Ordering cost, which may include purchasing, administrative handling and transportation costs.
3. Customer service level is expressed in the amount of safety stock held. For example, the numbers of locations that are required to meet the most stringent customer service requirements. This data available from marketing and sales department.

2.3.2. Inventory Management Performance Metrics

Regarding Inventory Management Performance Metrics, most logistics manager rate account receivables, returns on assets, and cash-to-cash cycle times as the most important inventory metrics. This is a good summary of how industry evaluates inventory performance. More detail metrics can be as follows:

- Reduce inventory handling costs
- Implement new order fulfillment models
- Provide reliable delivery dates
- Eliminate unnecessary shipping and handling cost
- Improve order fill rate
- Improve customer service level
- Reduction in transit time
- Reduction manufacture cost
- Increasing in management efficiency and effectiveness

An inventory system is a set of policies and procedures that determines what inventory level should be maintain when stock should be replenished and how large order should be (Ling Li, 2007, p198).

2.4. Supply Chain Performance and Evaluation

2.4.1. Useful Model of Markets and Their Supply Chains

A supply chain exists to support the market that it serves. To identify the performance that a supply chain should delivery, we need to evaluate the market being served. The figure below depict model of market categories based on supply and demand (Hugos, 2003, p140).

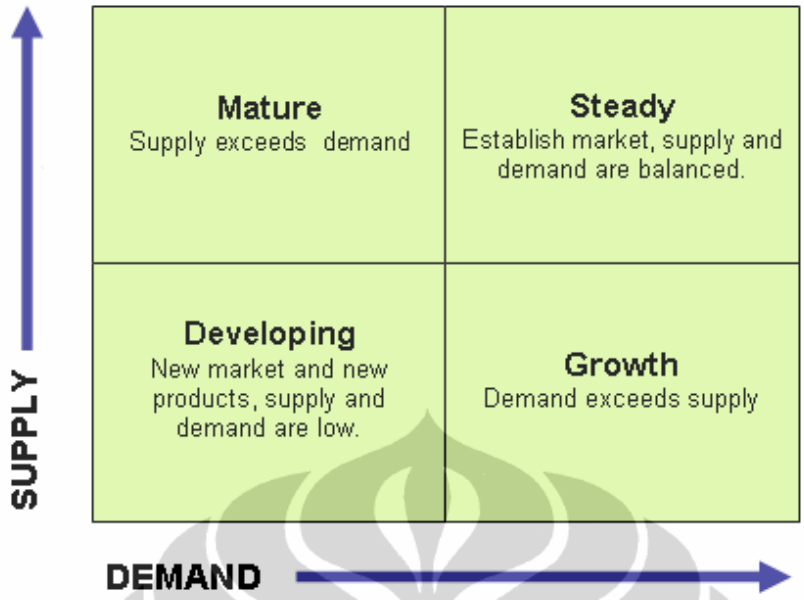

Figure 2-2 Market Quadrant Based Supply and Demand

Source: Michael Hugos, 2003, Essential of Supply Chain Management, p140

This model defines four basic kinds of markets or market quadrants.

- Quadrant 1: Developing Market

  In developing market, both supply and demand for its product are low and unpredictable. These are usually new markets that are just emerging. These markets are created by new technology becoming available or by social and economic trends that cause a group of customers to perceive some new set of needs. Opportunities in a developing market are in the areas of partnering with other players in the supply chain to gather intelligence about what market wants. Cost of sales is high in this market and inventories are low.

- Quadrant 2: Growth Market

  Growth markets are markets where demand is higher than supply and so supply is often uncertain. If a developing market solidifies and builds up momentum, it can suddenly take off and for a time there is a surge in demand that supplies cannot keep up with. Opportunities in a growth market are in providing a high level of customer service as measured by order fill rates and on-time deliveries. Customers in a market like this

value a reliable source of supply and will pay premium price for reliability. Cost of sales should be low since customers are easy to find and inventories can be higher because they are increasing in value. In the second quadrant supply is low and demand is high.

- Quadrant 3: Steady Market

  In steady market both supply and demand are high and thus relatively predictable. This is an established market where market forces have been at work for a while and have pretty well balanced supply and company operation. Opportunities here lie in fine tuning and optimizing internal company operations. Companies should focus on minimizing inventory and cost of sales while maintaining high levels of customer service.

- Quadrant 4: Mature Market

  In a mature market, supply has overtaken demand and excess supply capacity exists. Demand is reasonably stable or slowly falling but because of the fierce competition due to oversupply, demand seems uncertain from the point of view of any one supplier in the markets. Opportunities in this market are in the area of flexibility as measured by an ability to respond quickly to changes in product demand, while maintaining high levels of customer service. Inventories should be minimized and the costs of sales are somewhat higher due to the expense of attracting customers in a crowded market.

2.4.2. Supply Chain Measurement Categories

There are four measurement categories (Hugos, 2003):

1. Customer Services

   Customer Service is the ability of the supply chain to meet the customer expectations. There are two set of customer service metrics depending on whether the company or supply chain is in Build to Stock (BTS) or Build to Order (BTO) situation. Popular metrics for a BTS situation are:

   - Complete order fill rate and order line item fill rate
   - On-time delivery rate
   - Value of total backorders and number of backorders

- Frequency and duration of backorders
- Line item return rate

Popular metrics for a BTO situation are:

- Quoted customer response time and on-time completion rate
- On-time delivery rate
- Value of late orders and number of late orders
- Frequency and duration of late orders
- Number of warranty returns and repairs

2. Internal Efficiency

   Internal Efficiency refers to the ability of a company or a supply chain to use their asset as profitably as possible. Some popular measures of internal efficiency are:

   - Inventory Value
   - Inventory Turns

     Turn = Annual Cost of Sales/Annual Avg Inventory Value
   - Return on Sales

     Return on Sales = EBIT/Sales
   - Cash-to-Cash Cycle Time

     Cash-to-Cash Cycle Time = Inventory Days of Supply + Days Sales Outstanding - Average Payment Period on Purchase

     The shorter time this cycle time the better.

3. Demand Flexibility

   Demand Flexibility describes a company's ability to be responsive to new demands in the quantity and range of products and to act quickly. A company or supply chain needs capabilities in this area in order to cope with uncertainty in the market they serve. Some measures of flexibility are:

   - Activity Cycle Time: the amount of time to takes to perform a supply chain activity such as order fulfillment, product design, product assembly, or any other activity that supports the supply chain.
   - Upside Flexibility: the ability of a company or supply chain to respond quickly to additional order volume for the product they

carry. It can be measured as the percentage increase over the expected demand for a product that can be accommodated.

- Outside Flexibility: the ability to quickly provide the customer with additional product outside the bundle of products normally provided.

4. Product Development

   Product Development measures a company or a supply chain ability to design, build, and deliver new product to serve their markets as those market evolve overtime. A supply chain must keep pace with the market it serves or it will be replaced. The ability to keep pace with an evolving market can be measured by metrics such as:

   - Percentage of total products sold that were introduced in the last year
   - Percentage of total sales from products introduced in the last year
   - Cycle time to develop and deliver a new product.

2.4.3. Relationship of Supply Chain Variables to Income Statement

The outcomes of business model and supply chain activities affect a company's financial performance as shown in its income statement. An income statement indicates the company's financial performance, estimates its cash flow, and asses its future growth (Ling Li, 2007, p330). Table below shows the correlation between income statement items, supply chain activity and performances.

Table 2-2 Income Statement and Performance Metrics

Income Statement Items	*Supply Chain Management Variables*	*Performance Measures*
Net Sales	Demand Management CRM Order Winning	Number of Orders, Revenue
Cost of Goods Sold	Purchasing Supply Network Production Planning and Control	Cost and Profit
Selling &	Order Processing	Order Fulfillment Costs,

Table 2-2 Income Statement and Performance Metrics (Cont'd)

Administrative Expense	Transportation Warehousing Inventory Cost Packaging Other Support Activities	Transportation and Logistics Cost Overhead Costs
Inventory Expense	Inventory Control Inventory Carrying Cost	Cost, ROA, ROI
Income Before Taxes	Orders Revenue	Profit Contribution

Source: Ling Li, 2007, Supply Chain Management: Concepts, Techniques and practices, USA, World Scientific Publishing, p.330

2.5. The Supply Chain Operation Reference Model (SCOR)

2.5.1. SCOR Model Overview

The Supply Chain Operations Reference Model (SCOR) is the product of the Supply Chain Council (SCC), an independent, not for profit, global corporation with membership open to all companies and organizations interested in applying and advancing the state of the art in supply chain management systems and practices. The SCOR model captures the Council's consensus view of supply chain management. While much of the underlying content of the Model has been used by practitioners for many years, the SCOR model provides a unique framework that links business process, metrics, best practices and technology features into a unified structure to support communication among supply chain partners and to improve the effectiveness of supply chain management and related supply chain improvement activities. (Supply Chain Council SCOR Model 9, 2008)

The advantage of SCOR model is the ability of this model to use process model reference that integrate business process reengineering, benchmarking, and process measurement into cross-functional framework as describe on the figure below:

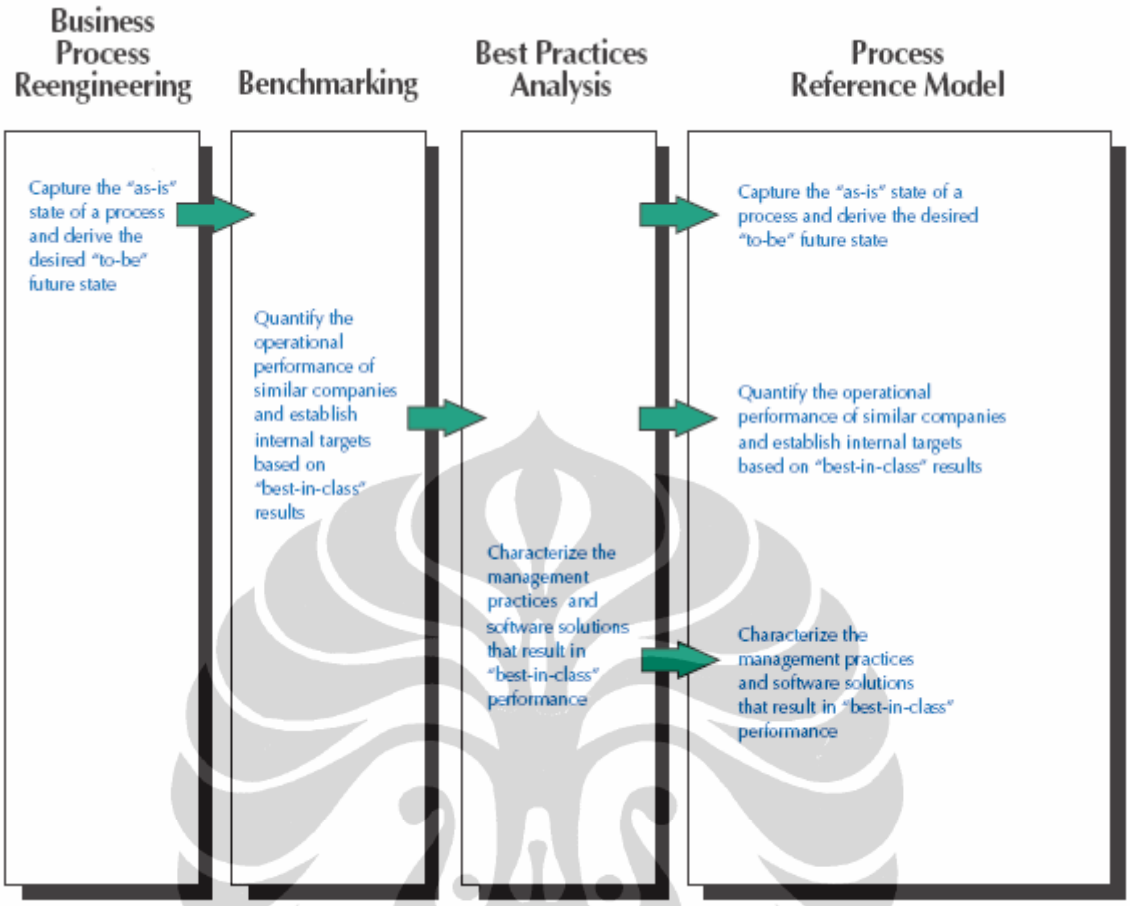

Figure 2-3 Integration of Business Process Concepts to Process Reference Model

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

A process reference model contains:

- Standard description of management processes
- A framework of relationship among the standard processes
- Standard metric to measure process performance
- Management practices that produce best-in-class performance
- Standard alignment to features and functionality

Once a Complex Management Process is captured in Standard Process Reference Model Form, it can be:

- Implemented purposefully to achieve competitive advantage
- Described unambiguously and communicated
- Measured, managed, and controlled
- Tuned and retuned to a specific purpose

SCOR spans:

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

SCOR does not attempt to describe every business process or activity, including:

- Sales and marketing (demand generation)
- Research and technology development
- Product development
- Some elements of post-delivery customer support

Links can be made to processes not included within the model's scope, such as product development, and some are noted in SCOR.

SCOR assumes but does not explicitly address:

- Training
- Quality
- Information Technology (IT)
- Administration (non SCM)

2.5.2. Scope of SCOR Process

SCOR is based on five distinct management processes. Below is the table of SCOR processes and definition:

Table 2-3 Detail SCOR Process and Definition

SCOR Process	Description
Plan	Demand/Supply Planning and Management • Balance resources with requirements and establish/communicate plans for the whole supply chain, including Return, and the execution processes of Source, Make, and Deliver. • Management of business rules, supply chain performance, data collection, inventory, capital assets, transportation, planning,

Table 2-3 Detail SCOR Process and Definition (Cont'd)

	configuration, and regulatory requirement and compliance. • Align the supply chain unit plan with the finance plan.
Source	Sourcing Stocked, Make-to-Order, and Engineer-to-Order Product • Schedule deliveries, receive, verify and transfer product, and authorize supplier payments. • Identify and select supply sources when not predetermined, as for engineer-to-order product. • Manage business rules, asses supplier performance, and maintain data. • Manage inventory, capital assets, incoming product, supplier network, import/export requirements, and supplier agreements.
Make	Make-to-Stock, Make-to-Order, and Engineer-to-Order Production Execution • Schedule production activities, issue product, produce and test, package, stage product, and release product to deliver. • Finalize engineering for engineer-to-order product. • Manage rules, performance, data, in-process products (WIP), equipment and facilities, transportation, production network, and regulatory compliance for production.
Deliver	Order, Warehouse, Transportation, and Installation Management for Stocked, Make-to-Order, and Engineer-to-Order Product • All order management steps from processing customer inquiries and quotes to routing shipments and selecting carriers. • Warehouse management from receiving and picking product to load and ship product. • Receive and verify product at customer site and install, if necessary. • Invoicing customer. • Manage deliver business rules, performance, information, finished product inventories, capital assets, transportation, product life cycle, and import/export requirements.
Return	Return of Raw Materials and Receipt of Returns of Finished Goods • All Return Defective Product steps from source – identify product condition, disposition product, request product return authorization, schedule product shipment, and return defective product – and deliver – authorized product return, schedule return receipt, receive product, and transfer defective product. • All Return Maintenance, Repair, and Overhaul product steps from source – identify product condition, disposition product, request product return authorization, schedule product shipment, and return MRO product – and deliver – authorize product return, schedule return receipt, receive product, and transfer MRO product. • All Return Excess Product steps from source – identify product condition, disposition product, request product return authorization, schedule product shipment, and return excess product – and deliver –authorize product return, schedule return receipt, receive product, transfer excess product. • Manage return business rules, performance, data collection,

Table 2-3 Detail SCOR Process and Definition (Cont'd)

	return inventory, capital assets, transportation, network configuration, and regulatory requirements and compliance.

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

2.5.3. SCOR Process Decomposition and Detail Level

Process decomposition models are developed to address one specific configuration of process element.

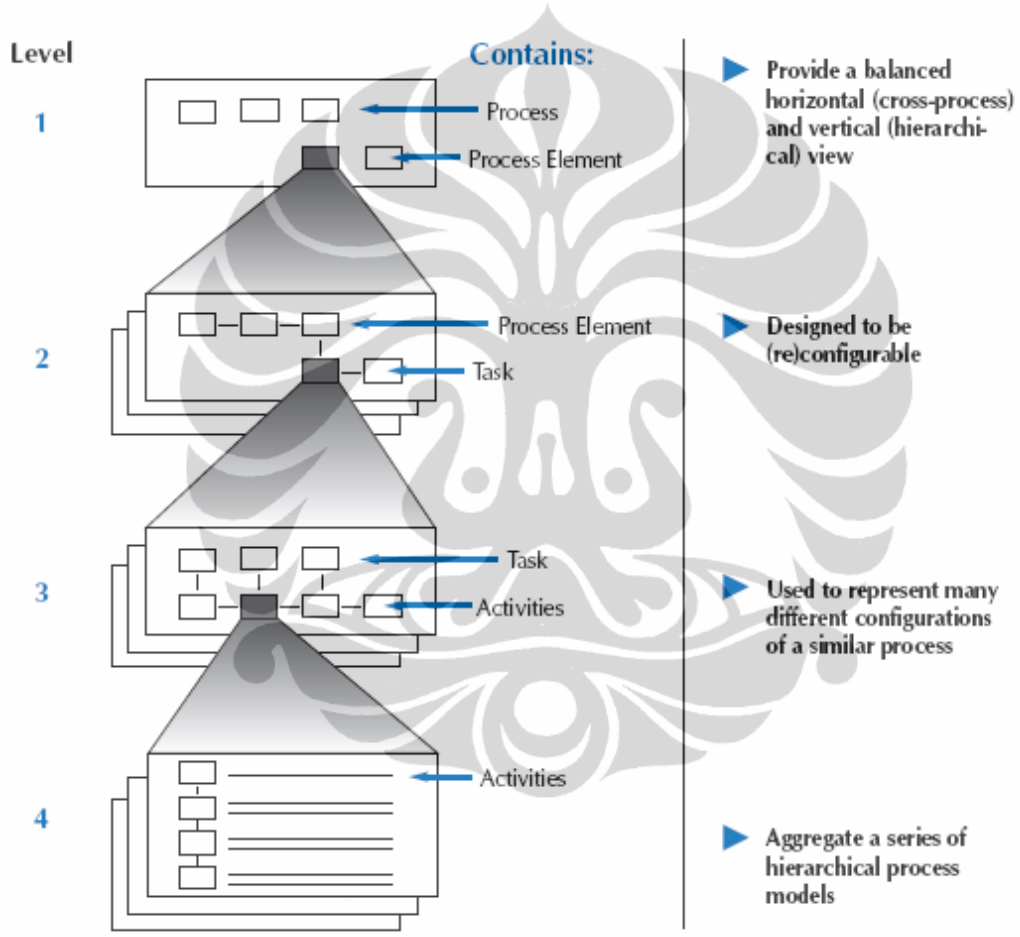

Figure 2-4 SCOR Decomposition Process

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

SCOR contains three level of process detail, as describe below:

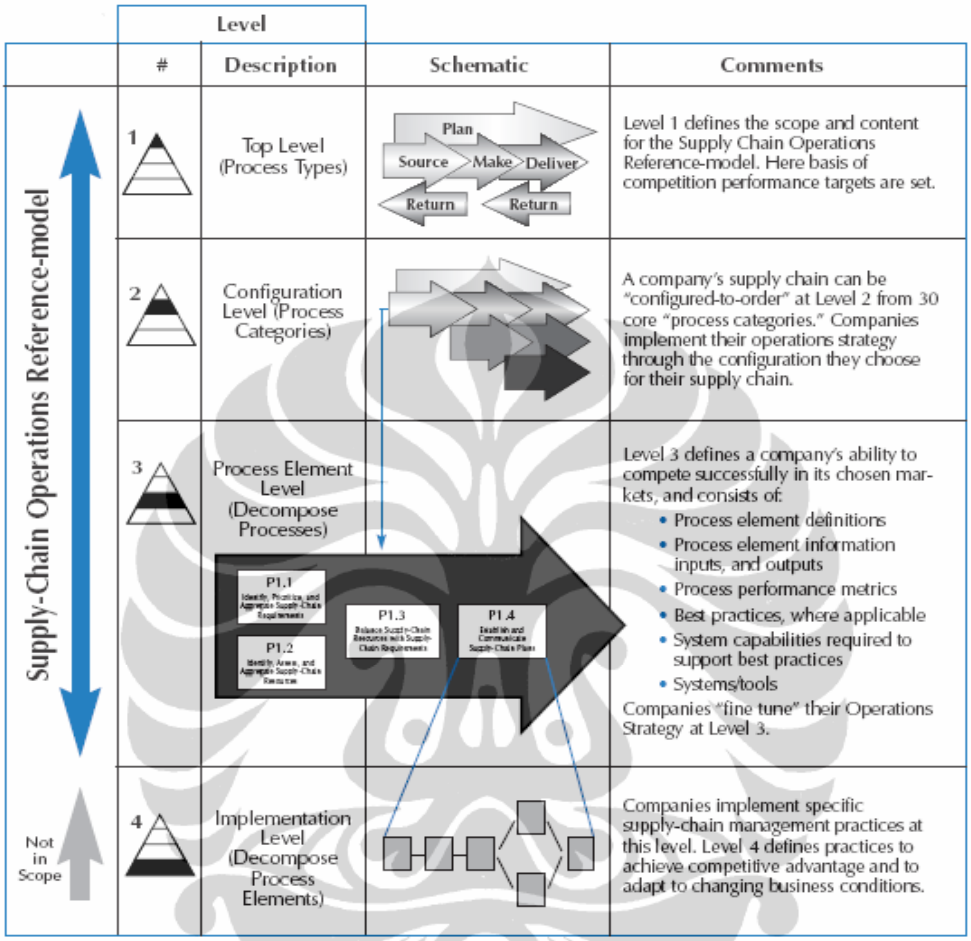

Figure 2-5 SCOR Level of Process Detail

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

2.5.4. Level 1 Process Definition and Performance Metrics

The table below explains level 1 process definition.

Table 2-4 SCOR Level 1 Definition Process (Supply Chain Council SCOR Model 9, 2008)

SCOR Process	Definitions
Plan	Processes that balance aggregate demand and supply to develop a course of action which best meets sourcing, production and delivery requirements
Source	Processes that procure goods and services to meet planned or actual demand
Make	Processes that transform product to a finished state to meet planned or actual demand
Deliver	Processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management, and distribution management
Return	Processes associated with returning or receiving returned products for any reason. These processes extend into post-delivery customer support

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

The Level 1 Metrics are the calculations by which an implementing organization can measure how successful they are in achieving their desired positioning within the competitive market space. Most metrics in the Model are hierarchical – just as the process elements are hierarchical. Level 1 Metrics are created from lower level calculations and are primary, high level measures that may cross multiple. Table belows show the level 1 metrics.

Table 2- 5 Level 1 Performance Metrics

Level 1 Metrics	Performance Attributes				
	Customer-Facing			Internal-Facing	
	Reliabilty	Responsiveness	Flexibility	Cost	Assets
Perfect Order Fulfillment	✔				
Order Fulfillment Cycle Time		✔			
Upside Supply Chain Flexibility			✔		
Upside Supply Chain Adaptability			✔		
Downside Supply Chain Adaptability			✔		
Supply Chain Management Cost				✔	
Cost of Goods Sold				✔	
Cash-to-Cash Cycle Time					✔
Return on Supply Chain Fixed Assets					✔
Return on Working Capital					✔

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

Performance attributes is divided into two major parts, Customer-Facing and Internal-Facing. Customer-Facing is related to customer service level that includes reliability, responsive and flexibility. Internal-Facing is related to efficiency of the supply chain that is reflected in financial statement. Below are the explanations of definition of each performance metrics. (Supply Chain Process Improvement, 2008)

Customer-Facing includes:

- Reliability: the performance of the supply chain in delivering the correct product, to the correct place and customer, at the correct time, in the correct condition and packaging, and with the correct quantity and documentation
- Responsiveness: the velocity at which a supply chain provides products to the customer.
- Flexibility: the agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.

Internal-Facing includes:

- Cost: the costs associated with operating the supply chain.
- Asset: the effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.

2.5.4.1. Perfect Order Fulfillment

According to a collaborative paper from the group, a perfect order is a compilation score which measures the result of each of the four major component of a perfect order. (Blanchard, Nov 2008, p58) They are delivered on time, shipped complete, shipped damage free and correct documentation.

- Delivered on time: the percentage of orders that arrive at their final destination at the agreed upon time between the customer and shipper.
- Shipped complete: the percentage of orders shipped with all line and units.
- Shipped damage free: the percentage of customers order shipped in good and usable condition

- Correct documentation: the percentage of total order for which the customer received an accurate invoice and other required document.

The perfect order index is calculated by multiplying each component to one another. If a company has a 95% score for each of the component then perfect order index would be 81.4%.

2.5.4.2.Order Fulfillment Cycle Time

Order Fulfillment Cycle Time is a continuous measurement defined as the amount of time from customer authorization of a sales order to the customer receipt of product. The major segments of time include order entry, dwell time for future dated orders, manufacturing, distribution, and transportation (http://www.scelimited.com/ orderfulfillmentcycletime.html, March 2009).

The order cycle starts when customers send the order and end when the supplier receipt signed off from the customers. The figure below describe some point that often mismatch when calculating the order fulfillment cycle time. (http://www.scortalk.com/talks/2008/04/24/order-fulfillment-cycle-time, March 2009)

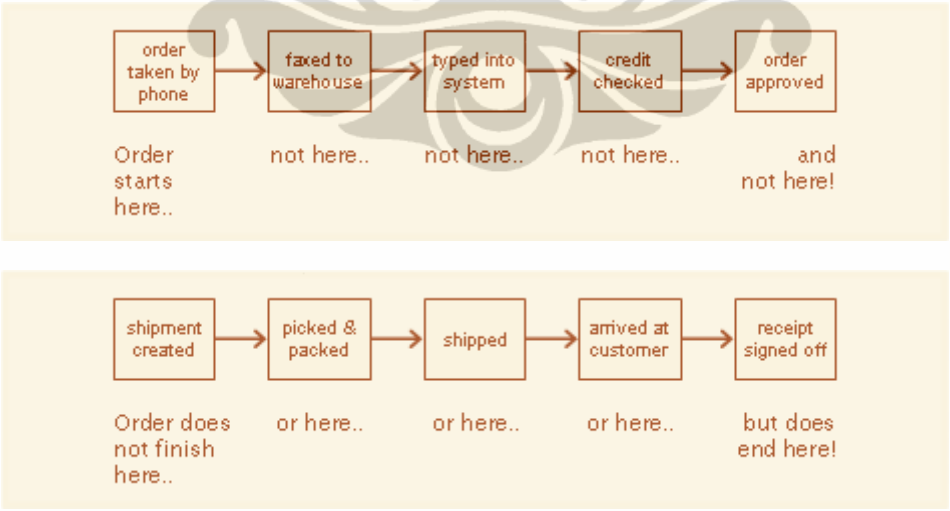

Figure 2-6 Start and End of Order Fulfillment Cycle Time

Source: http://www.scortalk.com/talks/2008/04/24/order-fulfillment-cycle-time, March 2009

The formula below explain how to calculate order fulfillment cycle time of a company:

$$\frac{\sum (\text{Customer Order Receipt Time} - \text{Customer Shipment Receipt Time})}{\text{Total Orders Shipped}}$$

2.5.4.3.Upside Supply Chain Flexibility

Upside Supply Chain Flexibility is the numbers of days required to achieve an unplanned sustainable 20% increase in quantities delivered. The component are number of day required to achieve, unplanned, sustainable, 20% increase, in quantities delivered. (http://www.scortalk.com/talks/2008/05/21/ upside-supply-chain-flexibility/, March 2009).

Upside supply chain flexibility formula is shown below:

Upside Supply Chain Flexibility = Max(Source Lead Time) + Max(Make Lead Time) + Max(Delivery Lead Time)

- Source Lead Time: time for supplier to fulfill 20% increasing in the raw material. If it needs more than one raw material, source lead time will use the longest raw material lead time.
- Make Lead Time: time for company to fulfill 20% increasing in manufacturing time.
- Delivery Lead Time: time to deliver 20% increasing in delivery of customer order.

The idea, here, is that your planned lead times is the best representation of flexibility without cost or service penalty.

2.5.4.4.Supply Chain Management Cost

Total Supply Chain Management Cost is a discrete measurement defined as the fixed and operational costs associated with the Plan, Source, Make, and Deliver supply chain processes. This "activity based lite" view of supply chain costs takes into account order management (Deliver), material acquisition (Source), inventory carrying (Indirect Plan), planning/finance (Plan), and

information technology costs (Indirect Enable). (http://www.scelimited.com/ totalsupplychainmanagementcost.html, March 2009)

Total Supply Chain Management Costs metrics attempt to segment cost centers into process based activity. Below are listed suggested level t**wo** and three metrics with brief definitions.

Table 2-6 Supply Chain Management Cost

SCOR Metrics	Definition	Explanation
Order Management Cost	Customer Service Cost	Cost centers that have to do with entering customer orders, reserving inventory, credit check, consolidating orders, processing inquiries and quotes.
	Finished Goods Warehouse Cost	Cost centers that have to do with the storage, receiving, picking, and shipment of finished good products.
	Outbound Transportation Cost	Cost centers that have to with the transportation (all modes including export) of finished goods products.
	Contract and Program Management Cost	Cost centers that have to do with the initiation and on going management of customer contracts including master agreements, compliance to volume based incentives, and other special incentives.
	Installation Planning and Execution Cost	Cost centers that have to do with the planning and execution of product installation at customer designated locations.
	Accounts Receivable Cost	Cost centers that have to do with the processing and closure of customer invoices including collection.
Material Acquisition Cost	Purchasing Cost	The cost centers associated with both the strategic as well as the tactical parts of the purchasing process.
	Raw Material Warehouse Cost	The cost centers associated with the receiving, storage, and transfer of raw material product.
	Supplier Quality Cost	The cost centers associated with supplier qualification, product verification and ongoing quality systems for raw materials.
	Component Engineering and Tooling Cost	The cost centers associated with the engineering (design and specification) and tooling costs for raw materials, i.e. packaging.
	Inbound Transportation	Cost centers that have to with the

Table 2-6 Supply Chain Management Cost (Cont'd)

	Cost	transportation (all modes including import) of raw material and/or purchased finished good products.
	Accounts Payable Cost	Cost centers that have to do with the processing and closure of supplier invoices including credit and disputes.
Planning Cost	Demand Planning Cost	The cost centers allocated to unit forecasting and overall demand management.
	Supply Planning Cost	The cost centers allocated to supply planning including overall supply planning, distribution requirements planning, master productions planning, production scheduling.
	Supply Chain Finance Control Cost	The cost centers in finance allocated to reconcile unit plans with financial plans, account and control supply chain cost centers, and report financial performance of the supply chain SCOR card.
Inventory Carrying Cost	Opportunity Cost	Inventory dollars times the cost of money for your company.
	Obsolescence Cost	The additional cost of obsolescence in the form of accruals and/or write offs.
	Shrinkage Cost	The additional cost of shrinkage in the form of accruals and/or write offs.
	Taxes and Insurance Cost	The cost centers allocated to the payment of taxes and insurance for inventory assets.
	Application Cost	The cost centers summarizing the fixed costs associated with supply IT application costs to Plan, Source, Make, Deliver, and Return.
	IT Operational Cost for Supply Chain	The cost centers summarizing the ongoing expenses associated with maintenance, upgrade, and development of IT costs to support Plan, Source, Make, Deliver, and Return.

Source: http://www.scelimited.com/totalsupplychainmanagementcost.html, March 2009

2.5.4.5.Cash-to-Cash Cycle Time

Cash-to-Cash Cycle Time is a continuous measure that is defined by adding the number of days of inventory to the number of days of receivables outstanding and then subtracting the number of days of payables outstanding. The result is the number of days of working capital organization has tied up in managing the supply chain.

Inventory Days of Supply = (Inventory Rp) / (Annualized COGS Rp / 365)

Days Sales Outstanding = (Receivables Rp) / (Annualized Revenue Rp / 365)

Days Payables Outstanding = (Payables Rp) / (Annualized Material Costs Rp / 365)

2.5.4.6.Return on Supply Chain Fixed Asset

Return on Supply Chain Fixed Assets measures the return an organization receives on its invested capital in supply chain fixed assets. This includes the fixed assets used in Plan, Source, Make, Deliver, and Return.

Return on Supply Chain Fixed Assets = (Supply Chain Revenue – COGS – Supply Chain Management Costs) / Supply-Chain Fixed Assets

2.5.4.7.Return on Working Capital

Working Capital used to measures a company's capability to pay short term obligations.

Working Capital = Current Assets - Current Liabilities for their supply chain

2.5.5 SCOR Version 9.0 Level 2

At SCOR Version 9.0 Level 2, each process can be further described by type. Each execution process has three different possible capabilities of representing and responding to customer orders:

1. Planning

   Planning is a process that aligns expected resources to meet expected demand requirements. Planning processes are:

   - Balance aggregated demand and supply.
   - (Generally) occur at regular, periodic intervals.
   - Consider consistent planning horizon.
   - Can contribute to supply chain response time.

2. Execution

   Execution is a process triggered by planned or actual demand that changes the state of material goods. Execution processes are:

- Generally involve
    a. Scheduling/sequencing
    b. Transforming product, and/or
    c. Moving product to the next process
- Can contribute to the order fulfillment cycle time

3. Enable

   Enable is a process that prepares, maintains, or manages information relationships on which planning and execution processes rely.

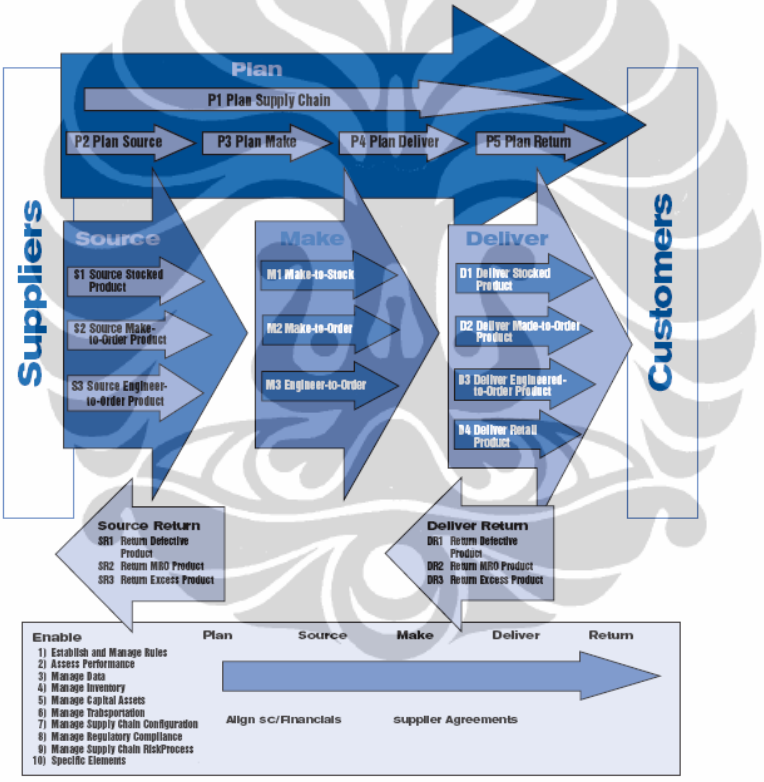

Figure 2-7 SCOR Version 9.0 Level 2

1. Stocked Product (S1, M1, D1)
    - Inventory Driven (Plan)
    - Standard Material Orders
    - High Fill rate, short turn-around
2. Make-to-Order (S2, M2, D2)
    - Customer Order Driven

- Configurable Materials
- Longer turn-around times

3. Engineer-to-Order (S3, M3, D3, D4)
    - Customer Requirements Driven
    - Sourcing New Materials
    - Longest long lead-times, low fill rates

2.5.6 SCOR Version 9.0 Level 3

In level 3, type of category is explained in more detail process element. Each level 2 Process Category is presented in level 3. Process Category D1, Deliver of Stocked product, can be presented some process element shown in the figure 2-8. Process Category D1 is decomposed to be more detail element D1.1, D1.2 until D1.15 element. These elements explain a whole process of deliver stock product from order inquiry until invoiced received.

Notation Dx.y represent element y of process category x from process D. So D1.2 represent element 2, which is receive, enter & validate order, of process category 1-Stock Product, from process Deliver.

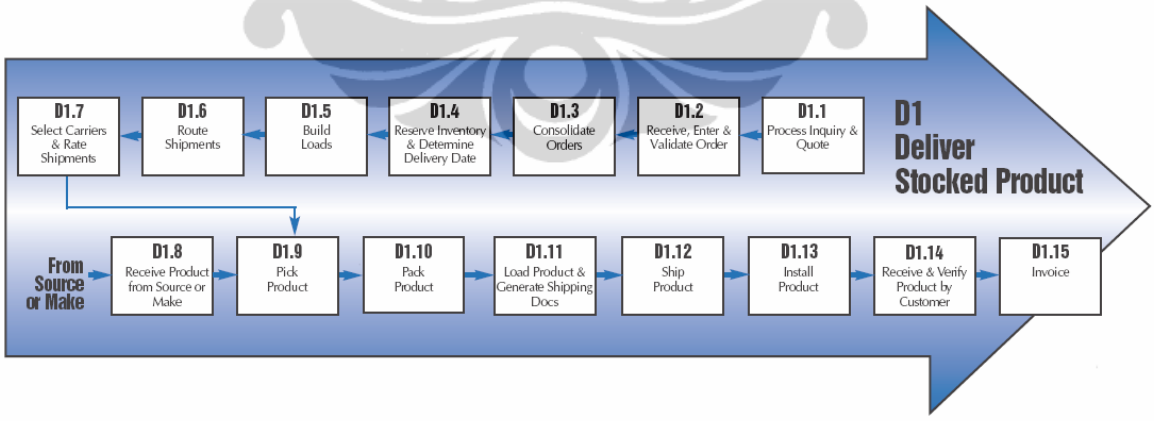

Figure 2-8 Decomposition of Process Category D1.

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

In these elements we can define:

- Process element information input and output
- Process element performance metrics attributes and definition

- Best practices definition (if any).

2.5.7 SCOR Version 9.0 Level 4 and Up

Level 4 is implementation level in implementation of supply chain practices within company occurred. Element in level 3 is decomposed to activities in level 4. Figure below shows the decomposition process of D1.2 element to more detail activities in level 4.

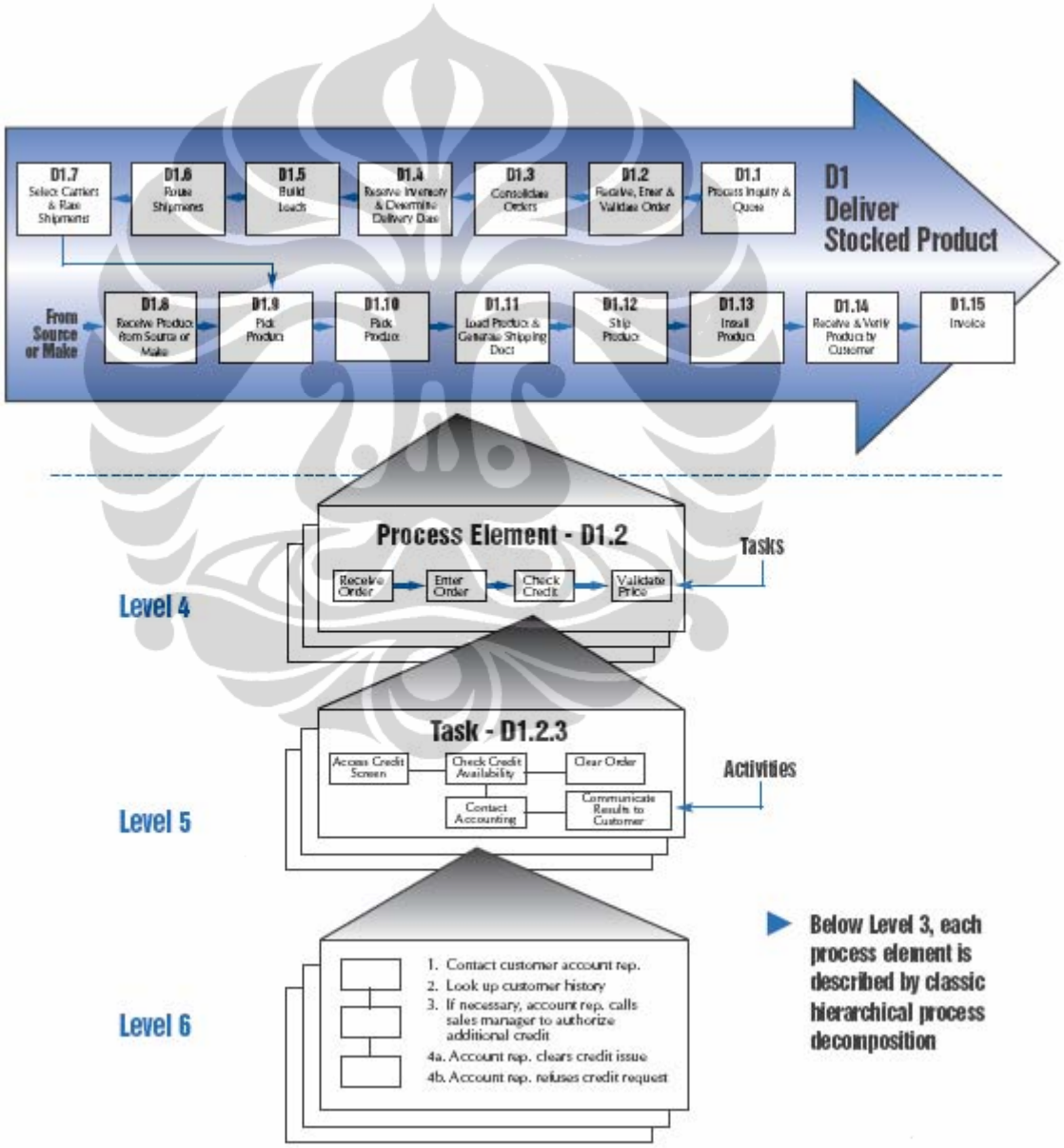

Figure 2-9 Decomposition of Process Category D1.2

Source: Supply Chain Council, 2008, Supply Chain Operation Model, SCOR version 9.0 overview

Process element D1.2 is decomposed to be detail tasks. Some task will be included in this element are Receive Order, Enter Order, Check Credit and Validate Price. Notation used for these tasks are D1.2.1, D1.2.2, D1.2.3, and D.1.2.4, respectively. In level 5, D1.2.3 is decomposed to be activity Access Credit Screen, Check Credit Availability, Contact Accounting, Communicate to Customer & Clear Order. If needed, each activity can be decomposed to level 6. Check Credit Availability is decomposed more detail to activity shown in the figure above.