CHAPTER 2
LITERATURE REVIEW AND THEORIES

This chapter is divided into two sections, the literature review and the theories related to solve the issue. The literature review consists of previous researches with a similar problem of this research paper. While in theories' section, the main discussion is the related concepts and method to solve the main problem.

2.1. Comparison of the Previous Researches and the Current One

In this section, the discussion will be about the researches have been done by other research in supply chain decision making.

2.1.1. Previous Research

Marimin and Slamet (2010) did a research in West Java, Indonesia for selecting what method is suitable to evaluate the supply chain's performance of the agriculture companies. In order to achieve the goal, Asian Productivity Organization (APO), *Metode Perrbaikan Eksponensial* (MPE), Data Envelopment Analysis (DEA), Supply Chain Operation Reference (SCOR) model and fuzzy Analytical Hierarchy Process (AHP) was tested. At the end, MPE method will be used to select the superior commodities, APO for descriptive analysis, a combination of DEA, SCOR and fuzzy AHP was used to analyze the performance of supply chain.

Chen, et al (2005) studied about determining the parameters of J Company's supply chain performance for its evaluation. SCOR model was chosen. By using SCOR model, the company was able to define the perspective of evaluation and its performance indicators. Responsiveness, reliability and cost perspectives were identified as base of evaluation. While production cycle time, joint order-taking rate and order cycle time were identified as the performance indicators.

Lestari, et al (2014) did a research about which method is suitable for measuring the Malaysian palm oil's supply chain performance. Balance Score Card (BSC), Total Quality Management (TQM), Economic Value Added (EVA), Activity Based Costing (ABC) and SCOR model were analyzed as for measurement method. As the result, SCOR model was selected as the suitable approach because it could cover indicators by suppliers, manufacturer and the customers related to the supply chain system.

Bukhori, et al (2015) studied about evaluating and giving a solution regarding the supply chain performance in XYZ slaughtering house in Yogyakarta. The approach used was SCOR model combined with AHP method and cause effect diagram. At the end, the product cycle time in the company's SC system had the worst performance. By using cause effect diagram several factors were found to the core problems such as overtime, lack of workers, orders were late, machine used were the traditional one and the company tends too late to start the activities. The solution made will be based according to the factors.

Salazar, et al (2012) did a research on identifying the contribution of SCOR model to evaluation on performance of Colombian Biodiesel Castor's supply chain. The method used was SCOR model. At the end, it was found, by using SCOR model the company was able to identify links and logistics, key performance indicators for supply chain system.

Vananny et al (2005) studied about designing a complex Supply Chain Measurement System (SCPMS) to PT. SARSL, a lamp industry by reviewing the performance of its supply chain system. The method used was SCOR model and AHP method combined. As the result, by implementing the new design of SCPMS could level the degree of Company's supply chain to be satisfying. Meanwhile, by using SCOR model, the performance indicator of the accuracy of forecast techniques and product failure in sealing process had the worst performance..

2.1.2. Current Research

Based on previous researches study in 2.1.1 it can be concluded that most of them used a combination between SCOR model and AHP method in order to evaluate the performance of supply chain of the company. Hence, in this research paper, SCOR model and AHP method combination will be used to solve the main issue of PT. AML.

Table 2.1. Comparison of Previous and Current Research

Comparison	Research			
	(Marimin & Slamet, 2010)	(Chen, et al., 2005)	(Lestari, et al., 2014)	(Bukhori, et al., 2015)
Problems	There were many methods to evaluate the agriculture company, which was suitable for them.	Identifying the parameters of J Company's supply chain performance for its evaluation.	The palm & oil company did not know the suitable method to evaluate the performance	The company wanted to find which part of its supply chain had to be highlighted and need an improvement
Methods	MPE. APO, DEA and SCOR	SCOR	SCOR, BSC, TQM, EVA and ABC	SCOR, AHP and Cause Effect Diagram
Result	MPE used to select the superior commodities, APO for descriptive analysis, and combination of DEA, SCOR and fuzzy AHP to analyze the performance of supply chain.	Responsiveness, reliability and cost perspectives as the base of evaluation. Production cycle time, joint order-taking rate and order cycle time identified as the performance indicators.	The suitable method for the company is SCOR due to capability to evaluate the relationship of supplier, company and customer	The product cycle time of the company's SC has the worst performance. The solutions are made based factors on cause effect diagram

Table 2.1. Continue

Comparison	Research		
	(Salazar, et al., 2012)	(Vanany, et al., 2005)	Current Research
Problems	Identifying the contribution of SCOR model to evaluation on Biodiesel's supply chain.	PT. SARSL wanted to design a complex (SCPMS) by reviewing the performance of its supply chain system	The company needs a supply chain performance evaluation and suggestion due to complaints by customers and financial loss.
Methods	SCOR	SCOR and AHP	SCOR and AHP
Result	company was able to identify links and logistics, key performance indicators for supply chain system by using SCOR model	As the result, implementing new of SCPMS leveled the degree of its supply chain performance into satisfying degree. By SCOR model, the performance indicator of accuracy of forecast techniques and product failure in sealing process had the worst performance.	Company's supply chain performance evaluation and suggestion to overcome the loss.

2.2. Theories

2.2.1. Supply Chain Management

The supply chain can be defined in many ways, the term of supply chain refers to the chain of elements of production and supply from the raw materials until the end customer (Scott & Westbrook, 1991). Supply chain includes all stakeholders to fulfill the request from the customer not only the manufacture and supplier but also the transporters, warehouse, retailers and the customer (Chopra & Meindl, 2010).

Supply chain management is the management of the material and information flows from the facilities like vendors, manufacturing, assembly and distribution centers (Thomas & Griffin, 1996).

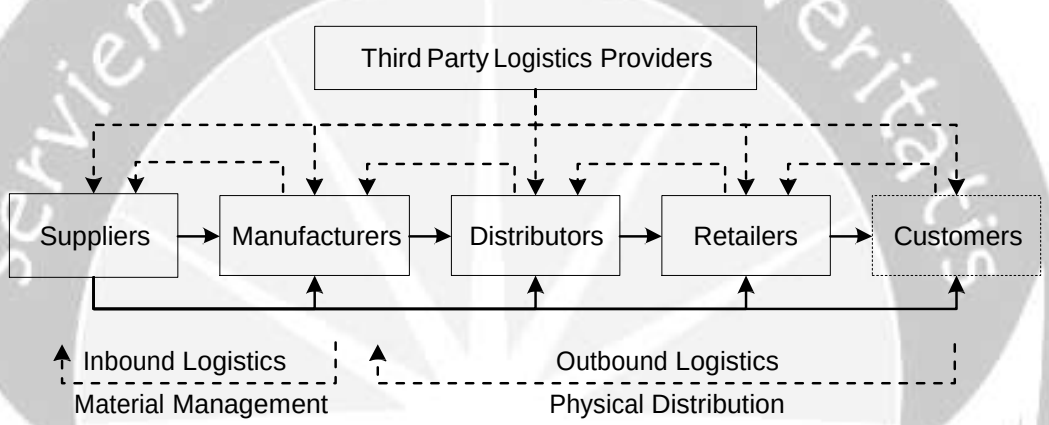

Figure 2.1. Flow of Supply Chain (Min & Zhou, 2002)

According to figure 2.1, each party of the supply chain has a relationship between each other. Their relationship is integrated into one system which synchronizes obtain raw materials, a transformation of raw material, value added, distribution and information exchange among business entities. The aim of the system is to increase the profit, efficiency of operation, and competitive position of all partners within the supply chain (Min & Zhou, 2002).

In order to gain the good supply chain management, the company has to operate effectively, there are three acts to support it (Jones & Riley , 1987):

1. Recognizing end-user customer service level requirements,
2. Defining where to position inventories along the supply chain, and how much to stock at each point,
3. Developing the appropriate policies and procedures for managing the supply chain as a single entity.

If the company can fulfill those requirements then the result will impact on high profits and the full customer's satisfaction can be achieved. Thus the design of supply chain of the company must be designed effectively and efficiently.

2.2.2. Supply Chain Networks

The integration is important in supply chain design, thus the structure of the supply chain network is necessary to link the all the members of the supply chain (Lambert, et al., 1998). The members can be classified into tiers as drawn below:

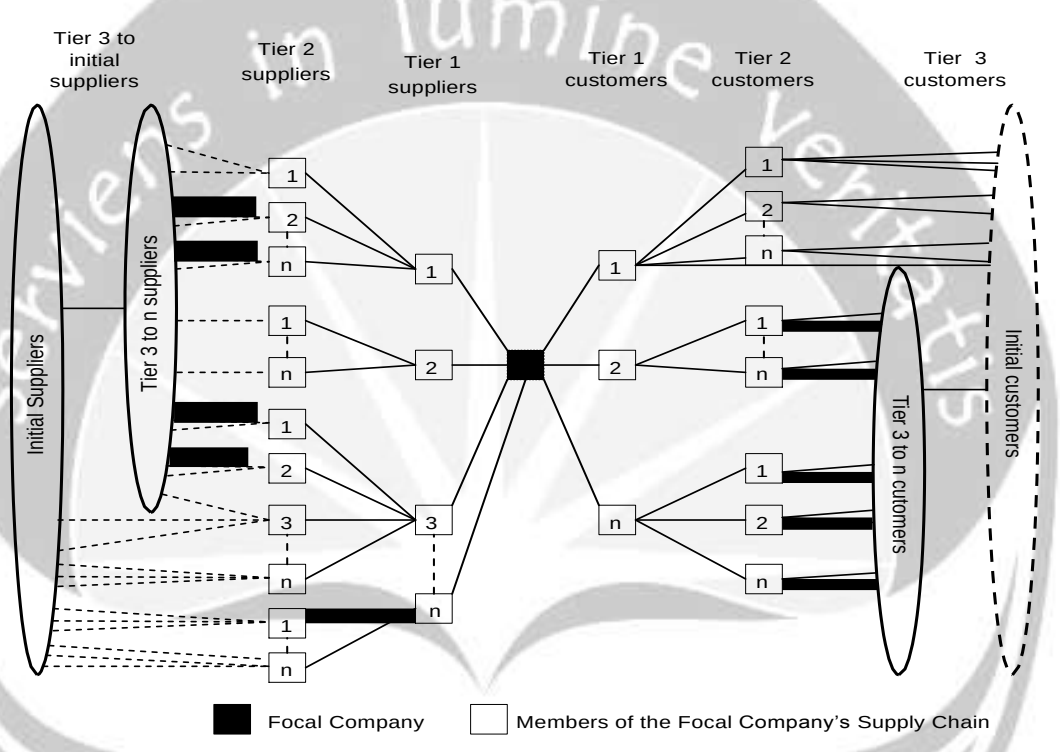

Figure 2.2. Figure 2.2. Supply Chain (Lambert, et al., 1998)

Figure 2.2 shows the portrayal of general supply chain networks structured. It starts from the relation of initial suppliers until the end customer. There are three types of supplier tiers on figure 2.2, the materials will be sent to the operation or manufacture is the first tier supplier. The one sends material to the first supplier is the second and the second gets material from the third supplier and continue until its original sources (Waters, 2006).

The number tier will increase depends on how many parties the material will be passed before manufactured. The customers are also separated into tiers, the one directly buys the product from manufacture is called as first tier customer. The next customer that gets the product from the first tier customer is the second tier

customer, so on until the end customer (Waters, 2006). So in conclusion, the number of customer tier is increasing until the end customer.

2.2.3. Supply Chain Performance Measurement

The measurement is important in the supply chain system. The aim is to measure whether the performance of the existing system is effective and efficient enough or not comparing to the new alternatives given (Beamon, 1997).

The measurement of performance of supply chain can be divided into two sections, the cost and combination of cost also customer responsiveness (Beamon, 1999). The cost involves the expenses and the operation cost. In this case the cost should be minimized as possible by reducing the cost of inventory includes the product and holding cost (Beamon, 1997). Therefore, an indicator of performance measurement is whether the current supply chain brought profit or not to the company.

Meanwhile in the customer responsiveness, the issue related to measure fill rate, delivery rate and probability of stock out. This indicators are related toward the reduction of lead time by the company. One way to do so is through minimizing the manufacturing time efficiently according to its business function (Beamon, 1999). Hence, this measurement is about whether the demand fulfillment from the company is satisfying to the customers or not. The measurement indicates an evaluation of the supply chain does necessarily.

One of many methods to evaluate while improving the company supply chain management is SCOR model (Supply Chain Operations Reference). his model does not relate to a mathematical model. Instead, it will use the performance indicators to analyze, compare and gain an improvement strategy and standards for the supply chain of a company (Salazar, et al., 2012).

The SCOR model covers the customers' interactions from order until paid invoice, all product transaction from the supplier and to the customer include equipment, supplies, spare parts and market interactions from aggregate demand to its fulfillment. Therefore, SCOR does not challenge to describe every business process such as research and technology development, product development, and elements of delivery support (Council, 2006).

The advantage of SCOR model is its flexibility that can do an overall overview of supply chain operations both internal and external. The model provides an

objective, effective in re-engineering, quantification of operational performance, future planning and specific process of the supply chain (Irfan , et al., 2008).

SCOR model comprises four major segments (Council, 2006):

a. Performance

Related everything to describe the process performance and address strategic goals.

b. Processes

This part is all about the management process and its relationship.

c. Practices

Related to the producing a significant better process performance.

d. People

Related to the definitions for any necessary ability to perform supply chain process which directly points out the human in managing supply chain process.

2.2.3.1. Process

SCOR model involves five major processes within the business (Council, 2006):

1. Plan

This scope includes the demand and supplies planning and management. The activities related to the plan processes are gathering the requirements to run the supply chain, information on any resources available, balancing the requirements and resources to determine capabilities and gaps in demand or resources to identify possible actions to fill the holes.

2. Source

This involves the sourcing stocked, make-to-order and engineer-to-order product. The aim is to ensure the schedules of deliveries, receive, verify, and transfer product to the storage also pay for the raw materials. Thus, the supplier performance, the selection and maintain the supplier belongs in this process.

3. Make

This process includes strategies like Make to Stock, Make to Order, and Engineer to Order production execution. Make process includes the conversion activities or in another word means all activities to change the raw material to be the finished one. Therefore, such in-process products (WIP), tools and facilities, transportation, even procedures of production are categorized in this process.

4. Deliver

The scope of this process is about the creating, maintaining and fulfilling the orders of the customers. Thus, the deliver process involves receipt, validation, a creation of orders, scheduling of shipment, pack, and invoicing the customer.

5. Returns

Return process consists of a reverse flow of goods. This process handles the issue related to the return item from customers whether it is defect or needs maintenance. Therefore, this process comprises the identification of the need of return, receipt and shipment of returned goods.

There are three levels of SCOR model for process in detail (Bolstoff & Rosenbaum, 2003; Council, 2006):

1. Level 1 : Process definition

This level covers the management process of the company, it starts from the plan, source, make, deliver and return process. The basis performance target is set here.

Table 2.2. SCOR in Business Process (Council, 2006)

SCOR PROCESS	Definitions
Plan	Processes to adjust the demand and company's capability. Therefore, all action takes can meet their best such as the sourcing, production and delivery requirements.
Source	This process involves the procurement of materials and service to meet the customers' desired
Make	Activities related to create the final product in order to fulfill the planned or actual demand
Deliver	All activities related to the delivery of finished products, including order management, transport management, and distribution management
Return	Processes related to the returning returned products for reasons, including the post-delivery of product in customer's hand

2. Level 2: Configuration level

In level 2, the aim is to configure the real operations by the company from the core process of level 1 (Council, 2006). The process will be described according to type:

a. Planning

The main idea of this type is to align the resources in order to fulfill the demands. In planning type, the process involves plan supply chain, source, make, deliver and return.

b. Execution

The execution means type of a process that involves the material goods. This includes scheduling, transforming materials and moving a good from process to process. This type involves source process, make process deliver process and source return.

c. Enable

Enable means the process that includes preparing, maintaining and managing information in which planning and execution process relying on. This type involves deliver return, manage rules, assess performance, manage data, manage inventory, manage capital asset, manage transportation, manage supply chain configuration, manage regulatory compliance and process specific elements.

Further explanation of categorization of the type of process is described as below (Bolstoff & Rosenbaum, 2003; Irfan , et al., 2008):

a. Plan

There are five types of plan process will be analyzed:

i. Plan Supply Chain (P1).

Here the idea is to take the actual data as the base to establish the plan of supply chain. This can be done by gathering the forecast of market and selling data, also collecting the data of current capacity of production and shipment.

ii. Plan Source (P2).

This can be done by comparing the total raw material need to the forecast on P1. The aim of P2 is to determine the source of anything necessary to run the company.

iii. Plan Make (P3).

The aim is to compare the actual production order to the P1. The aim is to predict the money to transform the raw material to be the finished one.

iv. Plan Deliver (P4).

The main concern of this process is to compare the actual customers' orders to P1 and develop a proper plan for distribution.

v. Plan Return (P5).

The main purpose is to compile the plan of returning and predict the cost and the goal of the inventory of return process.

b. Source

There are three types of the source process in level 2:

i. Source Stock Environment (S1)

The preparation of inventory is based on the forecast of the plan, make, deliver processes and supplier in order to create the finished goods although the order of customers is not there yet.

ii. Source Make to Order Environment (S2)

The finished goods will be made once there is an order from the customer either the conversion will be done from raw to the finished one or from semi-finished goods. In this case, raw materials have been collected before any orders come from the customers.

iii. Source Engineer to Order Environment (S3)

This type is similar to S2, the company requires a specific order of the customer first. The difference is the company has no inventory in the beginning, therefore the company will start to identify the supplier once the orders are received.

c. Make

The make process in level 2 consists of:

i. Make to Stock (M1)

In make to stock (M1), the production will be executed according to a forecast from a history of selling. Hence, the production activities will happen even before the actual orders from the customers come.

ii. Make to Order (M2)

In make to order (M2), the production activities will be executed once the company receives orders from customers. Thus, the number of finished goods will be processed is based on the size of order by the customers. The products in M2 are company's, thus once the order is received the production can be run.

iii. Engineer to Order (M3)

This engineer to order (M3) is similar to M2, however in this type production the order comes is specific and sometimes the company has to produce something that it has never done before. Therefore, in order to produce the demands, specification and design on the expectation must be completed. The quantity of product in M3 will be made depending on the specific order.

d. Deliver

The idea of delivery here is to characterize how a company will process the finished goods to response the orders from the customers. The delivery process usually takes place in warehouse site due to the purpose to fulfill finished materials to the customer. There are 3 types of deliver in level 2:

i. Deliver Stocked Product (D1)

Deliver stocked product (D1) is made based on the forecast on plan process. Which means the level of preparation of finished material is not based on the customer's order. In another word, the company will have initial inventory of the finished goods although the orders are not there yet.

ii. Deliver Make to Order Product (D2)

Deliver make to order product (D2) is usually triggered by the customers' order. Hence, usually the inventory level and sales order has the same amount with the customers' order quantities.

iii. Deliver Engineered to Order Product (D3)

Deliver engineered to order product (D3) is triggered by particular customer order either for the design or manufacturing specification. Usually, the number of order is equal to the customers' order quantity and be executed once in its production.

e. Return

The return process is associated with the customer's authority in a response to a defect of the final product to the company. In level 2 the return process divided into:

i. Return Defective Product (R1)

Return of defective product (R1) usually be done by the customers once they have a warrant from the company to give back any defective products.

ii. Return Maintenance until Overhaul Product (R2)

Return maintenance, repair, and overhaul (MRO) product (R2) are triggered by planned maintenance in plan process for return. It can also be triggered by an unexpected event by technical resources such as engineering and maintenance.

iii. Return Excess Product (R3)

Return of excess product (R3) happens because there is a plan of return due to a contract between the company and specific customer. This means since the beginning the company and the customer have an agreement upon the return of goods.

The process of return can be divided based on perspective to be Return from the customer (DRx) upon finished goods and Return to Supplier upon the raw materials supplied (SRx).

3. Level 3: Process Element Level

In level 3 of SCOR process, the focus will be about decomposing the process categories in level 2. Therefore, in this level the information is about a definition of process elements, its inputs and outputs, capabilities and process performance metrics.

4. Level 4: Decomposing Process Elements

Level 4 does not include in the scope of SCOR model. This level is defined by the company. The idea is to give information upon specific supply chain management practice from process elements.

2.2.3.2. Performance Attribute and Metric

In SCOR model to find out the performance of the supply chain, the elements of performance attributes and metrics can be used to measure the SCOR processes (Council, 2006).

1. Performance Attribute

The attribute of performance is a categorization of metric to define a particular strategy. For instance, a company would like to be the best among its competitors in reliability. SCOR model describes there are five performance attributes:

a. Reliability

This reliability attribute is specified for the skill to complete tasks as required. Its main concern always related toward the outcome of the process, usually it comes

with the idea of right time, quality and quantity. In the metric of attributes, the focus of will be on Perfect Order Fulfillment.

b. Responsiveness

Another word to describe this attribute in business activities is time effectiveness. The main idea is to focus of the speed of the company to do the business. Hence in the metric of attributes it focuses on Order Fulfillment Cycle times.

c. Flexibility

The idea is to define the capability to respond the external environment. This involves the changing in demand whether it can be forecast able or not, natural disasters, acts of violence by terrorist, financial status of the nation and labor issue.

d. Cost

The cost attribute related to all expenses due to the operating processes. This involves the cost of labor, material, and transportation. Hence, this attribute is focusing on the internal attribute.

e. Asset

Asset attribute involves the usage of the inventory to the minimum until the reduction. Typical metrics for the asset are capacity utilization, inventory days and inventory days of supply. This attribute covers Cash-to–Cash cycle time, Return on Fixed Assets and Capital.

2. Metrics

A metric is used as a standard in measuring the supply chain performance or process. In SCOR model, metrics are used as the diagnostic whether or not the performance of supply chain or process has achieved its best. The level 1 metrics are used to calculate the success of the company in pursuing the market position. Below is the list of metrics level 1 with the performance attributes:

Table 2.3. Metrics of SCOR model (Council, 2006)

Level 1 Metrics	Performance Attributes				
	Customer Facing			Internal Facing	
	Reliability	Responsiveness	Flexibility	Cost	Assets
Perfect Order Fulfilment	X				
Order fulfillment Cycle Time		X			
Upside Supply Chain Flexibility			X		

Table 2.3. Continue

Level 1 Metrics	Performance Attributes				
	Customer Facing			Internal Facing	
	Reliability	Responsiveness	Flexibility	Cost	Assets
Upside Supply Chain Adaptability			X		
Downside Supply Chain Adaptability			X		
Supply Chain Management Cost				X	
Cost of Good Sold				X	
Cash-to-cash Cycle Time					X
Return on Supply Chain Fixed Assets					X
Return on Working Capital					X

Based on table 2.3 there are two types of environments the performance attributes will face, they are customer and internal facing. Where internal business is all about the asset and cost. While customers related to reliability, responsiveness and flexibility.

2.2.4. Analytical Hierarchy Process (AHP)

2.2.4.1. Brief Explanation of AHP

Analytical Hierarchy Process (AHP) is a decision making method to solve an issue or a problem with an organized thinking in order to create an effective decision making (Marimin, 2004). The hierarchy can be defined as the representation of a complex issue that has been classified into levels that start with purpose, criteria, and sub-criteria until alternative. The aim of AHP is to quantify the expert's judgment in an essence to make a decision with complex considerations (Saaty, 1994).

AHP method has several main principals (Saaty, 1994):

a. Hierarchy Creation

In first principal, the complex issue will be explained as clear as possible. To make this happen, the decision making's purpose will put as the goal. The goal will be decomposed into most general until most easily controlled factors.

b. Priority determination

In this part, prioritizing the most important among elements does necessarily by using the personal's judgment. The relationship between two or more elements with the same parent will be represented by a number. The judgment determines the dominance of among the elements, either one of the elements has a superior position or both elements are equally strong. In order to show which of two elements have the importance the scale of importance by Saaty will be used.

Table 2.4. Intensity of Importance in AHP (Saaty, 1994)

Intensity of Importance	Definition	Description
1	Equal importance	Both elements contribute equally to the objective.
3	Moderate importance	Based on experience and judgment to some extent prefer one element than another.
5	Strong importance	Based on experience and judgment strongly prefer particular element over another.
7	Very strong importance	One element is believed has strong position compare to another. Its dominance can be seen in practice.
9	Extreme importance	All evidence support one activity has an absolute importance rather than the other one.
2, 4, 6, 8	Compromising between values	The respondents needs to compromise the numerical judgment because there is no good definition to describe the importance level.

The logic is if an element gets a higher value over another than the compared element will get lower importance level. After determining the importance level, then continue to calculate whether the comparison among elements are consistent or not. The judgment will be done by the expert on studied field.

c. Logical consistency

Sometimes the respondent does not realize the comparison he/she makes has an inconsistency in its logic. For instance a person would like to know which fruit is best to eat, is it apple, banana or orange. The person decides to give rate apple 2 over banana, and 3 for banana over orange, by logic the apple should get rate 6 over orange or in other words orange should get 1/6 level of importance over the apple, but the person rate orange 3 over apple. In this case, the respondent does

have an inconsistency in comparing which fruit is the best to be eaten. Hence the decision of the best fruit is not clear.

Given that inconsistency is inevitable, a limitation of inconsistency is given. The inconsistency is tolerable if it occurs maximum 10 percent from a whole judgment (Saaty, 1994). If it is more than 10 percent, then more information have to be gathered or the framework of the hierarchy has to be reexamined.

2.2.4.2. Steps on AHP

There are several steps to make a decision using AHP (Saaty, 1994):

1. Defining the Main Problem and Possible Solution

In this step, the aim is to analyze the problem that will be solved and decide the strategy to take over the issue.

2. Structuring the Hierarchy Model

As explained in the previous unit of 2.2.4.1, the first principal of AHP is to define a complex problem into hierarchy model. This can be done by determining a main problem and strategy. It continues with drawing a hierarchy from a goal, followed by its supporting criteria and sub criteria. The goal in the hierarchy represents the ideal situation that will be achieved from the problem, hence it will be put at the top of the hierarchy. Criteria are defined as the general direct factor to the goal, therefore it will be on the second level. While sub criteria are the sub factor of criteria that will be put at the third level, and at the bottom is alternatives. The number of level of sub criteria can be more than one depends on how many factors involved. The model of hierarchical structure can be seen in the figure below:

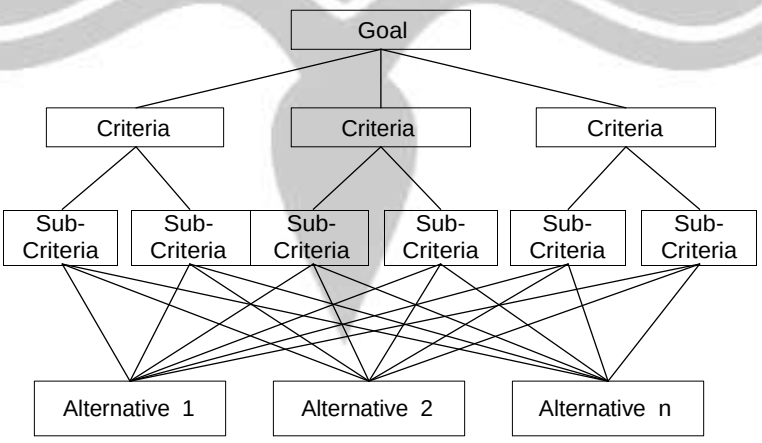

Figure 2.3. Hierarchy in AHP (Saaty, 1994)

3. Creating the Matric of Comparative Comparison

A numerical number is necessary for showing the significant of the relationship between two or more elements that share the same characteristic of a parent. There will be a comparison to find out whether one element has a higher level of importance over another or not. The expression of significance between elements will use the scale judgment by Saaty (1994) like the one in table 2.4. The numerical expression of comparative comparison will be put into a metric table. In order to determine the number of metrics needed, to know how many judgments necessary be compared this formula can be applied:

$$\text{Number of Judgments} = \frac{(n^2-n)}{2} \qquad (2.1)$$

Where n represents the number of the compared elements. In filling the table of comparative judgment, the main principle is if one element gets a higher level of importance, the other one automatically gets one over the importance level of the higher one as the weight. Therefore, the table of comparative judgment will look like table 2.5:

Table 2.5. Matric of Comparative Judgment (Saaty, 1994)

Element	A1	A2	A..	An
A1	$\frac{w_1}{w_1}$	$\frac{w_1}{w_2}$	$\frac{w_1}{w_{..}}$	$\frac{w_1}{w_n}$
A2	$\frac{w_2}{w_1}$	$\frac{w_2}{w_2}$	$\frac{w_2}{w_{..}}$	$\frac{w_2}{w_n}$
.	$\frac{w_{..}}{w_1}$	$\frac{w_{..}}{w_2}$	$\frac{w_{..}}{w_{..}}$	$\frac{w_{..}}{w_n}$
An	$\frac{w_n}{w_1}$	$\frac{w_n}{w_2}$	$\frac{w_n}{w_{..}}$	$\frac{w_n}{w_n}$

Where w represents the weight (intensity of importance) given by a respondent. Sometimes the number of experts use to give the judgment is more than one, hence to find out the right value of importance *geometric mean* has a role to settle it (Saaty, 2001; Permadi, 1992).

$$\mu ij = \sqrt[n]{aij1aij\ 2aij3\ldots aijn} \qquad (2.2)$$

Where:

μij = geometric mean at row i and column j's cell

n = number of evaluation

Finally, the table of comparative judgment by geometric mean will be used to continue the calculation of AHP.

4. Calculating the Eigenvector

Eigenvector is a vector that will result in eigenvalue if it is multiplied by a matric. This vector can be calculated by using:

$$Wi = \frac{\text{Average of geometric mean at row i}}{\text{Accumulation of averages of geometric mean}} \quad (2.3)$$

Where Wi symbolizes the Eigenvector's value.

5. Calculating the Eigenvalue Maximum

After defining the Eigenvector the next step is to discover the Eigenvalue for each element (λi). In order to find the Eigenvalue, a metric of geometric mean will be calculated along with the Eigenvector ratio. Therefore some equations can be used:

$$\text{Number of Metric} = \sum_{j=1}^{m} \alpha i \times wj \quad (2.4)$$

$$\lambda i = \sum_{j=1}^{m} \alpha i \times \frac{wj}{wi} \quad (2.5)$$

Where:

λi = Eigenvalue in row i

α*i* = Metric on row i's metrics

wi = Eigenvector on row i

wj = Eigenvector on Column j

m = Number of rows

After calculating each element's Eigenvalue, the highest value among the elements will be selected as Eigenvalue max (λmax).

6. Examining the Consistency

In this step, the aim is to find whether the respondent(s) has/have given the rate in a logical way or not. To find the rate of consistency, the consistency index has to be calculated first by using this formula:

$$CI = \frac{(\lambda \max - n)}{(n-1)} \quad (2.6)$$

Where:

CI = Consistency Index

(λmax) = Eigenvalue Maximum

n = Order of matrix

The calculation will continue to find the rate of consistency by using:

$$CR = \frac{CI}{RI} \quad (2.7)$$

Where:

CR = Consistency Ratio

RI = Index Random

The value of random indexes can be seen in the table below:

Table 2.6. Random Index (Saaty, 1994)

Order of matrix	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.40	1.45	1.49

7. Calculating the Overall Priority

The idea of overall priority is to find the significant contribution of every element among others toward the goal in the hierarchy (Saaty, 2001). Hence, the overall priority is a weight assessment of overall AHP structure.

This assessment of entire AHP structure will result in a final weight of each element. The final weight is called as global priority or weight, while the other one called as a local priority. The global priority can be calculated by multiplying the local priority's Eigenvector with its parent's. Therefore, by adding the weights of all elements within the same level, the result will be one (1) (Saaty, 2001).

2.2.5. Measurement of Supply Chain Performance

2.2.5.1. Measurement Tool for Performance Indicators

After identifying the Key Performance Indicators (KPI) and calculating its priority weight using AHP, the next step is equalizing the units of KPI. Therefore, normalization is necessary. The method to normalize can be done by using Snorm DeBoer equation larger for better (Gen, et al., 2015):

$$S_{norm}(score) = \frac{(Si\text{-}Smin)}{Smax\text{-}Smin} x100 \quad (2.8)$$

Where:

Si = Actual performance value that has been reached

Smin = The worst value achieved by the performance indicators

Smax = The best value achieved by the performance indicators

In this measurement, the scale of the result is in the interval zero until a hundred (0-100), where 0 represents the worst and 100 as the best performance of KPI. The interval of value Snorm DeBoer equation can be classified into:

Table 2.7. Monitoring System of Performance Indicator (Trienekens & Hvolby, 2000)

Monitoring System	Indicator of Performance
<40	Poor
40-50	Marginal
50-70	Average
70-90	Good
>90	Excellent

2.2.5.2. Total Performance Supply Chain Measurement

As explained in 2.1.2 the combination of SCOR model and AHP method will be used to evaluate the performance of company's supply chain. By using SCOR model, the key performance indicators will be identified and AHP will support to clarify the significant contribution of indicators in the supply chain.

The calculation of final performance can be done in two different ways. The first one is by using local weight priority and global weight. The idea is the weight will be multiplied by key performance indicators to see the index of the performance.

1. Local Weight Calculation

Calculation with local weight means that the local weights of the bottom level of the hierarchy will be multiplied by the score of KPI first. The process is continued by using a result of multiplication as the score to be multiplied by the parents of a lower level. It continues until the multiplication of score with the local weight of criteria level. Finally, the final scores will be summed. The result will reflect the performance of supply chain of the company. The equation can be written as below:

$$Score_j = Score_{i1} \times Weight_{i1} + .. + Score_{in} \times Weight_{in} \quad (2.9)$$

Where $Score_i$ represents the score of performance indicator by Snorm Deboer calculation and $Weight_i$ represents the significant contribution according to respective element. $Score_j$ is the total score of performance as the parent of lower levels.

2. Global Weight Calculation

A calculation with global weight means the overall weight will be multiplied by the score of performance indicators. The idea is to find the index performance of each performance indicator. The index indicates the significant contribution of each indicator in the supply chain of the company. By summing all value of index indicators the final result will be gained. The final result represents the performance of supply chain of the company and its degree. The equation to calculate the performance index can be expressed as below:

$$\text{Performance Index}_i = Score_i \times \text{Global Weight}_i \quad (2.10)$$

Where $Score_i$ indicates the score of Snorm DeBoer calculation upon certain performance indicators and Global $Weight_i$ represents the significant contribution according to the AHP calculation. Performance $Index_i$ represents the contribution of performance indicator according to a perspective of the experts and its real performance to the succession of the supply chain of the company.