CHAPTER 3
PROPOSED METHODOLOGY

3.1 Introduction

To address the research problem, the decision on investment should be derived from an integrated analysis of various theories. However, the literature survey and questionnaires were conducted to indicate the main factors impacting Foreign Direct Investment (FDI). Those factors are the financial and economic situation, supply chain and infrastructure, as well as knowledge skill and performance.

In this chapter, the main aim is to propose an integrated framework to help decisions for FDIs. The framework is based on the three main necessities mentioned above. In this regard, a Risk Knowledge Matrix is introduced to help evaluate the impact of existing risks, as well as, the modeling of the supply chain simulation which is used to analyse future cost of investment. However the framework consists of two levels of static and dynamic analysis. Thus the first part of this chapter, results from the survey of questionnaires to reconfirm the selected potential factors and classify them into sub factors. In the second part, the research framework is constructed with three main requirements pertaining to the three questions of: "Who", "What" and "How" which will be introduced to the proposed framework. Finally, to clarify the position, the last section will be explained in detail to analyze the strategy from static and dynamic perspectives.

3.2 Potential factors and sub factors classification of FDI decision

Several factors are considered as key factors that have been taken into account for the FDI. The attributes used in each research are different and the contents of each type of decision remain very general. The distinguished factors resulting from the survey of literature were presented in three aspects: i) factor endowment ii) financial and economic situation iii) supply chain and infrastructure. To confirm the critical factors resulting from the survey, as described in chapter 1 (section 1.5.1, 1.6), research was done by the use of questionnaires provided to the case study area of Northern Region Industrial Estate, Lumphun, Thailand (see Appendix A: Questionnaire). Finally, each factor is subdivided for the integrated framework. These are composed of "financial and economic situation", describing the situation effected to financial problem, "supply chain and infrastructure", explaining about physical infrastructure such as transportation and distribution networks, communication or public utilities, and "worker skill and performance" which refer to factors of labor, for instance, worker attitude, skill and performance and educational level. Thus the following section, will categorize sub factors by grouping all discovered factors from the literature in the context of FDIs' investment context shown in chapter 1 (section 1.5.1). Then sub factors are classified and represented in the following table (Table 3.1).

Table 3.1 Classification of factors and lower sub factors from review of literatures.

Factor		Sub Factor	Discovered factors	Definition
Worker skill and performance	1	Employees' skill and requirement	Employee skills Experienced in equipment and technology use.	The ability to do the good job. The experience to work and improve the job Sufficient qualified and number of technicians, engineers, and managers.
	2	Work ethic and attitude of the employees	Work stoppages Loyalty to employer Employee relationship	A willingness to work and do the job well. Looking for something useful to do if their job description work is completed. A positive attitude on their work and the company.
	3	Educational level of employees	Qualified educational system for labor	Educational level of labor workers in the companies.
	4	Turnover rate in human resources	High staff turnover Impatient attitudes and frequent turnover of workers.	Qualified technical skill are hardly to find Labor is considered to be impatient, which resulted in high turnover. This affected business in a negative way by making it necessary to recruit new employees or suspend production temporarily.
Financial and economic situation	5	economic situation	Exchange rate Tax Economic development and fiscal policies Interest rate/ inflation rate country risk market demand non-tariff barrier to trade	Fiscal and monetary policies Market demand, competition, policy environment, domestic inflation rates, and domestic interest rates and international trade.
	6	Unstable of political situation	Transparency of government policy Corruption Credibility of government	The government was appointed or elected; it has been able to show more transparency in managing the country.
	7	Uncompetitive wages	Wages of employees	Wages of labor, local intensive, low average wages
	8	Unattractive and inconvenient regulations for company	Benefits due to access to overseas markets Financial service accessible	Investment and business support from government

Table 3.1 (continued)

Factor		Sub Factor	Discovered factors	Definition
Supply chain and infrastructure	9	Inefficient collaboration among company with supplier and/or customer	Subcontractors existence Supplier reliability Raw material proximity Product market proximity Supply chain cost Supply chain risk	Availability of qualified local suppliers Availability of local raw material of good quality
	10	Difficulties related to internal operations	Production quality Raw material quality Leadership style and organizational climate Internal culture	Organizational changes (communications, goals, policies, and operating condition.
	11	Unwelcome facilities, infrastructure and supporting environment	No. of project of investment in R&D Telecommunication Public utilities Educational facilities Technology support BOI investment incentive and support	Infrastructure, labor intensive technology, distance of the locating from market, supplier and customer, utilities, cost of land, good airport facilities, geographical concentration
	12	Inconvenient logistics	Availability of transportation infrastructure Availability of quality logistics service providers Logistics cost	The availability and performance to utilize the channel of transportation Transportation network

In summary, among three main factors, factors from the literature are categorized into 12 sub factor groups. Those sub factors are needed to explain the Risk Knowledge Matrix of our proposed framework.

In the following sections, how to integrate these potential factors within the proposed framework is considered. The components, techniques and tools of each model in this research framework will also be described. Finally, the integrated framework on making a decision for entrepreneurial status of plant will be clarified.

3.3 Components to construct the research framework

As described above, the research studies potential factors for FDIs' investment. There are finance, supply chain infrastructure and knowledge skill in companies. To construct the research framework, three questions were proposed: "***Who***" are the relevant stakeholders for FDIs' investment, "***What***" are their needs from FDI, and "***How***" to measure their performance and capability for FDIs' investment.

Who: As explained in chapter 1, three relevant stakeholders who correspond to the potential factors. The partners or stakeholders consist of foreign investors, local industrial estates, and manufacturers. To sustain foreign businesses and attract new FDIs, each stakeholder performs as an agent in the supply chain network. The effectiveness on each partner leads to the achievement in overall supply chain. This means that the success in the FDIs' investment depends not only on how well their internal processes are implemented but also on how well they integrate and manage the relationships with all their business partners.

What: in general terms, the decision for foreign investors of when to decide to conduct the business is to gain profits and reduce costs. Investors are interested in the value of their investment in finance. Local industrial estate deals and supports facilities of logistics network and utilities, which expects to welcome the newcomers to invest in their own land. To improve productivity, manufacturers need to enhance skill and performance of workers by controlling human error at their workplace.

However, to be assured of these partners' expectations, the empirical data was conducted in a survey of 3 sample manufacturers in the case study area. Table 3.2 (a, b, c) shows the responses of what each stakeholder expects from respondents.

Table 3.2 what each stakeholder expects from FDI's investment

	Stakeholder: Investor		
Objective, Expectation	**Manufacturer A**	**Manufacturer B**	**Manufacturer C**
1. More profits	1	1	
2. Sustain the existing investors and attract new comers			
3. Stable sale forecast		1	
4. On time delivery			
5. Good/qualified quality of product and raw material			
6. Exact quantity of product and raw material			
7. Supply chain effectiveness		1	
8. Effective networks for transportation and logistics infrastructure (road, rail, seaport, airfreight)			
9. Best practice on skilled and labor performance		1	
10. Reduce ordering lead time			
11. Reduce operation time			
12. Reduce delivery lead time			
13. Reduce operation cost	1	1	1
14. Effective network in communication services			
15. Stable social situation	1		1
16. Stable economic situation	1	1	
17. Stable political situation	1		

(a) Investor's expectation

From table a), all of the respondents considered the objective of the investors aim to reduce operational cost, and gain more profits from doing business which has been remarked respectively.

Objective, Expectation	Stakeholder: IEAT		
	Manufacturer A	Manufacturer B	Manufacturer C
1. More profits		1	
2. Sustain the existing investors and attract new comers	1	1	1
3. Stable sale forecast			
4. On time delivery			
5. Good/qualified quality of product and raw material			
6. Exactly quantity of product and raw material			
7. Supply chain effectiveness	1		
8. Effective networks for transportation and logistics infrastructure (road, rail, seaport, airfreight)	1		1
9. Best practice on skilled and labor performance	1		
10. Reduce ordering lead time			
11. Reduce operation time			
12. Reduce delivery lead time			
13. Reduce operation cost			
14. Stable social situation		1	
15. Stable economic situation		1	1
16. Stable political situation		1	1
17. Effective network in communication services	1		1

(b) Local industrial estate

In terms of the local industrial estate, attempts to sustain existing investors and attract new comers, is given by all respondents. Also, considering the effectiveness of logistics networks is another main point of the industrial estate's responsibility.

Objective, Expectation	Stakeholder: Manufacturer		
	Manufacturer A	Manufacturer B	Manufacturer C
1. More profits		1	
2. Sustain the existing investors and attract the new comers			
3. Stable sale forecast	1	1	
4. On time delivery		1	1
5. Good/qualified quality of product and raw material	1	1	1
6. Exactly quantity of product and raw material		1	
7. Supply chain effectiveness	1		
8. Effective networks for transportation and logistics infrastructure (road, rail, seaport, airfreight)	1	1	
9. Best practice on skilled and labor performance	1	1	1
10. Reduce ordering lead time	1		
11. Reduce operation time	1	1	1
12. Reduce delivery lead time	1	1	
13. Reduce operation cost	1		
14. Stable social situation	1	1	
15. Stable economic situation	1	1	
16. Stable political situation			
17. Effective network in communication services			

(c) Manufacturer

Indeed, manufacturers are most aware and concerned on reducing time and cost along manufacturing activities and processes. Satisfying the need of customers, quality of goods and raw materials, best practice of skill and labor performance are also recognized from manufacturers. From the results, the conclusion is that the objectives of manufacturers are the best practice of skill and labor performance, and also supply chain effectiveness.

How: As noted earlier in Chapter 1 (section 1.5.2: approach used on make a decision of FDIs) about approach used to make a decision on FDIs, the technique of Net Present Value (NPV) is suited to evaluation cost of business. Since NPV is a well-known technique used to present value of future cash flows associated with an investment. Whereas, to measure supply chain performance, SCOR is suggested by many practitioners to perform the standard processes and measure system performance. "In a system with such interdependencies, the occurrence of a risk event has ever widening consequences, both within and across enterprises [Ray *et al.*, 08]". Thus, to estimate existing risks and mitigate on the occurrence of the related risks leading to the crises is necessary.

However, table 3.3 summarizes once again all components with three questions that help to construct the research framework.

Table 3.3 Components to construct research framework.

Who are relevant (see chapter 1, I.7)		**Foreign Direct Investors (FDIs)**	**Local Industrial Estate**	**Manufacturers**
What are their needs		Maximum return on investment ***(Financial)***	SC and infrastructure effectiveness ***(Supply chain and infrastructure)***	Internal SC effectiveness and best practice of labor skill and performance ***(Supply chain and worker performance)***
How to measure their performance	**Static**	Risk analysis	Risk analysis	Risk analysis
	Dynamic	NPV	SCOR Attribute	SCOR attribute SC cost

Finally, all components are represented as guideline to construct the research framework. The purpose on decision framework of FDI's investment will be explained in the following section.

3.4 Integrated framework on making a decision for FDI

In this section, the proposed integrated framework is presented according to the components described. This framework helps manufacturers to analyze the capability of the current situation of plant and support the decision making of FDIs' investment. The framework focuses on three perspectives. These are financial, supply chain and infrastructure, and knowledge skill and performance. The knowledge framework is shown in Figure 3.1.

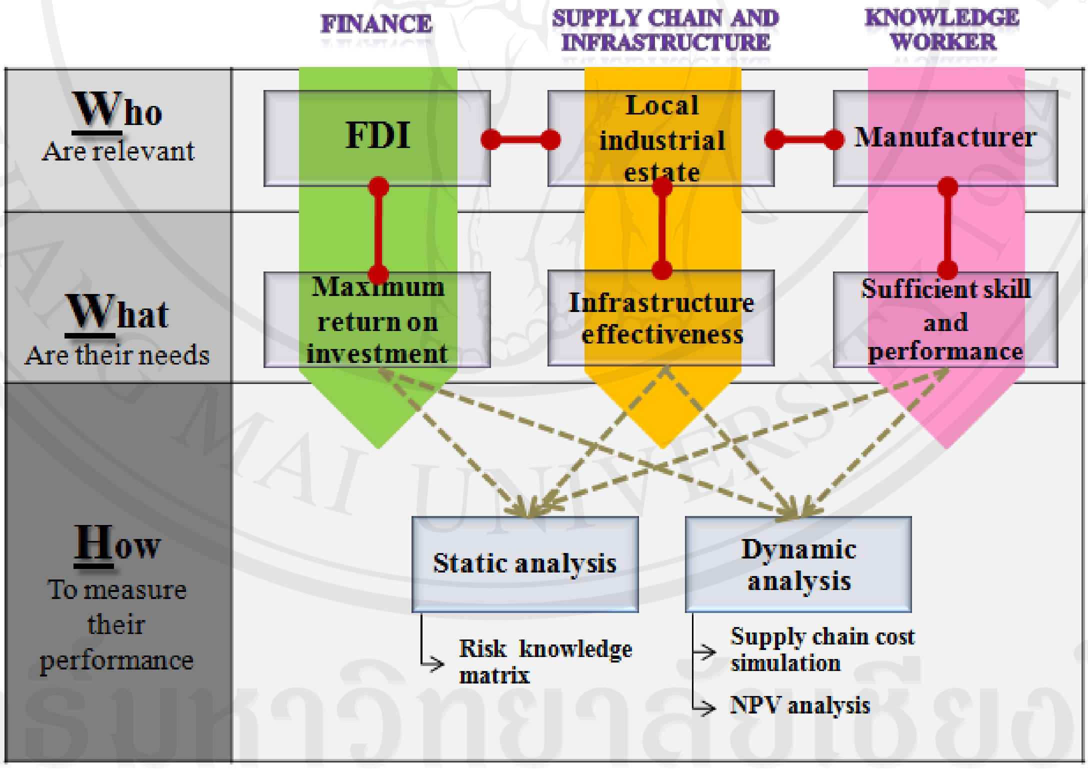


Figure 3.1 Proposed framework on making a decision for FDIs

From the proposed framework, the relevant stakeholders of foreign investors, the local industrial estate, and manufacturers are the major partners to take actions. Finance, supply chain, and worker skill and performance are the contexts for each partner. Each partner's expectations in each own criteria, are assessed by integrating different methods to evaluate performance. As described above, the conclusion is that foreign investors need to gain maximum return on their investment, local industrial estate concentrates on effective infrastructure and logistics networks, while internal supply chain effectiveness and enhancing the skill and performance of employees are the main objectives for manufacturers. Thus, to evaluate those objectives, it can be concluded that there are two types of analysis; static and dynamic. For static analysis, this section helps investors or manufacturers evaluate their related risks on existing businesses. Results of risk evaluation will be evaluated among three scenarios of relocation, transferring, or divestment of plant. For dynamic analysis, measurement of supply chain performance, forecast on cost of future investment, supply chain modeling and calculation of NPV will be presented (see chapter 4, Section 4.5.2: Cost simulation). In order to construct the modeling of the supply chain, software simulation by ARENA will be performed to illustrate manufacturing processes and activities based on the SCOR model. Outcomes from the simulation will be used to forecast NPV calculation of future investment of plant. The following section will be explained in terms of the strategy to be analyzed for static and dynamic analysis. In addition, the detail of the application will be discussed in Chapter 4.

3.4.1 Static analysis

In terms of static analysis, this method aims to help manufacturers or foreign investors evaluate the occurrence of risks on their current plant situation. Analysis of risks is often useful for manufacturers or investors and a categorising risk is considered as a starting point in the initial assessment of risks. The results of the evaluation will be explained in three scenarios which are relocation, transfer and divestment of plant.

Due to the group of sub factors considering FDIs' investment (described at the beginning of the chapter) these sub factors explain the unwelcoming situation or occurrence of risks. 20 potential of occurrences sub risks are described in detail corresponding to each category of sub factors and the three main necessities of FDI as shown in Figure 3.2.

3.4.1.1 Sub factors and the three main necessities of FDI

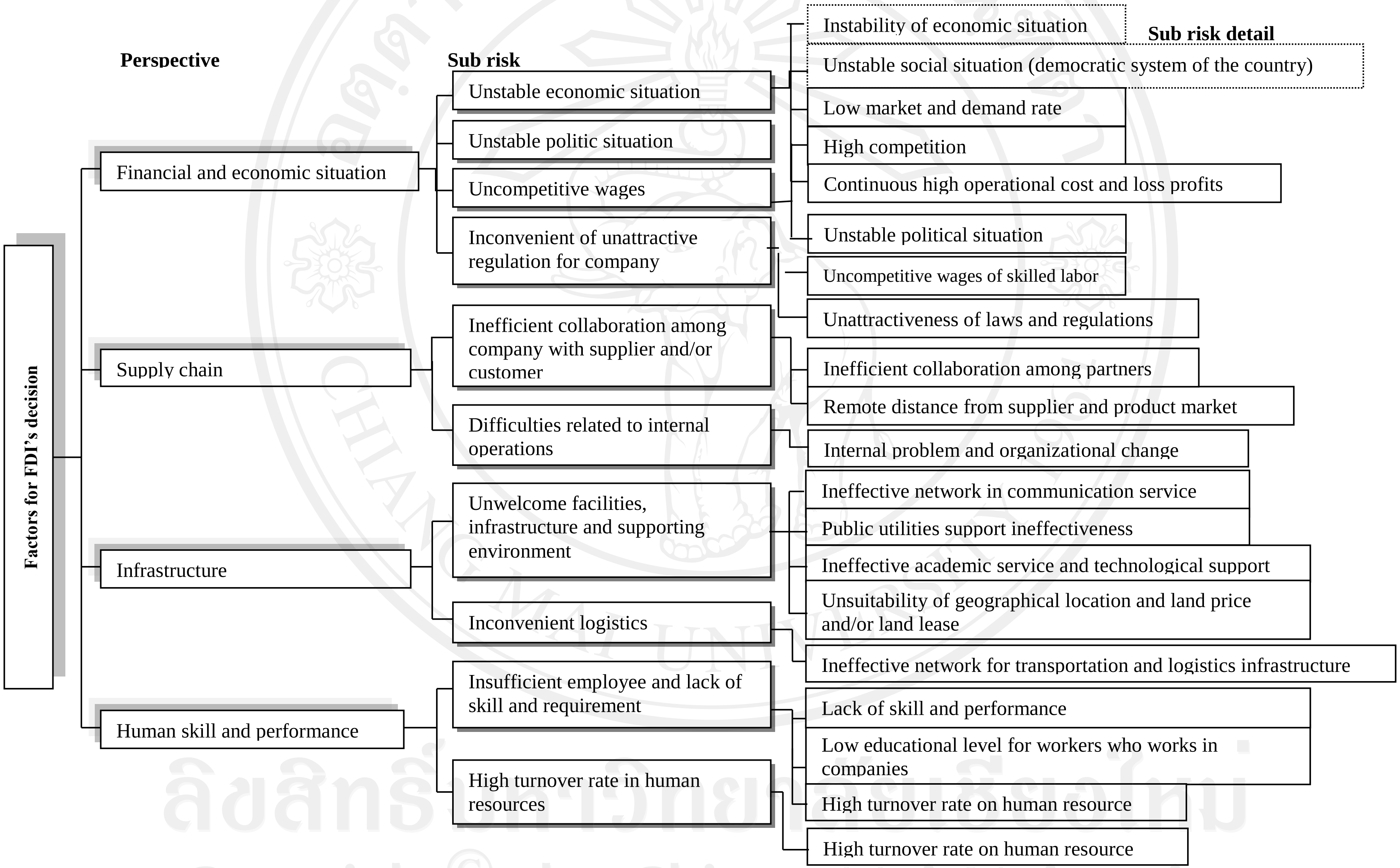


Figure 3.2 The proposition of risk and sub risk factors

From Figure 3.2, each factor has lower-level risks reaching a total of 20 sub-risks. Consequently, the three major aspects on "financial and economic situation", "supply chain risk and infrastructure", and "worker skill and performance", construct the "***Risk Knowledge Matrix***". Factors influencing FDIs and related risks are identified, then the next step is to evaluate the risks. Several methods were used to develop and measure risk attitudes. However, the difficulty of risk evaluation is that there is no precise methodology to estimate the associated risk. The risk estimation from experiences or experts is somewhat arbitrary [Liang and Song 94]. For example, [Tuncel and Alpan 09]; applied petri nets (PN) to observe the cause and effect relation between events of risk factors on supplier performance. [Wu *et al.,* 06] developed an analytic hierarchy process (AHP) to determine weight of supplier risk. Weight and probability of each risk are calculated for overall risk index. These are used to evaluate risk in terms of measureable value, such as total revenue, customer order fill rate, and order delay.

Meanwhile, [Kersten *et al.,* 07] used five point Likert scales to collect data concerning supply chain risk between manufacturing companies and logistics service providers. They explain value of risks in terms of the estimation from experiences and experts. The significance of risk can be expressed as a combination of its consequences or impacts on a process's objectives and outputs, and the likelihood of those consequences arising (Impact and Likelihood) [Stephan and Badr 07]. Based on quantity analysis, the "Calculated Risk," a simple arithmetic formula, is used to classify risks. The Calculated Risk refers to the risk that a firm can handle or the cost it is willing to support in case it happens. ISO/FDIS 31000, which is the international standard of the principles and generic guidelines on risk management, purposes terms and definitions of risk as is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.

The risk evaluation corresponds to a rating scale from 1 to 5. The scale is used to explain potential impact and likelihood of occurrence from experts or experiences. The level of risk is referred as magnitude of a risk, expressed in terms of the combination of consequences and their likelihood [ISO/FDIS 31000:09], formerly expressed by the risk exposure as follows:

Level of risk = (*P x I*)

Where:

« P » [ISO/FDIS 31000 (p.5, 09)], denotes as *"The chance of something happening whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically"*. This parameter depends on previous experience, the circumstance in the environment and the risk criteria (i.e. business, politic, technology, etc.)

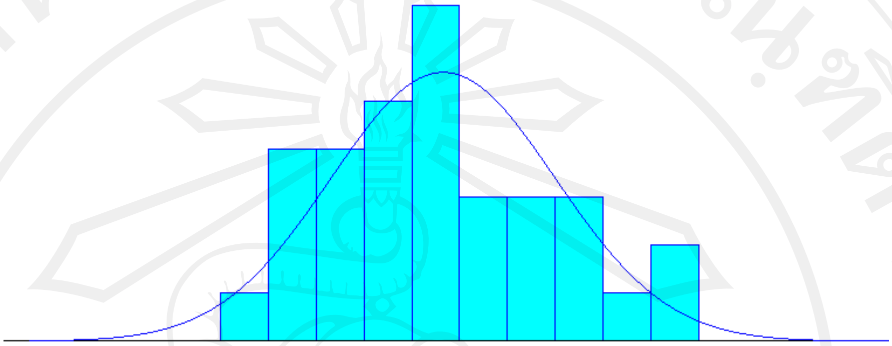
« I » denotes the impact of a risk in order to highlight its effect on the organization. This parameter is important to the normal functioning of a process and has one of the following values: 1 (very insignificant), 2 (insignificant), 3 (significant), 4 (important), 5(very important).

Thus, risk exposure might be on a scale from 1 to 25. Then risk value is mapped into 4 classes of "Low", "Medium", "High", and "Critical" as shown below.

Table 3.4 Indicator mapping risk exposure

Risk value	**Risk level**
>11.50	Critical
9.15-11.50	High risk
6.81-9.15	Medium risk
< 6.81	Low risk

However, risk values for each risk level's decision are derived from all outcomes by case studies questionnaires, afterwards fitting all values with normal distribution. The expression in normal and standard deviations is represented as 9.15 and 2.38 respectively [shown in Figure 3.3]. Thus we identify the range into lower, medium, high and critical by using standard deviation.



```
        Distribution Summary

Distribution:   Normal
Expression:     NORM(9.15, 2.34)
Square Error:   0.012591

Chi Square Test
  Number of intervals     = 4
  Degrees of freedom      = 1
  Test Statistic          = 1.39
  Corresponding p-value   = 0.242

        Data Summary

Number of Data Points     = 33
Min Data Value            = 4.84
Max Data Value            = 13.8
Sample Mean               = 9.15
Sample Std Dev            = 2.38
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Figure 3.3 Expression of normal and standard deviation

Finally, to evaluate the result of risk analysis, three scenarios of plant situation are proposed as described below.

- Relocation plant:

The move of manufacturing process to low-cost labor-abundant locations as described by [Arthuis (93), OECD (95), Brainard and Riker (97), European Parliament (98)] by a "combination of an investment abroad and subcontracting" [Enrico and Leo (p.181, 00)]

- Transferring plant:

Remain high technology process and expand processes that need laboring in other countries such as China, Vietnam or Philippines

- Divestment plant:

Withdraw the investment, a plant closure or downsizing

The questionnaires sent to the case study area consist of two parts. The first part focuses on factors impacting on FDIs' investment decision, which was explained in the first chapter. This section is an implementation of the second part. It will focus on the respondents providing the value of impact and likelihood of the risk ratings. Those values are demonstrated to construct the Risk Knowledge Matrix decision. Consequently, values of the level of risk will be presented as a guideline matrix to distinguish results according to the three scenarios. In each case the ratings given by thirteen respondents as well as the mean calculation are shown, afterward, the level of risk is interpreted as per the method described above. All the results are tabulated in summary in Table 3.5.

Table 3.5 Calculated mean of likelihood and impact value of risk

						Risk value					
						Likelihood(1-5)			Impact(1-5)		
	Risk perspective	Risk		Sub risk		Relocation	Transfer	Divest	Relocation	Transfer	Divest
1	Labor skill and performance	Lack of skilled labor and requirement	1.1	Insufficient employee and lack of skill and requirement	A negative attitude for organization	3.6	2.6	2.5	3.4	2.8	2.4
					Lack of skill and performance				3.6	3.6	3.4
					Low educational level for worker who works in companies				2.2	2.8	2.8
			1.2	High turnover rate in human resources	High turnover rate on human resource	2.8	2.7	2.7	4.0	3.0	3.0
2	Financial and economic situation	Financial problems	2.1	Unstable economic situation	Instability of economic situation	3.5	2.2	3.6	2.4	3.0	2.2
					Unstable social situaiton				2.6	2.6	2.4
					Low market and demand rate				4.0	4.0	3.0
					High competitiion				3.0	4.0	4.0
					Continuous high operational cost and loss profits				4.0	4.0	5.0
			2.2	instability of Thai political situation	Unstable political situation				2.8	3.2	2.6
			2.3	Uncompetitive wages	Uncompetitive wages of skilled labor				3.6	2.8	2.8
			2.4	Inconvenient of unattractive regulations for company	Unattractiveness of laws and regulations				2.6	2.2	2.8
3	Supply chain and Infrastructure situation	Supply chain ineffectiveness	3.1	Inefficient collaboration among company	Inefficient collaboration among partners	2.9	2.6	2.7	4.2	4.2	3.6
					Remote distance from supplier and				3.0	3.8	3.8
			3.2	Difficulties related to internal operations	Internal problem and organizational change	2.7	2.5	2.9	4.0	4.0	4.0
4		Facilities and infrastructure ineffectiveness	3.3	Insufficient on facilities, infrastructure and supporting environment	Ineffective network in	3.46	2.1	3.18	2.4	2.6	2.0
					Public utilities support				1.8	1.4	2.2
					Ineffective academic service and technological support				1.8	2.4	2.6
					Unsuitability of geographical locationand land price and/or land lease				2.4	2.2	2.3
			3.4	Inconvenient logistics	Ineffective network for transportation and logistics infrastructure	3.5	2.2	2.6	3.0	3.0	2.2

From Table 3.5, the combination of level of importance and likelihood are interpreted and represented in three scenarios: i) relocation, ii) transfer, iii) divestment, as shown in Table 3.6.

Table 3.6 The Risk Knowledge Matrix of FDIs

	Risk perspective	Risk detail		Sub risk	Sub risk detail	Relocation	Transferring	Divestment
1	Labor skill and performance	Lack of skilled labor and requirement	**1.1**	Insufficient employee and lack of skill and requirement	A negative attitude on their work and the company	12.2	7.3	6.0
					Lack of skill and performance	13.0	9.4	8.5
					Low educational level for workers who works in companies	7.9	7.3	7.0
			1.2	High turnover rate in human resources	High turnover rate on human resource	11.2	8.2	8.0
2	Financial and environmental situation	Financial problems	**2.1**	Unstable economic situation	Instability of economic situation	8.3	6.6	8.0
					Unstable social situation (democratic system of the country)	9.0	5.7	8.7
					Low market and demand rate	13.8	8.8	10.9
					High competition	10.4	8.8	14.5
					Continuous high operational cost and loss profits	13.8	8.8	18.1
			2.2	Unstable of Thai political situation	Unstable political situation	9.7	7.0	9.4
			2.3	Uncompetitive wages	Uncompetitive wages of skilled labor	12.5	6.2	10.1
			2.4	Inconvenient of unattractive regulations for company	Unattractiveness of laws and regulations	9.0	4.8	10.1
3	Supply chain and Infrastructure situation	Supply chain ineffectiveness	**3.1**	Inefficient collaboration among company with supplier and/or customer	Inefficient collaboration among partners	12.2	10.9	9.7
					Remote distance from supplier and product market	8.7	9.9	10.3
			3.2	Difficulties related to internal operations	Internal problem and organizational change	10.8	10.0	11.6
		Facilities and infrastructure ineffectiveness	**3.3**	Insufficient facilities, infrastructure and supporting environment	Ineffective network in communication service	8.3	5.5	6.4
					Public utilities support ineffectiveness	6.2	2.9	7.0
					Ineffective academic service and technological support	6.2	5.0	8.3
					Unsuitability of geographical location and land price and/or land lease	8.3	4.6	7.2
			3.4	Inconvenient logistics	Ineffective network for transportation and logistics infrastructure	10.5	6.6	5.7

These risk exposures are presented as the Risk Knowledge Matrix. It shows how much the level of risk is adopted in different scenarios of FDI's investment. Afterwards, we distinguish the consequences of this Risk Knowledge Matrix decision regarding the three scenarios.

3.4.1.2 Analysis of Risk Knowledge Matrix decision among three scenarios of relocation, transfer and divestment of plant

According to the previous section, the proposed Risk Knowledge Matrix decision is shown, which risk values are the most and less important are distinguished according to the three scenarios of relocation, transfer and divestment of plant. In this regard, the three perspectives of finance, supply chain and infrastructure are denoted, as well as workers skill and performance as FRV, SRV and WRV. Consequently, the analysis of the Risk Knowledge Matrix decision can be classified into four groups, according to the level of impact and level of probability of the occurrence. Details of each group are summarized below:

- Factors with medium potential impact and high probability of occurrence (M:H)

Factors which have medium potential impact on entrepreneurial status of plant and high potential probability of occurrence.

- Factors with medium potential impact and low probability of occurrence (M:L)

Factors which have medium potential impact on entrepreneurial status of plant and low potential probability of occurrence.

- Factors with medium potential impact and medium probability of occurrence (M:M)

Factors which have medium potential impact on entrepreneurial status of plant and medium probability of occurrence.

- Factors with low potential impact and low probability of occurrence (L:L)

Factors which have low potential impact on entrepreneurial status of plant and low probability of occurrence.

According to four classifications, which are derived from the results of the exploration as presented in Figure 3.4, 5 and 6, the results showed the critical factors leading to the scenario of relocation, transferring and divestment plant. Focusing on three aspects of worker, supply chain and infrastructure, and financial risk, distinctive factors among each three scenarios was found and is explained below:

Worker Risk Value (WRV)

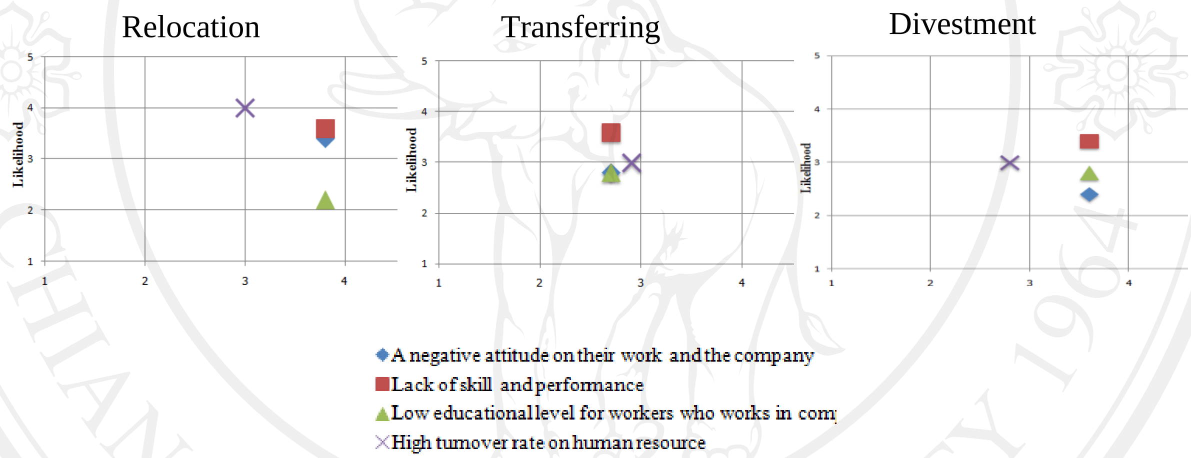

Figure 3.4 The analysis on Worker Risk Value (WRV) among relocation, transfer and divestment plant.

Most factors related to worker risk value are presented in medium potential impact and medium probability of occurrence (M: M). However, some relevant factors are identified from differences in other scenarios. For example, a negative attitude on their work is rather affected to relocation, while low educational level for workers is mostly focused on divestment of plant. High turnover rate is also considered for relocation.

Supply chain and Infrastructure Risk Value (SRV)

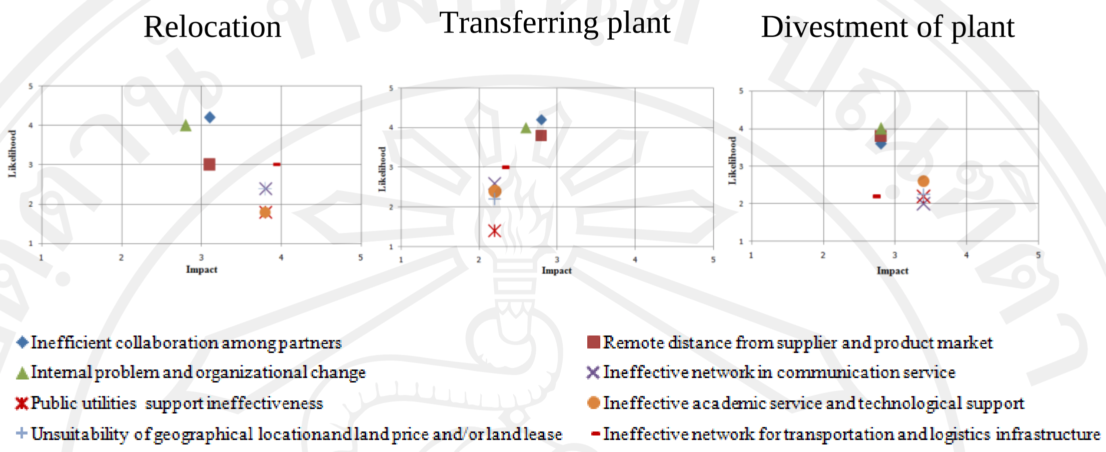

Figure 3.5 The analysis on Supply chain Risk Value (SRV) among relocation, transfer and divestment of plant.

From Figure 3.5, it has been noticed that factors related to supply chain and infrastructure aspect are mostly considered for relocation of plant. Those factors from supply chain are inefficient collaboration among partners (M: H), remote distance from supplier and product market (M: M), inefficient communication network (M: M), unsuitability of geographical location (M: M), and inefficient transportation network (M: M). The same evaluation for three scenarios shows internal problem and organizational change (M: H). However, ineffective academic service and technological support is less important for offshore plant (M: L).

Financial Risk Value (FRV)

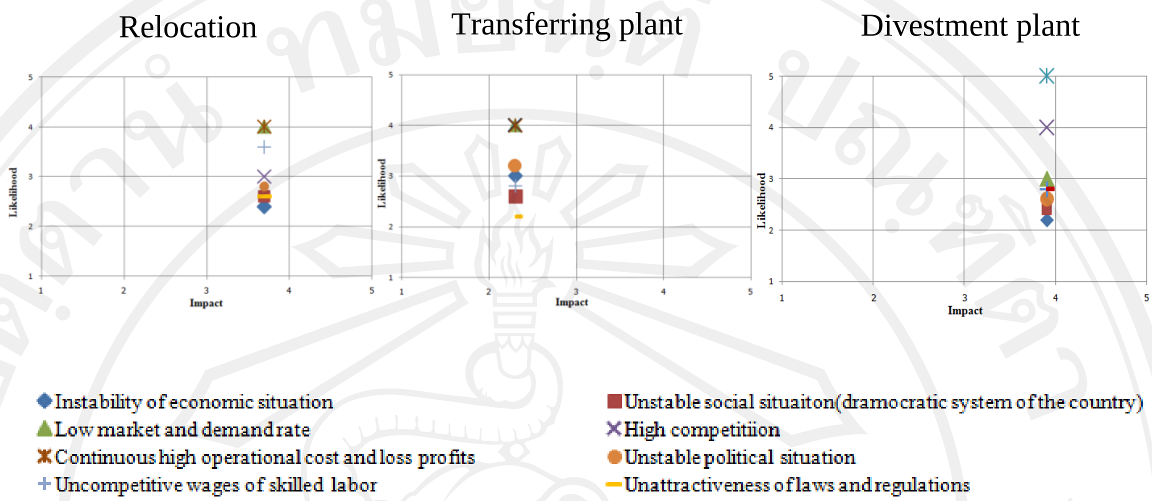

Figure 3.6 The analysis of Financial Risk Value (FRV) among relocation, transfer and divestment of plant.

The distinct factors causing divestment of plant are continuous high operational costs and loss of profit, and high competition (M: H). Influences on the economic situation, such as politics, economic situation and uncompetitive wages (M: M) are less important for relocation, whereas the important factors for this scenario are identified as low market and demand rate.

On the contrary, focusing on three scenarios of relocation, transfer, and divestment, it is concluded that the distinctive factors among each three aspects is explained below:

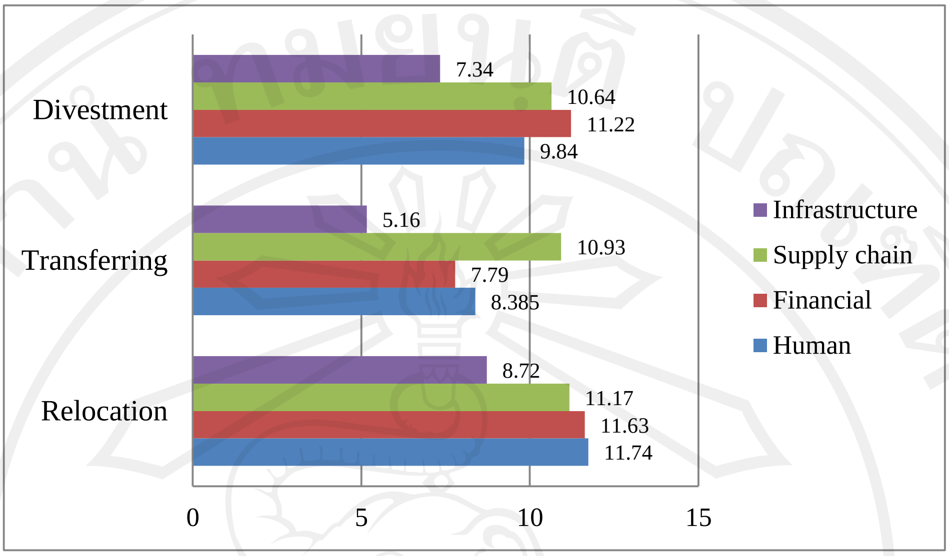

Figure 3.7 Degree of influencing factors causing FDI's decision as related to the three scenarios.

Figure 3.7 illustrates influencing factors that may cause FDI's decision are in three scenarios of relocation, transferring and divestment of plant. The bar chart reflects issues that are the result of a comparison of each potential factor among the three scenarios as well as of those factors within each scenario.

Regarding the comparison among three scenarios, infrastructure is considered as the least influencing factor. For the scenario of relocation, factor of infrastructure is not differentiated from the supply chain, financial and human aspects, while human skill and performance is considered as the most influencing factor leading to this situation. Financial and supply chain aspects are also noted. Besides the scenarios of divestment, financial perspective is placed as the most important role for this status, while supply chain and human performance are noticed as second and third priority. One of the important decisions to make while deciding to transfer plant is the supply chain aspect. On the contrary, human and skill performance, and financial perspective, these factors are considered respectively as the following concerns.

Among the three scenarios, the financial aspect is shown as the most critical issue leading to divestment of plant, while human and skill performance are the main potential factors causing relocation of plant. The impact on supply chain aspect influenced plant transfer the most.

Since two types of analysis are needed for constructing the framework architecture, static analysis is described which is referred to by the Risk Knowledge Matrix in this section. Thus in the following section, dynamic analysis will be described.

3.4.2 Dynamic analysis

It is necessary to find or develop an estimated future cash flow when deciding whether to invest. It is also important to estimate the uncertainty in these estimates. This is normally done by comparing past results, for example, by looking at actual results versus predicted results over a one year prediction horizon.

Regarding dynamic analysis, the modeling of the supply chain system, and carrying out "what if" analysis in different scenario, are the main focuses. Different scenarios in dynamic analysis refer to "Existent" and "Expected" location of plant. To experiment with supply chain environment, simulation is undoubtedly one of the most powerful techniques to apply as a decision support system [Sergio 03]. The framework building supply chain simulation is constructed according to the SCOR model, and implemented by the use of ARENA application and Microsoft Excel Spreadsheet. However, to measure the performance of supply chain network, metrics and attributes provided by SCOR help to explain how well the chain performances. Supply chain cost will be calculated as the outcome of the framework application, while forecasting on investment cost using the NPV technique will also be applied in order to suggest further investment. Thus the following section will clarify on these contexts.

3.4.2.1 Supply chain simulation framework

The framework of supply chain simulation presented in the research, is based on the Supply Chain Operations Reference model (SCOR). This reference model is proposed by the Supply Chain Council, (2007). [Herrmann, [2003, p.2] also noted that *"The SCOR model was developed to describe the business activities associated with all phases to satisfy a customer's demand".* The model establishes five distinct supply chain management processes of: Plan, Source, Make, Deliver, and Return. To describe the supply chain processes, the process building blocks which are named as process categories, help to structure process along the supply chain network. Three kinds of participants are identified, namely customer, manufacturer, and supplier [see Figure 3.8]. Customer is the participant who places orders for finished products, but does not supply any products to any other participant. Here is the most downstream participant in the model of the supply chain. Supplier is the most upstream participant in the model of the supply chain, as the supplier supplies parts to the manufacturer. Manufacturer is the intermediate participant in the supply chain. Manufacturer places orders to supplier and delivers orders to customer.

In this framework, a simulation model of a supply chain comprises of three levels. The first level describes partner relationship of the simulation model of supplier, manufacturer and customer. The corresponding activities of each supply chain partners are presented as sub models which are explained on level two. Lastly, the third level provides sub models of each participant corresponding to the process elements. From the proposed model, the scope of level 1 processes (Plan, Source, Make, Delivery and Return), process categories, and process element are explained. With the Source, Make, Deliver process elements, a common internal structure has been agreed upon. However, the proposed model focuses on a Make-to-Order (MTO) environment.

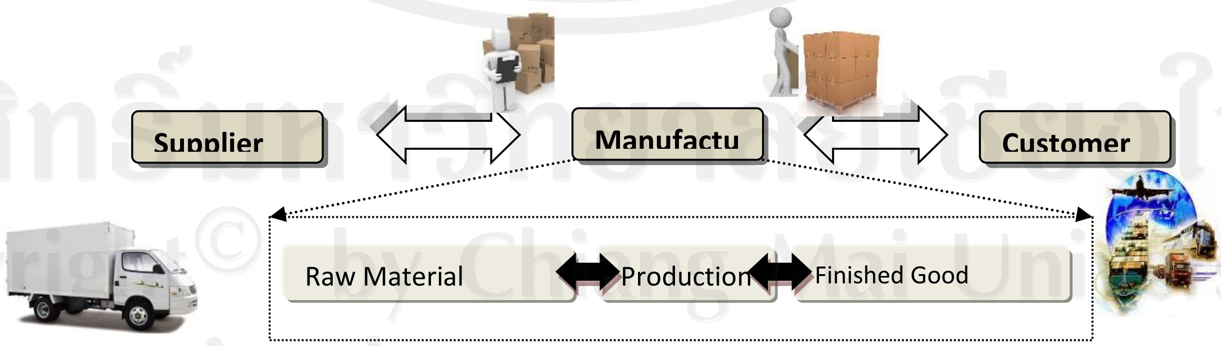

Figure 3.8 The three participants of the supply chain model

An MTO environment is described by Persson [2009, p.579] as, *"…planning of the Source, Make, and Deliver processes…established on the basis of customer orders and the different lead times (production lead time, supplier lead time, etc.)"*. There are differences in the sub models for supplier, manufacturer, and customer. In the case of the supplier, raw material sourcing is not performed. Batch quantity is fixed as user defined. The numbers of batch quantity depend on ordering quantities from manufacturer requirement and are assumed to be available all the time. The customer acts as a place for receiving the products corresponding to the orders that he/she places, implying that the customer does not perform production and delivery activities. These processes are represented as the SCOR model structure. Each entity contains elements that determine the simulation flow. Thus, the supply chain structure as modeled in SCOR, is shown in Figure 3.9:

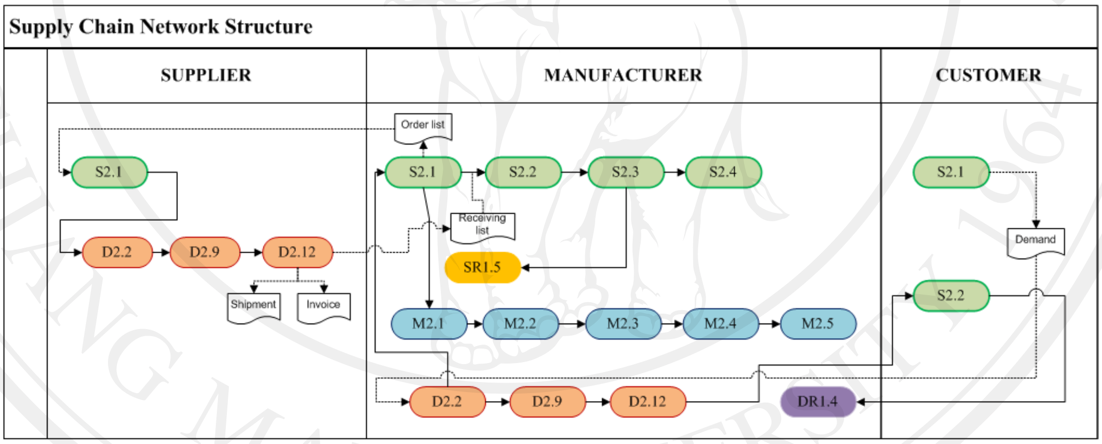

Figure 3.9 Flowchart of processes and activities of the supply chain model

As shown in Figure 3.9, the supply chain structured sub model represents a set of processes at all nodes which are interrelated. Processes are related to SCOR Level3.

Process symbols used in the above figure are consistent with the SCOR model. Process IDs and process names given in Table 3.7.

Table 3.7 Process IDs and process names.

Process ID	Process name
S2.1	Schedule Product Deliveries
S2.2	Receive Product
S2.3	Verify Product
S2.4	Transfer Product
M2.1	Schedule Product Activities
M2.2	Issue Product
M2.3	Produce and Test
M2.4	Package
M2.5	Stage Product
D2.2	Receive, Configure, Enter & Validate order
D2.9	Pick Product
D2.12	Ship Product
SR1.5	Return Defective Product
DR1.4	Transfer Defective Product

Figure 3.10 (a, b, c) displays the corresponding hierarchy of sub models for supplier, manufacturer and customer. Each participant sub model includes a subset of the process element sub models shown in Figure 3.10. Each process element is implemented as a separate submodel that represents a specific activity in the supply chain. Herrmann *et al*. [2003, p.2] explain the three structure levels as follows, *"The process element submodels contain ARENA blocks… The participant submodels contain process element submodels and other submodels needed to initialize the simulation model"*. Also it has clearly defined interfaces, which are used to integrate the submodels.

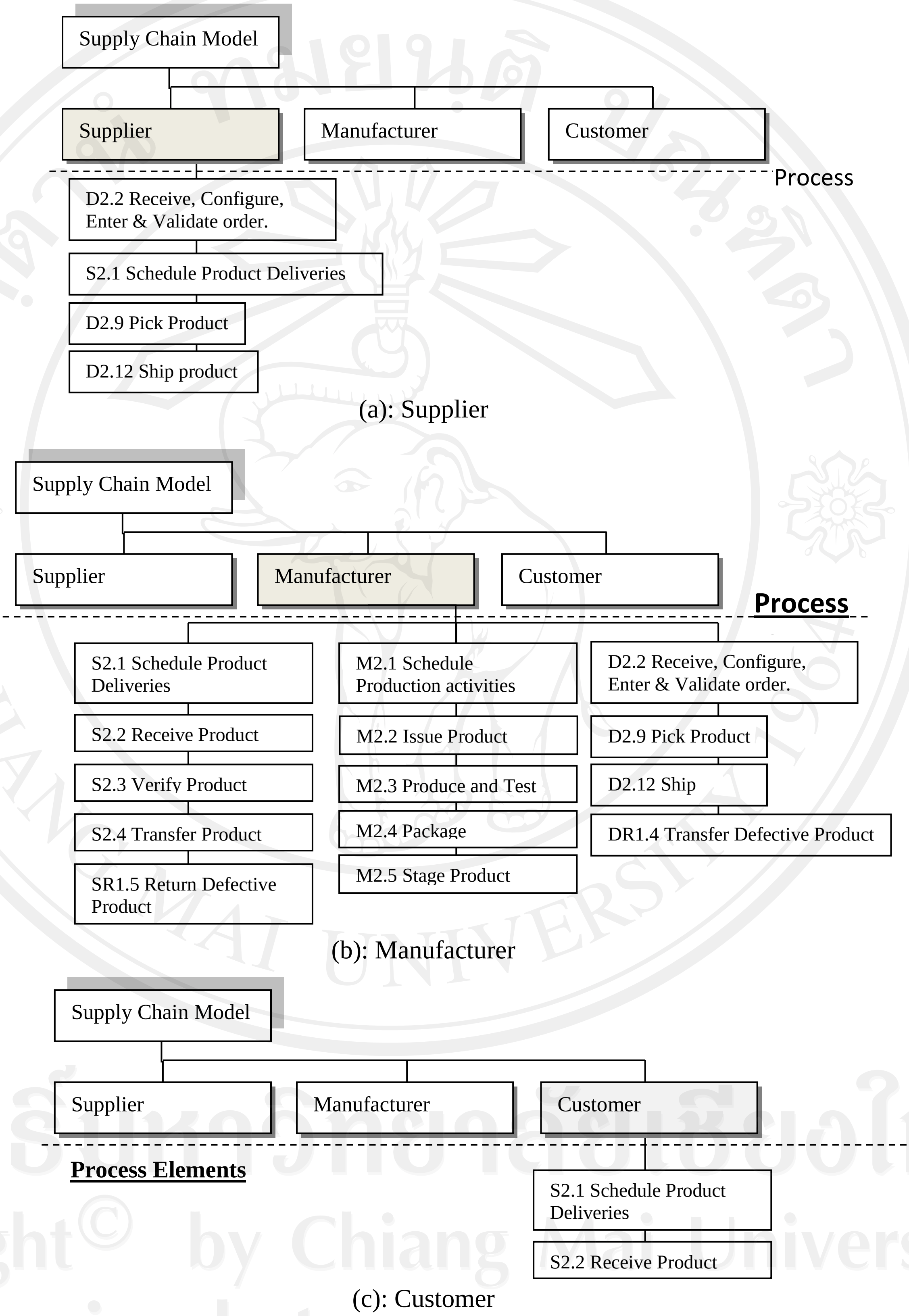

Figure 3.10 Sub model hierarchy of manufacturer
(Adapted from Herrmann *et al*. 2003)

The implementation on ARENA software simulation will be applied. However details will be described in chapter 4.

3.4.2.2. Supply chain management cost analysis

From the supply chain framework, analysis on cost of supply chain was also performed. The sum of the costs associated with the SCOR level 2 processes to Plan, Source, Make, Deliver and Return are all referred to as supply chain costs. To explain the structure of total supply chain management costs, the hierarchical metric structure is shown below.

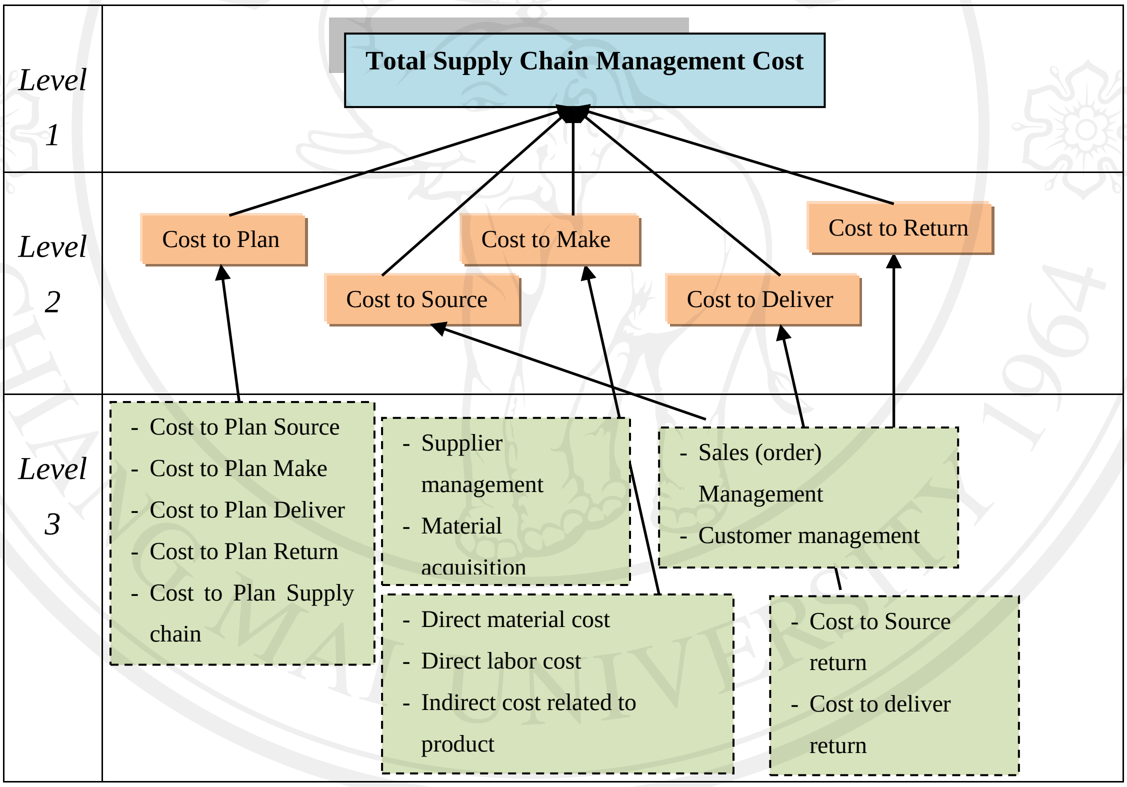

Figure 3.11 Hierarchical metric structure of supply chain management cost (SCC 07)

Regarding the construction of supply chain modeling, we design submodels and activities which are associated with source, make, deliver and return processes. Thus simulation attempt to incorporate parameters required to represent each cost. However representing related cost of supply chain in level 3 of SCOR, consist of both costs from management and activities, thus the focus is on cost from activities while supply chain simulation can determine the outcomes. The following are parameters used for calculation.

Table 3.8 Parameters and equations used for supply chain cost calculation

Cost category	Parameters and calculations
Cost to Source	Supplier management + Material acquisition management
	Supplier Management = material planning + planning procurement staff + supplier negotiation and qualification + etc. Material Acquisition Management = bidding and quotations + ordering + receiving + incoming material inspection + material storage + payment authorization + sourcing business rules and requirement. + inbound freight and duties + etc.
- Calculation	= ordering + receiving + incoming material inspection + material storage + inbound freight and duties
Cost of Make	Sum of Direct Material, Direct Labor, and Direct non-Material Product-related Cost (equipment) and of Indirect Product-related Cost
- Calculation	Direct material+ Direct labor + indirect cost (utilities, land) + additional cost (scrap cost)
Cost of Deliver	Sum of Cost of (Sales order management + Customer Management)
- Calculation	= distribution + transportation + outbound freight and duties

Table 3.8 (continued)

Cost category	Parameters and calculations
Cost to Return	Sum of Cost to Return (to Sources + from Customers)
- Calculation	- Cost to Return to Source (SRx) = Verify Defective Product Costs + Disposition of Defective Product Costs + Identify MRO Condition Costs + Request MRO Return Authorization Costs + Schedule MRO Shipment Costs + Return MRO Product Costs + etc. -Cost to Return From Customer (DRx) = Authorization Costs + Schedule Return Costs + Receive Costs + Authorize MRO Return Costs + Schedule MRO Return Costs + Receive MRO Return Costs + Transfer MRO Product Costs + etc.

From table 3.8, the formula was input to an Excel spreadsheet linking parameters derived from outputs of the supply chain simulation. The details of these calculations will be discussed further in chapter 4. Finally, the combination of costs among source, make, deliver and return will be represented on total supply chain cost. However, the outcome of the calculation is provided as an initial cost (year = 0) in order to forecast following investment cost (year = 1, 2, 3, 4 and 5) by using the NPV technique. The following section will describe the analysis of this investment cost.

3.4.2.3. Investment cost analysis

The terms of capital budgeting, Louderback and McNichols, [1986 p.113] define Net Present Value as *"The present value of the future cash flows associated with an investment minus the amount of the investment"*. This analysis will determine the capital investment by taking into account the net cash flow over an extended period using the net present value technique. The technique is used as a tool, which was described by Robert *et al.*, [2008, p.1] *as a tool "…applied to optimize decision making,…(and) estimate the current value of cash flows relating to an investment"*.

This research manipulates simple investment scenarios of a property held over a five year period. The technique of net present value with anticipated returns is shown in criteria as follows.

$$\text{NPV} = \frac{NCF}{(1+\text{r})^{t}}$$

Where

NCF_t = Net cash flow (receipts minus payments) at time *t*

r = Interest rate

Net Present Value is a term created from the two related financial terms of, present worth of benefits and present worth of costs [Luenberger, 1998]. The value isdetermined bysubtracting the present value of the costs and benefits meaning higher positive net present value is more preferable on an investment.

However, another factor affects the value of NPV is inflation rate. Luenberger [1998] determines Inflation rate is *"Characterized by an increase in general prices with time … indeed do not remain constant, but in planning studies future rates are usually estimated as constant"*.

In other words, inflation rate influences by considering the value of money, for example, *"…If the inflation rate is f, then the value of a dollar next year in terms of the purchasing power of today's dollar is 1/ (1+f)"*. Further, Luenberger [1998] gave the reasons to define a new interest rate, which is *"…The rate at which real dollars increase if left in a bank that pays the nominal rate,….the purchasing power of the bank balance has probably increased in spite of inflation, and this increase measures the real rate of interest"*.

An analysis can be carried out consistently by using either real or nominal cash flows and is outlined below.

$$r_0 = (r\text{-}f) / (1+f)$$

Where:

r_0 = real interest rate

r = interest rate

f = inflation rate

To consider on future investment cost, we consider two investment decisions of existing location (Thailand) and expected location of plant in other developing countries (Vietnam or China) should be analyzed. In the first scenario, a manufacturer or investor decides to manufacture using existing plant in Thailand where the case study is located. In the second scenario, they must decide either to manufacture in developing country in China or Vietnam. The reason to decide China or Vietnam is because both of them are the major competitors of Thailand.

In summary, this chapter introduces tools used to analyze risks and costs from investment to foreign investors. Static analysis is used to examine risks which might occur from an existing plant, while dynamic analysis is applied to identify costs of supply chain management and costs of future investment. Comparing two presented scenarios on the present value of the investment, the project with the highest potential financial value is more likely to be undertaken by a decision maker. This outcome is conducted from the formula provided in an Excel spreadsheet which will be discussed in the next chapter to support the decision of manufacturers or investors to decide on what scenario is the most preferable. Further, Chapter 4 will describe the implementation of using ARENA and Microsoft Excel to explain how the sub models interact. The knowledge based system will serve as a supporting tool to integrate two analyses of the static and dynamic approach which will result in applying and implementing a web application to the case study.

In addition, as the effective performance on supply chain and collaboration help manufacturers gain more benefits by reducing costs and satisfying customers' needs, the last section looks at a supply chain context that not only suggests supply chain performance but also gives a supply chain cost consideration as a result of running a simulation. To evaluate supply chain performance, Supply Chain Operation Reference (SCOR) has been suggested and supported by the Supply Chain Council

(SCC) as standard descriptions of management processes, and standard metrics to measure process performance. So the SCOR model is suitable for implementing to evaluate overall supply chain performance of our study to build a model to apply to design process categories and to decompose processes which are implemented in the ARENA simulation.