CHAPTER 4
THE APPLICATION OF THE PROPOSED FRAMEWORK

4.1 Introduction

From the previous chapter, the integrated framework helping FDIs in making investment decisions was proposed. There are two types of static and dynamic analysis. The results from those analyses will be used to evaluate risks and forecast future investment by using NPV calculation. Thus this chapter mainly focuses on the integration of these two analyses within a knowledge based system. In the first part, the architecture of the knowledge based system will be described. There are four main components: database, procedure, simulation model, and a user interface. Afterward, each main component will be described in detail including their function in Knowledge Based Decision Support System (KBDSS). Finally, the design of the user interface and the implementation of the application on the web based system will be examined.

4.2 Web application architecture

In this section, the system architecture of the Knowledge Based Decision Support System (KBDSS) for FDI investment will be illustrated in order to visualize the main components in terms of their functions, tools, and interface construction. The knowledge based system is constructed on the basis of a web application. This system was designed with PHP and JavaScript language, and managed data using MySQL. Figure 4.1 illustrates the main architecture of the Knowledge Based Decision Support System (KBDSS) on FDI investment. The system provides a user-friendly interface. The likelihood and impact value from the decision maker(s), and also the estimations of operational costs can be provided as input through the interface. Consequently, the results from risk evaluation can be reported to the user(s) in the form of data, graphs and figures. In order to construct KBDSS, the system comprises of four main components: 1) user interface, 2) database, 3) model base, and 4) a procedure as shown in Figure 4.1. The database management subsystem contains a relational database. The model base includes a simulation model which is performed to estimate and investigate the supply chain cost of investment. The procedure is the process to operate actions and also to manipulate the results from the simulation model. User interface is the interaction between decision makers and the knowledge-based system. Excel spreadsheets and text editors are also used jointly to exchange input and output data between the simulation model and the web application. Finally results from the simulation are used as input to estimate investment costs which is conducted in an Excel spreadsheet.

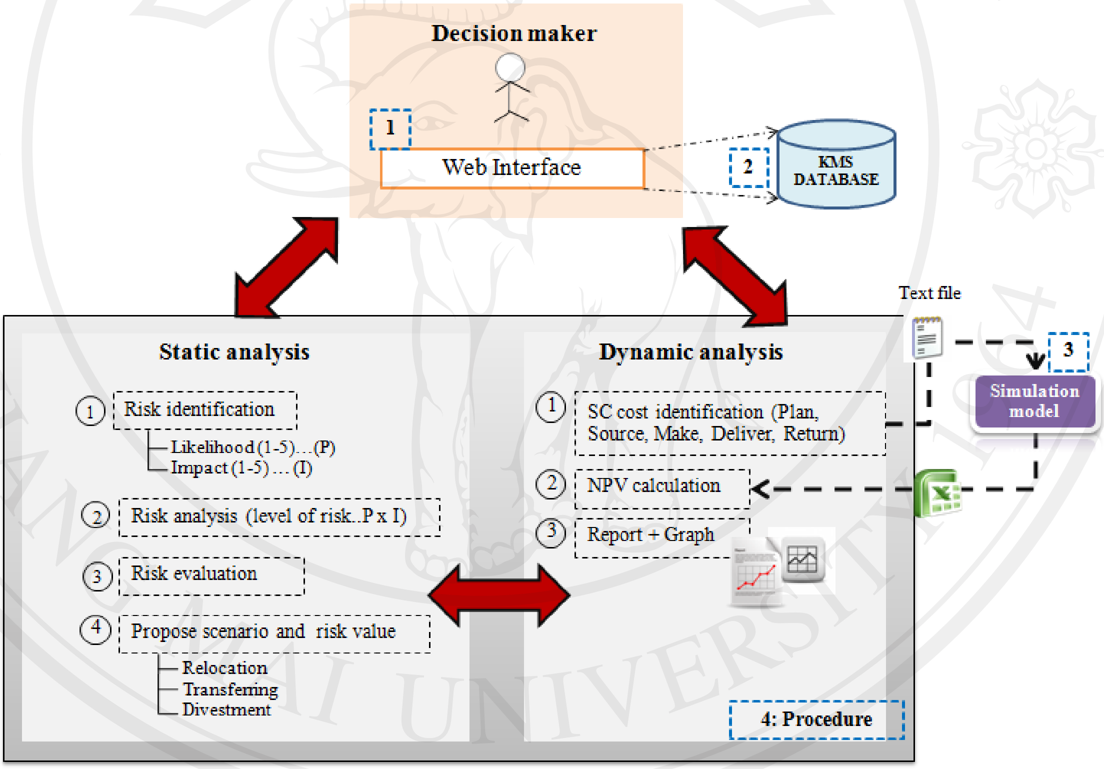


Figure 4.1 Architecture of the knowledge system on FDIs

Thus, the next section, will examine each component of the knowledge-based decision support system and use practical examples to illustrate its' operations.

4.3 Structure and database design

Elmasri and Navathe [11, p.5], define a Database Management System (DBMS) as *"A collection of programs that enables users to create and maintain a* *database"* of which collection of data records and files are integrated and sharing among various users and applications. This research uses MySQL to create a database. The database in this knowledge-based decision support system consists of 9 tables, including the Company_info, FinancialRisk, HumanskillRisk, InfrastructureRisk, SupplychainRisk, Share_holders, Template, Cost and RiskExplanation tables. The main segment of the logical database schema is related to modeling, which is an adequate set of entities and their relationships, as is shown in Figure 4.2.

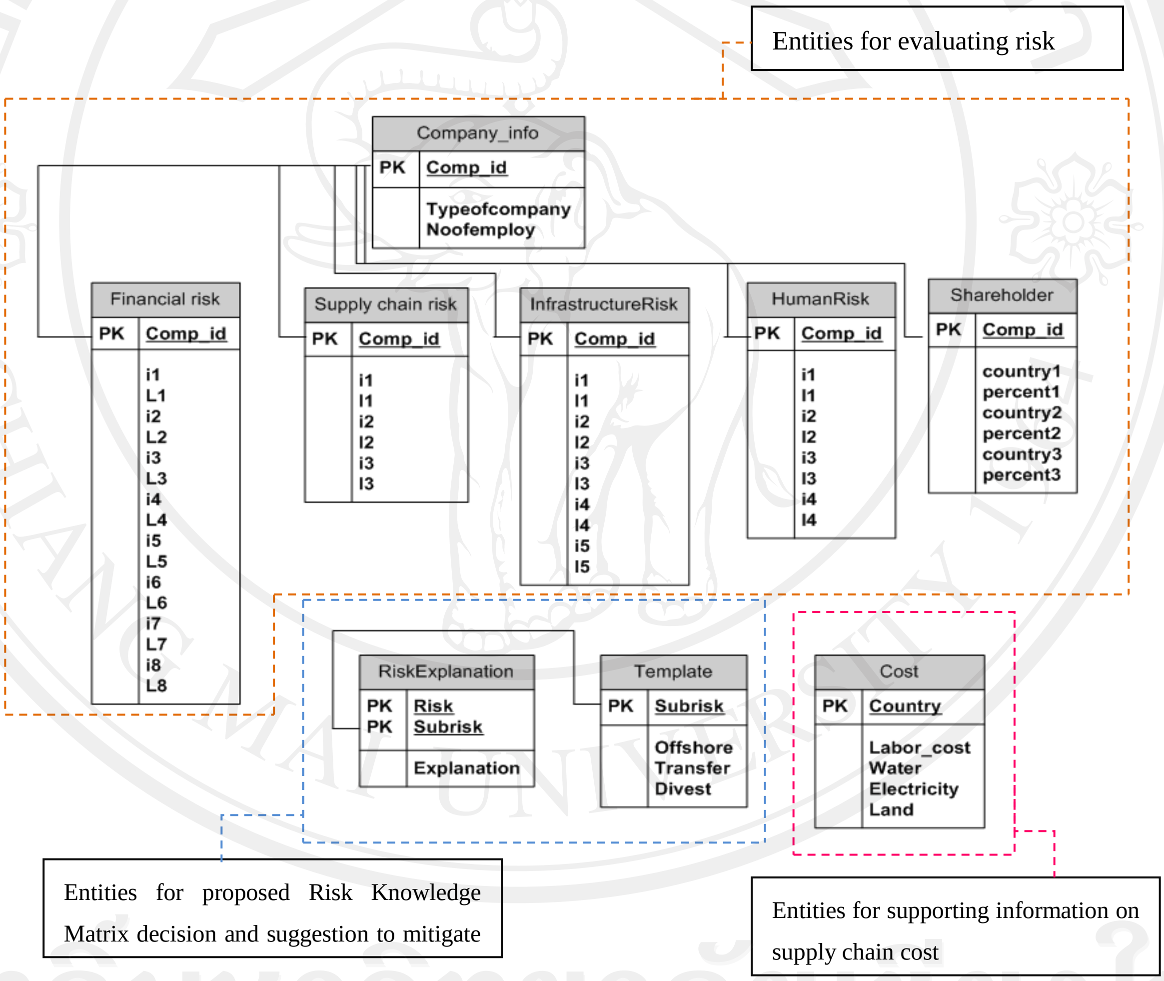


Figure 4.2 Set of entities and their relationships of database design

Data related to the simulation model is included in several associated entities. The first group of entities represents the database structure for evaluating risk. The structure consists of the impact and likelihood from risk evaluation corresponding to the profile of decision makers. The second group of entities is related to two objectives. The first objective is the suggestion mitigating risks, and the second objective, contains risk values of the proposed Risk Knowledge Matrix. It is used to compare the indicated value of risks from users with the matrix. The third group of entities stores data concerning supporting information on supply chain cost. The system relates information between tables with a unique primary key named as “comp_id”. Next functional and key components used for those 9 tables are explained.

4.3.1 Main function and key component of designed tables

The main function of the “company_info” table is to store general information of the company. Whenever users access the web application, the system provides a unique index of company_id and stores its general information in the table. The primary key of this table is “comp_id”. This table consists of three attributes, company_id, type of company and number of employees in the company. The “Share_holder” table is another table which holds information relevant to “company_info” table. This table consists of six attributes for comp_id, country1, share1, country2, share2, country3, and share3. However, table of “Share_holder” is used to store the countries of shareholders and their percentage ownership of the company. This information helps to classify groups of users when making a decision. For risk factors of likelihood and impact for each risk and sub risk factors, four tables are relevant. There are the main perspectives which we aim to study on “Financial risk”, “Infrastructure risk”, “Human risk” and “Supply chain risk”. These entire tables also contain comp_id as their primary key associated with the values of likelihood and impact for each perspective.

However the table which is not created and updated with user information to retrieve data for comparison is referred to as Table “Template”. This table specially contains values of risk for three scenarios of: relocation, transferring and divestment. Those values are used to compare and evaluate the outcome of risk level indicated by the user. Thus the sub risk is the primary key of the table, while attributes of “relocation”, “transfer” and “divest” consist of indicated value (Impact and Likelihood) from user(s) corresponding to each key sub risk. While the table “Risk Explanation” provides information to explain and make suggestion to users according to the related risk and sub risk issues. Therefore, this table contains index of risk, sub risk and their explanations. Also the table “Cost” contains additional values providing users with cost analysis. The minimum labor cost, water cost per unit, electricity cost per unit, and cost of land associated with the selected country are contained. However, a structure of each designed table is illustrated in Appendix B: Structure of design table.

The following section describes steps to obtain the results from both static and dynamic analyses and will be constructed using PHP and Java script language.

4.4 Procedure in knowledge based system

To comprehend processes within a knowledge based system, the procedure is developed and divided into two stages of decision analysis. The first stage is a risk evaluation algorithm with static analysis. The second stage is a simulation model and cost calculation on dynamic analysis. Thus we will start to explain the procedure of static analysis. This procedure conducts the actions for evaluating risks. As described in the static analysis in Chapter 3 (3.4.1) , there are twenty sub risks in the three main necessities of risk categories. However, to evaluate those risks practically, we demonstrate the procedure by categorizing into four groups, namely, human skill and performance, financial situation, supply chain, and infrastructure.

4.4.1 Procedure on static analysis

The first analysis focuses on risk evaluation. In this part, the required values of impact and likelihood for 20 sub risks were needed. Those values were provided from decision makers who were willing to evaluate their existing situation of their plant. Afterwards, comparing those values with the values in the Risk Knowledge Matrix, the suggested scenario will be introduced from one of the three scenarios among relocation, transfer or divestment situation. Thus a step by step explanation on the procedure to analyse risks is conducted. Figure 4.3 shows the procedure for evaluating risks.

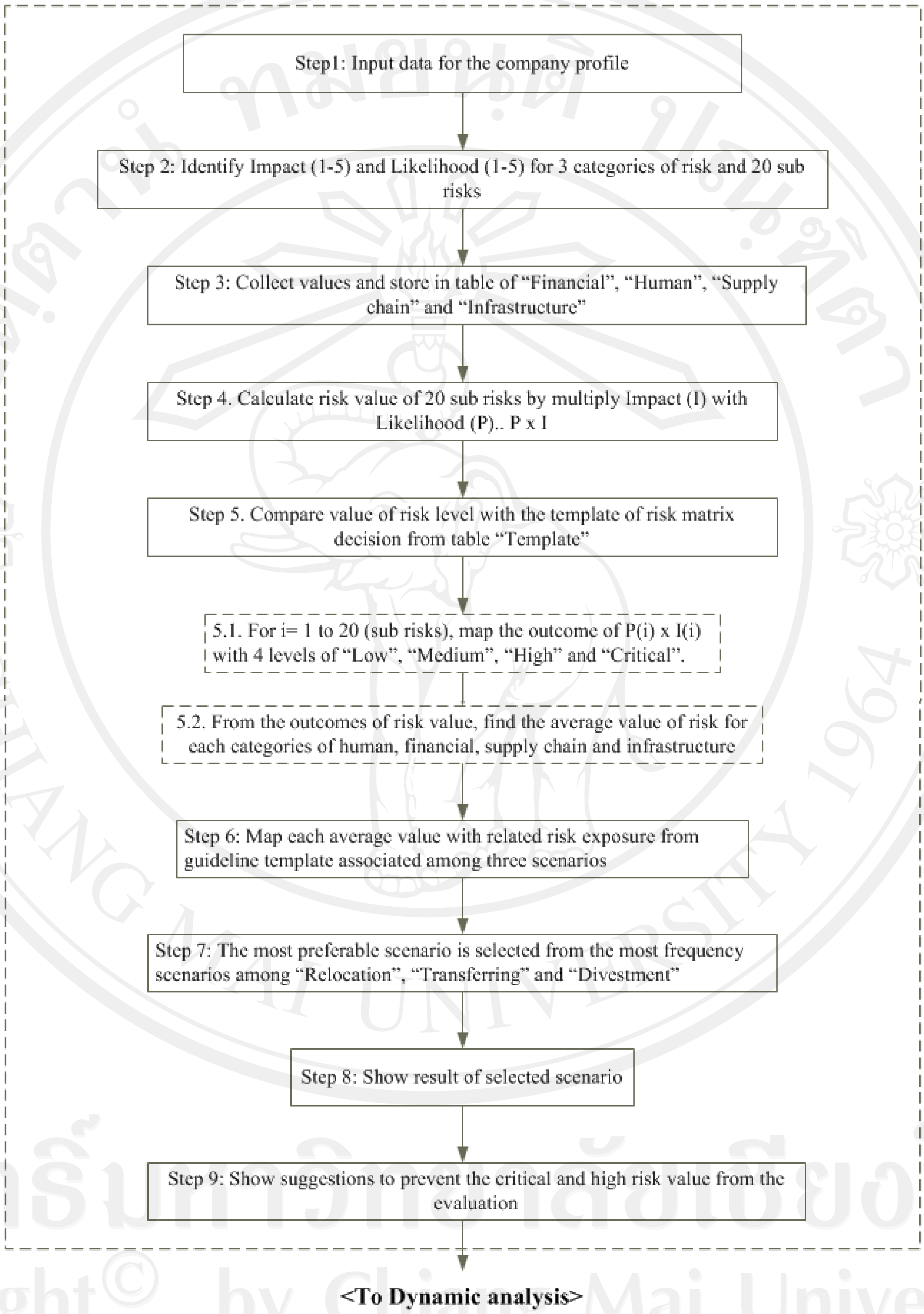


Figure 4.3 The procedure for static analysis

Step 1: This is the first step to fill the data by decision maker(s) for the company profile of: manufacturing type, number of employees in the company and shareholders, e.g,

Manufacturing type:	Electronics manufacturing
Number of employees:	100 workers
Shareholders:	100%, German

Step 2: This is also a step to collect data concerning the preference of the decision maker(s) to identify values of impact and likelihood for 20 sub risks, each value scores from 1 to 5 (see descriptors of 1 to 5 on chapter 3(3.4.1: Static analysis)). The values of impact and likelihood are obtained according to the experience of the decision maker(s). Table IV.3 presents sample values of impact and likelihood for the 20 sub risks.

Step 3: Those values are stored in the tables of financial, Human, Supply chain and infrastructure.

Step 4: This step is to calculate the value of risk exposure by multiplying "Likelihood" with "Impact" (P x I). For example (see Table 4.3), risk exposure of the sub risk "*Lack of skill and performance*" is valued at "4". This value is calculated from "2" (Likelihood: P) multiplied with "2" (Impact: I).

Step 5: Risk exposure will be made for each category of risk. Then mapping of the risk exposure within the four levels of risk which are "Low", "Medium", "High", and "Critical" (See the indicator of risk level on chapter 3 (Table 3.4)). The sample is shown in Figure 4.4. According to the risk category of "Skill labor and requirement", the average risk exposure is equal to "*3*" which is evaluated into the level of "*Low*" risk.

Step 4

	Risk category		Risk	Subrisk	Impact	Likelihood	Risk exposure	Risk level
1	Lack of skill labor and requirement	1.1	Insufficient employee and lack of skill and requirement	A negative attitude on their work and the company	2	1	2	Low
				Lack of skill and performance	2	2	4	Low
				Low educational level for workers who works in companies	2	2	4	Low
		1.2	High turnover rate in human resources	High turnover rate on human resource	2	1	2	Low
							3.0	**Low**
2	Financial problem	2.1	Unstable economic situation	Instability of economic situation	4	4	16	Critical
				Unstable social situaiton(dramocratic system of the country)	3	2	6	Low
				Low market and demand rate	4	4	16	Critical
				High competitiion	4	5	20	Critical
				Continuous high operational cost and loss profits	5	5	25	Critical
		2.2	Unstable of thai political situation	Unstable political situation	2	2	4	Low
		2.3	Uncompetitve wages	Uncompetitive wages of skilled	3	3	9	Medium
		2.4	Inconvenient of unattractive regulations for company	Unattractiveness of laws and regulations	3	4	12	Critical
							13.5	**High**
3	Supply chain ineffectiveness	3.1	Inefficient collaboration among company with supplier and/or customer	Inefficient collaboration among partners	3	3	9	Medium
				Remote distance from supplier and product market	3	2	6	Low
		3.2	Difficulties related to internal operations	Internal problem and organizational change	2	3	6	Low
							7.0	**Medium**
4	Facilities and infrastructure ineffectiveness	4.1	Unwelcome on facilities, infrastructure and supporting environment	Ineffective network in communication service	1	1	1	Low
				Public utilities support ineffectiveness	3	3	9	Medium
				Ineffective academic service and technological support	2	2	4	Low
				Unsuitability of geographical locationand land price and/or land lease	2	2	4	Low
		4.2	Inconvenient logistics	Ineffective network for transportation and logistics infrastructure	2	2	4	Low
							4.4	**Low**

Step2

Step 5

Figure 4.4 Sample calculation of the risk exposure.

Step 6: Mapping the value of average risk exposure from the previous step with the average risk exposure from the Risk Knowledge Matrix. Thus the three scenarios of relocation, transfer and divestment, are evaluated.

Step 7: One of three scenarios is chosen according to the adjacent value by comparing vales of average risk exposures with the Risk Knowledge Matrix (see Figure 4.5).

Step 8: Finally, the scenario with the most frequent exposure is represented as the suggested scenario. For example in Figure 4.5, the suggesting scenario of this sample is "*Divestment*".

	Risk category		Risk	Subrisk	Risk exposure	Risk level	Status
1	Lack of skill labor and requirement	1.1	Insufficient employee and lack of skill and requirement	A negative attitude on their work and the company	2	Low	
				Lack of skill and performance	4	Low	
				Low educational level for workers who works in companies	4	Low	
		1.2	High turnover rate in human resources	High turnover rate on human resource	2	Low	
					3.0	Low	Divestment
2	Financial problem	2.1	Unstable economic situation	Instability of economic situation	16	Critical	
				Unstable social situaiton(dramocratic system of the country)	6	Low	
				Low market and demand rate	16	Critical	
				High competiition	20	Critical	
				Continuous high operational cost and loss profits	25	Critical	
		2.2	Unstable of thai political situation	Unstable political situation	4	Low	
		2.3	Uncompetitve wages	Uncompetitive wages of skilled labor	9	Medium	
		2.4	Inconvenient of unattractive regulations for company	Unattractiveness of laws and regulations	12	Critical	
					13.5	High	Divestment
3	Supply chain ineffectiveness	3.1	Inefficient collaboration among company with supplier and/or customer	Inefficient collaboration among partners	9	Medium	
				Remote distance from supplier and product market	6	Low	
		3.2	Difficulties related to internal operations	Internal problem and organizational change	6	Low	
					7.0	Medium	Divestment
4	Facilities and infrastructure ineffectiveness	4.1	Unwelcome on facilities, infrastructure and supporting environment	Ineffective network in communication service	1	Low	
				Public utilities support ineffectiveness	9	Medium	
				Ineffective academic service and technological support	4	Low	
				Unsuitability of geographical locationand land price and/or land lease	4	Low	
		4.2	Inconvenient logistics	Ineffective network for transportation and logistics infrastructure	4	Low	
					4.4	Low	Transferring plant
					Suggested scenario		Divestment

Figure 4.5 Sample result from the evaluation of risk

Step 9: Additionally, only when the risk exposure is critical and high levels of risk are present, will the system provide suggestions to mitigate those risks for the decision maker. The suggestions are derived from table "Risk Explanation".

4.4.2 Procedure on dynamic analysis

From the previous section, risk evaluation on the existing situation of plant was conducted. In this section, to estimate the future cost of investment among two selected site locations, the supply chain cost based on SCOR processes are provided from the decision maker which are stored in the text file as input for the simulation model. Afterwards, outputs from running the simulation are presented as one-year investment costs through the excel spreadsheet. To estimate the future cost, a forecasting technique to derive inflation rate and demand rate change is needed to analyse the net present value (NPV). Figure 4.6 explains the approach on this dynamic analysis.

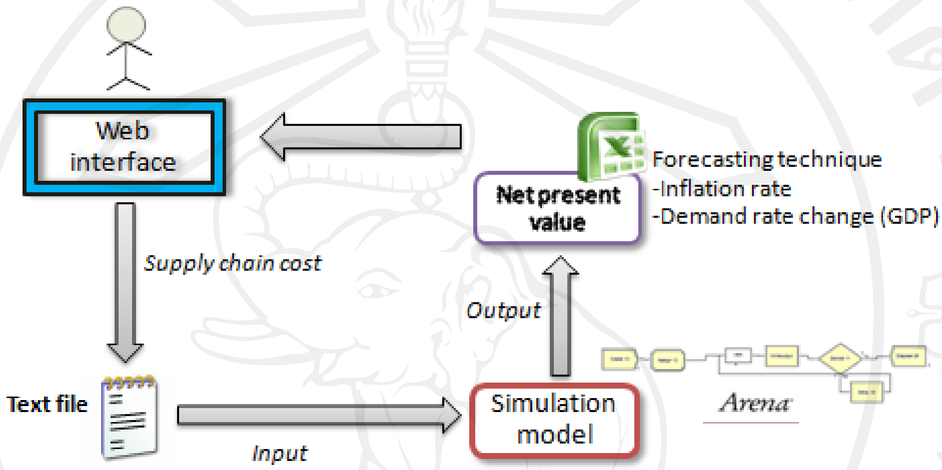


Figure 4.6 Approach of dynamic analysis

Thus the following steps, will describe approaches to obtain those outcomes by giving the sample of Thailand and China. Figure 4.7 presents the procedure to analyse future cost of investment on dynamic analysis.

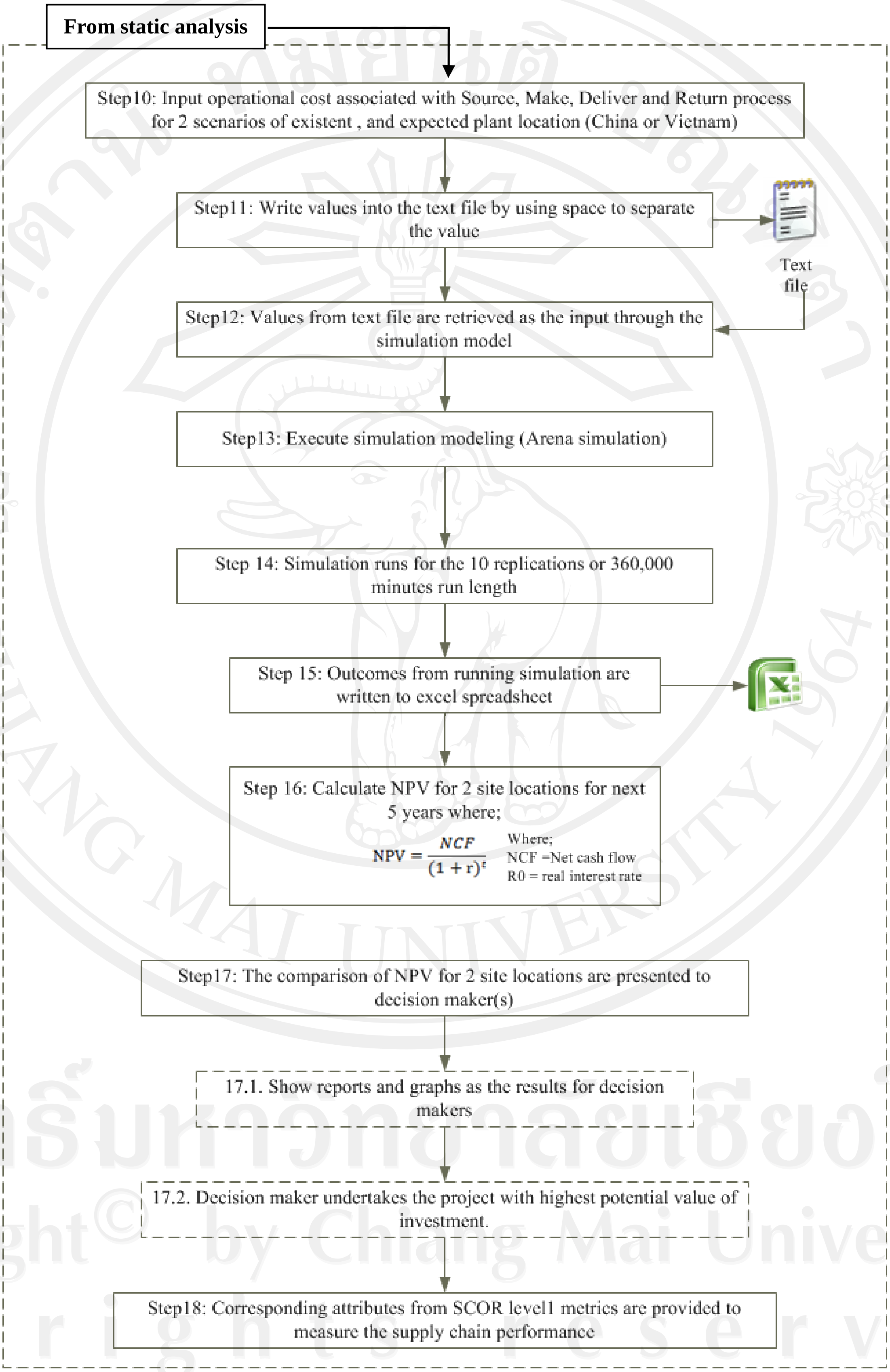


Figure 4.7 Procedure for dynamic analysis

Step 10: This step is to input parameters used for supply chain simulation through the interface. These input data are operational costs associated with Source, Make, Deliver and Return processes. The decision maker is required to complete those values of two sites for the current location in Thailand and expected location by choosing between the China and Vietnam site. However, this sample chooses the expected location as China. Figure 4.8 shows the sample input of "Source" cost based on SCOR through the interface.

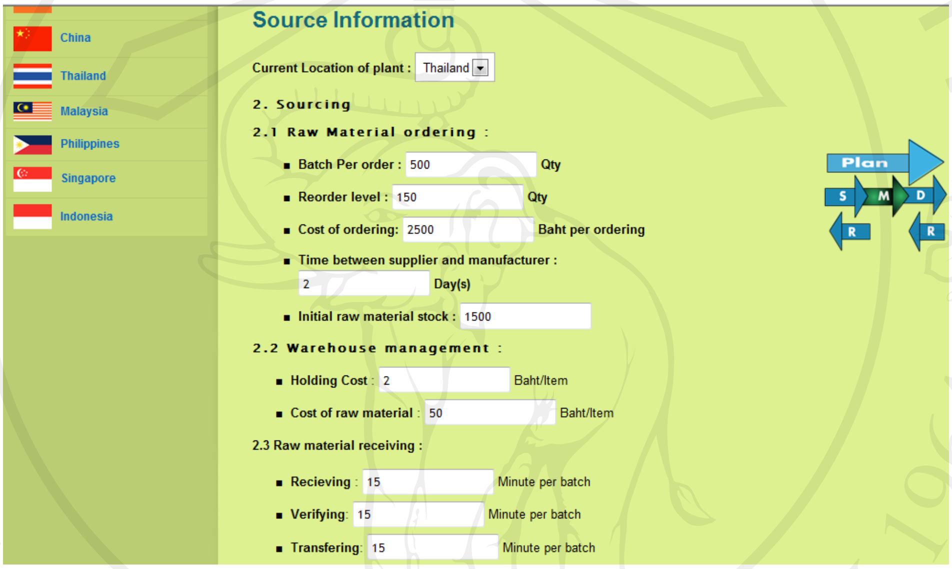
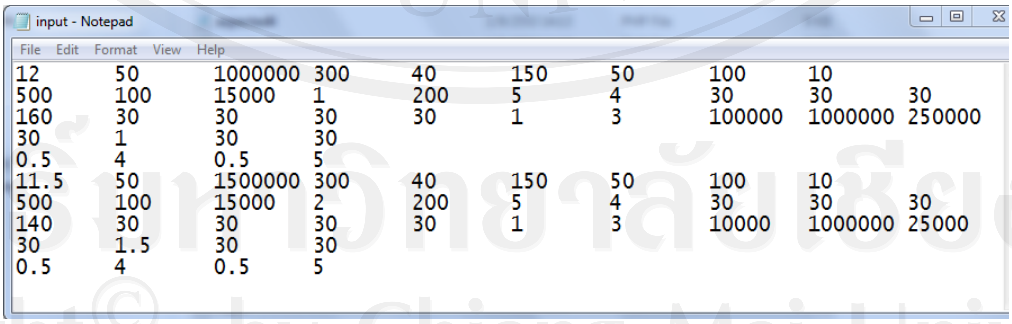


Figure .8 Sample input of "Source" cost from user interface

Step 11: Then, all input data are written into the text file as shown on figure below.



12	50	1000000	300	40	150	50	100	10	
500	100	15000	1	200	5	4	30	30	30
160	30	30	30	30	1	3	100000	1000000	250000
30	1	30	30						
0.5	4	0.5	5						
11.5	50	1500000	300	40	150	50	100	10	
500	100	15000	2	200	5	4	30	30	30
140	30	30	30	30	1	3	10000	1000000	25000
30	1.5	30	30						
0.5	4	0.5	5						

Figure 4.9 Input identified by user

Step 12: Those values are manipulated as the input through the model of supply chain simulation.

Step 13: The decision maker executes the simulation model in this step. In order to visualize the interrelation among cost manipulation and simulation model, the supply chain SCOR model will be described in detail in section 4.4.3 (Simulation model).

Step 14: Simulation runs for 10 iterations of the 360,000 minutes run length or 250 working days (one year).

Step 15: Finally, the outcomes from running the simulation are written into an Excel spreadsheet as cost of *Source*, *Make*, *Deliver* and *Return* processes for the first year of investment. There are three sheets on the Excel file. The first sheet shows in the Figure 4.10. It is used as the intial outcome to estimate future cost of investment.

Output ---> 10 replication	**InProcess(Status=3)**	**1715200**
	FGinWH(status=4)	1598200
	FGShip(status =5)	1553500
	FGtoCus(Status=6)	1541100
	Count no. of delivery	2303
	ScrapMake	159
	No.of cus receiving FG	2285
	Count no.ordering RM	1147
	Sum orderRM	1719000
	AverageRM	12809
For 1 replication	InProcess(Status=3)	171520
	FGinWH(status=4)	159820
	FGShip(status =5)	155350
	FGtoCus(Status=6)	154110
	Count no. of delivery	230
	ScrapMake	16
	No.of cus receiving FG	229
	Count no.ordering RM	115
	Sum orderRM	171900
	FG complete in WH	159804
	FG complete ship	155334
	FG complete to Cus	154094
	FG complete Cus accepted	151012
	Current WIP	11716
	OnHandFG	4470
	Avg.InventoryRM	12809
	Current Source return volume	3438
	Current delivery return volum	3082
	Rejected Return RM	0.02
	Rejected Return FG	0.02
	Rejected Make	0.01

Source cost			
Shipment cost	count RM receive from sup.	171900	
+	Freight cost RM per item	5	859500
Ordering cost	No. of RM order Qty	115	
+	Ordering cost	1000	114700
Holding cost	Avg. inventory level	12809.09	
	Holding cost	5	64045.45455
Total Source cost			**1,038,245**
Make cost			
Direct mat cost	Material used qty	171520	
+	Material cost	10	1715200
Direct labor cost	no. of labor used*	10	
+	Labor cost per day	160	
	250 day per year	250	400000
indirect cost	utilities cost...per month (or year)	280000	
+	12 months per year	12	3360000
Additional cost	scrap cost per unit	7	
	Sum of scrap	16	111.3
Total Make cost			**5,475,311**
Delivery cost			
Freight cost FG		5	
Total no. of FG delivery		155334	**776,671**
Total Delivery cost			
Return cost			
Disposition of defective product cost	cost of rejected material	2	
+	count RM_receive from supplier)	171900	
	%RM_rejected	2.00%	6876
Return FG cost	Cost of rejected FG	2	
	No.of Rejected FG from cus	3082	6164
Total return cost			**13,040**

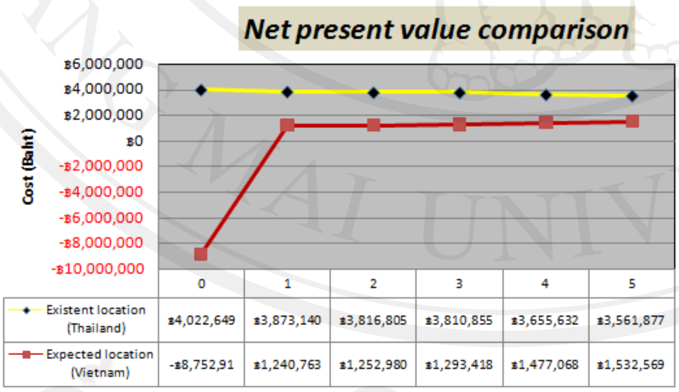
Figure 4.10 Outcomes from running simulation

Step 16: This process is to calculate NPV by estimating the net cash flow for the next 5 years of two site locations as shown in Figure 4.11. The procedure is conducted on the second spreadsheet. Cells in the second spreadsheet are filled with formula used for the Net Present Value (NPV) calculation. To estimate the cash flow and obtain NPV, inflation rate and demand rate are also integrated to estimate the future cost of investment. How to obtain those two values by using forecasting technique and method to calculate NPV is described in section 4.4.3.2 (Cost simulation).

Thailand	Year 0	1	2	3	4	5	Total
Total revenue	**11,325,916**	12,005,471.33	12,698,187.03	13,349,604.02	13,879,583.30	14,341,773.42	77,600,535.45
Demand rate		6.0%	5.8%	5.1%	4.0%	3.3%	
Initial investment cost	-						
Total expenditure	**7,303,267**	7,741,463	8,188,145	8,608,197	8,949,943	9,247,976	40,791,015.59
-source cost (ordering + holding+ transporting cost of material)	1,038,245	1,100,540.18	1,164,041.35	1,223,756.67	1,272,339.81	1,314,708.73	7,113,632.20
-Make cost (Direct mat cost + Direct labor cost + indirect cost + additional cost)	5,475,311	5,803,829.98	6,138,710.97	6,453,626.84	6,709,835.83	6,933,273.36	37,514,588.27
-Delivery cost (Shipped finished good cost)	776,671	823,270.73	870,773.45	915,444.13	951,787.26	983,481.78	5,321,427.85
-Return cost	13,040	13,822.15	14,620	15,370	15,980	16,512	89,343.12
Net CF	4,022,649	4,264,008	4,510,042	4,741,407	4,929,641	5,093,798	36,809,519.87
Interest rate (Thailand)	12%	12%	12%	12%	12%	12%	
Inflation rate (Thailand)		1.73%	3.03%	4.13%	3.93%	4.27%	
Real interest rate: (r-f)/(1+f)		10.092%	8.703%	7.554%	7.761%	7.417%	
NPV: NCF/(1+r)n	฿4,022,649.33	฿3,873,140.86	฿3,816,805.24	฿3,810,855.25	฿3,655,632.98	฿3,561,877.82	**฿22,740,961.49**

Figure 4.11 Net present value calculation for 5 years of investment plan

Step 17: Then the comparison of NPV for two site locations are presented to the decision maker. The outcomes are shown in the graphs and reports which describe values of supply chain cost and NPV as shown in Figure 4.12.



NPV	
Current location (Thailand)	22,740,961.49
Expected location (Vietnam)	- 1,956,118.32

Figure 4.12 The comparison of NPV for two site locations

Step18: Since the supply chain cost is presented, supply chain performance is also measured and conducted on the third spreadsheet. Standard SCOR level 1 metrics are the corresponding attributes provided to measure the performance (see Appendix C: Performance attributes and associated Level 1 and Level 2 metrics).

SCOR attribute and measurement

Performance attribute	Level 1 metric	Level 2 metric	Constraint factors	Performance measurement	
				Current	Expected
Reliability	Perfect Order Fulfillment	% of order delivered in full		0.98	0.98
Responsiveness	Order Fulfillment cycle time	Source cycle time		2.38	2.33
		Make cycle time			
		Deliver cycle time			
Flexibility	Upside supply chain flexibility, Upside supply chain adaptability,downside supply chain adaptability	Upside Make Flexibility (Upside Make Adaptability)	current on-hand WIP	11,715.90	11,916.20
		Upside Deliver Flexibility (Upside Deliver adaptability)	Current on hand FG	4,470.00	3,800.00
		Upside Source Return Flexbility (Upside source return adapability)	Current source return volume	3,438.00	3,492.00
		Upside deliver Return Flexbility (Upside deliver return adapability)	Current delivery return volume	3,081.88	3,150.08
Cost	Supply chain management cost, Cost of Goods sold	Cost to Source	Source cost	7,113,632.20	4,810,875.08
		Cost to Make	Make cost	37,514,588.27	36,170,320.70
		Cost to Deliver	Deliver cost	5,321,427.85	3,261,709.02
		Cost to Return	Return cost	89,343.12	91,017.56
Asset management	Cash-to-Cash Cycle time, Return on supply chain fixed assets, Return on working capital	Supply chain revenue		77,600,535.45	52,878,421.76
		Cost of Good sold		37,514,588.27	36,170,320.70
		Supply chain management cost		40,791,015.59	36,140,331.09

Figure 4.13 Comparison of SCOR attribute and measurement among two site location of plant

From Figure 4.13, not only NPV calculations are illustrated, but also performance in the supply chain is measured and explained on the basis of level 1 metrics of SCOR.

Consequently, the comparison of NPV and supply chain performance among two site locations of Thailand and China are provided to the decision maker. This information support the decision on FDIs' investment by providing them with understanding of the existing situation of plant and future cost of investment for the 5 year plan. However, in order to visualize the interrelation among cost manipulation and simulation model, the supply chain SCOR model will be described in detail in the following section.

4.4.3 Simulation model

This section describes how the simulation model works and executes the key activities used for calculation of NPV and measures performance in supply chain operations. There are two stages of simulation. Firstly, the simulation model describes the supply chain activities. The outcomes obtained from this simulation are represented in terms of supply chain cost. The second simulation model is cost simulation conducted in an Excel spreadsheet.

4.4.3.1 Supply chain simulation model

This simulation is performed by ARENA software. The sub models which were broken down into activities are carried out as process elements based on SCOR. The sub models also associated with a participant include VBA blocks that communicate with corresponding Excel spreadsheets by the use of VBA language.

As described in chapter 3.4.2.1 (Supply chain simulate in framework) the simulation model approach contains three partners as supplier, manufacturer, and customer along the supply chain system. In this section, the simulation describes the proposed model in practical analysis. As shown in Figure 4.14, the illustration on process element based on SCOR for supplier and customer are illustrated. The processes for supplier activities are described on receiving, delaying and sending material to the manufacturer. Additionally, process elements describing the “schedule product delivering” and “receive” process are also explained. There are three volumes for the schedule of customer demand; High, Medium and Low season.

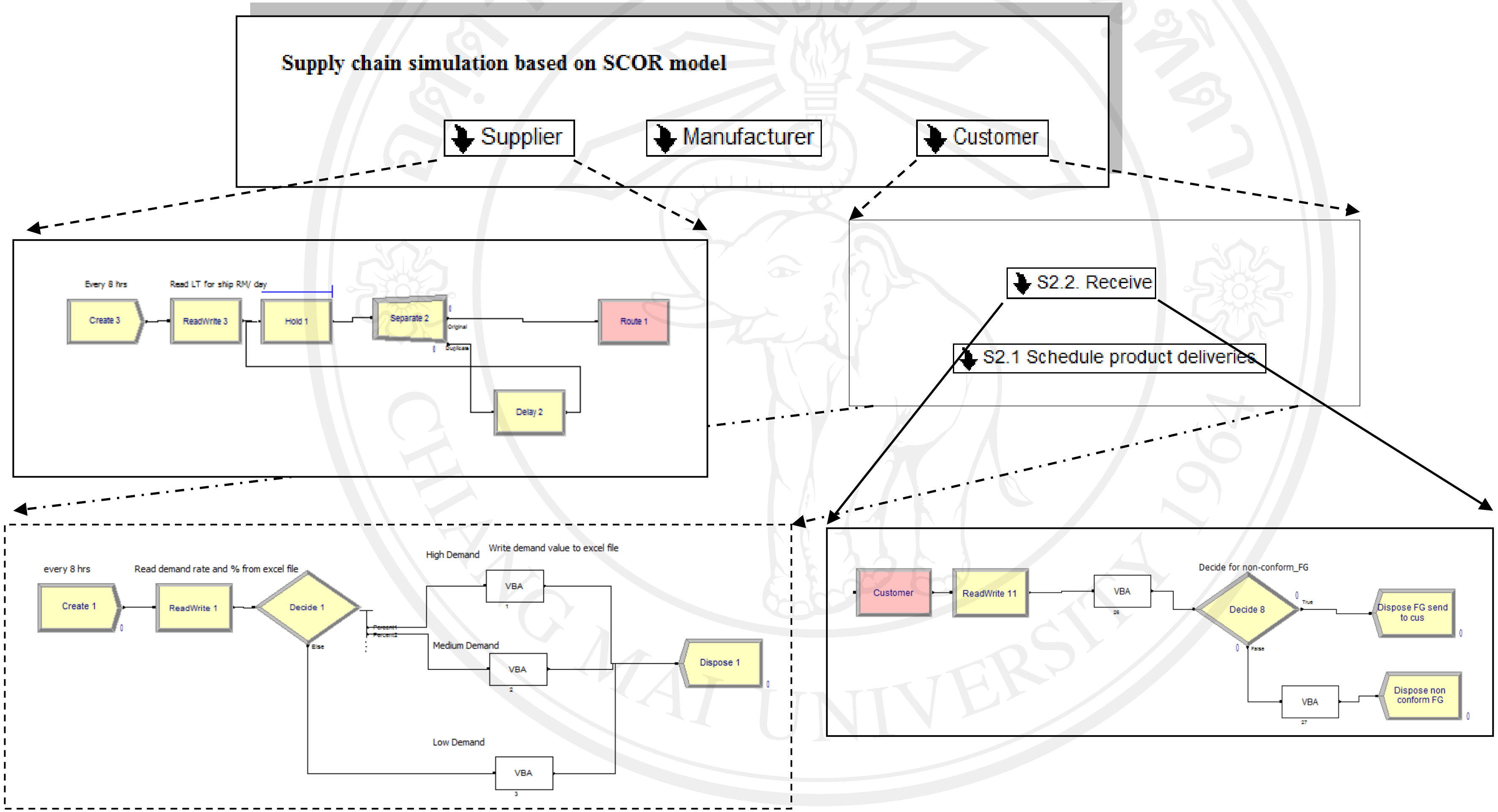


Figure 4.14 Supply chain simulation based on SCOR model for supplier and customer

From Figure 4.15, the process elements for manufacturer represent the four basic processes of SCOR which are *Source*, *Make*, *Deliver and Return* processes. The model focuses on a Make-to-Order (MTO) environment.

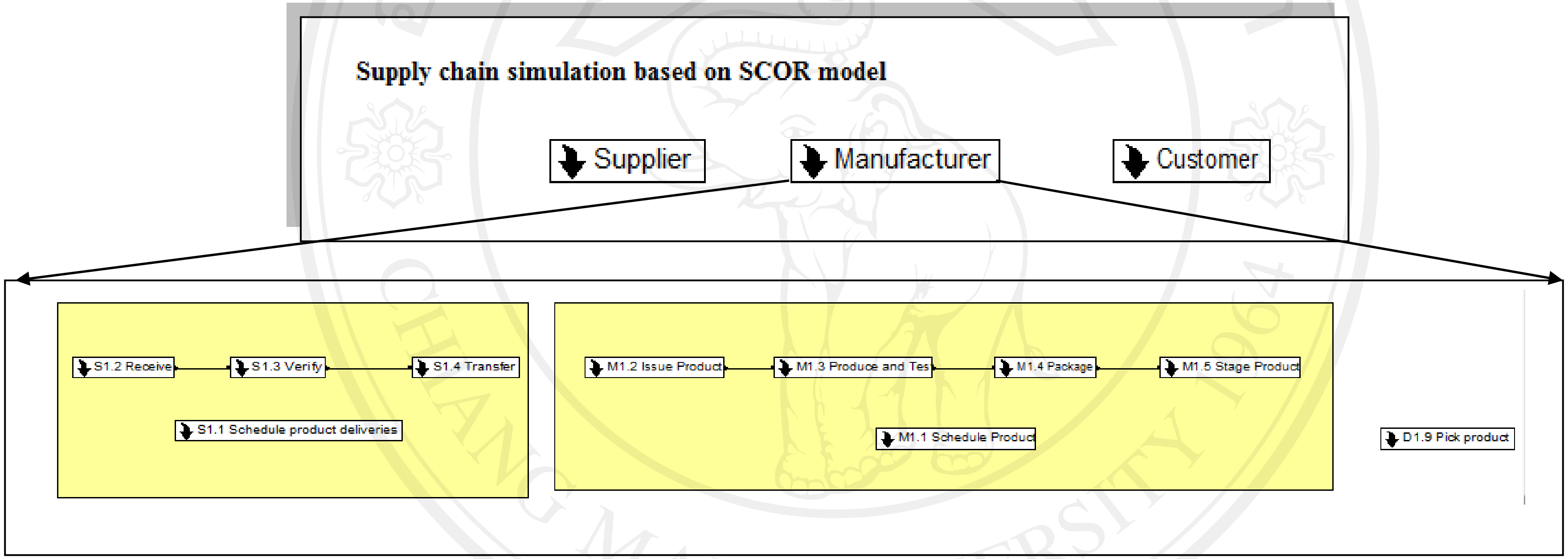


Figure 4.15 Supply chain simulation based on SCOR model for manufacturer

First, to be in the supply chain simulation, input data of supply chain and operational costs are provided to the simulation at the beginning of the run time. For example, demand quantity, lead time used along the supply chain system, or even transportation cost for Source, Make, Deliver and Return processes. However, simulation was completed by running for 10 replications within the 360,000-minutes run length (or 250 working days of one year). While running the simulation, a separate summary report was generated in the Excel file. This file contains outputs for supply chain cost calculation and NPV analysis. These outputs are provided as the initial cost of one year investment. However to estimate the future investment cost, analysis of net present value will be discussed in the following section.

4.4.3.2 Cost simulation

From the previous section, values of *Source*, *Make*, *Deliver* and *Return* cost at time 0 were presented. To obtain the NPV for future cost of investment, it is necessary to integrate values of net cash flow and real interest rate with the parameters of inflation and demand rate change as shown in the following formula.

$$\text{NPV} = \frac{NCF}{(1 + \text{r}_0)^t}$$

Where;

NCF	=	Net cash flow
r_0	=	Real interest rate = (r-*f*) / (1+*f*)
f	=	Inflation rate
t	=	Time, year

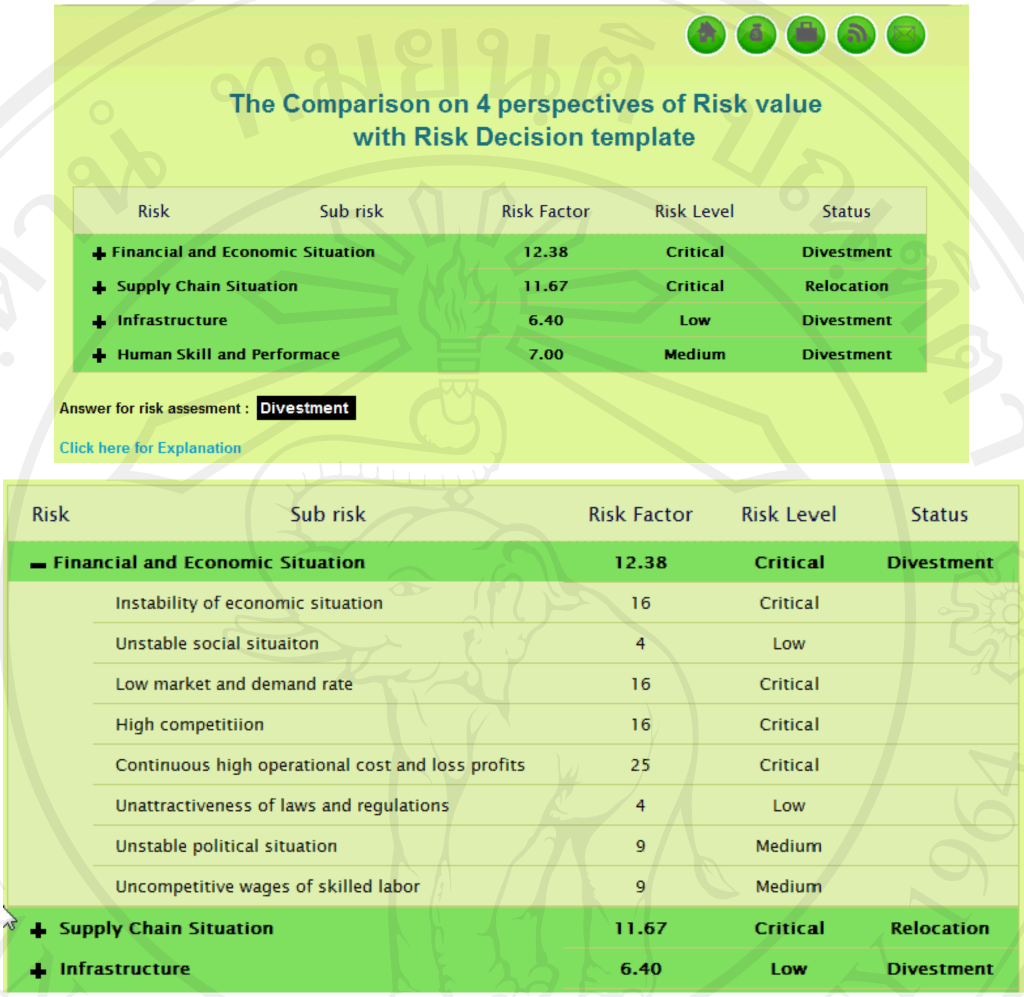
However, the value of net cash flow and real interest rate, both varied from time to time according to capability to produce, customer demand and inflation rate. Thus our cost simulation applies the forecasting technique of “Moving average” to estimate inflation and demand rate for the next 5 years plan. To calculate NPV (see Figure 4.16), the five-year term (n) is fixed. Each year, the net cash flow and interest rate will be allowed to vary in this simulation. Conducting a simulation of the NPV, it is necessary to estimate as realistically as possible, therefore demand rate change was included (C5:G5) to adjust the amount of the actual net cash flow (C12:G12) and integrate inflation rate (C17:G17) to obtain the real interest rate (C20:G20) for the next 5 year plan. By using the technique of moving average, both forecasting values of demand and inflation rate are estimated and used for NPV analysis. The forecasting approach to estimate those required values are given in Appendix D: Approach used on forecasting inflation and demand (GDP) rate.

	A	B	C	D	E	F	G	H
1								
2		Year						
3	**Thailand**	**0**	**1**	**2**	**3**	**4**	**5**	**Total**
4	Total revenue	**7,550,611**	8,003,647.55	8,465,458.02	8,899,736.01	9,253,055.53	9,561,182.28	51,733,690.30
5	Demand rate		6.0%	5.8%	5.1%	4.0%	3.3%	
6	Initial investment cost	1,300,000						
7	Total expenditure	**7,303,358**		8,188,247	8,608,304	8,950,054	9,248,091	33,049,963.94
8	-source cost (ordering + holding+ transporting cost of material)	1,038,336	1,100,636.55	1,164,143.27	1,223,863.82	1,272,451.22	1,314,823.84	7,114,255.07
9	-Make cost (Direct mat cost + Direct labor cost + indirect cost + additional cost)	5,475,311	5,803,829.98	6,138,710.97	6,453,626.84	6,709,835.83	6,933,273.36	37,514,588.27
10	-Delivery cost (Shipped finished good cost)	776,671	823,270.73	870,773.45	915,444.13	951,787.26	983,481.78	5,321,427.85
11	-Return cost	13,040	13,822.15	14,620	15,370	15,980	16,512	89,343.12
12	Net CF	-1,052,747	8,003,648	277,211	291,432	303,001	313,091	18,683,726.36
14	Interest rate (Thailand)	12%	12%	12%	12%	12%	12%	
17	Inflation rate (Thailand)		1.73%	3.03%	4.13%	3.93%	4.27%	
20	Real interest rate: (r-f)/(1+f)		10.092%	8.703%	7.554%	7.761%	7.417%	
21	**NPV: NCF/(1+r)n**	(฿2,352,747.03)	฿7,269,979.86	฿234,600.72	฿234,235.01	฿224,694.24	฿218,931.56	**฿5,829,694.35**

Figure 4.16 Spreadsheet simulates NPV for existing plant in Thailand

4.5 Designed user interface for knowledge based system

One of the main components of the system is referred to as user interface. User interface allows the decision maker to operate interactions with the system, for example, input of the values, evaluation on risk, or even accessment of charts or graphic facilities. Thus in this section, the design and main functional uses of user interface for the knowledge-based decision support system on FDIs' investment are described. The two modules of static and dynamic analysis focused on the KBDSS of FDIs' investment. Regarding the static analysis, it refers to the evaluation of existing risks of the situation of plant. The outcomes of the suggested scenario and information on critical and high risk levels are the main results from this analysis. Figure 4.17 illustrates the interface of those providing outcomes.



The Comparison on 4 perspectives of Risk value with Risk Decision template

Risk	Sub risk	Risk Factor	Risk Level	Status
+ Financial and Economic Situation		12.38	Critical	Divestment
+ Supply Chain Situation		11.67	Critical	Relocation
+ Infrastructure		6.40	Low	Divestment
+ Human Skill and Performace		7.00	Medium	Divestment

Answer for risk assesment : Divestment

Click here for Explanation

Risk	Sub risk	Risk Factor	Risk Level	Status
– Financial and Economic Situation		12.38	Critical	Divestment
	Instability of economic situation	16	Critical	
	Unstable social situaiton	4	Low	
	Low market and demand rate	16	Critical	
	High competitiion	16	Critical	
	Continuous high operational cost and loss profits	25	Critical	
	Unattractiveness of laws and regulations	4	Low	
	Unstable political situation	9	Medium	
	Uncompetitive wages of skilled labor	9	Medium	
+ Supply Chain Situation		11.67	Critical	Relocation
+ Infrastructure		6.40	Low	Divestment

Figure 4.17 Outcomes from static analysis

In terms of dynamic analysis, it is necessary to manipulate supply chain cost and evaluate NPV of future investment. User interfaces obtaining supply chain parameters are required for the initial input to manipulate supply chain modeling. The user interfaces on dynamic analysis are shown in Figure 4.18.

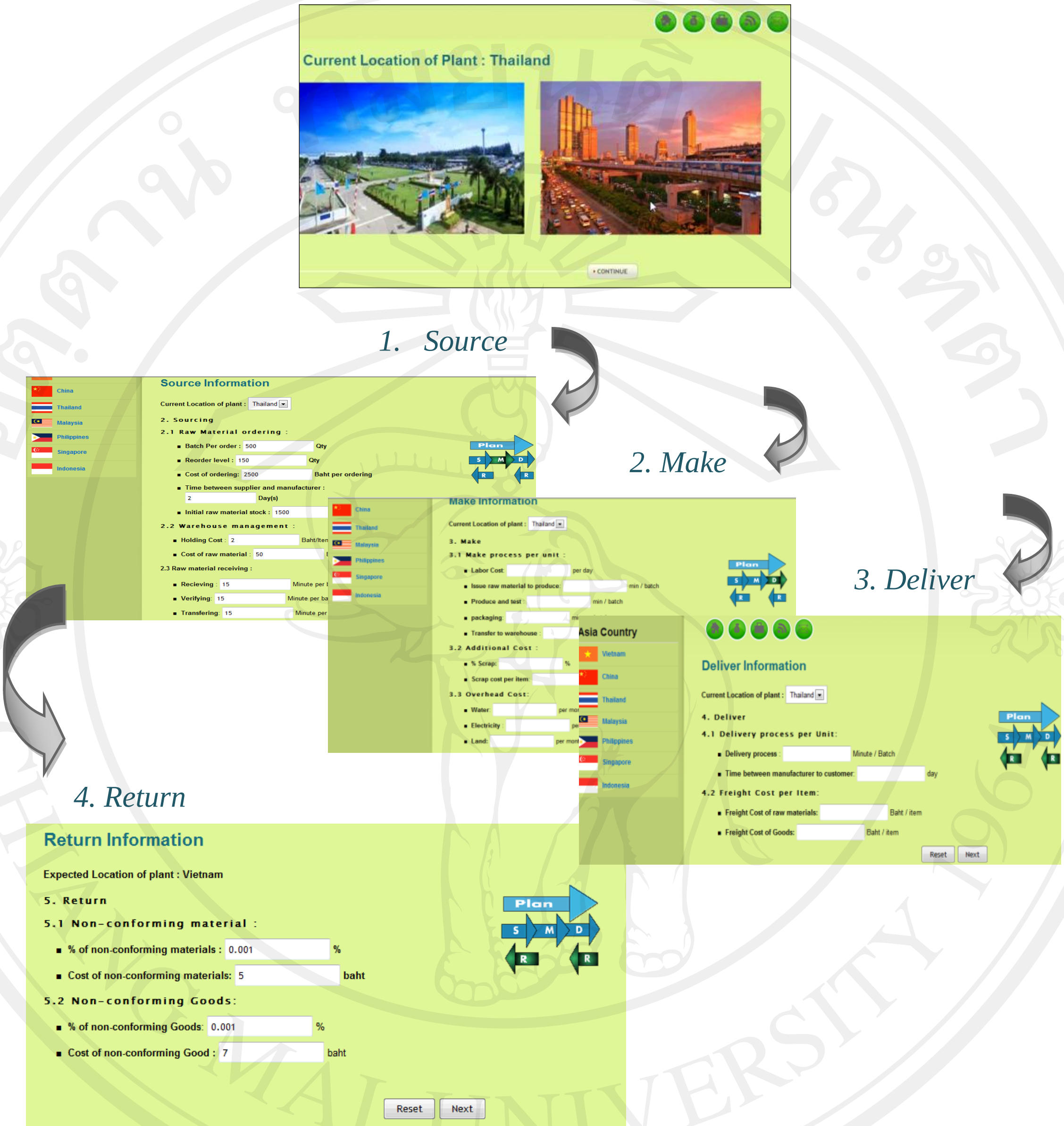


Figure 4.18 User interface on dynamic analysis

In addition, not only the major function is required to obtain the results but also provide supporting information to investors as shown in Figure 4.19. The KBDSS provides useful supporting information on the three main requirements of infrastructure, cost of doing business and human resources mainly from three countries: China, Vietnam and Thailand.

Figure 4.19 Homepage of the KBDSS

4.6 Conclusion

In summary, this chapter shows the application and obtained results from the proposed framework. The application of a knowledge based supporting system is mainly developed by integrating functions of the risk evaluation and the supply chain simulation according to the proposed methodology. This knowledge based system is performed via a web application by utilising PHP and JavaScript language as developing tools. However four components, namely a user interface, database, model base, and a procedure, are the main parts required to construct the system. The results from the knowledge based system can help decision makers who are faced with business crises to make a good decision on the investment of plants by suggesting the possible scenario of the existing situation of plant and estimating the supply chain cost of investment. Thus in the next chapter, the research framework is applied to a case study. The application will be demonstrated by scenarios from the manufacturer in Lumphun Industrial estate area, Thailand.