CHAPTER III
RESEARCH METHODOLOGY

This chapter will discuss on research methodology. There are consists of 7 main steps for this research.

3.1 Step of research methodology

In this section, research methodology will be consisted of 7 main steps as following:

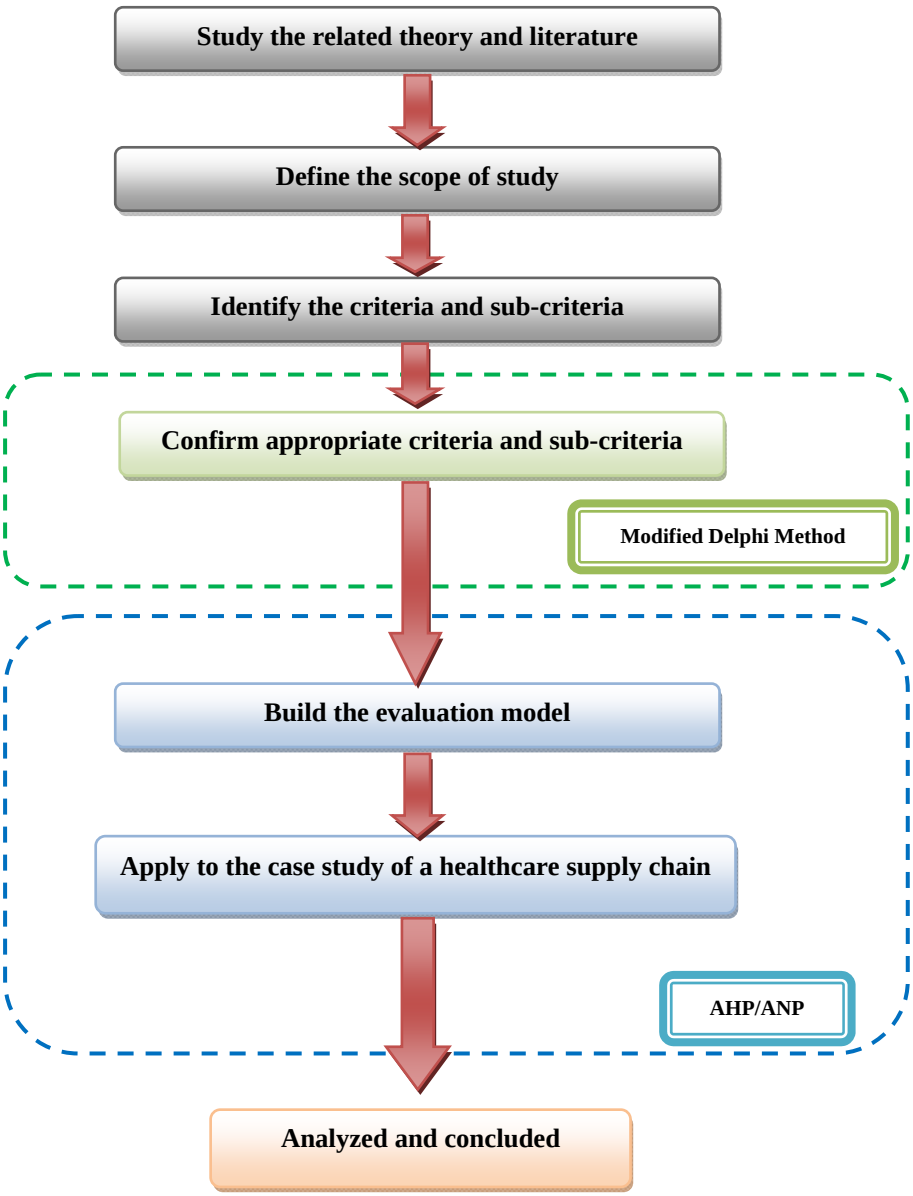

Figure 3.1 Steps of research methodology

3.1.1 Study the related theory and literature

This study presents a case of healthcare supply chain in Thailand. The structure of healthcare supply chain and the performance measurement methods are reviewed by literatures related topic. It useful to identify the appropriate of theory that suited to supply chain improvement.

3.1.2 Define the scope of study

As reviewed in the previous step, the research objective is to study the appropriate criteria and sub-criteria and to present a framework for analyzing the priorities of the performance improvement in a healthcare supply chain. The scope of this study is the study of performances in supply chain processes between distributors and providers as study area.

3.1.3 Identify the criteria and sub-criteria

The main criteria adopted in this study are based on reviewing relevant literature and opinions from healthcare supply chain experts. The first of two questionnaires is developed based on an extensive review of the literature about healthcare supply chain. The criteria and sub-criteria used that used to build the proposed performance measurement model for healthcare supply chain is determined in this step. After identifying the criteria and sub-criteria for evaluating healthcare supply chain performance, research identified the interrelationship among the criteria. When endeavoring to maximize the outcome from performance improvement activities, these interrelationships are base for prioritizing improvement attempts.

3.1.4 Confirm appropriate criteria and sub-criteria

The proposed framework is built in 3.1.4. The criteria and sub-criteria of the proposed framework will be confirmed by experts in this step. The panel of experts is consists of who related in logistics and supply chain academic, purchasing or procurement department and supply chain management such as academic, scholar, executive, supply analyst, doctor, pharmacist and staff. These experts were invited to confirm criteria and sub-criteria through Delphi process. There are consisted of six criteria and 39 sub-criteria. The six criteria are quality, cost, time, flexibility, innovativeness, and collaboration.

3.1.4.1 Select panelists

The Collecting of data in the first and second round can collect from the answers of who are panelists and there are categories panelists according to field works as following Table 3.1. All panelists are who have well knowledge in healthcare supply chain field.

Table 3.1 Expert lists for criteria and sub-criteria evaluation

Groups of experts	Number of experts
Logistics and supply chain academics	4
Hospital and GPO or distributor executives	2
Supply chain analysts	4
Warehousing and procurement managers	8
Total	**18**

3.1.4.2 Form a questionnaire based on Delphi technique

A Questionnaire is generated based on Delphi technique. The data will be collected through a questionnaire and an interview. There are 18 experts needed. There are 2 rounds and 2 questionnaires with 6 sections each. The first questionnaire has developed from the extensive review of the literatures about performance measurement in healthcare supply chain. In the first round, questionnaire consists of 39 items as following:

For Section 1, it is a questionnaire about the criterion which affects to the quality performance in healthcare supply chain. Quality criterion consists of 9 sub-criteria as following:

1. Backorders
2. Delivery accuracy
3. Fill rate
4. Delivery reliability
5. Distribution planning
6. Delivery invoice method
7. Driver reliability
8. Accuracy of forecasting techniques
9. Customer Dissatisfaction

For Section 2, it is a questionnaire about the criterion which affects to the cost performance in health care supply chain. Cost criterion consists of 10 sub-criteria as following:

1. Overhead cost

2. Warehouse cost

3. Distribution cost

4. Return on investment

5. Transport productivity

6. Purchase cost

7. Transaction cost

8. Administrative cost

9. Economic order quantity

10. Inventory investment cost

For Section 3, it is a questionnaire about the criterion which affects to the time performance in healthcare supply chain. Time criterion consists of 3 sub-criteria as following:

1. Customer response time

2. Lead time

3. On-time delivery

For Section 4, it is a questionnaire about the criterion which affects to the flexibility performance in healthcare supply chain. Flexibility criterion consists of 6 sub-criteria as following:

1. Volume flexibility

2. Order flexibility

3. Transport flexibility

4. Resource flexibility

5. Responsiveness to urgent deliveries

6. Flexibility of service system to meet particular customer needs

For Section 5, it is a questionnaire about the criterion which affects to the innovativeness performance in healthcare supply chain. Innovativeness criterion consists of 2 sub-criteria as following:

1. New technology

2. New product launched

For Section 6, it is a questionnaire about the criterion which affects to the collaboration performance in healthcare supply chain. Collaboration criterion consists of 5 sub-criteria as following:

1. Information sharing/Transparency of information
2. Decision synchronization
3. Incentive alignment
4. Buyer-Supplier relations
5. Supplier ability to respond to quality problem

All 6 sections are close-ended question. The example of questionnaire in Table 3.1 consists of 5 Likert scales as following:

Strongly agree, responses in the "5" range mean that the dimension is very high agree among respondents.

Agree, responses in the "4" range mean that the dimension is somewhat agree among respondents.

Neither agree or disagree, responses in the "3" range mean that the dimension is neutral agree among respondents.

Disagree, responses in the "2" range mean that the dimension is not significant among respondents.

Strongly disagree, responses in the "1" range mean that the dimension is not very significant among respondents.

Table 3.2 Example of questionnaire (Quality criterion)

No.	Criteria and Sub-Criteria' Descriptions	Rating				
		1	2	3	4	5
1.	Quality					
1.1	Backorders…… For this study, it means the number of medicines and medical appliances that cannot send to customers (providers such as hospitals) according customer requested in that time and need for delivering the orders to customers (providers such as hospitals) later.	…	…	…	…	…
1.2	Delivery accuracy……..... For this study, it means the accuracy of medicines and medical appliances	…	…	…	…	…

	delivering to customer (providers such as hospitals).					
1.3	Fill rate……..... For this study, it means the number of medicines and medical appliances that can fill the customer (providers such as hospitals)'s order.	…	…	…	…	…
	⋮					
1.9	Customer Dissatisfaction……..... For this study, it means the satisfaction of customers (providers such as hospitals) perceived.	…	…	…	…	…

Additionally, a cover letter is the important thing. It can introduce about the surveying, objectives of surveying, the facts involving this study and it can guarantee that the information given by the respondent will be confidential (App. B). The cover letter will be attached together with the questionnaires.

In the second round, questionnaire is generate by summary the results of respondents from close-ended questions in the first round questionnaire and providing the answers for this second round which respondents have consensus. Panelists will be considered the item that have median more than 3.50 and interquatile range that have lower 1.50 with opinions among panelists. These panelists can change or reconfirm your answer in this round.

3.1.4.3 Statistics and data analysis

Data analysis is based on Delphi technique. Data analysis for first and second round, it will be analyzed base on median and interquartile range through using Microsoft Excel 2007 and SPSS Version 17 program. For median, researcher will interpret according the standard of Wongwanij (2005) as Table

Table 3.3 Median with descriptions

Median	Descriptions
< 1.50	The criterion is strongly disagree among respondents.
1.50 - 2.49	The criterion is somewhat disagree among respondents.
2.50 – 3.49	The criterion is neither agree or disagree

	among respondents.
3.50 – 4.49	The criterion is somewhat agree among respondents.
≥ 4.50	The criterion is strongly agree among respondents.

Wongwanij, 2005

For Interquartile Range, it is calculate to find the different between first and third quartile. If the result of the interquartile range is less than or equal to 1.50 below, means that consensus among experts to each criterion is received. At the same time, if the result of the interquaretile range is more than 1.50 above, means that consensus among experts to dimension is not received. The sub-criteria that received the consensus of both median and interquartile range, those will be recognized and summed for further studies in the future.

When more than 70% reviewers judge that a criterion would be appropriate for evaluating the performance of an upper level criterion, it will be listed in the reformed evaluation model. The reformed evaluation model is structured by objective in the first level, criteria in the second level, and sub-criteria in the third level.

3.1.5 Build the evaluation model

The initial evaluation model proposed based on ANP model by the criteria and sub-criteria confirmed in 3.1.4. The initial evaluation model is structured by objective in the first level, criteria in the second level, and sub-criteria in the third level as Figure 2.3. However, performance evaluation model in healthcare supply chain usually encompass several interdependent criteria, and each criterion has numerous sub-criteria. An incomplete measurement model can result in appropriate actions that may harm company competitiveness. To accurately evaluate the influence of these criteria in terms of goal and sub-criteria with respect to upper level criteria, the analytic network process (ANP) are utilized. Figure 3.2 proposes the hierarchical ANP-based structure of Healthcare supply chain performance measurement.

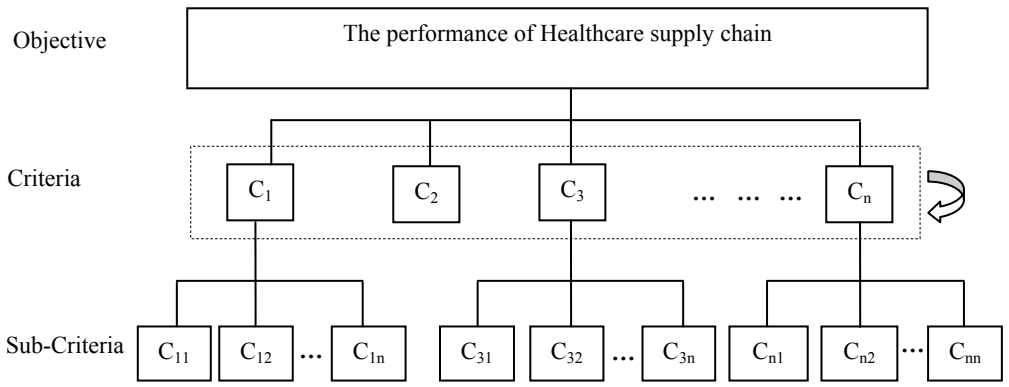

Figure 3.2 The hierarchical of ANP-based structure of Healthcare supply chain for performance measurement.

3.1.5.1 Select experts of healthcare supply chain

Experts will be selected from reviewing their profile and fieldwork. These experts, who are selected, are a part of a supply chain at working areas.

3.1.5.2 Determine criteria and sub-criteria weights

In this step, selected experts are invited to form the Pair-wise comparison matrices. The local weights of the criteria and sub-criteria which are a part of the second and third level of ANP-based model as Figure 2.3 in the chapter 2 are calculated.

3.1.6 Apply to the case study of a healthcare supply chain

For this section, An ANP-based framework that was built in 3.1.5, it will be utilized in the real case study of a healthcare supply chain.

3.1.6.1 Select experts of healthcare supply chain

Experts will be selected through reviewing their profile and fieldwork. These selected experts who are a part of a supply chain at working areas.

3.1.6.2 Design a questionnaire and Send to panelists

The questionnaire consists of criteria and sub-criteria that come from the previous ANP-model. A Questionnaire is generated with 5-point Likert scale. The scale has integer values between 1 and 5, where 1 indicates “low

performance", 3 indicates "moderate performance", and 5 indicates "high performance". Even numbered values fall between performance level.

3.1.6.3 Calculate the performance rating

The data are collected from panelists. The overall performance of a healthcare supply chain is calculated using the following procedure: first, a sub-criterion score (SCS) is combined with a total weighted score of each criterion (CS) and is formulated as follows:

$$CS_{ij} = \sum_{j=1}^{m} \sum_{k=1}^{n} SCS_{ijk} SCW_{jk'} \quad (3.1)$$

Where

CS_{ij} indicates the total weighted score of criterion j (j = 1, …, m) of supply chain i;

$SCS_{ijk'}$ the score of sub-criterion k of criterion j of supply chain i;

$SCW_{jk'}$ the weighted value of sub-criterion k of criterion k of criterion j;

i, the number of supply chains (i = 1);

j, the number of criteria (j = 1, …, 6);

k, the number of sub-criteria (k = 1, …, m); and

m indicates the total number of a main criterion j

n indicates the total number of a sub-criterion k with respect to an upper criterion j.

Then, the final weighted score for overall supply chain performance (FWS_i) can be formulated as follow:

$$FWS_i = CS_{ij} * CW_j \quad (3.2)$$

Where

SC_i indicates the final weighted score of main criteria I; and CW_i indicates the weighted value of criterion j.

3.1.7 Analyze and conclude

The appropriate priorities of criteria and sub-criteria are identified for supply chain improvement and the results from the previous section will be analyzed and concluded. The limitations and suggestions for future research will be presented in this research.

3.2 Research Time

Table 3.4 Research time

Activities	**Month**							
	2	4	6	8	10	12	14	16
1. Study the related theory and literature	■	■						
2. Define the scope of study		■						
3. Identify the criteria and sub-criteria			■					
4. Confirm appropriate criteria and sub-criteria				■	■			
5. Building the evaluation model						■		
6. Apply to the case study of a healthcare supply chain							■	
7. Analyzed and concluded								■