CHAPTER III
RESEARCH METHODOLOGY

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

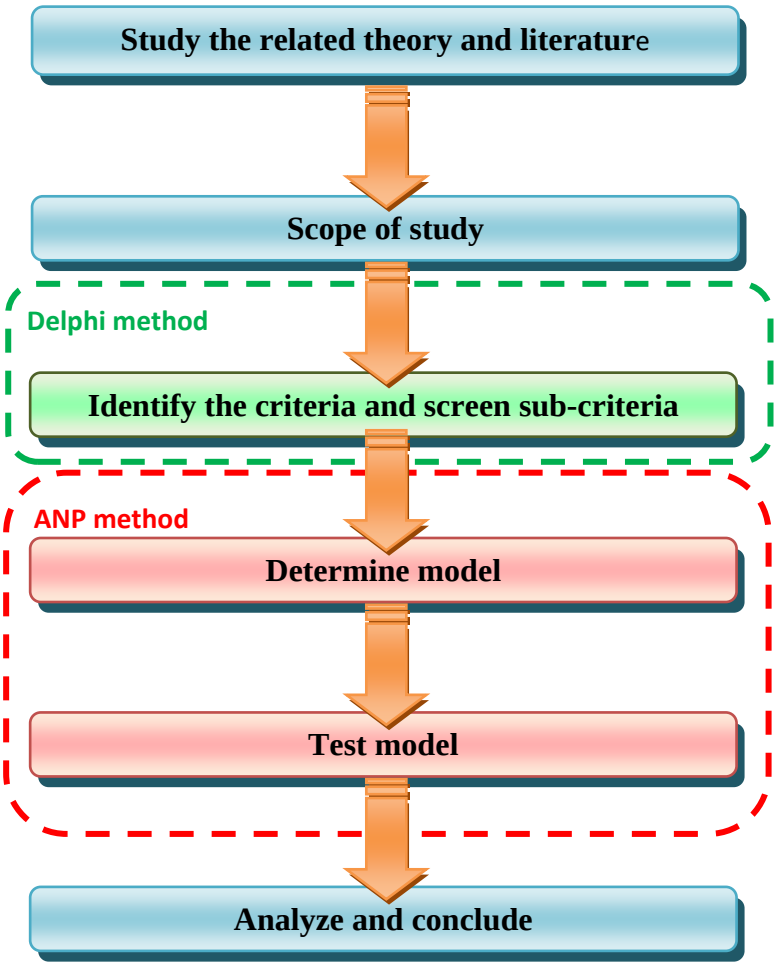

Figure 3.1 Steps of research methodology

3.1 Research methodology

In this research, methodology consists of 6 main steps to achieve the objectives. They can be explained as followed in Figure 3.1.

3.1.1 Study the related theory and literature

In order to achieve the successfulness in this research, this step presents literature review that relate to material handling system and the background theory. It is useful to indentify theory that is suitable for alternative selection or project analysis.

3.1.2 Scope of study

This research focuses on conveyor system which is a part of material handling equipment. The research objective is to study criteria to support decision making for conveyor system investment and to present model support decision making for selected kind of conveyor system.

3.1.3 Identify the criteria and screen sub-criteria

The main criteria in this study are based on reviewing relevant literature. Sub-criteria of the proposed in this study will be screened and confirmed by group of experts. The panel of experts is comprise of people who related in 3 main group that are: faculty of teachers in department of engineering, executive or engineers who are user in conveyor system and executive or engineers who produce and service in business of conveyor system. Those supporters are screen and confirm sub criteria through Delphi method.

3.1.3.1 Panelist selection

The panelist in this research are consists of people 3 group who are experts of conveyor system or related in business of conveyor system.

- Faculty of teachers in department of engineering.
- Executives or engineers who are user in conveyor system.
- Executives or engineers who are produce and service in business of conveyor system.

3.1.3.2 Series of questionnaires based on Delphi method

Each round of questionnaire is based on Delphi method. The first is open-ended questions by number of experts in this round is 15 person. For this round have 4 criteria consists of the first criteria is benefit, second criteria is opportunity, third criteria is cost and finally criteria is risk.

Benefit (positive) is the benefits gained that should be considered in selecting the conveyor system and it can be separated into two parts:

- Technical
- Benefit from used

Opportunity (positive) is the opportunities occurred of buyer and user that should be considered in selecting the conveyor system.

Cost (Negative) is the costs that should be considered before selecting, during implementing and after running of the conveyor system.

Risk (Negative) is the risks or uncertainties occurred that should be considered in selecting the conveyor system.

All 4 criteria are open-ended question. The questionnaire of the first round as Appendix A.

In the second round, questionnaire of this round is different from the first round because it built as open-ended question. Criteria in this questionnaire is generate by summary the answers from the first round and respondents will be considered criteria each based on Likert scales as following:

Level of agreement

1 ➔ Strongly Disagree

2 ➔ Disagree

3 ➔ Neither agree nor disagree

4 ➔ Agree

5 ➔ Strongly agree

Questionnaire in this round, it consists of 4 sections as same as the previous round. The questionnaire of the second round as Appendix B.

Final round, questionnaire is the same as the previous round just increased median, interquatile range and previous answer of respondents for each item. Each respondent can change or reconfirm own answer in this round.

3.1.3.3 Statistics and data analysis

Data analysis based on Delphi technique. Data analysis for second and third round, it will be analyzed base on median and interquartile range through using Microsoft Excel 2007. Meaning of median of Delphi technique as follow Table 3.1.

Table 3.1 Meaning of median range

Median	Meaning
< 1.50	The dimension is strongly disagreed among experts.
1.50 - 2.49	The dimension is somewhat disagree among experts.
2.50 – 3.49	The dimension is neither agreed nor disagreed among experts.
3.50 – 4.49	The dimension is somewhat agreed among experts.
≥ 4.50	The dimension is strongly agreed among experts.

Source: Wongwanij, 2005

For Interquaretile Range (IQR), it is calculate to find the different between the 1st quartile (25th percentile) and 3rd quartile (75th percentile). Meaning of interquartile range (IQR) as follow Table 3.2.

Table 3.2 Meaning of interquartile range

Interquartile range	Meaning
≤ 1.50	The result is consensus among experts to criterion is received
> 1.50	The result is consensus among experts to dimension is not received

Source: Wongwanij, 2005

3.1.4 Determine model

This step will proposed model base on ANP model. The ANP model formed by the criteria and sub criteria determined previous step. ANP model is structured by the first level is an objective, the second level is a criteria, the third level is a sub-criteria, and the final level represents the alternatives. Figure 3.2 and 3.3 presents the network of the decision problem.

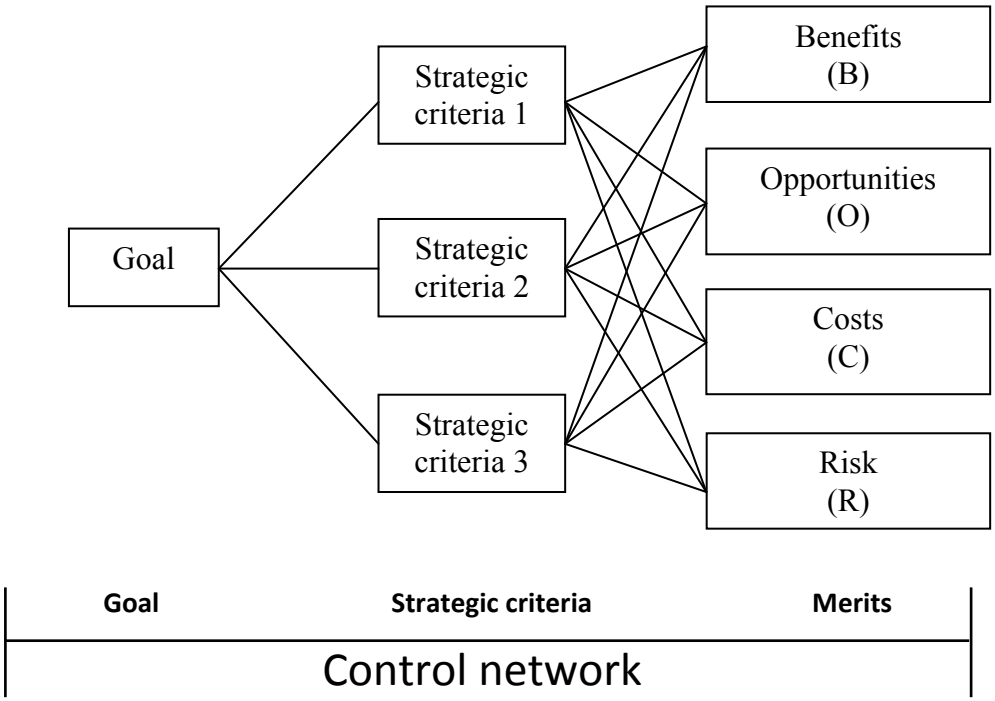

Figure 3.2 The network of the decision problem (Control network)

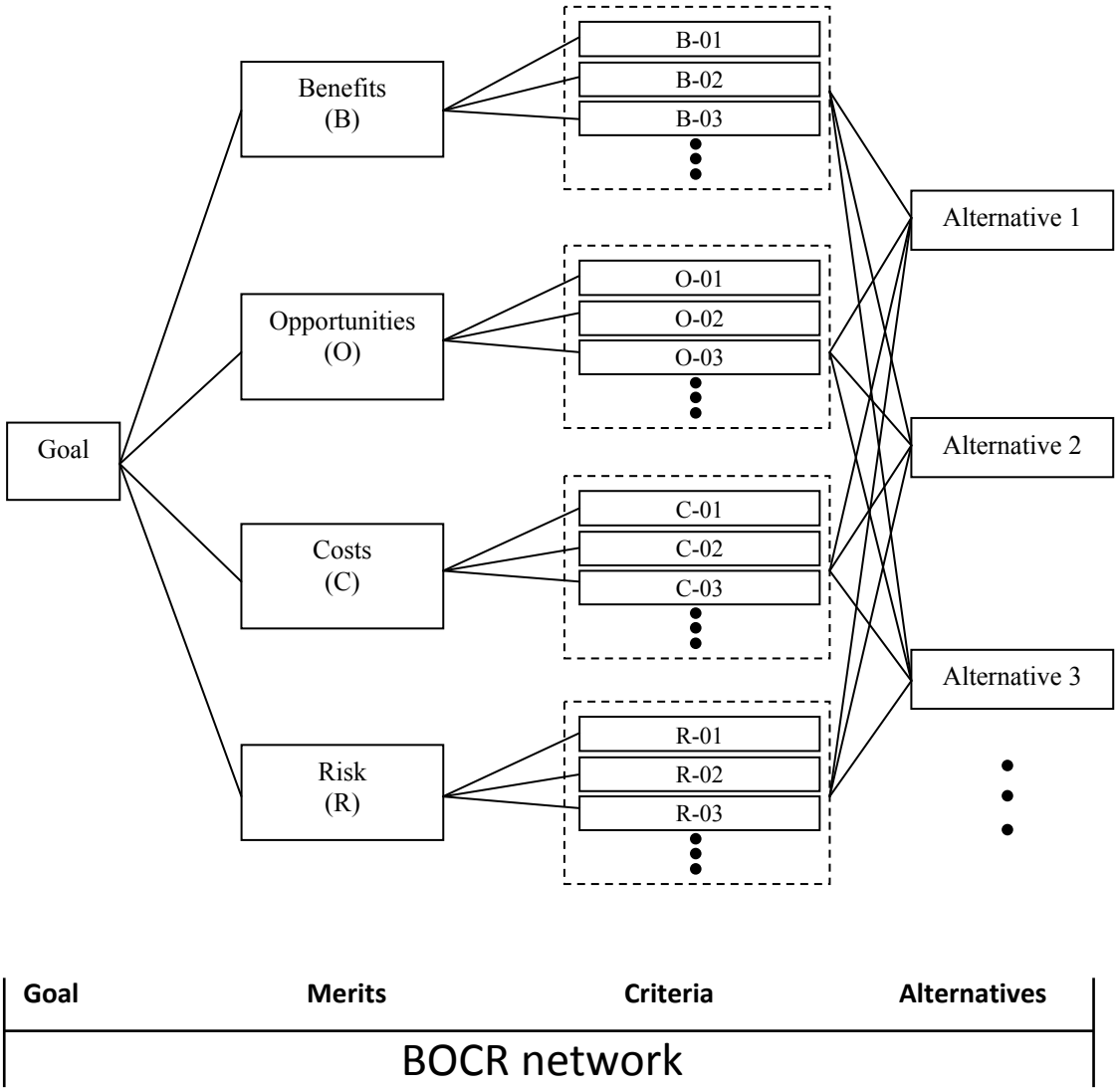

Figure 3.3 The network of the decision problem (BOCR network)

3.1.5 Test model

For this step, multi criteria decision making methodology for conveyor selection system was built in previous step. It will be advantaged in the case of conveyor selection system and verify the model. There are five ways to combine the scores of each alternative under B, O, C and R, It consist of

1. Additive

$$P_i = bB_i + oO_i + c[(1/C_i)_{Normalized}] + r[(1/R_i)_{Normalized}]$$

2. Probabilistic additive

$$P_i = bB_i + oO_i + c(1 - C_i) + r(1 - R_i)$$

3. Subtractive

$$P_i = bB_i + oO_i - cC_i - rR_i$$

4. Multiplicative priority powers

$$P_i = B_i^b O_i^o [(1/C_i)_{Normaltzed}]^c [(1/R_i)_{Normaltzed}]^r$$

5. Multiplicative

$$P_i = B_i O_i / C_i R_i$$

3.1.6 Analyze and conclude

After the previous step, the model has been tested already and next step will be discussed the results and research limitations. After that, these will be recommended for the future research.

3.2 Research schedule

Table 3.3 Demonstrate research time

Activities	Month							
	2	4	6	8	10	12	14	16
1. Study the related theory and literature	■							
2. Scope of study	■	■						
3. Identify the criteria and screen sub-criteria			■	■	■			
4. Determine model					■	■		
5. Test model							■	
6. Analyze and conclude								■