CHAPTER III
RESEARCH METHODOLOGY

3.1   General

Upon completion of this master's degree project thesis, thorough planning and scheduling have been organized on the methodology and research sequence to ensure a smooth running of the research program from literature review, data collection, until discussion and validation of result and conclusion.

3.2   Literature Review

Literature review involves a thorough search and investigation of manager related issues through many different sources such as text books, articles, journals, international conference papers, and project management manuals. Additionally, there is also searching and browsing through internet web pages, internet websites, online library, electronic database, online articles and journals to seek complementary information. The aim of literature review is to gather important information related to the topic and to deepen the proper understanding of the knowledge and competencies of construction project managers.

3.3   Data Collection

In spite of literature review, interviews with mainly practical contractors, consultants, and owners in construction projects are needed to gain practical information, hands-on issues and experiences related to the knowledge and competencies of construction project managers. On the other hand, a series of question are set for conducting a survey to obtain feedback and response from pertinent respondents.

The tool utilized to gather the useful data is questionnaire method. A questionnaire will be developed based on relevant literature reviews. The questions are structured according to the purpose of the research. The pattern questions are composed of open-end question and closed-end question. The questions are prepared on multiple choices with check-boxes for respondents' answers.
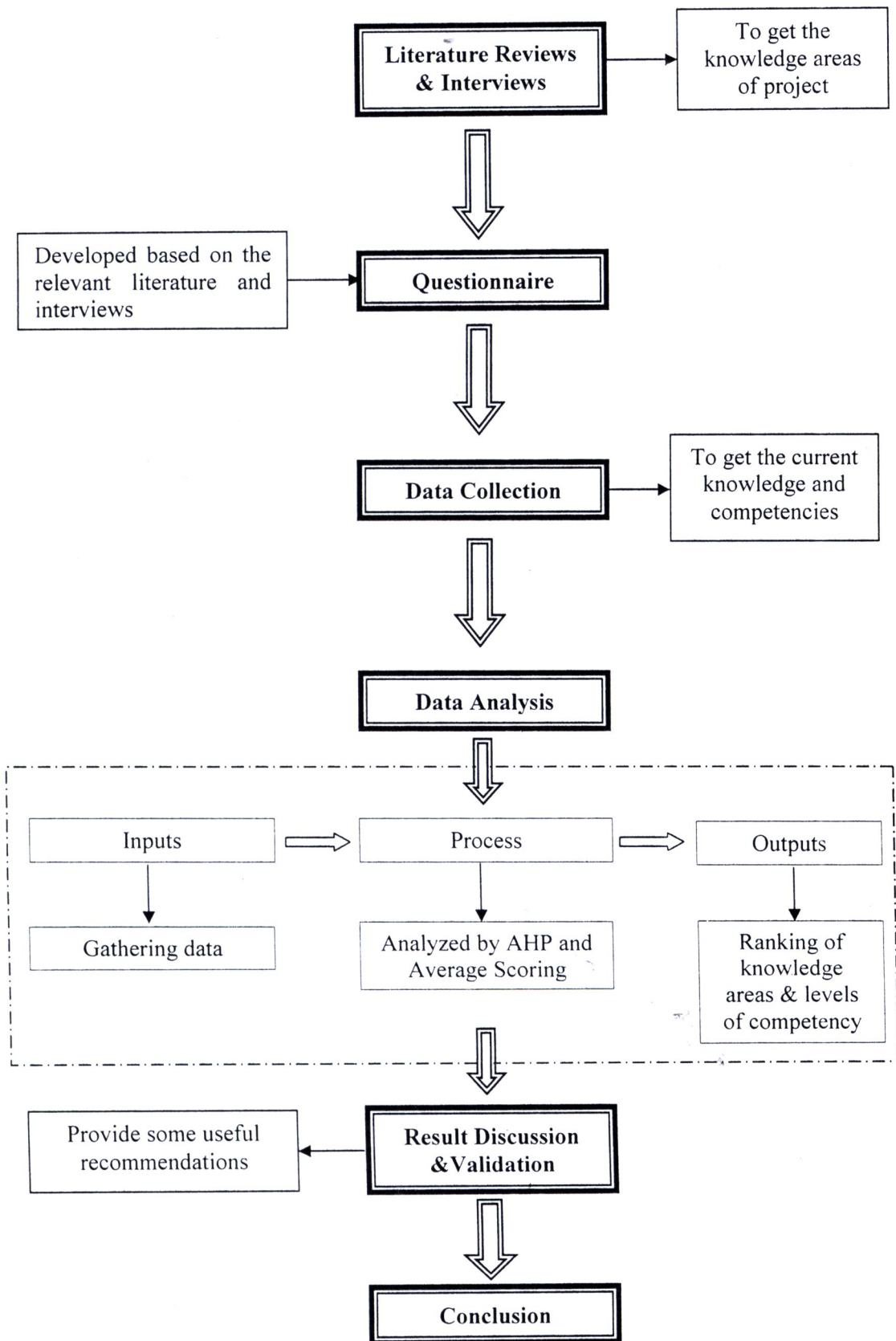
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│ & Interviews        │         │ knowledge areas  │
└─────────────────────┘         │ of project       │
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┌──────────────────┐   ┌─────────────────────┐
│ Developed based  │──▶│ Questionnaire       │
│ on the relevant  │   └─────────────────────┘
│ literature and   │           │
│ interviews       │           ▼
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│ Data Collection     │────────▶│ To get the       │
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         │                      │ knowledge and    │
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│              │ Scoring    │ │ levels of    │   │
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Figure 3.1 Framework of research methodology

The questionnaire is clearly designed and given to those who play a role as contractors, consultants, and owners in Cambodia, Lao PDR, and Thailand. They will be asked to describe personal information and current knowledge and competencies that construction project managers possess.

The project managers working in construction projects need to develop their competencies to apply the knowledge that they are presently utilizing in their works. Simultaneously, the interview is also conducted with managers in construction projects as shown in Figure 3.2. The interviews are accordingly conducted following the questionnaire which consists of the name of the respondent's organization, the profession, the role of the organization in the construction industry. It also contains the number of years the construction project managers have been working in the construction industry. The data collection is an extremely crucial step of the research methodology because it is the significant information which delineates the current knowledge and competencies of construction project managers in pertinent countries: Cambodia, Laos PDR, and Thailand.
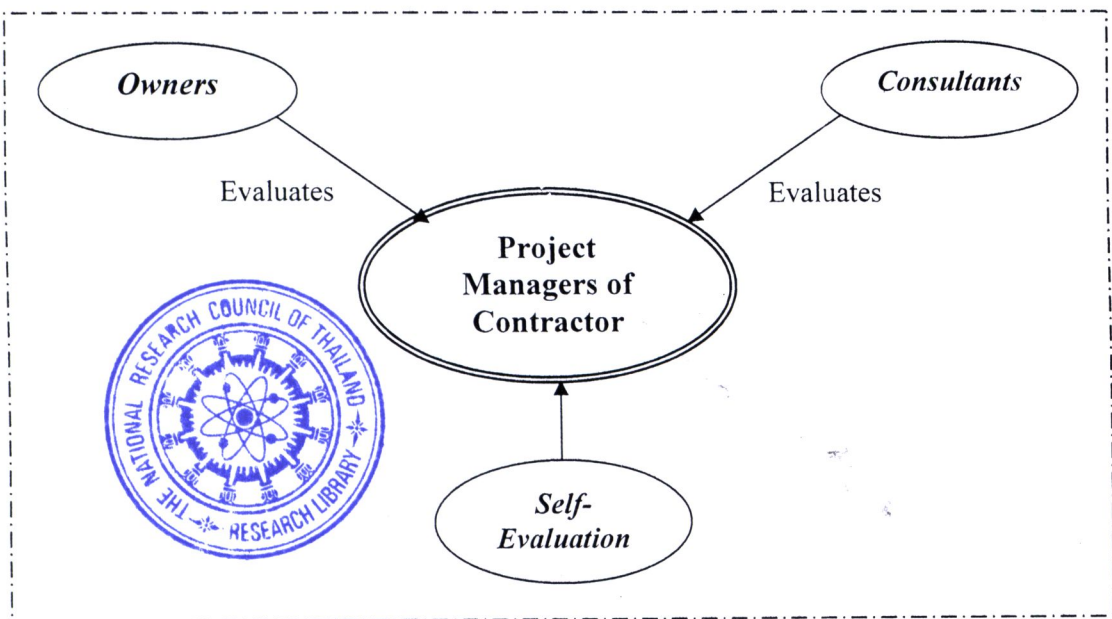
Figure 3.2 Scope of interview

3.4 Sample Size

According to *Yamane (1973)*, he provided a simplified formula to calculate sample sizes. In this case, this formula is used for calculating the sample sizes for 85% confidence level because the necessary data was collected from opinion or feeling of evaluation of respondents.

$$n = \frac{N}{1 + Ne^2}$$

Where,
n : Sample size (Construction project)

N : Population size (Total construction project)

e : The error of sampling was appropriately taken 15% because the data was collected from the opinions of respondents which often vary.

The estimated sample size was attempted to conduct the interviews with questionnaire, whereas the questionnaires which were responded to are the real sample size shown in Table 3.1.

Table 3.1 Sample size in each country

Country		Construction Project	Estimated Sample Size	Reponded Sample Size
Cambodia	Phnom Penh City	211	37	14
	Siem Reap Province			
Lao PDR	Vientiane City	116	32	11
Thailand	Bangkok City	Unknown	Unknown	12 (Assumption)

3.5   Data Analysis

After compilation of responses, every type of crucial data received under different respondents will be appropriately analyzed by an analysis tool. In this case of study, there are 2 main types of data; knowledge and competencies, which are taken into account for analysis.

3.5.1   Knowledge Analysis

One interestingly statistical method utilized for analyzing this kind of data is called Analytic Hierarchy Process (AHP).

- **Fundamentals of AHP**

AHP was introduced by Saaty (2000), an American mathematician, as a management tool for decision making in multi-attribute environment. The fundamental approach of AHP is to break down a "big" problem into "small" problems; while the solution of these small problems is relatively simple, it is conducted with a view to the overall solution of the big problem. The main uniqueness of AHP is its inherent capability of weighting a great number of different-nature factors (qualitative and quantitative) in order to make a decision, thereby producing a formal and numeric basis for solution. Although the current study did not deal with decision making, the use of AHP was deemed suitable here given the instrument AHP provides for weighting multiple varied factors.

- **Prescription and benefits of AHP**

AHP is a method for formalizing decision making where there are a limited number of choices but each has a number of attributes and it is difficult to formalize some of those attributes. The AHP has been also used in a large number of applications to provide some structures on a decision making process. Furthermore, an unscrupulous case can easily manipulate the ranking to get a preferred outcome (by using a non-management science technique called "lying"). Despite the rather arbitrary aspects of the procedures, however, it can provide useful insight into the tradeoffs embedded in a decision making problem. AHP helps capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team thus

reducing bias in decision making. AHP allows organizations to minimize common pitfalls of decision making process, such as lack of focus, planning, participation or ownership, which ultimately are costly distractions that can prevent teams from making the right choice.

- **Review steps of AHP**

    1. *Step 1:* decompose the decision-making problem and find out the criteria or factor of the problem. Then construct the linear hierarchy of the problem consisting of a finite number of levels or components. Each level consists of a finite number of decision elements. The goal, or focus, of the problem lies at the first level. Usually, the criteria occupy the second and third levels respectively. Lastly, the decision alternatives are placed at the lowest level of the hierarchy.

    2. *Step 2:* Construct pairwise comparison matrices for all the criteria, sub-criteria, and alternatives. The typical form of a pairwise comparison matrix is as follows:

'O'	F_1	F_2	...	F_n
F_1	a_{11}	a_{12}	...	a_{1n}
F_2	a_{21}	a_{22}	...	a_{2n}
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
F_n	a_{n1}	a_{n2}	...	a_{nn}

Where $a_{ij} = \dfrac{w_i}{w_j}$ (for $i, j = 1,2,...,n$) represents the strength of importance/preference of the factor (criterion/alternative) F_i over F_j with respect to the objective 'O', $a_{ji} = \dfrac{1}{a_{ij}} w_i, i = 1,2,...,n$ are the priority weights (to be determined) of the factors. The entries a_{ij}s normally taken from the (1/9-9) ratio-scale. The semantic interpretation of the matrix elements is provided in Table 1.

Table 3.2 Saaty's nine scale and its description

Intensity of importance	Definition	Description
1	Equal importance	Two criteria contribute equally to the objective in the immediate higher level
3	Weak importance of one over another	Experience and judgment slightly favor one criterion over another
5	Strong importance	Experience and judgment strongly favor one criterion over another
7	Very strong importance	A criteria is favored very strongly, its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one criterion over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between adjacent scale values	When compromised is needed

3. **Step 3:** Determine the weights of the criteria, sub-criteria, alternatives, from the pairwise comparison matrices obtained in Step 2 by using the eigenvalue method. This is done by solving the following linear simultaneous equations:

$$a_{ij} = \frac{1}{\lambda_{max}} \sum_{j=1}^{n} a_{ij} w_j, i = 1, 2, ..., n$$

where λ_{max} is the largest eigenvalue of the pairwise comparison matrix A.

For uniqueness, we normalize the set of weights such that $\sum_{i=1}^{n} w_i = 1$

4. **Step 4:** Using the principle of hierarchy composition, synthesize all the local set of weights and obtain the set of overall or global weights for the alternatives. The alternative that receives the overall highest weight with respect to the goal of the problem is selected as the best.

5. ***Step 5:*** Find consistency ratio to ensure the perception of respondent is consistent.

Consistency Index, $CI = \dfrac{\lambda_{max} - n}{n - 1}$

Random Index, RI = 1.56 (n=13)

Consistency Ratio, $CR = \dfrac{CI}{RI}$

$CR \leq 10\%$, the result is acceptable.

$CR > 10\%$, the result is not acceptable.

Remark: The total ranking of knowledge areas would be obtained from average of weight of all respondents by simultaneously checking the variances of all respondents in order to ensure that they do not have quite different variances.

3.5.2 Competency Analysis

The successively main data gathered from the perceptions of main stakeholders (contractors, consultants, and owners) is the evaluation which delineates the ability of construction project managers of how to apply those kinds of important knowledge for carrying out in their current construction projects.

In the developed questionnaire, the level of competencies of construction project managers is divided into 5 levels: (1) Very Low, (2) Low, (3) Medium, (4) High, and (5) Very High, which will be evaluated by opinions of three principle actors in project (the contractors, the consultants, and the owners).

The method used to analyze the level of competencies of construction project managers is Scoring tool. The mean item score for each knowledge area is calculated to obtain the relative level index as follows:

$$\text{Relative Level Index} = \dfrac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N} \quad \text{(Gushgar, 1997)}$$

Where n_1 = number of respondents for very low level, n_2 = number of respondents for low level, n_3 = number of respondents for medium level, n_4 = number of respondents for high level, n_5 = number of respondents for very high level and N = total number of respondents.

Table 3.3 Relation between Average Level Index and Level

Average Level Index (ALI)	Level
$1.00 \leq ALI < 0.80$	*Very High*
$0.80 \leq ALI < 0.60$	*High*
$0.60 \leq ALI < 0.40$	*Medium*
$0.40 \leq ALI < 0.20$	*Low*
$0.20 \leq ALI < 0.00$	*Very Low*

3.5.3   Evidence Analysis

In order to validate the result of analysis of levels of competency, evidence of competencies of local project managers would be explored in terms of components of each knowledge areas. In other words, evidence is the components of the 3rd level of each knowledge area as shown in Figure 3.3.
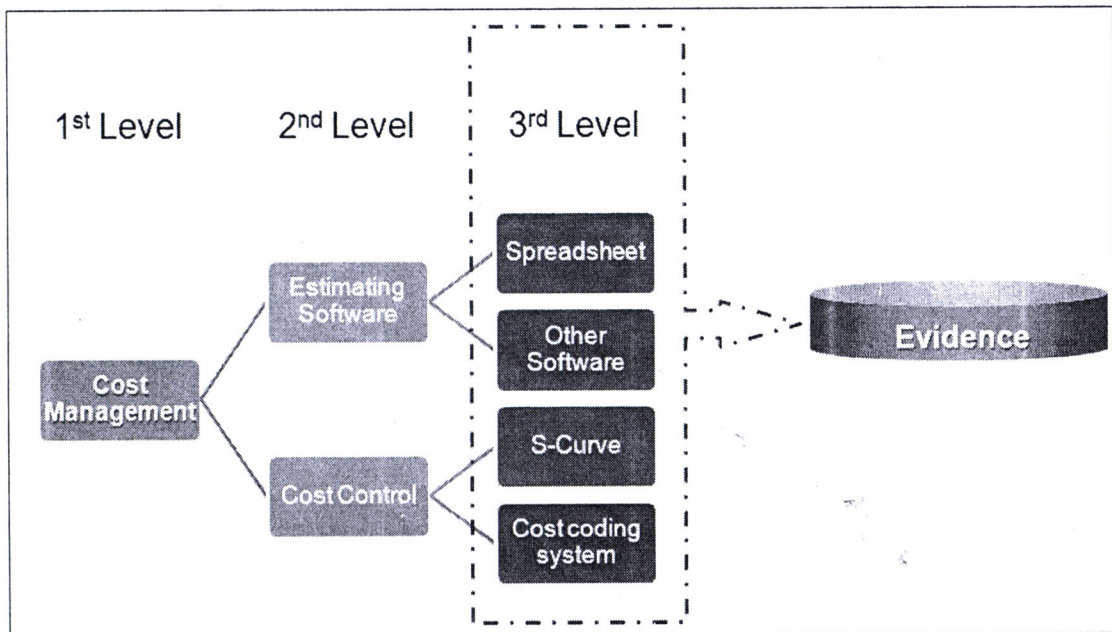
Figure 3.3 Example of evidence of cost management

- **Criteria of Evidence**

There are certainly many components in the 3rd level for one knowledge area. Some of them were especially picked up and assumingly considered as the evidence based on their main influences on competencies of project managers. The example of criteria of evidence is indicated in Figure 3.3.

- **Value of Evidence**

The values of involved evidence are presented as the percentage obtained from quantitative analysis of number of contractors in each country. The analysis is illustrated in detail in Appendix G.

$$\text{Percentage of quantitative competency} = \frac{\text{number of contractor applying each evidence}}{\text{total interviewed contractors}}$$

One example is given as below in order to clearly understand this formula:

The interviewed project managers of contractors in Cambodia using CPM technique in time management is 0 of 14 project managers, which is why the percentage of quantitative competency is 0/14 = 0%.

- **Level of Evidence**

The levels of evidence of each knowledge areas would be explored in an attempt to compare the results of competency level to obtain the validation. Furthermore, the levels of evidence would be set in accordance with the values of evidence in the 3rd level of knowledge area. The level of each component in the 3rd level is, on the other hand, assumed as described and given in below examples:

Four examples of important knowledge areas are given in order to understand well the level of evidence:

Table 3.4 Level of evidence of time management

1st Level	2nd Level	3rd Level
Time Management		*CPM*
		Others (PERT...)
	Scheduling Software	*M. Excel*
		M. Project
		Others (Primavera...)
	Time Control	*CPM*
		Delay Control

The components of knowledge areas in the 3rd level are particularly discussed to obtain the level of evidence.

➤   Scheduling Techniques

-     Using *Bar Chart* to develop project schedule is assumed as *medium level* of competency of project managers because it is not effective enough for all projects since it has only a limited ability to show many detailed work activities and their associated interactions. It would become bulky and unwieldy on larger projects with complex activities. It also cannot show clearly the interaction between early and late finish dates of activities and the resulting float of noncritical activities.

-     Developing project schedule by using *CPM* is counted as *high level* of competency because it can monitor and track the work done and evaluate progress by comparing planned with actual schedule. Next, forecast progress trends and apply corrective action to keep the project on course. It is also able to reduce project risk and uncertainty by identifying the critical activities.

-     Using PERT or Line of Balance is considered as *very high level* of competency of project managers because they are advanced scheduling techniques.

➤   Scheduling Software

-     Using *Spreadsheet* to develop bar chart is considered as *low level* of competency because it is not effective enough to clearly show the duration of each activity. It will become very difficult to draw bar chart in large project.

-     Using *M. Project* as software to set up bar chart schedule is assumingly considered as *high level* of competency of project managers because of flexibility of its interface.

-     Utilization of *other software* (e.g., Primavera, and Project Office…) is counted as *high level* of competency as well because these applications are not so different from M. Project.

Table 3.5 Level of evidence of cost management

1st Level	2nd Level	3rd Level
Cost Management	Estimating Software	*Spreadsheet*
		Others (WinEstimate…)
	Cost Control	*S-Curve*
		Cost coding system

➤ Estimating Software

- Using *spreadsheet* is not effective enough to estimate the project cost because it is just simple software while there are presently many up-to-date software available. It is therefore considered as *medium level* of competency in using spreadsheet.

- Using other *special software* for cost estimate is counted as *high to very high level* of competency because these tools can organize the estimate, link it to resource database, provide reports, and possibly integrate with other systems.

➤ Cost Control

- Using *S-Curve* technique for controlling project cost is considered as *medium level* of competency because it enables project managers to plan ahead by knowing what budgets are required, when they are required and how much is required and to give timely warning of negative cash flows.

- Using *cost coding system* is considered as *high level* of competency because it provides feedback information essential for effective estimates and bids on new projects.

Table 3.6 Level of evidence of quality management

1st Level	2nd Level	3rd Level
Quality Management	Quality Control	*Quality testing*
		Quality inspection
		Quality checklist
	Quality Improvement	*Quality problem record*

➤ Quality Control

- Implementing *quality testing and quality checklist* to control the work quality is assumingly counted as *medium level* of competency of project managers.

- Executing *quality inspection* in construction projects is counted as *high level* because it plays a vital role in controlling the whole quality of works by assigning some engineers or inspectors to examine all work activities.

➤ Quality Improvement

Conducting quality problem record in construction projects is considered as high level of competency of project managers because it can record the problems and solutions related to the work quality as the historical data to use for the future works.

Table 3.7 Level of evidence of safety management

1st Level	2nd Level	3rd Level
Safety Management	Safety Strategy Implementation	*Protective tool utilization*
		Safety sign implementation
		Safety inspection
		Safety meeting
	Safety Risk Control	*Accident investigation*
		Accident recording

➤ Safety Strategy Implementation

- Using *protective tools and safety signs* in construction sites is considered as *medium level* of competency because these strategies enable workers to avoid any site accident.

- Conducting *safety inspection and safety meeting* is assumingly counted as *high level* of competency because they are the main strategies to prevent site accidents occurring in construction sites.

➤ Safety Risk Control

- Implementing *accident investigation* in construction sites is considered as *medium level* of competency of project managers because it can determine what happened, and why the accident or incident happened.

- Executing *accident recording* is counted as *high level* of competency because it can determine procedures or policies that should be adopted to minimize the potential for future occurrence of similar accidents or incidents.

3.5.4 Recommendations

To enhance the inadequacy of competencies of construction project managers in these countries, some useful recommendations would be proposed by obtaining

results of the gap between important knowledge and competency level and from expectations obtained from contractors, consultants, and owners, through questionnaire.