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Measurement of the importance of knowledge areas and competency levels of construction project managers in the Lao PDR

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Abstract

This paper presents a ranking of the important levels of knowledge and the results of competency level measurements of construction project managers (PMs) in the Lao PDR. The important levels of knowledge in various areas were analyzed and ranked using the Analytic Hierarchy Process (AHP) method, and their competency levels were measured using a Relative Level Index (RLI) from the perceptions of primary stakeholders such as contractors, consultants, and project owners. The results of this ranking showed that time, quality, cost, and safety management were the most important knowledge areas for construction PMs in the Lao PDR. However, the relative importance of these knowledge areas for construction PMs was different among the various stakeholders. Moreover, the result of these measurements indicated that the levels of competency of construction PMs in the Lao PDR is medium to low. In spite of this, construction PMs' are perceived by contractors to be more competent than by consultants and project owners.

Keywords: Knowledge, Competency, Construction, Project managers, Lao PDR

1. Introduction

1.1 Background

The last decade has seen a steep arising in the quantity and complexity of construction projects in Asia as a result of spectacular economic development of the whole region [1]. Finding the right project manager for a construction project is a major task in project implementation. To make any project management system effective, a project must be managed by a project manager whose knowledge and competencies are high. In this regards, success is achieved when the project satisfies what are called the triple constraint comprising performance specification, time (schedule), and money (budget) [2]. Consequently, it is crucial that strong competencies required by the construction project managers should be clearly known or elaborated in so as to make the improvement of inadequacy. Like other developing countries, Lao People's Democratic Republic (Lao PDR) has many construction projects being implemented in various sectors such as building projects and infrastructure projects such as dam and bridge projects. Undoubtedly, many project-management problems have been occurring in construction projects in this country. In addition, Lao PDR is one of the developing countries in ASEAN, which would be intensively invested by many stockholders from various countries in the future on all sectors, especially the construction field. In this research, the construction project managers (PMs) of contractors were studied in terms of knowledge and competencies in order to accordingly conduct in an attempt to enhance performances of the construction project managers in Lao PDR.

The Lao People's Democratic Republic is spread over the total area of 236,800 square kilometers. Lao PDR is surrounded by China, Vietnam, Cambodia, Thailand, and Myanmar. The Mekong River, where forms the boundary with Myanmar and Thailand, flows through the country for 1,500 kilometers. The major cities contain Vientiane (the capital), Savannakhet, Pakse, Luang Prabang, and Thakek where are located along Mekong River. Its economic growth has reduced the poverty rate from 46% in 1992 to 26% in 2009. The economy has, until recently, benefited from high foreign investment in hydropower, mining, and construction. Despite this growth rate, Lao PDR remains a country with an undeveloped infrastructure, particularly in rural areas. It has a rudimentary, but improving, road system, and limited external and internal telecommunications. The three pillars of the strategy are to foster economic growth with equity, develop and modernize its social and economic infrastructure and enhance human resource development [3].

1.2 Literature reviews

According to Awazu [4], knowledge is one of the most important resources for both managerial decision-making and competitive advantage of any organization. It can also be information, which has been used and becomes a part of individual's experience base and behavioral pattern. Renck, Kahn, and Gardner [5] identified that knowledge refers to the content or technical information needed to perform

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adequately in a job and is normally obtained through formal education, on-the-job training, and information media, such as manuals. Moreover, it encapsulates the ability of an individual to perform an activity in a job-relevant area as well as what is required from this individual to realize effective performance [6]. It is important to address the differences between knowledge, information, and data. Data is raw numbers and facts, whereas information is a flow of messages or processed data. Knowledge is actionable information that is possessed in the mind [7]. From literature reviews, the importance level of knowledge is the degree or strength of its importance of the necessary knowledge used for working and doing the activities.

The PMBOK [8] recognized 9 knowledge areas typical of almost all projects, including integration management, scope management, time management, cost management, quality management, human resource management, communication management, risk management, and procurement management. As internationally recognized, it provides fundamentals of project management and, irrespective types of projects which include construction, software, engineering, and automotive.

Spencer [9] defined competency as an underlying characteristic of an individual that is casually related to criterion-referenced effective and/or superior performance in a job or situation. In industrial engineering, the concept is often presented as involving the implementation of combined knowledge among theoretical, contextual, procedural, know-how (empirically practical control), and behavior (relational or cognitive attitudes and behaviors) [10].

2. Objectives

The first objective of this research is to rank the importance levels of knowledge areas for construction PMs or PMs in contractor firms in Lao PDR from perceptions of contractors, consultants and owners. The second aim is to measure competency levels of construction PMs in Lao PDR so as to apply those important knowledge areas in construction projects.

Therefore, this research was scoped for local construction project managers of contractor firms and in building construction projects. The data was collected in two important cities of Lao PDR, including Vientiane and Luang Phrabang in 2011.

3. Research methodologies

This research was conducted step by step as shown below:

3.1 Exploring PMs' important knowledge areas from literature reviews and interviews

The aims of literature reviews and interviews are to gather important knowledge areas from text books, articles, journals, international conference papers, and project management manuals, and deepen the proper understanding of knowledge and competencies of construction PMs.

3.2 Questionnaire development

A questionnaire was developed, based on relevant literature reviews. The pattern questions are composed of open-end questions and closed-end questions. It consists of three parts such as general questions, comparison of important knowledge areas, and measurement of competency levels. It was clearly designed and distributed to the key parties who play a role in construction projects such as contractors, consultants, and owners in Lao PDR.

3.3 Data collection

A capital city and one important province in Lao PDR (Vientiane and Luang Phrabang) were selected to conduct the surveys in order to collect the required data in this research.

Besides, a simplified formula to calculate sample sizes was provided by Yamane [11]. In this case, equation (1) was used for calculating the sample sizes and based on 85% of the confidence level.

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

Where x = Sample size
N = Population size
e = Error of sampling
(Appropriately taken, e = 15%, due to the data being collected from the opinions of respondents, it often varies and population size comes from approximation.

Based on the limitation of the number of construction projects and respondents in Lao PDR in 2011, it cannot be found exactly amount of building construction projects. However, from approximate information by interviewing public departments of the important cities; Vientiane and Luang Phrabang, there are around 120 building construction projects. Thus, simple size can be estimated around 32 projects. Nonetheless, random surveying indicates that, only 16-17 projects can be found all 3 parties which include project owners, consultants, and contractors, thus the around 48-51 respondents should be found. According to the sample size calculated by equation (1), and populations were 51 respondents from 17 building construction projects, the samples were 24 respondents, including 9 contractors, 8 consultants, and 7 project owners from 11 building construction projects. They were randomly interviewed to obtain the detailed information such as important knowledge areas and competency levels of local construction project managers in Lao PDR.

3.4 Data analysis

There were 2 main types of data such as ranking of important knowledge areas and competency levels of construction PMs which were taken into analysis.

1. The importance level of knowledge areas for construction PMs in Lao PDR were analyzed and ranked by using Analytic Hierarchy Process (AHP) method stated by Saaty [12] which consists of 5 scales for making pair-wise comparison such as (1) equal importance, (3) weak importance, (5) strong importance, (7) very strong importance, and (9) absolute importance. Data was collected from perception of three main stakeholders such as contractors, consultants, and owners. The total rankings of knowledge areas would be obtained from average weight (w) of all respondents by simultaneously checking the variances of all respondents to ensure that they did not have quite different variances. The average weight (w) was analyzed by pair-wise comparison matrix as shown in Figure 1.

Column j (j=1, 2, 3,...., n)

Row i (i=1, 2, 3,...., n)	'O'	F_1	F_2	F_3	....	F_n
	F_1	a_{11}	a_{12}	a_{13}	....	a_{1n}
	F_2	a_{21}	a_{22}	a_{23}	....	a_{2n}
	F_3	a_{31}	a_{32}	a_{33}	....	a_{3n}
	.	.	.	.		.
	.	.	.	.		.
	.	.	.	.		.
	F_n	a_{n1}	a_{n2}	a_{n3}	....	a_{nn}

Figure 1 Pair-wise comparison matrix

The a_{ij} (i, j = 1, 2, 3,…, n) represents the strength of importance of the factors F_i over or under F_j with respect to the objective 'O'. The $a_{ij}$is equal to $1/a_{ij}$ (i, j = 1, 2, 3,…, n) are the priority weights (to be determined) of the factors. The entries a_{ij} and a_{ji} normally are taken from the (1/9 - 9) ratio scale. If i is equals to j, a_{ij} will be equal to a_{ji} and equal to 1.

Determine the average weights of the factors from the pair-wise comparison matrices that obtained by using the value in eigenvector.

The $\sum_{j=1}^{n} w_j$ is equal to summation of a_{ij}anda_{ji} in column j (1, 2, 3,…., n). Then, $\sum_{j=1}^{n} w_j$ was normalized by $\sum_{j=1}^{n} w_j$ is equal 1.00 and a_{ij} in row i (1, 2, 3,…., n) and a_{ji} in column j (1, 2, 3,…., n) were converted to be weight (w_{ij}) by a_{ij} and a_{ji} divided by $\sum_{j=1}^{n} w_j$. Then the values in eigenvector were determined the average of weight (w_{ij}) in row i (1, 2, 3,…., n). Those values represent the degree of importance of each factor from perception of a respondent. In this research, the 13 knowledge areas (knowledge of management) were analyzed to obtain the average weight (w) by using perception of 3 construction project parties.

Thus, sizing of pair-wise comparison metric is [13x13]. The number of row is 13 (i= 1, 2, 3,…., 13) and the number of column is 13 (j = 1, 2, 3,…., 13). Table 1 shows an example of pair-wise comparison metric used to determine average weight that can be used to indicate the strength of importance of each knowledge area. Table 2 presents an example of determining of average weight (w) for each knowledge area from perception of a respondent. After that, it will be analyzed by using all respondents' perception of each party and all parties that will obtain the average weight ($\bar{W}$) of each knowledge area from perception of all respondents in each party and all party, respectively.

Table 1 An example of pair-wise comparison metric for determining average weight of each knowledge areas from perception of a respondent

Knowledge area	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
A: Cost	1	2	5	1/3	2	4	1/2	5	1/5	3	1/3	2	1/2
B: Time	1/2	1	a_{23}	.	.	.	.	.	.	.	.	.	a_{213}
C: Quality	1/5	a_{32}	1	.	.	.	.	.	.	.	.	.	a_{313}
D: Safety	3	.	.	1	.	.	.	.	.	.	.	.	a_{413}
E: Contract	1/2	.	.	.	1	.	.	.	.	.	.	.	a_{513}
F: risk	1/4	.	.	.	.	1	.	.	.	.	.	.	a_{613}
G:material	2	.	.	.	.	.	1	.	.	.	.	.	a_{713}
H: Sub contr.	1/5	.	.	.	.	.	.	1	.	.	.	.	a_{813}
I: Human res.	5	.	.	.	.	.	.	.	1	.	.	.	a_{913}
J: Labor	1/3	.	.	.	.	.	.	.	.	1	.	.	a_{1013}
K: Commu.	3	.	.	.	.	.	.	.	.	.	1	.	a_{1113}
L: doc.	1/2	.	.	.	.	.	.	.	.	.	.	1	a_{1213}
M: equip.	2	a_{132}	a_{133}	a_{134}	a_{135}	a_{136}	a_{137}	a_{138}	a_{139}	a_{1310}	a_{1311}	a_{1312}	1
$\sum w_j$	18.5	.	.	.	.	.	.	.	.	.	.	.	.

Table 2 An example of the average weight (w) determining for each knowledge area

Knowledge	A	B	C	.	.	.	M	$\sum w_i$	**Avg. weight (w)** ($\sum w_i$ / 13)
A: Cost	0.05	0.10	0.25	.	.	.	0.03	1.75	**0.135**
B: Time	0.03	w_{22}	w_{23}	.	.	.	w_{213}	2.58	**0.198**
C: Quality	0.01	w_{32}	w_{33}	.	.	.	w_{313}	1.93	**0.149**
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
M: equip.	0.11	w_{132}	w_{133}	.	.	.	w_{1313}	0.23	**0.018**
$\sum w_j$ (Normalized)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	**1.00**

However, the consistency of results should be proven by Consistency Ratio (CR) which is calculated by Consistency Index (CI) and Random Index (RI) as shown in equation (2), (3), and (4) in order to ensure the consistent of respondents' perception. λ_{max} equals to summation of consistency vector divided by n (numbers of factor).

Consistency Index, $CI = \frac{\lambda_{max} - n}{n-1}$ (2)

Random Index [12], RI = 1.56 (n=13) (3)
Where, n = number of factors (knowledge areas)

Consistency Ratio, $CR = \frac{CI}{RI}$ (4)

If Consistency Ratio (CR) is lower than 0.1, the result will be acceptable, on the other hand if CR is greater than 0.1, the result will not be acceptable [12].

In this research, average weights ($\overline{W}$) used to indicate the importance level of knowledge areas of construction project managers were divided into 3 levels, including high importance level ($\overline{W}$ >0.1), medium importance level (0.1>$\overline{W}$>0.04), and low importance level ($\overline{W}$<0.04).

2. The PMs' competency levels were obtained from the evaluations of main stakeholders (contractors, consultants, and owners) which delineate the abilities of construction project managers to apply those kinds of important knowledge areas for carrying out in their current construction projects. The method used for analyzing the competency levels of construction project managers is a scoring tool. The mean score of each knowledge area was calculated to obtain the Relative Level Index (RLI) [13] as shown in equation (5).

$$RLI = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{5N} \quad (5)$$

While, n_1, n_2, n_3, n_4,and n_5 are the numbers of the respondents for very low level, low level, medium level, high level, and very high level, respectively, N is the total number of the respondents.

From equation (5), the competency levels of the PMs were divided into 5 levels by RLI (0.0 to 1.0), for instance, 0.0≤ RLI<0.2 means very low, 0.2≤ RLI<0.4 means low, 0.4≤ RLI<0.6 means medium, 0.6≤ RLI<0.8 means high, and 0.8≤ RLI≤ 1.0 means very high level, respectively.

To ensure the results of PMs' competency levels measurement, the result validation was done for the highly important knowledge areas by interviewing 9 construction PMs and collecting evidences of knowledge that were applied by those PMs. The evidence of applied knowledge will be requested to be shown and explained during interviewing. The percentage of evidences found during interviewing can indicate the competency levels of the PMs. Some examples of the evidences are time management, e.g. scheduling software, and time control system; cost management, e.g. cost control system, and cost estimating software; quality management, e.g. quality control system. The percentage of the evidence is determined by using equation (6). In this case, the number of respondents is 9 (Construction PMs).

$$\% \ of \ evident = \frac{Number \ of \ evident \ found \ \times 100}{Number \ of \ respondent} \quad (6)$$

4. Results

The 13 knowledge areas (n=13) of PMs in construction firm were explored from literature reviews and interviews by Hang [14], such as time management, quality management, cost management, safety management, contract management, risk management, material management, subcontractor management, human resource management, labor management, communication management, documental management, and equipment management.

The results of this research were divided into two parts, such as the ranking of important knowledge areas of construction project managers and their competency levels to apply those knowledge areas in Lao PDR.

4.1 Ranking of important knowledge areas

From data analysis by the AHP method, the results showed that, from overall perceptions, time management, quality management, and cost management were considered as high importance level of knowledge areas for construction PMs in Lao PDR, because the values of their average weight ($\overline{W}$) are around or more than 0.1 as shown in Table 3 and Figure 2.

Table 3 Ranking of importance levels of PMs' knowledge areas from the overall perception

Knowledge Areas	Avg. weight ($\overline{W}$)	Importance Levels	Rank
Time management	0.1982	High	1
Quality management	0.1487	High	2
Cost management	0.1321	High	3
Safety management	0.0911	Medium	4
Contract management	0.0821	Medium	5
Risk management	0.0564	Medium	6
Material management	0.0449	Medium	7
Subcontractor management	0.0431	Medium	8
Human resource management	0.0406	Medium	9
Labor management	0.0365	Low	10
Communication management	0.0343	Low	11
Document management	0.0329	Low	12
Equipment management	0.0175	Low	13

Remark: CR = 0.07

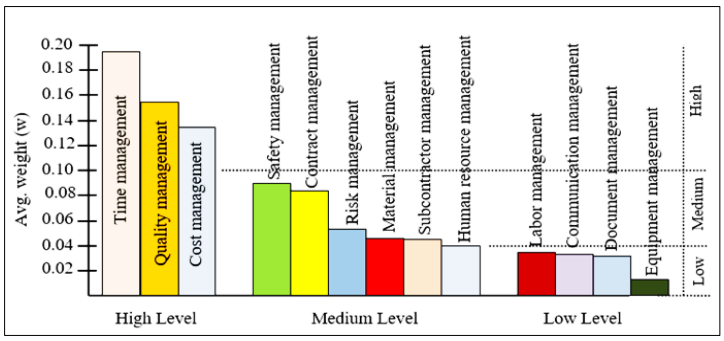

Figure 2 The three importance levels of knowledge areas for PMs from overall perceptions

Furthermore, safety management, contract management, risk management, material management, subcontractor management, and human resource management, were counted as medium importance level of knowledge areas, respectively. At last, labor management, communication management, documental management, and equipment management were assumed as low importance level of knowledge areas, respectively. In this case, CR was equal to 0.07 (n = 13, λ_{max} = 14.2, CI = 0.10, RI = 1.56). Thus, the results should be accepted because CR was lower than 0.1.

Moreover, the ranking of importance level of knowledge areas for construction PMs from perceptions of contractors, consultants, and owners were indicated in Table 4, Table 5, and Table 6, respectively. In these cases, CR was lower than 0.1 (0.06 – 0.07) that means the results of analysis should be accepted.

The result showed that, from perception of contractors, knowledge areas of cost management, time management, quality management, and risk management were in high importance level. However, time management, quality management, and safety management were in high importance level from perception of consultants. Nevertheless, from perception of owners, time management, quality management and contract management were in high importance level of knowledge areas for construction PMs in Lao PDR.

4.2 Competency levels

In Figure 3, the RLI indicated that, from the overall perceptions, the competencies of construction PMs in Lao PDR to apply the important knowledge areas was mostly in medium and low level. On the other hand, in Figure 4, the competencies of PMs in Lao PDR from perceptions of contractors were generally in higher level than that of consultants and owners. Nevertheless, from perceptions of consultants and owners, those PMs' competencies were in low level to apply some knowledge areas, such as time management, cost management, safety management, risk management, and document management.

4.3 Result validation for competency levels

The results of competency levels of project managers of contractors were validated by using the evidence collected by using interviewing. In this research, the highly important knowledge areas such as time management, quality management, and cost management would be validated and discussed in detail one by one, involved with applying of those knowledge area by construction project managers in Lao PDR.

4.3.1 Time management

Time management is the 1st rank of important knowledge areas in Lao PDR; while, the competencies of local project managers to apply this knowledge area is not efficient enough to achieve the construction projects on time. From interviewing, the evidences have shown that some effective techniques were not applied to construction work. They only used the bar chart developed by spreadsheet and scheduling software to present the entire project schedule, while there are not other techniques such as Critical Path Method (CPM), which are more efficient than a simple bar chart. The shortage of applications of new techniques causes of non-effective construction project planning in Lao PDR. The examples of evidences are shown in Figure 5. Thus, construction PMs' competencies for time management were evaluated in medium level.

4.3.2 Quality management

From the above result, the levels of competencies to apply the knowledge of quality management are in medium level. The evidences show that there is no any quality management system such as Quality Control (QC) system or Quality Assurance (QA) system to apply in construction projects in Lao PDR. Local project managers carry out the quality by merely implementing some tools such as quality testing,

Table 4 Ranking of importance levels of PMs' knowledge areas from contractors' perception

Knowledge Areas	Avg. weight ($\overline{W}$)	Importance Levels	Rank
Cost management	0.2304	High	1
Time management	0.1112	High	2
Quality management	0.1038	High	3
Risk management	0.0971	High	4
Material management	0.0809	Medium	5
Human resource management	0.0735	Medium	6
Labor management	0.0670	Medium	7
Contract management	0.0638	Medium	8
Safety management	0.0547	Medium	9
Subcontractor management	0.0391	Medium	10
Communication management	0.0306	Low	11
Document management	0.0251	Low	12
Equipment management	0.0228	Low	13

Remark: CR = 0.06

Table 5 Ranking of importance levels of PMs' knowledge areas from consultants' perception

Knowledge Areas	Avg. weight ($\overline{W}$)	Importance Levels	Rank
Time management	0.2150	High	1
Quality management	0.1688	High	2
Safety management	0.1260	High	3
Cost management	0.0779	Medium	4
Subcontractor management	0.0522	Medium	5
Contract management	0.0496	Medium	6
Risk management	0.0433	Medium	7
Document management	0.0355	Low	8
Communication management	0.0246	Low	9
Labor management	0.0245	Low	10
Material management	0.0237	Low	11
Human resource management	0.0222	Low	12
Equipment management	0.0118	Low	13

Remark: CR = 0.06

Table 6 Ranking of importance levels of PMs' knowledge areas from owners' perception

Knowledge Areas	Avg. weight ($\overline{W}$)	Importance Levels	Rank
Time management	0.2684	High	1
Quality management	0.1734	High	2
Contract management	0.1328	High	3
Safety management	0.0925	Medium	4
Cost management	0.0880	Medium	5
Communication management	0.0479	Medium	6
Subcontractor management	0.0381	Low	7
Document management	0.0381	Low	8
Material management	0.0302	Low	9
Risk management	0.0288	Low	10
Human resource management	0.0260	Low	11
Equipment management	0.0179	Low	12
Labor management	0.0179	Low	13

Remark: CR = 0.06

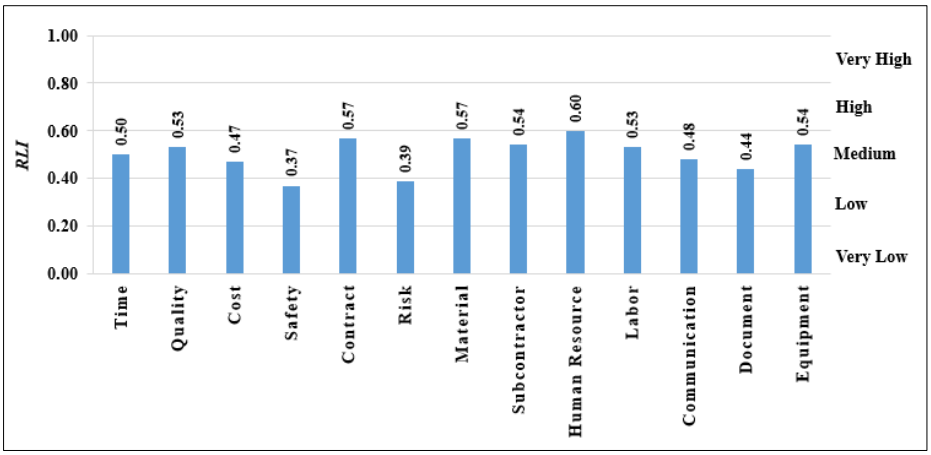

Figure 3 Competency levels of construction PMs in Lao PDR from overall perceptions [14]

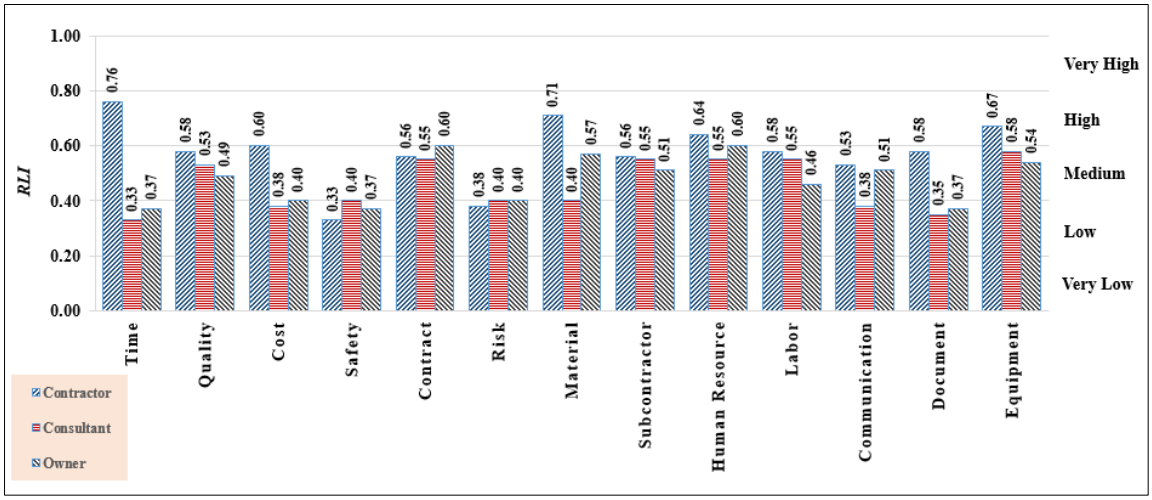

Figure 4 Competency levels of construction PMs in Lao PDR illustrated by RLI from perception of contractors, consultants and project owners [14]

quality inspection, and quality checking list. The evidences of quality management are shown in Figure 6. From those evidence findings, their competency level of quality management was evaluated as in low-medium level.

4.3.3 Cost management

The results showed that the level of competency of local project managers to apply this important knowledge is in medium level. Starting with cost estimating, local project managers practically use the past experiences and historical data for approximating the cost of a project. They normally check the market price and historical information for material cost and labor cost. Simple software; spreadsheet, is widely used by local project managers for estimating the project cost. Furthermore, only some of local project managers are able to create S-curve analysis for modeling the cash flow which provides the link between the bar chart and the budget. Undoubtedly, they develop S-curve to control the cost of project and particularly to claim the monthly payment from the owners. Regarding another technique for cost control; cost coding system, most of them do not use this technique to control the project cost. The evidence of this knowledge is demonstrated in Figure7 that was evaluated in low-medium level.

After thoroughly calculating and discussing the results and validated by evidences, it is noticed that they are in the same direction of competency because the evidences of each knowledge area represented the competency levels of local project managers corresponding to the results as demonstrated in Table 7. Thus, the evidence of important knowledge is definitely able to validate the obtained results from the overall perceptions.

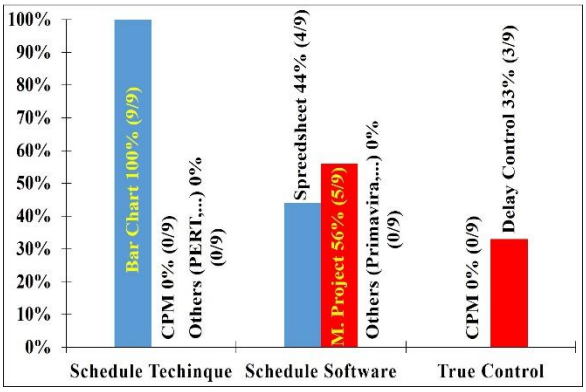

Figure 5 Percentage of evidence for time management [14]

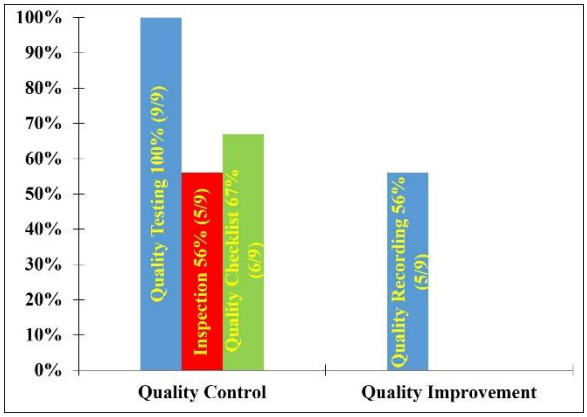

Figure 6 Percentage of evidence for quality management [14]

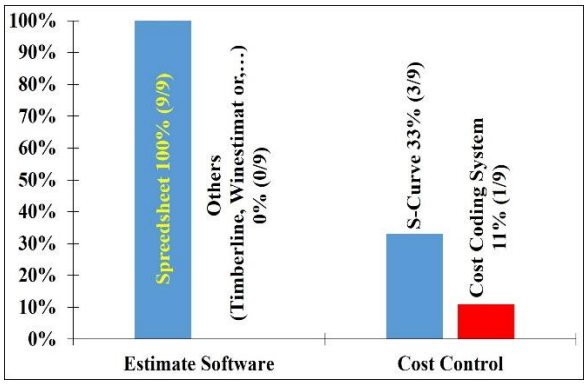

Figure 7 Percentage of evidence for cost management [14]

Table 7 Validation of competency results

Knowledge Areas	Results of competency levels	Level of evidences found
Time management	Medium	Medium
Quality management	Medium	Low-Medium
Cost management	Medium	Low-Medium

5. Conclusions

After analyzing the collected data by the AHP method, the results indicated that time management, quality management, and cost management were in high importance level of knowledge areas for construction PMs in Lao PDR, based on the overall construction parties' perception. The Relative Level Index (RLI) showed that, according to overall perceptions, the competency levels of PMs in Lao PDR to apply the important knowledge areas were mostly in medium and low level. On the other hand, the competency level of construction PMs in Lao PDR to apply the important knowledge areas from the perceptions of contractors were generally in higher level than that from the perceptions of consultants and owners. However, from the perceptions of consultants and owners, the competency of construction PMs to apply some knowledge areas such as time management, cost management, safety management, risk management, and document management were mostly in low level and required for improvement.

6. Acknowledgements

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