Key Performance Indicators for Project Management Performance of Large Contractors in Developing Countries: A Case Study in Vietnam

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Abstract

In order to deal with severe competition in the construction market of developing countries, large contractors must continually improve their own performance and operation. Performance measurement is the heart of ceaseless improvement in organizations. Key performance indicators (KPIs) play a key role in measuring project management performance (PMP) of large contractors in developing countries. The main objective of this paper is to identify KPIs, which can be used to measure PMP of contractors, and then analyze the underlying relationships of these KPIs in order to gain insight into PMP of large construction firms in Vietnam construction industry (VCI). Literature reviews and the pilot survey provided 30 KPIs. Fourteen KPIs, which have the mean values higher than 3.0, were considered as important KPIs through a questionnaire survey of 32 professionals. Factor analysis of these KPIs was employed to categorize them. The results of the survey revealed that top six KPIs are construction time and cost, owner satisfaction on services and products, and quality management and project team performance. Factor analysis uncovered that 14 top-ranked KPIs can be grouped under six categories, namely: (1) construction input management, (2) owner satisfaction, (3) cost and quality, (4) manpower management, (5) subcontractor performance and (6) equipment management. The findings of this research can be used as a guideline to measure PMP of contractors in Vietnam as well as in other developing countries. Since contractors from a country to the other country may have the same manner to manage construction projects, the results of this study may be useful not only to practitioners and researchers in Vietnam but also to participants in other developing countries.

Keywords: Construction projects, Factor analysis, Key performance indicator (KPI), Project management performance, Vietnam.

1. INTRODUCTION

The construction environment in developing countries may be risky due to poor infrastructure, backward management mechanisms, and a bureaucratic local government. In this context, large contractors must continually improve their own performance and operation to deal with severe competition in the construction market. Performance measurement is the heart of ceaseless improvement (Luu et al., 2007). Based on performance indicators, project management performance (PMP) of contractors can be measured. However too many indicators can be unmanageable, thus key performance indicators (KPIs) must be identified (Luu et al., 2008). In Vietnam, as well, although the scope of investments and a boom in the VCI is smaller than other developing countries, VCI has faced many problems such as complexity of legal and institutional framework, lack of capable consultants and domestic contractors for handling large projects (Long et al., 2004), poor change management, bureaucracy of several local authorities, fraudulent practices, and kickbacks (Luu et al., 2008). Large contractors in Vietnam are trying to measure their PMP as an effective way to adapt to this circumstance. As a result, a distinct need has emerged for identifying KPIs to measure PMP of large contractors.

The main objectives of this paper is to identify KPIs, which can be used to measure PMP of large contractors, and then analyze the underlying relationships of these KPIs in order to gain insight into PMP of large construction firms in the VCI.

2. LITERATURE REVIEW

Research efforts to measure the performance in construction industry were reviewed by Luu et al. (2008). There were some concentrations on: (1) applying improved BSC approach to measure the performance of two companies in UK construction industry (Kagioglou et al., 2001); (2) developing a conceptual performance measurement framework for Tanzania contractors (Samson and Lema, 2002), (3) proposing a BSC framework to measure IS/IT performance in construction (Steward and Mohamed, 2001); (4) developing a framework to identify gaps and best practices in the performance measurement system which is compatible with the construction firms' strategy in Brazil (Costa and Formoso, 2003); (5) developing a set of KPIs to measure success of construction projects (Chan and Chan, 2004); (6) suggesting a framework for a performance measurement system aligning to the company's strategies and objectives (Beatham et al., 2004); (7) developing a system model to measure the construction site performance and determining success factors of a construction site (Salminen, 2005); and (8) identifying a set of 11 KPIs for strategic healthcare facilities management in Israel (Shohet, 2006).

KPIs has recently been developed as a tool for measuring performance of projects and organizations in the construction industry of developing countries, for example, evaluating performance of the water resource development project (Wongsamut, 2002) and the training project (Welker, 2002) in Thailand, evaluating performance the construction department in Thailand (Chaichan, 2002), measuring performance of the construction management department in Vietnam (Khanh, 2005), and evaluating performance of a large contractor (Cao, 2006) and a real estate project in Vietnam (Dang, 2006).

The above literature implied that a little effort has been devoted to the application of KPIs for measuring PMP of construction firms in Vietnam where the construction industry considerably contributes to the economy's growth rate. Therefore, identifying suitable KPIs to measure and evaluate PMP of contractors is an imperative need.

3. RESEARCH METHOD

3. 1. Conceptual research framework

Since an appropriate framework may create a good study, the frameworks of previous studies on performance measurement were adapted to find out the conceptual research framework (Figure 1). Identifying potential KPIs is the importantly initial step of this research.

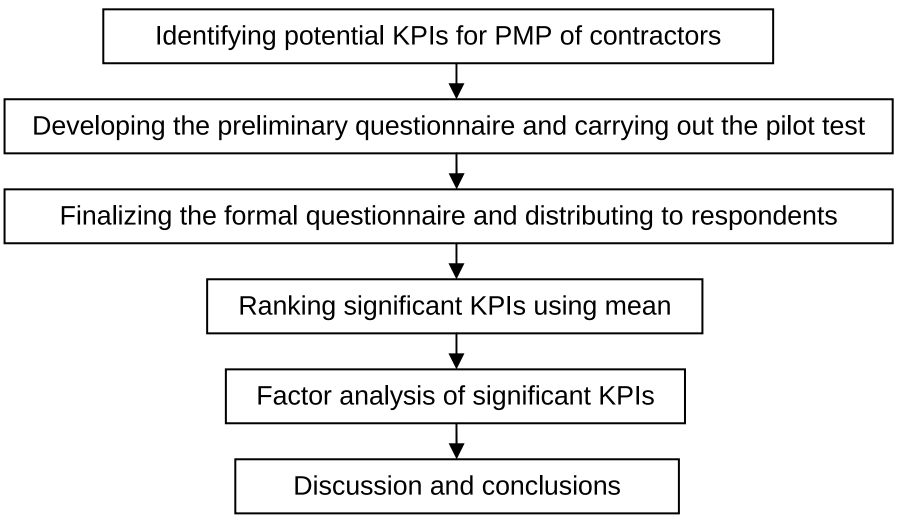

Figure 1: The conceptual research framework

3. 2. Questionnaire

A set of potential KPIs was uncovered from the rigorous literature review of previous studies on PMP. Unstructured interviews were selected to add or remove KPIs during the preliminary questionnaire design. In order to be suitable for the VCI conditions, the preliminary questionnaire was tested. An expert group of five practitioners and four researchers was involved in the pilot test. Test participants were asked to revise the final survey questionnaire. This provided 30 potential KPIs (Table 1), which can be grouped under 11 categories. The formal questionnaire was designed and distributed to a random sample of owners, site supervisors, designers and contractors, in the filed of building projects in Ho Chi Minh city, Vietnam. The respondents rated KPIs using five-point Likert-scale rating (from 1='not suitable for measuring PMP' to 5='very suitable for measuring PMP').

Categories	KPI code	Potential KPIs
Time management	KPI1	Construction time
	KPI2	Time to repair construction defects in the construction phase
	KPI3	Time to repair defects under warranty
Cost management	KPI4	Construction cost
	KPI5	Costs of defect repairs in the construction phase
	KPI6	Cost of defect repairs under warranty
Quality	KPI7	Quality management performance
	KPI8	Percentage of defect items which must be reworked
	KPI9	Percentage of defect items which must be removed
Change management	KPI10	Change management performance
Owner satisfaction	KPI11	Owner satisfaction on products made by contractors
	KPI12	Owner satisfaction on services offered by contractors
Purchasing goods	KPI13	Percentage of purchasing construction materials
	KPI14	Percentage of construction materials met requirements
Construction process	KPI15	The proportion of actual to planned man-hours
	KPI16	Performance of material management on site
	KPI17	A waste of construction materials
	KPI18	The proportion of actual to planned machine-hours
	KPI19	Efficiency of construction schedule
	KPI20	Project team performance
	KPI21	Level of applying modern technologies
Health and safety	KPI22	Labor safety performance
	KPI23	Absenteeism level
Subcontractors	KPI24	Efficiency of subcontractor schedule
	KPI25	Subcontractor cost
Efficiency of manpower management	KPI26	Employee salary
	KPI27	Level of quitting work
	KPI28	Level of training
Environment and residents	KPI29	Performance of environmental sanitation
	KPI30	Resident satisfaction on contractor activities

Table 1: Potential KPIs and KPI categories

3. 3. Data collection and analysis

Hundred and three questionnaires were distributed. The authors received 32 responses showing a response rate of 31.07%. This rate is appropriate for surveys in the construction industry (Arditi et al., 1985). Responses to the questionnaire were then collected and analyzed. The analysis included ranking KPIs in terms of suitability for measuring PMP. Factor analysis was employed to derive interrelationships among KPIs. Data analysis provided 14 significant KPIs, which have mean values higher than 3. Standard deviation of these KPIs was small enough to conclude the respondents agreed on its significance. In addition, the reliability analysis resulted in Cronbach's alpha coefficient to be

0.807. This coefficient is large enough to confirm the reliability of the measure scale used in the formal questionnaire.

4. FINDINGS AND ANALYSIS

4. 1. Ranking of KPIs

Data analysis uncovered that time-, cost-, customer satisfaction-related KPIs are prominent KPIs. Table 2 shows 14 significant KPIs that can be used to measure PMP of large contractors. The top six KPIs are construction time and cost (KPI4 and KPI1), owner satisfaction on services (KPI12) and products (KPI11), quality management performance (KPI7) and project team performance (KPI20).

Rank	Code	Significant KPIs	Mean	SD
1	KPI4	Construction cost	4.72	0.46
2	KPI1	Construction time	4.66	0.48
3	KPI12	Owner satisfaction on services offered by contractors	4.38	0.49
4	KPI11	Owner satisfaction on products made by contractors	4.28	0.46
5	KPI7	Quality management performance	3.91	0.39
6	KPI20	Project team performance	3.78	0.42
7	KPI10	Change management performance	3.60	0.50
8	KPI16	Performance of material management on site	3.56	0.50
9	KPI22	Labor safety performance	3.50	0.51
10	KPI19	Efficiency of construction schedule	3.44	0.50
11	KPI26	Employee salary	3.34	0.60
12	KPI15	The proportion of actual to planned man-hours	3.22	0.42
13	KPI18	The proportion of actual to planned machine-hours	3.13	0.49
14	KPI24	Efficiency of subcontractor schedule	3.03	0.40

Table 2: Ranking of 14 significant KPIs

As shown in Table 2, all respondents considered 'Construction cost' and 'Construction time' as top KPIs. This implied that construction time and cost were recognized as important indicators for project success in the VCI. 'The owner satisfaction on services and products' was also ranked relatively high.

Table 2 showed that 'The proportion of actual to planned man-hours', and 'The proportion of actual to planned machine-hours', and 'Efficiency of subcontractor schedule' are KPIs with low ranks. These reflected the actual context in the VCI. Most contractors in the VCI have no record of actual man-hours at various times of the construction phase. Site engineers often neglect their duty in recording actual machine-hours. Many subcontractors in Vietnam are not professional, thus, lack of information on subcontractor schedule will provide difficulties in getting data of these KPIs.

4. 2. Factor analysis of KPIs

Since factor analysis (FA) is an appropriate solution to obtain multivariate interrelationships existing among major factors (Hair et al., 1998), it was employed to derive interrelationships among KPIs. The top-fourteen highly-ranked KPIs were selected for factor analysis. The means of these KPIs were greater than 3.0 and their standard deviation values were less than 0.601 on a scale of 1-5.

Hair et al. (1998) suggested that each variable's communality should be equal to, or greater than, 0.5 to have sufficient explanation. Thus, all 14 KPIs were appropriate for factor analysis (Table 3).

Sharma (1996) suggested rules of thumb required to ascertain that the present data set is appropriate for factor analysis. They are the Bartlett's test for sphericity and the Kaiser-Meyer-Olkin (KMO) measure. For the collected data set, the SPSS resulted in the Bartlett's test statistic to be highly significant ($p=0.000$). This indicated that the correlation matrix is not orthogonal (i.e., the major causes are correlated among themselves) (Sharma, 1996). Kaiser and Rice (1974) cited in Sharma (1996) suggested that the overall KMO measure should be greater than 0.80; however, a measure of above

0.50 is acceptable. Therefore, the value of the KMO measure of sampling adequacy (0.557) confirmed that the KPIs were appropriate for FA.

Factors	Factor labels	KPIs	Factor loading	Communalities
1	Construction input management	Efficiency of construction schedule	0.875	0.878
		Employee salary	0.745	0.841
		Construction time	0.654	0.804
		Project team performance	0.637	0.796
		Change management performance	0.635	0.754
		Performance of material management on site	0.624	0.775
2	Owner satisfaction	Owner satisfaction on products made by contractors	0.758	0.890
		Labor safety performance	0.733	0.773
		Owner satisfaction on services offered by contractors	0.711	0.933
3	Cost and quality	Quality management performance	0.717	0.749
		Construction cost	0.669	0.853
4	Manpower management	The proportion of actual to planned man-hours	0.507	0.791
5	Subcontractor performance	Efficiency of subcontractor schedules	0.533	0.846
6	Equipment management	The proportion of actual to planned machine-hours	0.466	0.686

Table 3: Ranking of 14 significant KPIs

Since the important components are those whose eigenvalues are greater than or equal to 1. Principal component analysis (PCA) produced six extracted components, with descending order from 3.333 for component 1 to 1.095 for component 6 (Table 4). As shown in Table 4, percentage of variance describes proportion of variance explained by each component. For example, component 1 accounted for 23.804% of the variance.

Component	Eigenvalue	Percentage of Variance	Cumulative percentage
1	3.333	23.804	23.804
2	2.534	18.102	41.906
3	1.732	12.375	54.280
4	1.507	10.766	65.047
5	1.168	8.343	73.389
6	1.095	7.819	81.208
7	0.608	4.341	85.549
8	0.528	3.775	89.324
9	0.432	3.088	92.411
10	0.328	2.345	94.757
11	0.298	2.132	96.889
12	0.176	1.255	98.144
13	0.166	1.189	99.332
14	0.093	0.668	100.000

Note: Communality of all causes of delay is set equal to 1.0

Table 4: Initial statistics of FA

Based on results of varimax rotation, 14 KPIs can be grouped under six factors (Table 3). Factor 1 labeled 'Construction input management' concerns efficiency of construction inputs. Factor 2 labeled 'Owner satisfaction' concerns owner satisfaction on services, products, and safety management. Factor 3 labeled 'Cost and quality' concerns construction cost and efficiency of quality management system. Factor 4 labeled 'Manpower management' relates to the proportion of actual to planned man-hours. Factor 5 named 'subcontractor performance' related to efficiency of subcontractor schedules. Factor 6 named 'Equipment management' related to the proportion of actual to planned machine-hours.

The communalities of KPIs, as shown in Table 3, describe the proportion of variance in the variables accounted for KPIs by the extracted factors. For example, 93.3% of variance in 'Owner satisfaction on services offered by contractors' is accounted for KPIs specified by six extracted factors. Table 3 also presents factor loading of the determinants of KPIs. It is loosely to explain that factor loading is the correlation coefficient between an original variable or determinant and an extracted factor (Kaming et al, 1997).

In addition, the screen plot, which is used to determine how many KPIs should be kept, is reasonable (Figure 2). This plot is a plot of the variance associated with each factor. The plot typically shows a distinct break between the steep slope of the large factors and the gradual trailing of the rest. Figure 2 also indicated that there were six extracted components.

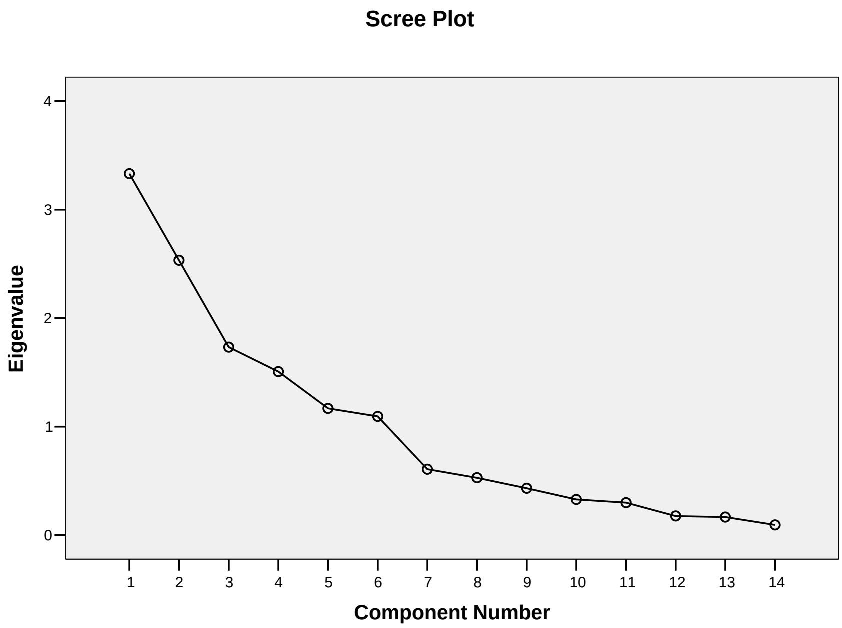

Figure 2. The screen plot of the eigenvalues

4. 3. Discussion

Since lack of effective construction management may strongly affected PMP of contractors, efficiency of construction inputs such as construction schedule and time, performance of project team and change management, and performance of material management onsite was recognized as important KPIs for measuring PMP of lager contractors in the VCI. Recently, poor human resource management and ineffective site management are weakness of the construction firms in Vietnam (Luu et al., 2008).

Since a well-synchronized and effective project team will provide many competitive advantages leading to project success (Luu et al., 2007), most respondents ranked 'Project team performance' as one of important KPIs to measure PMP of large contractors. Moreover, most Vietnamese contractors have no effective system which can record changes at the construction site. Hence, 'Change management performance' was considered as an indicator to measure PMP.

Since customers are more and more fastidious, enhancing the quality of construction products and services may raise competitive advantage in the construction market. Therefore, 'Owner satisfaction on products made by contractors' and 'Owner satisfaction on services offered by contractors' were predominant KPIs to evaluate PMP of large contractors.

Recently, there is a high demand for investment opportunities and higher demand for capable human resource because of the continual growth of the Vietnamese economy during the past ten years. In addition, poor project planning and scheduling at site may resulted in ineffective construction management. As a result, 'Subcontractor performance', 'Manpower management' and 'Equipment management' were recognized as important KPIs. Unfortunately, the available human resource in the VCI did not meet the requirements of construction projects.

Vietnam has Asia's second-fastest-growing economy, with 8.4 percent growth last year (Bradsher, 2006). However, Vietnam is still a relatively poor country. Since construction works involve huge amounts of money (Sambasivan and Soon, 2007), the VCI intensively needs funds to meet rapid growth in construction. Consequently, 'Construction cost' was evaluated as one of significant KPIs for PMP by respondents.

5. Conclusions

The major objective of this paper was to identify KPIs, which can be used to measure PMP of large contractors in Vietnam. Thirty KPIs were identified as a result of a comprehensive literature survey. Data analysis provided fourteen significant KPIs, which have the mean value higher than 3. The construction participants identified construction time and cost, owner satisfaction on services and products, quality management performance and project team performance as top six KPIs.

In order to gain insight into KPIs for PMP of large construction firms in VCI, FA was selected. The results of FA indicated that there were certain interrelationships among KPIs. The 14 top-ranked KPIs were grouped under six major factors: (1) construction input management, (2) owner satisfaction, (3) cost and quality, (4) manpower management, (5) subcontractor performance and (6) equipment management.

The findings of this research can be used as a guideline to measure PMP of contractors in Vietnam as well as in other developing countries. Moreover, since contractors from a country to the other country may have the same manner to manage construction projects, the results of this study may be useful not only to practitioners and researchers in Vietnam but also to participants in other developing countries.

Since limitations are unavoidable in any study, several limitations were pointed out. The survey was made on building projects located in Ho Chi Minh city, thus it may seem inappropriate to generalize for the whole of Vietnam on the basis of the data. However, a large proportion of building projects in Vietnam are located Ho Chi Minh city and Hanoi. Further studies should be performed to other kind of construction projects or located in other provinces so that a perfect set of KPIs for PMP of large contractors can be identified.

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