Building Project Performance Evaluation Model

Wadugodapitiya, R. R. M. M. K.
Department of Building Economics, University of Moratuwa
(email: manjulawadugodapitiya@yahoo.com)
Sandanayake, Y. G.
Department of Building Economics, University of Moratuwa
(email: yasangee@yahoo.com)
Thurairajah, N.
School of Built Environment, University of Salford
(email: N.Thurairajah@salford.ac.uk)

Abstract

Building project performance evaluation is a novel research interest in performance measurement (PM) and it is the process of quantifying the efficiency and effectiveness of construction activities. The traditional view of PM highly relies on financial and accounting data, which gives only the past performance. Moreover, the construction industry has been always criticized for its underperformance due to its uniqueness in nature. According to past researchers, there is lack of an appropriate PM system to improve construction performance. There is therefore a necessity for multi-dimensional approach to measure the building construction project performance. Past literature reveals that both balanced scorecard (BSC) and analytic hierarchy process (AHP) tools have been used in manufacturing industry for performance evaluation. This study therefore developed a multi-dimensional performance measurement model for building construction project performance evaluation by integrating BSC and AHP tools. Comprehensive literature review and preliminary survey approach were used to develop a novel extended BSC model, which comprises with six perspectives namely, Client, Financial, Internal business processes, Project team, Health, safety and socio-environmental, and Innovation, learning and growth. Extended BSC model further comprises with key building project performance indicators (KBPPIs) in each perspective. Structured questionnaire survey was then conducted to collect data and AHP tool was used to analyze and prioritize BSC perspectives and KBPPIs. Survey findings revealed that client and financial perspectives have relatively two times higher important level than other perspectives in the model while, three times important than innovation, learning and growth perspective. In conclusion, this novel multi-dimensional performance measurement model can be duly applied by construction industry practitioners to optimize building performance.

Keywords: performance measurement (PM), extended balanced scorecard (BSC), analytic hierarchy process (AHP), key building project performance indicators (KBPPIs)

1. Performance Measurement in Construction Industry

Construction project performance evaluation continues to be one of the primary competitive issues of the new millennium. Performance measurement (PM) is an integral part of management and defined as a process of quantifying both the efficiency and effectiveness of an action (Neely *et al.*, 2005). Some of the major concerns of performance measurement include *"What to measure?"*, *"Which measures are used?"*, *"How to measure?"* and *"How to interpret results?"* (Sandanayake and Oduoza, 2007). Traditionally performance has mainly been measured from the financial perspective. Therefore traditional management accounting systems were highly criticized due to their dysfunctional behaviour (Ridgway, 1956). This dissatisfaction led to the development of "balanced" or "multi-dimensional" PM frameworks in the late 1970s (Bourne *et al.*, 2000). Kagioglou *et al.* (2001) stated organizations that rely on financial measures alone, can identify their past performance but not what contributed to achieve that performance. Further, Kagioglou *et al.* (2001, pp 86) emphasised "in addition to measuring 'what' the performance of an organization was, 'how' that performance was achieved should also be identified on an on-going basis". This made aligning the leading indicators for PM concurrently with the lagging indicators.

Cain (2004) identified PM as the first stage in any improvement process that benefits the end users as well as the organisations. Therefore Kulatunga *et al.* (2007) emphasised that PM is important for organisations to evaluate its actual objectives against the predefined goals and to make certain that they are doing well in the competitive environment. Traditionally, PM in construction is approached in two ways: in relation to the product as a facility and in relation to the creation of the product as a process (Kagioglou *et al.*, 2001). Although a similar set of process stages is involved in every project, the construction industry is a project-oriented industry where each project is unique and can considered as a prototype (Wegelius-Lehtonen, 2001). Therefore, measuring construction performance focuses more on projects rather than the construction organisations (Kagioglou *et al.*, 2001). The researchers and the industrial experts agree that the lack of appropriate performance measurements have become one of the principle barricades to promote improvements in the construction industry (Alarcon and Serpell, 2001).

Kagioglou *et al.* (2001) argued that traditional indicators such as cost, time and quality do not in isolation, provide a balance view of the projects' performance. Researchers further stated that implementation of three traditional indicators in construction projects is apparent at the end of the project and therefore they can be classified as 'lagging' indicators of performance. Salminen (2005) developed a system for measuring construction site performance. The researcher analysed the measurement results to determine the success factors for a construction site. Kagioglou *et al.* (2001) mentioned that the project performance would be addressed on an induction basis by all companies involved in the project. The measures will therefore include both company and project performance issues. It was noted that there are different applications of key performance indicators (KPIs) in construction (Luu *et al.*, 2008). Chan and Chan (2004) developed a set of KPIs to measure success of construction projects. The researchers used three cases to test the validity of the proposed KPIs.

According to the past literature, it is obvious that performance measurement systems such as performance prism, SMART system, performance measurement questionnaire, integrated performance measurement system, EFQM framework and balanced scorecard (BSC), and multi-criteria decision making tools such as value engineering and analytic hierarchy process (AHP) have been used in manufacturing industry for performance evaluation. However, few aforementioned tools such as BSC and AHP have been adapted to performance evaluation in construction industry, individually. It has also been identified that the performance has not been measured quantitatively and qualitatively in the construction industry. There is therefore a lack of a multi-dimensional approach to quantify construction project performance and hence, there is a need to develop a multi-dimensional approach for construction project performance evaluation. Thus, the main objective of this paper is to introduce a multi-dimensional performance measurement model with prioritised BSC perspectives and Key Building Project Performance Indicators (KBPPIs) for construction project performance evaluation, using multi-criteria decision making tool such as AHP.

The paper structure begins with an introduction to PM and reviews PM in construction industry. Sections two and three, review BSC and AHP tools respectively and their applications in construction industry. Fourth section develops a conceptual model and introduces a methodological framework. Section five presents building project performance evaluation model and final section summarizes conclusions derived from the overall research finding and recommendations to improve construction project performance.

2. Balanced Scorecard approach

The Balanced Scorecard (BSC) is a performance measurement system developed in early 1990s' by Professor Robert S. Kaplan and David P. Norton. The BSC has been described as a set of measures that gives top managers a fast but comprehensive view of the business (Kaplan and Norton, 1996). Hence, it translates an organisations' mission and strategy into a comprehensive set of performance measures and provides a framework for strategic performance management (Kaplan and Norton, 1996). Traditional BSC was consisting with four perspectives. It includes financial measures that emphasis the results of actions already taken and it complements with operational measures on customer satisfaction, internal business processes and the organisations' innovation and improvement activities. Kaplan and Norton (1993) emphasised that BSC is not a template that can be applied to businesses in general or even industry wide. Researchers further added the view that different market situations, product strategies, and competitive environments require different scorecards while business units devise customized scorecards to fit their mission, strategy, technology and culture. Hepworth (1998) and Ahn (2005) suggested that additional perspectives should be included if applicable and necessary. Lee *et al* (2008) also mentioned "depending on the sector in which a business operates and on the strategy chosen, the number of perspectives can be enlarged or new perspectives can be replaced by the other".

The use of BSC tool can be identified through lot of researches. According to Stewart and Mohamed (2001), BSC has been used extensively in the manufacturing, government, banking, retail, insurance and financial services sectors. 'Apple computer' developed a BSC with the use of five performance

indicators; *Customer Satisfaction, Core Competencies, Employee Commitment and Alignment, Market Share and Shareholder Value* (Kaplan and Norton, 1993). Letza (1996) analysed three companies; construction supply, specialist coatings, telecommunications, which have implemented BSC tool in their organisation.

Implementation of BSC for PM in construction sector can be identified from early 1990s. Construction industry also has come forward to implement BSC approach and lot of researches have been conducted during last two decades (Kagioglou *et al*., 2001). Kaplan and Norton (1993) described the implementation of BSC tool thorough three case studies. One of them was under water engineering and construction company named Rockwater, which has implemented BSC successfully. Stewart and Mohamed (2001) developed the BSC framework allowing for the measurement of IT/IS performance in construction. Mohamed (2003) adopted the BSC tool to benchmark organisational safety culture in construction. Kagiouglou *et al*. (2001) developed a PM process (conceptual) framework based on the BSC with the addition of 'project' and 'supplier' perspectives, which can be tailored to construction industry needs.

3. Analytic hierarchy process tool

The AHP was first introduced by Saaty in 1971 to solve the scarce resources allocation and planning needs for the military (Saaty, 1980). AHP is about breaking a problem down and then aggregating the solutions of all the sub-problems into a conclusion (Saaty, 1994). Further, it facilitates decision making by organizing perceptions, feeling, judgements and memories into a framework that exhibits the forces that influence the decision. Clinton *et al*. (2002) suggested that the AHP tool is mathematically rigorous yet easy to understand because it focuses on making a series of simple paired comparisons. Ahmed and Rafiq (1998) stated AHP helps not only in identifying major competitors of a company but also to assess the performance of the organisation on each attribute relative to its principal competitors. Rangone (1996) described AHP as a multi-attribute decision tool that allows financial and non-financial quantitative and qualitative measures to be considered and trade-offs among them to be addressed. Recently the AHP has been applied to several decision-making areas. Rangone (1996) enhanced the application of AHP to measure and compare the overall performance of different manufacturing departments based on multi-attribute financial and non-financial performance criteria. Dey (2001) applied AHP tool for construction risk management and Chan *et al*. (2004) used AHP method to determine the priority of processes for Occupational Health and Safety Management Systems for the Hong Kong construction industry.

Ahmed and Rafiq (1998) identified BSC and AHP as common tools, which assess common frameworks' role in benchmarking. Stewart and Mohamed (2001) looked at potential applications and benefits of using the BSC as framework to evaluate the performance improvement resulting from information technology implementation by a construction organisation. According to Sale and Sale (2005), using the AHP to structure the BSC requires the decision maker to first structure the problem as a hierarchy. Sale and Sale (2005) combined AHP and BSC tools to create a technique that is superior to the use of either one in isolation.

4. Development of a building project performance evaluation model

Various research studies have been caried out to investigate and quantify performance in construction industry. However, there is no evidence in literature of any mechnism to identify KBPPIs. Therfore three step approach was adopted to identify and prioritize Building Project Performance Indicators (BPPIs). Figure 1 describes three-step approach with data collection and analysis tools and research outcomes at each step of the research.
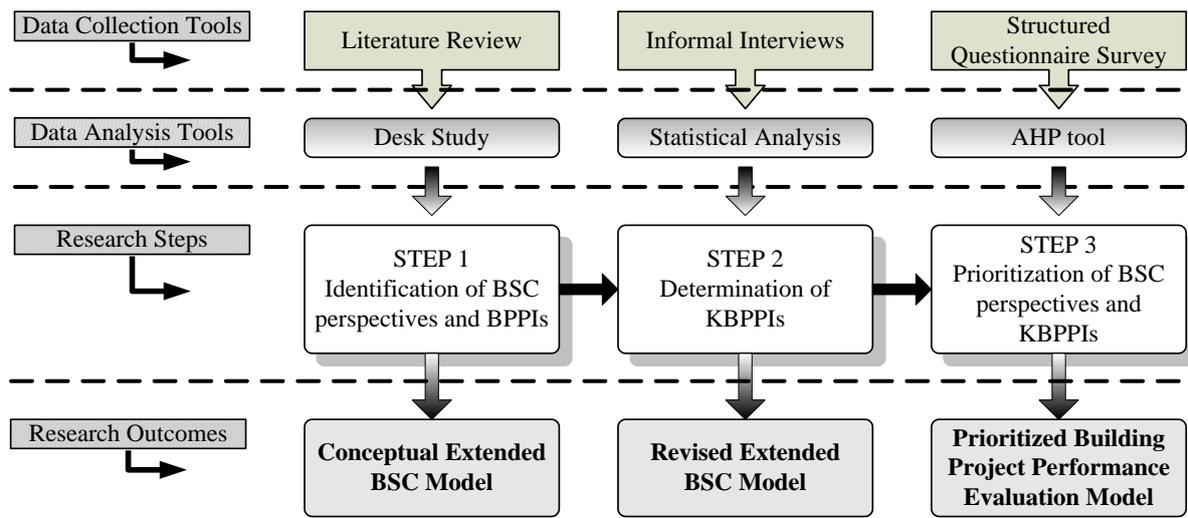
Data Collection Tools	Literature Review	Informal Interviews	Structured Questionnaire Survey
Data Analysis Tools	Desk Study	Statistical Analysis	AHP tool
Research Steps	STEP 1 Identification of BSC perspectives and BPPIs	STEP 2 Determination of KBPPIs	STEP 3 Prioritization of BSC perspectives and KBPPIs
Research Outcomes	**Conceptual Extended BSC Model**	**Revised Extended BSC Model**	**Prioritized Building Project Performance Evaluation Model**

Figure 1: Three-Step Approach for Building Project Performance Evaluation

4.1 Identification of Balanced Scorecard perspectives and building project performance indicators

Determination of BSC perspectives and BPPIs is one of the prime objectives of this study. A comprehensive literature review on construction and manufacturing industries was carried out to identify BSC perspectives and BPPIs. Currently construction projects are highly influenced by project teams and health, safety and socio-environmental issues. Thus, the traditional BSC would need to be expanded to incorporate other perspectives such as "Project team" and "Health, safety and socio-environmental". Further, the customer perspective in original BSC renamed as the 'Client Perspective' to comply with the construction terminology.

4.2 Determination of key building project performance indicators

Preliminary survey was carried out through informal interviews in order to revise the conceptual extended BSC model, with the aim of collecting common BPPIs, which are applicable in building construction project performance evaluation. Focused group consists of ten construction industry experts from the fields of project management, engineering and quantity surveying. Respondents were requested to identify the relevancy and the importance levels of BPPIs and perspectives in

conceptual model. Preliminary interview data analysis reveals that all extended BSC perspectives and BPPIs are relevant for each perspective in extended BSC model and the perspectives identified are relevant for building project performance evaluation. Moreover, three new indicators were identified and included in the revised extended BSC. BPPIs included in revised extended BSC model were named as the Key Building Project Performance Indicators (KBPPIs). Figure 2 presents the revised extended BSC for building project performance evaluation.
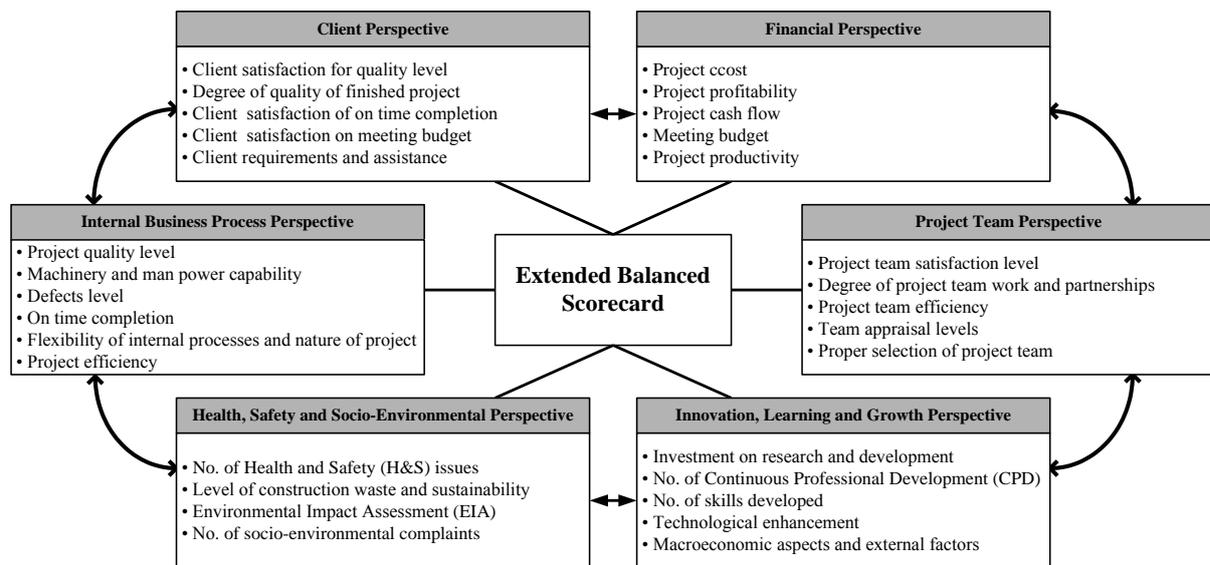
Client Perspective
- Client satisfaction for quality level
- Degree of quality of finished project
- Client satisfaction of on time completion
- Client satisfaction on meeting budget
- Client requirements and assistance

Financial Perspective
- Project ccost
- Project profitability
- Project cash flow
- Meeting budget
- Project productivity

Internal Business Process Perspective
- Project quality level
- Machinery and man power capability
- Defects level
- On time completion
- Flexibility of internal processes and nature of project
- Project efficiency

Extended Balanced Scorecard

Project Team Perspective
- Project team satisfaction level
- Degree of project team work and partnerships
- Project team efficiency
- Team appraisal levels
- Proper selection of project team

Health, Safety and Socio-Environmental Perspective
- No. of Health and Safety (H&S) issues
- Level of construction waste and sustainability
- Environmental Impact Assessment (EIA)
- No. of socio-environmental complaints

Innovation, Learning and Growth Perspective
- Investment on research and development
- No. of Continuous Professional Development (CPD)
- No. of skills developed
- Technological enhancement
- Macroeconomic aspects and external factors

Figure 2: Extended BSC for Building Project Performance Evaluation

4.3 Prioritization of BSC perspectives and key building project performance indicators

The next step in the building project performance evaluation model development process is data analysis using AHP tool. A series of focused and structured interviews were carried out with clients, quantity surveyors, engineers, project team members, health and safety officers and project managers. The respondents were asked to give their individual opinion and indicate the magnitude of the importance placed on selected KBPPIs for each BSC perspective. For all decision alternatives, geometric mean was calculated from the allocated weights from the participants; the mean for each alternative was considered in the analysis. The AHP is consisting with set of mathematical calculations mainly focusing three steps, i.e. "Pair-wise Comparisons", "Normalise the Comparison" and "Consistency Calculations". The AHP analysis is used to identify the impact of each BSC perspective on overall project performance and the importance of KBPPIs on each BSC perspective. The performance pair-wise comparison for BSC perspectives are given in Table 1. The weights of Table 1 are then normalised and presented in Table 2. The consistency calculations are given in Table 3.

Table 1: Pair-Wise Comparisons of Extended BSC Perspectives

Performance Perspective	Client	Financial	Internal Business Processes	Project Team	Health, Safety and Socio-Environmental	Innovation, Learning and Growth
Client	1.000	1.613	2.006	3.008	2.035	2.594
Financial	0.620	1.000	2.028	2.967	2.351	2.963
Internal Business Process	0.498	0.493	1.000	1.328	1.256	2.329
Project Team	0.332	0.337	0.753	1.000	2.123	2.548
Health, Safety and Socio-Environmental	0.491	0.425	0.796	0.471	1.000	1.693
Innovation, Learning and Growth	0.385	0.338	0.429	0.392	0.591	1.000
SUM	**3.328**	**4.206**	**7.012**	**9.167**	**9.355**	**13.127**

Table 2: Pair-wise Normalized Comparisons of the BSC Perspectives

Performance Perspective	Client	Financial	Internal Business Processes	Project Team	Health, Safety and Socio-Environmental	Innovation, Learning and Growth	SUM	Performance Score
Client	0.301	0.384	0.286	0.328	0.218	0.198	1.713	**0.286**
Financial	0.186	0.238	0.289	0.324	0.251	0.226	1.514	**0.252**
Internal Business Process	0.150	0.117	0.143	0.145	0.134	0.177	0.866	**0.144**
Project Team	0.100	0.080	0.107	0.109	0.227	0.194	0.817	**0.136**
Health, Safety and Socio-Environmental	0.148	0.101	0.114	0.051	0.107	0.129	0.650	**0.108**
Innovation, Learning and Growth	0.116	0.080	0.061	0.043	0.063	0.076	0.439	**0.073**
							6.000	

Table 3: Consistency Calculations for Extended BSC Perspectives

Performance Perspective	Client	Financial	Internal Business Processes	Project Team	Health, Safety and Socio-Environmental	Innovation, Learning and Growth	SUM	SUM ÷ Performance Score
Client	0.286	0.407	0.290	0.410	0.220	0.190	1.802	**6.312**
Financial	0.177	0.252	0.293	0.404	0.254	0.217	1.598	**6.333**
Internal Business Process	0.142	0.124	0.144	0.181	0.136	0.171	0.899	**6.225**
Project Team	0.095	0.085	0.109	0.136	0.230	0.187	0.841	**6.175**
Health, Safety and Socio-Environmental	0.140	0.107	0.115	0.064	0.108	0.124	0.659	**6.087**
Innovation, Learning and Growth	0.110	0.085	0.062	0.053	0.064	0.073	0.448	**6.115**
						λ_{max}	=	**6.208**

$$CR = \{(\lambda_{max} - n) / (n - 1)\} \times (1/ RI) = \{(6.208 - 6) / (6 - 1)\} \times (1/ 1.25) = \mathbf{0.033}$$

Where CR is Consistency Ratio, n is size of matrix (i.e. Number of BSC perspectives) and RI is Random Index for n number of matrices.

The next step of AHP analysis is the pair-wise comparison of KBPPIs with respect to extended BSC perspectives. The same procedure is followed and results are given in Table 4. Results are discussed and building project performance evaluation model is presented in the following section.

5. Building project performance evaluation model

The ultimate objective of this study is to develop a **'Building Project Performance Evaluation Model'** with prioritized BSC perspectives and KBPPIs. Table 4 presents the prioritized building project performance evaluation model. Relative performance scores of each BSC perspective and KBPPIs provide the importance level of perspectives and KBPPIs in building project performance evaluation.

Table 4: Prioritized Building Project Performance Evaluation Model

Perspectives and Key Performance Indicators	Performance Score	Overall Score %
Client Perspective	**0.286**	**28.56%**
Client satisfaction for quality level	0.389	11.10%
Degree of quality of finished project	0.225	6.41%
Client satisfaction of on time completion	0.161	4.59%
Client satisfaction meeting budget	0.144	4.12%
Client requirements and assistance	0.082	2.34%
Financial Perspective	**0.252**	**25.23%**
Project profitability	0.333	8.39%
Project cost	0.210	5.29%
Project cash flow	0.197	4.97%
Meeting budget	0.143	3.61%
Project Productivity	0.117	2.96%
Internal Business Process Perspective	**0.144**	**14.44%**
Project quality level	0.316	4.56%
On time completion	0.179	2.59%
Defects level	0.171	2.47%
Machinery and manpower capability	0.136	1.97%
Project efficiency	0.125	1.81%
Flexibility of internal processes and nature of project	0.072	1.03%
Project Team Perspective	**0.136**	**13.62%**
Proper selection of project team	0.290	3.95%
Project team efficiency	0.243	3.30%
Project team satisfaction level	0.178	2.42%
Degree of project team work and partnerships	0.175	2.39%
Team appraisal levels	0.115	1.57%
Health, Safety and Socio-Environmental Perspective	**0.108**	**10.83%**
Number of health and safety issues	0.412	4.46%
Level of construction waste and sustainability	0.266	2.87%
Environmental Impact Assessment (EIA) score	0.163	1.77%
Number of socio-environmental complaints	0.159	1.72%
Innovation, Learning and Growth Perspective	**0.073**	**7.32%**
Continuous Professional Development (CPD)	0.282	2.07%
Investment on research and development	0.269	1.97%
Number of skills developed	0.188	1.37%
Technological enhancement	0.165	1.21%
Macroeconomic aspects and external factors	0.096	0.71%

According to Table 4 'Client' is the most important perspective with 0.286 performance score. 'Financial Perspective' is in the second place in the revised BSC with a 0.252 performance score. The third, fourth and the fifth perspectives are 'Internal Business Process Perspective' (0.144), 'Project Team Perspective' (0.136) and 'Health, Safety and Socio-Environmental Perspective' (0.108) respectively. According to the research the least important perspective is the 'Innovation, Learning and Growth Perspective' with 0.073 performance score.

According to analysis of Table 4 'client satisfaction for quality level' (0.389) is the most important KBPPI in client perspective, while 'project profitability' is the most important KBPPI in financial perspective with 0.333 performance score. Ward et al (1991) also found that when looking back on the conduct of a project, what sticks in the mind is often not the financial success or early completion, but memories of clients involved and abiding impressions of harmony, goodwill and trust or, conversely, of arguments, distrust and conflict. In internal business process, project team, health safety and socio-environmental and innovation, learning and growth perspectives, the most important KBPPIs are 'project quality level' (0.316), 'proper selection of project team' (0.290), 'number of health and safety issues' (0.412) and 'continuous professional development' (0.282) respectively. In client perspective 'client requirements and assistance' (0.082) is the least important KBPPI and for financial perspective it is 'project productivity' (0.117). 'flexibility of internal processes and nature of project' (0.072), 'team appraisal levels' (0.115), 'number of socio-environmental complaints' (0.159), and 'macroeconomic aspects and external factors' (0.096) are the least important KBPPIs respectively in internal business process, project team, health safety and socio-environmental and innovation, learning and growth perspectives. The CR for each perspective is less than 0.10. Therefore, data used for the study can be considered as acceptable and consistent.

The overall comparison of KBPPIs is providing a spectacular point of ranking all the PIs with the priority levels towards PM in building construction. According to the results 'client satisfaction for quality level' (11.10%) is the most apparent BPPI, while 'project profitability' (8.39%) is the second most important BPPI. 'Degree of quality of finished project' (6.41%) and 'project cost' (5.29%) have taken the places of third and forth, which are in client and financial perspectives respectively. 'Macroeconomic aspects and external factors' (0.71%) in innovation, learning and growth perspective is the least important BPPI in overall scorecard.

6. Conclusions

The study developed the Building Project Performance Evaluation Model to evaluate building project performance. A three step approach to evaluate building project performance using BSC and AHP tools has been presented. This included the use of comprehensive literature review to identify BSC perspectives, BPPIs and application of statistical analysis to determine KBPPIs. AHP tool was applied to prioritize BSC perspectives and KBPPIs in order to develop building project performance evaluation model. The implication of AHP tool for analysis scrutinized the perspectives and KBPPIs through pair-wise comparisons and bestowed relative performance scores for each perspective and BPPI. Therefore model developed, enriched with relative performance scores from importance levels to the building construction. These performance scores provide the opportunity to consider a

magnitude importance of each perspective or a KBPPI from another perspective or a KBPPI respectively. The prioritised model emphasised the important extended BSC perspectives as well as KBPPIs for building project performance evaluation. The approach developed benefits from its simplicity and operability. However the complexity of AHP analysis increases with the number of BSC perspectives and KBPPIs.

The analysis of responses revealed that "Client Perspective" and "Financial Perspective" in building construction projects hold higher importance levels compared to the other perspectives in the revised extended BSC. The two perspectives were comparatively two times more important than the other perspectives while comparatively three times more important than "Innovation, Learning and Growth Perspective". Though the industry practitioners accepted the "Innovation, Learning and Growth Perspective" as an important aspect for performance measurement, the final analysis exposed the importance level of particular perspective as a lower amount. It was consisted the literature that using innovation learning and growth perspective is not much appropriate for project performance. According to the overall AHP analysis 'client satisfaction for quality level' is the most critical KBPPI followed by 'project profitability'. Since these two most important KBPPIs indicate the final expectations of both parties of the contract. From the clients' aspect it is client satisfaction, while from the contractors' point of view it is project profitability.

The building project performance evaluation model developed here can serve as a tool to enhance construction project performance. It will enable strategic decision on client satisfaction, financial stability, efficiency and effectiveness of internal business process and project teams, sustainable projects and delivery of innovative projects to clients. Therefore this innovative three step approach and building project performance evaluation model can be simply applied by construction industry practitioners and academic researchers to optimise building project performance.

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