

UNIVERSITY OF BAHRAIN

College of Engineering

Department of Mechanical Engineering



Performance Assessment of Construction Management Provisions in Building Projects in Bahrain

A Thesis Submitted in Partial Fulfilment of the Requirements for the Master Degree in Engineering Management

Submitted by

Sayed Fadhel

University Number: 20042967

Supervised by

M. P. Saka

(Professor)

University of Bahrain

Kingdom of Bahrain

November 2017

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The student awarded grade A In the thesis subject _____

- ☒ Without making any changes to the thesis
☐ After making the modifications attached with this decision



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Abstract

Construction industry has complexity in its nature since it involves many stakeholders as clients, contractors, regulators and others. Construction projects in Bahrain suffer from many issues and complex problems in performance such as cost and time overrun as well as many quality matters. The main aim of this study is to identify the most influential performance measures identified in existing project management literature and aggregate them in a comprehensive model. The analysis was performed targeting Building construction industry with a focus on Bahraini market peculiarities. Literature review about performance was reviewed to study previously established models as a base for adaptation and to identify the most relevant performance indicators for Building construction projects. In order to reorient the finding of the literature review with local needs a Pilot study was conducted through a scouting sample consisted of 10 questionnaires resulted the addition of two extra indicators as recommended by local experts. Subsequently, A questionnaire survey was conducted and 47 indicators were identified, categorized into 11 groups, evaluated and ranked by construction companies of the top four ranked classes according to Ministry of work classification. In this study, it was hypothesized that the underperformance of local construction in companies is due to their low perceptions of the concept of performance measurement. And that neither does the classification of the construction company nor the position of respondents affect the ranking of the Key Performance Indicators (KPI). The top five indicators agreed by all contractors were: Clients satisfaction; Profitability; End-user satisfaction; Cash flow and Cost rate. Furthermore, it was confirmed that the little awareness about the concepts of performance measurement was a major cause for the underperformance of the construction sector. Not surprisingly, a consensus of agreement among all contractors was missing as contractors vary in ranking each according to their priorities. However, to verify whether the differences among the classes of contractors were significant or not the degree of agreement between parties was determined according to ANOVA and independent t-test. Results indicate that these differences are insignificant and the proposed model can be utilized by the different contractor classes. The methodology of assessing the performance along with their analysis is examined through the use of Multi Criteria Decision Analysis (MCDA) by using Analytic Hierarchy Process (AHP), Accordingly, it can be concluded that, this study has introduced a model to measure contractor's performance on three levels both in subjective (qualitative) and the objective (quantitative) terms. The model proposed a holistic set of project performance metrics that cover time, cost, quality, Health & safety and Planning. In addition, the model incorporated the dimensions of the BSC to represent the corporate performance; as well as responding to the many researcher's recommendations to involve all concerned stakeholders by focusing on meeting their expectations. The results of the study contributed both to Bahraini construction and project management field of study. Further research is encouraged by expanding the scope of current research to includes the different stages of the project life cycle.

Dedication

I dedicate the effort on this thesis to my wife who has been along my side throughout this journey, and to all my family members, and Mom without your prayers I could never reach where I am.

Acknowledgment

I wish to express my gratitude to Prof. M. P. Saka for his support and positive feedback in supervising the study. Extended warm thanks go to Prof. Saad Suliman for his guidance and encouragement all the way along.

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Chapter 1

Introduction to the Study

1.1 Introduction

1.2 Research Problem

1.3 Research Questions

1.4 Research Objectives

1.5 Importance of the Research

1.6 Limitations of the Research

Chapter 1

Introduction to the Study

This chapter introduces the research topic to provide a justification for the need of studying the particular research problem.

1.1 Introduction

The construction industry is often described as complex, and requires extensive amount of cost and time, involve a high risk and a great deal of uncertainty. On the other hand, as stated by Ahadzie *et al.* (2008) construction projects are also challenging and dynamic which in turn attracts more capital, brilliant minds and a target for new technologies. Off all the construction industry sectors, building projects in particular are considered amongst the largest sectors in the most developing economies world wise.

As per the result of ICD Research (2011), trading is one of the major elements contributing to the economy of Bahrain. To enhance the growth and development of the construction industries, the transport infrastructure was developed so that it can assist in the performance of the contractors. Few of the strategies that were encouraged for the enhancement of the construction works are the investment of USD 4.8bn to the expansion of Bahrain International Airport to triple airport capacity to 27 million passengers per annum. Bahrain spent over USD 4.7bn towards the construction of projects that included 100 km of bridge and road. It was also observed that during the boom period, the mid to high end construction

led towards the deficit of low income from the housing as there was a long list of waiting households such as 53,000 as the annual Over USD expansion was only 4,000.

However, the construction industry in Bahrain continues to face major challenges regarding overall performance. A common problem with several companies in Bahrain is the absence of a long-term strategy for the establishment to track and eventually achieve its target objectives. The majority of the corporations lack a proper performance assessment system to monitor how they are operating (Al-Sehali, 2001).

Al-Sehali (2001) further states that problems in the construction industry in Bahrain generate substantial losses in the national economy, substandard project outcomes, substantial maintenance costs, disputes and conflicts caused by inadequate specifications, projects missing deadlines causing loss of money and time.

For construction firms to distinguish best practice, the performance assessment frameworks as a management monitoring tool needs to be developed in parallel with the construction firms' characteristics and utilized to achieve the sought-after performance improvements. This might pose a challenge without an in depth and systematic framework to reach the target results in spotting performance gaps together with best practice that can enhance the firms' overall performance.

Hence, the main purpose of this research is to build and present a quantitative performance assessment model that determine the evaluation criteria by identifying the key performance indicators (KPIs), that are aligned to Building projects. In order to carry out rigorous self-assessment within a coherent and appropriately structured framework, identifying precisely the most relevant measures and subsequently addressing the particular area to improve overall performance.

1.2 Research Problem

The sophisticated nature of managing construction organizations at present demands that senior managers be capable of viewing performance in different areas concurrently. No single measure is able to deal with the many crucial aspects of the organization or give a precise performance target. Financial measures have long been criticized because they are depending on lagging results than leading processes, as well as their well-documented insufficiencies. A group of non-financial measures should therefore be incorporated to balance the heavily dependence on financial measures in order to build a robust performance measurement system.

Moreover, without a proper performance system decision makers won't be able to evaluate whether they will be able to accomplish their planned goals and objectives or not. This highlights that the selection of suitable performance Indicators features a substantial influence on the implementation of strategies, and is particularly important for developing a more effective improvement programs.

1.3 Research Questions

- What are the existing models used to measure performance?
- What are the most significant performance indicators to measure Performance in the construction industry in Bahrain?
- How Construction Companies could measure their performance?

1.4 Research Objectives

1. To review previous performance assessment models being employed within the construction industry.
2. To investigate the key performance indicator for of Building construction projects in Bahrain based on accumulative knowledge and judgment of experts (owners, Construction Managers and project engineers) through a survey questionnaire.
3. To develop a proposed Building Construction Performance model (BCPM) based on the key performance indicators recommended by the construction experts and professionals.

1.5 Importance of the Research

A Performance Measurement system (PMS), if implemented by the construction organizations, would certainly support them in building achievable and practical objectives, control the trade-off between the competing demands for quality, time, and cost. This will ensure a timely completion of the project, within the allocated budget and disputes free (Gandhi, 2005). Therefore, there is a need for a performance system, which assess the prevailing practices of construction organizations and identify

the shortfalls in which, they could possibly eliminate. This performance system may also serve as a prequalification condition for clients such as governmental organization (i.e. Ministry of Works) if its further developed into a benchmarking system.

1.6 Limitations of the Research

The main limitation of this study is the relatively small sample size used. Nevertheless, this should not invalidate the research findings considering the fact that the adequacy of the sample size has undergone the necessary preliminary tests on which the central limit theorem was assumed, and the results of those tests were in favor of proceeding the research analysis. Another limitation is the willingness and availability of the construction companies to provide information for the research. Typically, organizations are conservative and hesitant to share their internal confidential information. To minimize these constraints the questionnaire survey approach was adapted promising the participants a total anonymity and restricting results to academic purposes.

1.7 Terminologies of the Research

1.7.1 Abbreviations of the Research

AHP	Analytical Hierarchy Process
BCPM	Building Construction Performance Model
BPMSG	Business Performance Management Singapore
BSC	Balanced Scorecard
CBPP	Construction Best Practice Programme
CI	Consistency Index
CR	Consistency Ratio
DLP	Defect Liability Period
CSF	Critical success factor
EFQM	European Foundation for Quality Management
FTA	Free Trade Agreement
FY	Fiscal Year
GCC	Gulf Cooperation Council
GDP	Gross domestic product

KPI	Key performance indicator
KPO	Key Performance Outcome
MBNQA	Malcolm Baldrige National Quality Award
MCDA	Multi Criteria Decision Analysis
MOW	Ministry of Works
PMBOK	Project management book of knowledge
PMI	Project management Institute
PMS	Performance measurement System
RI	Relative Importance
SPSS	Statistical Package for Social Sciences
SPM	stakeholder perspective measurement
TQM	Total Quality Management
UK	United Kingdom
US	United State
USITC	United States International Trade Commission

1.7.2 Symbols of the Research

SS	Sample size
Z	Value (e.g. 1.96 for 95% level of confidence)
P	Degree of variance between the element
C	Confidence interval
POP	Population
α	Cronbach's coefficient alpha
t_o	t - statistic (observed t value)
$\bar{x}$	the sample mean
μ	the critical rating specified by the null hypothesis
n	sample size
$n - 1$	degree of freedom
α	the significant level
R_{II}	Relative importance index
$\overline{M}_i$	the mean importance score of measure i

ΣM	summation of all mean scores for all measures
CI	Consistency Index
n	number of criteria in the matrix
λ_{Max}	Maximum Eigenvalue
CR	Consistency ratio
RI	Random Consistency Index

Chapter 2

Literature Review

2.1 The construction industry in Bahrain

2.2 Introduction of Performance Measurement System

2.3 Importance of PMS

2.4 Previous models of performance measurement

2.5 General View of Construction Industry

2.6 Performance Measurement in Construction Industry

2.7 KPI in Construction Industry

2.8 Levels of performance measurement in construction

2.9 Literature conclusion

Chapter 2

Theoretical Framework and Previous Studies

The comprehensive literature study is a tremendously fundamental phase to set the theoretical background of the research, therefore areas related to the concept of measuring performance in construction industry will be the subject of this part of the study.

2.1 The construction industry in Bahrain

In the field of construction in Bahrain, there is a greater demand to bring more of the improvements due to the reason that the clients wish for better value from their projects whereas the contractors desire for the reasonable profits to ensure long term profits in the future. The improved performance of the contractors can lead the organization towards satisfaction of the client, and reputation of the organization.

According to the Deloitte & Touche (2012), the total industry value of the construction industries in Bahrain has been forecasted at the approximate value of USD 1.2bn in FY11. The steady growth was recorded to be 1.6% in the year 2010 but it again gradually rose to 3.2% by the end of the year 2011.

In the year 2014, the construction sector of Bahrain contributed 10.7% of growth to the real GDP. The entire sector was found to attain the growth of 7.3% from the year 2013 to 2014. The growth was successful due to the

government aim to diversify the economy by prioritization of housing and infrastructure projects in the kingdom. All these data were available in the study of Bahrain Economic Development Board (2016).

Table (1) provides clear view of the SWOT analysis done upon the construction sector in Bahrain.

Table (1)
SWOT analysis for the construction sector in Bahrain (Source: USITC 2004)

Strengths	Weaknesses
1) More diverse economy than that of the other GCC countries 2) Regional financial hub containing developed banking sector and growing Islamic finance industry 3) The government had strong initiatives in investing in the construction projects	1) Political instability can possess threat of economic stability along with prevention of international flow of capital 2) Shifts in the oil price is always risk. The export and import of the oil highly dependable on the changes in demand among the oil dependent countries 3) The complicated process of project approval discourages the leading companies to make investments in the infrastructure projects in Bahrain.
Opportunities	Threats
1) The productivity can be improved along with boosting of the growth can be encouraged through the labor market reforms supported by the Economic Development Board. 2) Huge market has been opened for the domestic players by signing of the Bahrain-US FTA	1) Various kinds of proposals for limiting of the work permits of the expatriate worker can definitely lead towards the shortage of labors in the construction sector as the majority of the labors are from South Asia. 2) The oil reserves are declining irrespective of the efforts of renewed exploration and the output of it is expected to fall by the end of the decade.

However, Despite the fact that the construction industry in Bahrain is substantially smaller in scale and mature in its capability in comparison to other developed countries such as the UK construction industry, nevertheless the obstacles facing the construction industry in Bahrain possess a significant challenge.

Al-Sehali (2001) in his study reviewed the concepts of total quality management (TQM) and the extent of its application by Bahraini contractors stated a number of problems facing the construction industry in Bahrain as follows:

- Exceeding the allocated project's budget as a result of the many changes and variations orders.
- Inability to handover projects on the planned schedule in many cases.
- Project's quality is compromised in favor of early project completion.
- Conflicts arise with unsatisfied clients due to incomplete or wrong specifications leading to third party arbitration or court adjudication.

Relevant to this matter, a study covering middle eastern countries Al-Kharashi and Skitmore (2009) stated numerous causes for time overrun which includes substantial changes in the project scope and financial difficulties as the two major reasons that disrupt the planned schedule and delays the project handing over. Moreover, issues related to human factors for example, the lack of experienced and qualified personnel has a direct impact on the project time performance.

Notwithstanding many cost control approaches which have been employed, cost overruns keeps arising in lots of countries. The problems associated are mostly relating to delayed payments, over-budget not to mention the lengthy claims process. Several reasons behind the low project cost performance, such as; imprecise estimation of project cost and time by key participants, inadequate specification of the project design, increased variation orders, and selection of unqualified subcontractors; have led to substandard cost performance (Ahcom, 2004).

All of these obstacles have triggered serious conflicts and disputes between project stakeholders and an adversarial relationship between parties. On top of that, clients' desires for a quicker handing over of the project with minimal costs through expediting the process yet maintaining a satisfactory quality of work. As a result, the clients' needs are not met, due to the contractor inability to keep pace with an over tightened project schedule (Masrom, 2012).

Thus, for construction organizations that seek an improved overall performance and wishes to excel in business, they need to consider these deficiencies and they are required to perform their tasks differently than they used to. This may not be achieved straightaway, still it needs mindful decisions, dedication and foresight to embark on this strategy.

2.2 Introduction of Performance Measurement System

Performance measurement system (PMS) is the quantitative indicators that are objective and are intended to monitor the performance situations such as customer satisfaction, efficiency, effectiveness,

productivity, cost and quality. According to Kulatunga *et al.* (2005), performance measurement can be defined as the regular collection and reporting of the information concerning the efficiency, effectiveness and inputs of the construction projects. The concept of PMS has evolved over three generations back. In the initial generation, PMS was introduced for the measurement of financial information but it was not successful due to the non-integration of the actual PMS. The second generation was introduced to identify the first-generation's weaknesses through the factors and strategies so that it can be installed in the process. The final generation was introduced to make connection between the financial and non-financial information with that of the cash flow.

Several definitions were given by the different scholars on the concept of PMS but among all the definitions, a common factor that was found were the existence of two major terms such as efficiency and effectiveness. This system was mainly measured for the determination of efficiency and effectiveness of construction organizations.

2.3 Importance of PMS

The study of Bourne *et al.* (2003) explains that the majority of the companies make use of PMS for their project evaluation through the use of financial and non-financial measures and to compare their performance with that of the others so that the efficiency and effectiveness of the projects can be improved further. The measuring of the performance has been a common concept for all the sectors and the organizations due to the ensuring of success and the growth of competitiveness. Basically, there remains a misconception between the organizational performance and

project performance but both of the concepts are completely different than that of each other.

Contradictorily, Zeglat *et al.* (2012) stated that the companies generally measure their performance in order to keep a track whether the goals and objectives of the organization is met or not. For the measurement of the specific aspects of the performance of the firm, indicators concerning to the areas to be monitored is developed. The performance measurement reflects one of the major issues of business i.e. the degree of success. Several of the frameworks have emphasized on the measurement of the project performance. The unique feature of the construction project creates difficulties in the development of generic framework that can measure the performance of the various projects. This particular study also revealed that the measurements are required for the forecasting, tracking, and controlling the critical success factors of the project. The PMS is specifically used by the participants of the construction projects such as the decision makers, contractors, the project managers' and designers to meet the targets of the construction performance at the levels of project and the company.

2.4 Previous models of performance measurement

In this segment of the study, four of the previous models for the performance measurement shall be discussed.

2.4.1 Balanced scorecard (BSC) model

In the study of Yang *et al.* (2010), Kaplan & Norton (1992) had introduced this model and explained it as the management system that encourages the organization to provide clear view of its strategy and vision

along with translating them into an action. The basic purpose of the balanced scorecard model is to develop balance among the financial and non-financial goals of the organization. In order to meet this purpose, the company translates the vision and long term strategy into the goals that can be measured. The major aim of this model is to act as the indicator so that adequate information can be provided to the management so that the control of the organization can be facilitated.

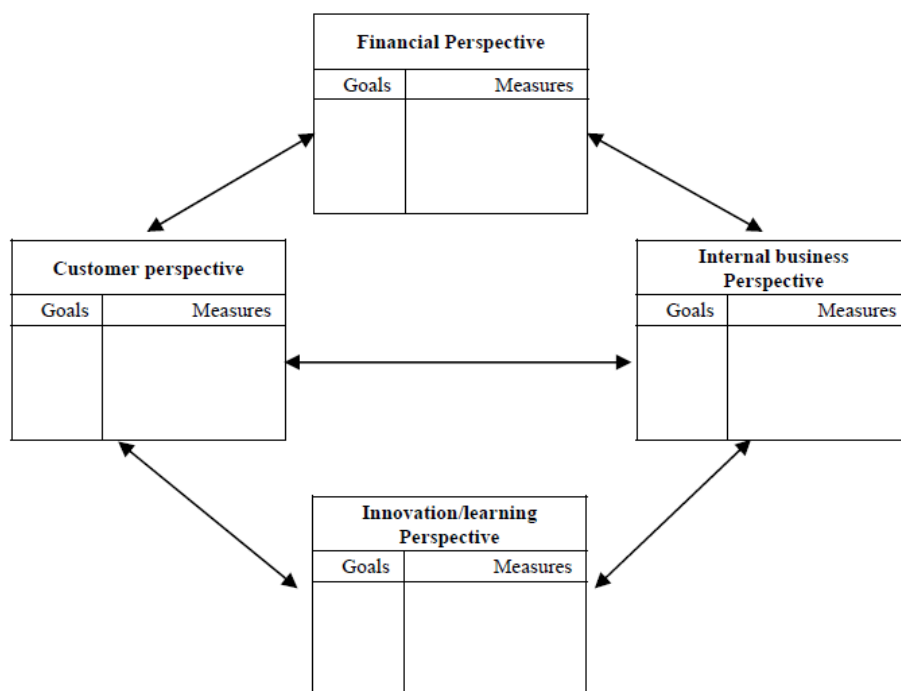


Figure (1)

The Balanced Scorecard Structure (After Kaplan and Norton, 1992)

In the study of Isik *et al.* (2009), it was reviewed that the balanced scorecard model was presented as a framework for measurement for the strategic, financial and operational measures. This model aims to mix corporate values with the various factors such as customer satisfaction,

operational objectives, individual employees' objectives, shareholder values and expectations, aspirations and competencies. This model as shown in Figure (1) enables executives to monitor their organization from four perspectives such as financial, innovation and improvement, internal process and customers. Contradictorily, Mäkilä (2014) stated that this model recommends the areas that need to be focused but provide limited guidance on the ways of identification, introduction and ultimate use of the original approaches for the determination of business success.

The study of Nudurupati *et al.* (2007) determined that balanced scorecard model is widely accepted framework as it begins with the opinion that for managing the business, financial measures alone are not sufficient. The financial measures are not considered to be helpful during the improvisation of the value creation through the investment made among the customers, employees, suppliers and technology. Thus, the balanced scorecard model was developed to complement the measures of the past performances with that of the measures of future performance.

The BSC had its share of popularity in the construction industry as well, ZG Jin and Deng (2012) reported several application of the BSC across many researches in the construction management literature where the BSC was applied to construct frameworks for measuring performance (Ali *et al.*, 2013; Bassioni *et al.*, 2005; Kagioglou *et al.*, 2001), to analyze the organization' performance when investigating causes of deficiencies (Lee *et al.*, 2013), to measure strategic performance through conducting a case study (Luu *et al.*, 2008) and to propose an empirical assessment model (Yu *et al.*, 2007), However construction researchers criticized BCS for lacking some essential dimensions such as supplier performance and

project management (Bassioni et al. 2005; Kagioglou et al. 2001) Health, Safety and Socio-Environmental (Wadugodapitiya *et al.*, 2010). These studies used several techniques for implementing BSC in the field of building construction, thereby support the employment of BSC in this study.

2.4.2 European Foundation for Quality Management

According to the study of Minier (2014), the European Foundation for Quality Management (EFQM) identifies three specific types of performance measures namely the Key Performance Indicators (KPIs), the Key Performance Outcomes (KPOs) and the perception measures as depicted in Figure (2). The KPIs are those which indicate the processes involved in performance. KPIs are considered as the leading indicator that allows for the identification of the problems and highlighting the requirement of further investigation. They also provide the opportunity to transform through the adoption of appropriate corrective actions. To meet this specification, KPIs are required for the continuous measurement during the process. Conversely, KPOs are the results of completed process. These are the lagging indicators that do not offer the opportunity to change since they are focused backward. At last, the perception measures can be used at any stage and can be considered both as the lagging or leading measures that require direct feedback on the past performance. For instance, the perception measures hold the capacity to be measured in terms of customer satisfaction.

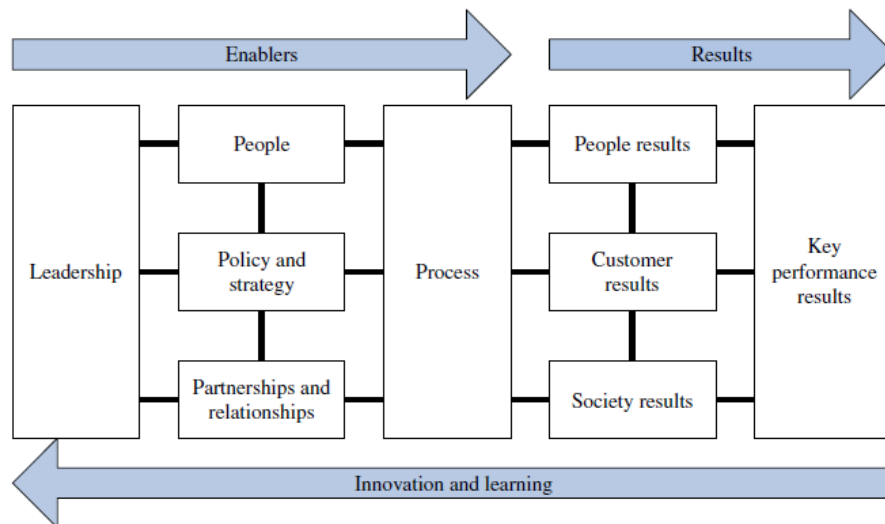


Figure (2)
 “The EFQM excellence model” (source: Yang et al., 2010)

The EFQM Excellence Model is a national quality award to identify the organizations that have surpassed in practices of quality management. This national quality award was developed by EFQM on the basis of practical experiences of the organizations across Europe. Since the launch of this model in the year 1991, many of the European organizations have been using this excellence model as the major framework for the assessment of their performance. On the other hand, the study of Ahmad-Latiffi (2012) explained that this model has usually been used as a part of the activities concerning to total quality management. TQM is a management approach of an organization that has been centred on quality, based on the participation of all its members and aims at long-run success through customer satisfaction and benefits to all members of the organization and to the society as well. This model has also been found to be used within the self-assessment for meeting the purpose of improving the organizational performance. This model has completely been designed under the concept that leadership driving the policy and strategy, resources

and processes, people management, that leads to the ultimate excellence in the business results has the significant impact on the society, customer satisfaction and employee satisfaction. This model has also been found to provide mechanism for the quantification of the current situation of TQM of an organization by means of a point score.

2.4.3 The Malcolm Baldrige National Quality Award

The Malcolm Baldrige National Quality Award (MBNQA) is the infamous award in United States of America (USA). The study of Vokurka *et al.* (2000) explained that this model was developed and used prior to 1997 with the intention to stimulate all the western organizations for the improvement of their quality so that they can compete in a more competent manner with the higher levels of quality being achieved by the Japanese competitors that they were dealing with. This methodologies and principles have long been used in the self-assessment with the technique that supports different core values and also the TQM.

The MBNQA consisted of seven major criteria such as strategic planning, leadership, information and analysis, human resource focus, customer and market focus, business results and process management as presented in Figure (3). The study of Wu (2009) determined that among all the above mentioned factors of the MBNQA, higher importance is been given to the business results, customer, process management factors and human resource development and management. On the similar note, there are other elements that adds value to the model through the existing seven factors are long-range view of the future, fast response to environmental changes and customer requirements, continuous improvement and learning, partnership development, management by fact and results

orientation. Despite of the fact, that all of these factors undergo changes every year but customer satisfaction factor will always remain the most important as it is the overall objective of the quality system.

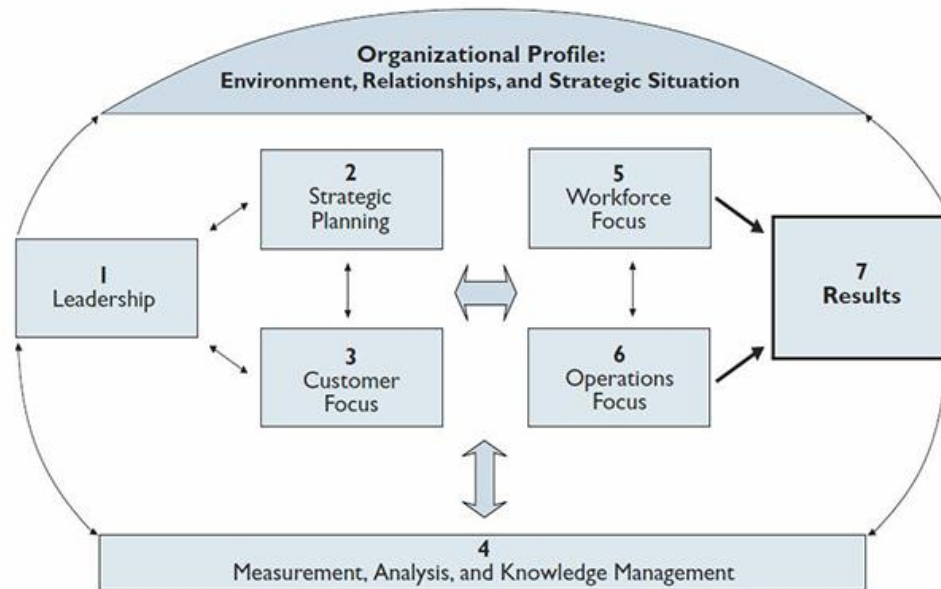


Figure (3)
 “Baldrige Criteria for Performance Excellence Framework” (Source:
 Baldrige Excellence Resources, 1988)

According to James (2009), the major purpose of this model is the promotion of quality awareness, understanding the requirements for the quality excellence, publicize the quality strategies successfully and recognition of quality achievements of the companies of the United States. There are three eligibility categories under this model, which are manufacturing and service companies or their subsidiaries and small businesses. The report of National Institute of Standards and Technology (2013) stated that this model have three major roles in the process of strengthening the competitiveness among the US firms. Those three roles are improving organizational performance results, capabilities and practices, facilitation of communication and sharing of best information

practices among all the organizations of US and serve as a tool for managing performance and providing guidance for the organizational planning and learning opportunities.

2.4.4 The Performance prism

A. D. Neely *et al.* (2002) recognized performance prism as the performance management framework of the second generation. The study also mentioned three of the major reasons for the replacing of the first-generation models with the new framework. The first-generation models focused on the needs of the owners, customers and the organization. They completely ignore the needs of the suppliers and the employees. However, this system of focusing only on one or two of the stakeholder is no more accepted by any of the organizations. It was also found that most of the performance measurement frameworks avoid the changes that must be made towards the strategies, capabilities and processes so that the stakeholder's needs can be met.

Both the study of A. D. Neely *et al.* (2002) and Susilawati *et al.* (2013) explained that the performance prism seeks to incorporate five of the major perspectives along with providing structure as shown in Figure (4), which encourages the executives to think through the answering of the five vital questions. Those questions are as follows:

1. **Stakeholder satisfaction:** Who are the stakeholders and what do they need and want?
2. **Stakeholder contribution:** What do we need from the stakeholders?
3. **Strategies:** What strategies must be proposed to satisfy the needs and wants?

4. **Processes:** What are the processes that must be implemented to satisfy the needs and wants?
5. **Capabilities:** What are the capabilities that must be placed so that the processes can be operated more effectively and efficiently?

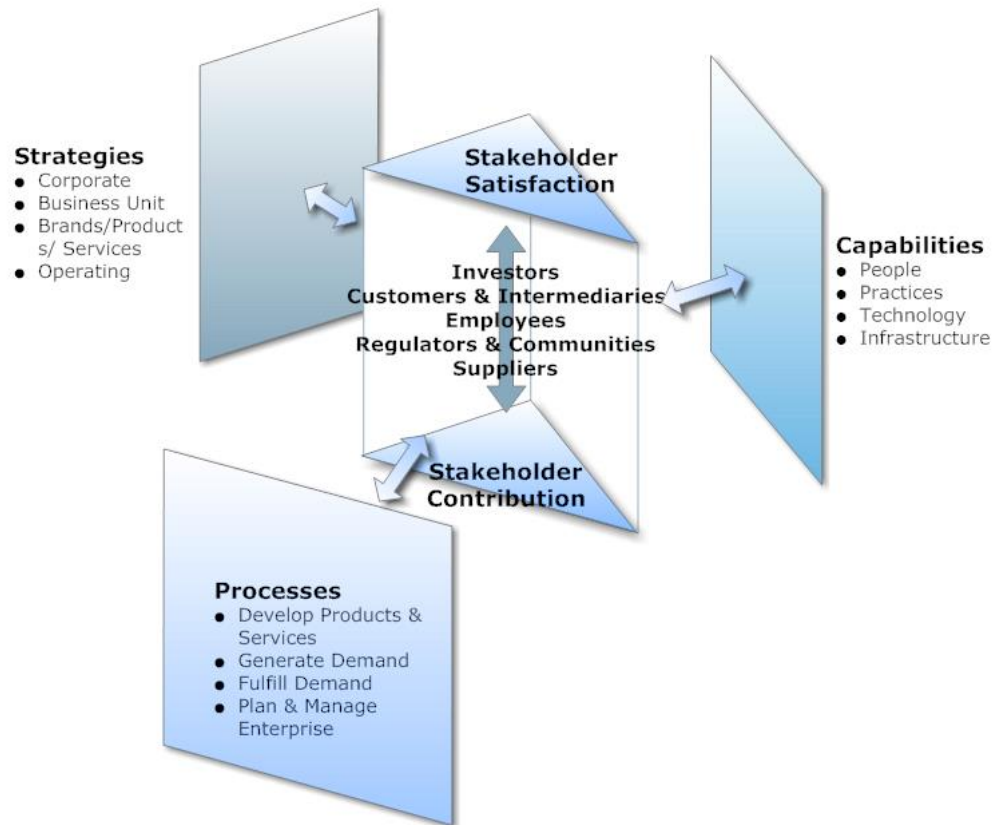


Figure (4)

The Performance Pyramid (Source: Neely et al., 2002)

A comprehensive and incorporate framework for the management of organizational performance can be obtained through the above mentioned five of the viewpoints. Through answering these questions, corporations may develop an organized business performance framework.

2.5 General View of Construction Industry

The use of performance measurement has not become common in the construction industry. The performance measurements are specially used in the construction industries for the assessing of how effectively they have been operating, how effectively they are presently operating, and how effectively they will operate in the future so as to recognize and improve the areas that have been failing. It has also been found that the construction industries must be changed in order to focus on the major areas such as leadership, customer satisfaction, quality agenda and process integration and team.

2.5.1 The Key Project Stages

The construction project stages are often been described in different ways by the various researchers. Regardless of these differences, it is believed that for the achievement of the expectations of project stakeholders, monitoring and performance measurement systems are of prime importance in each of the stages (Alsulamy, 2015).

According to KPI Working Group (2000), for defining the KPIs across the project lifecycle, five stages have been identified. Those stages have been briefly described as below:

Commit to invest: At this stage, the client decides to invest in a project, sets out the business terms requirements and approves the project team to proceed with the conceptual design.

Commit to construct: It is that stage wherein the client approves the project team to start the constructing of the project.

Available for use: At this stage, the project is made available for the substantial use. It can also be in advance of the project completion.

End of defect liability period: In this period within the construction contract, the contractor is motivated to rectify the defects ends even 12 months from the stage of available for use.

End of lifetime of project: In this stage, the period on which the project is employed in its original or near original purpose ends. This stage usually takes place after many years of project completion due to which it is a theoretical point on which the concepts such as full life costs can be applied.

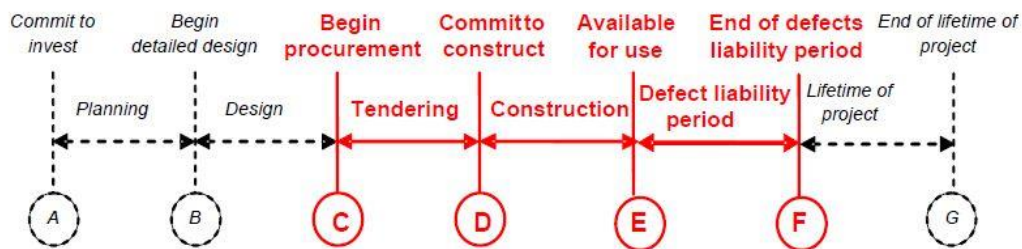


Figure (5)
suggested project stages for measuring construction companies performance (Source: adapted from KPI Working Group, 2000)

In the quest for a comprehensive PMS, researchers (Pillai *et al.*, 2002; Willis & Rankin, 2011) advocate engaging all the project phases for maximum effectiveness, this may be valid to a certain type of projects such as Research and development (R&D) projects or Design & Build housing projects since it is the duty of the contractors to manage the design stage. However, it's not applicable for the other construction projects types. Cha and Kim (2011) further argues that the criteria of management objectives

may possibly vary depending on the period of evaluation (design phase, construction phase, maintenance phase, etc.), therefore, in order to generate reliable outcomes, relevant performance data has to be present while considering the particular project timing.

Furthermore, Although several studies (Sødal, 2014; Song *et al.*, 2009) promote the integration of construction knowledge in the design process as it improves drawing quality and eventually decreases the chances of discrepancies, the construction industry in Bahrain according to Al-Sehali (2001) suffer from the limited involvement of contractors in the design stage, where they are brought to the picture only after the client has approved the design and the process that precede the construction stage from the feasibility studies until the production of the architectural drawing set is considerably lengthy and is often done so much advance of the tendering stage. Therefore, this study is primarily centered on the project performance assessment from Phases C to F through the construction company's perspective as shown in Figure (5).

2.5.2 Construction Project Types

According to Takim and Akintoye (2002), the types of project can be classified into industrial, heavy engineering, building and residential construction. The industrial construction consists of nuclear power plants, steel mills, petroleum refinery plants and large heavy manufacturing plants. The design and construction of these requires highest level of engineering expertise. The design and construction of heavy engineering projects such as ports, tunnels, dams and harbors need its associated contractors to be more knowledgeable about the related technologies. Building construction deals with the structures from the small retail stores to the urban

redevelopment complexes that include social, educational, recreational and religious activities.

Therefore, acknowledging that the identification of a proper set of KPIs for the proposed framework is influenced by the properties of the various project types and that projects are of such diversity that would make the quest of a general construction PMS an impossible task to achieve (Masrom, 2012). it is therefore necessary to define the category under which the PMS is intended for. That should gradually help to improve their viability and reliability (Cha & Kim, 2011).

In this study, the methodology of performance measurement is meant to provide the required information for evaluating project performance, establishing best practices that will be used in later stage as benchmarking nodes. Thus, in order to make this research comprehensive, the scope of the research will be limited to building construction organizations in Bahrain.

2.6 Performance Measurement in Construction Industry

Masrom (2012) described that the construction projects are no longer using the iron triangle as it is the traditional measure for the measurement of performance. The iron triangle consists of elements such as cost, quality and time and it was also used by many of the professional and practitioners of the construction field. However, this traditional method was disregarded due to the major focus on short term aims. Few of the reasons for not using of this method are the economic changes, frequent change in the

technology, increasing number of participants in the project and large and complex projects. For the achievement of the complete advantages of performance measurement approach, it is very much necessary to address the consideration on internal and external measures. Furthermore, the developing of an effective performance measurement through the combination of objective and subjective factors is also required for the creation of facilities of the revolution of business processes. There are three major levels that have to be considered in designing of performance measurement system irrespective of the fact that there are other factor forces changing the performance measurement namely information technology, stakeholders, policies, marketplace and the future uncertainties.

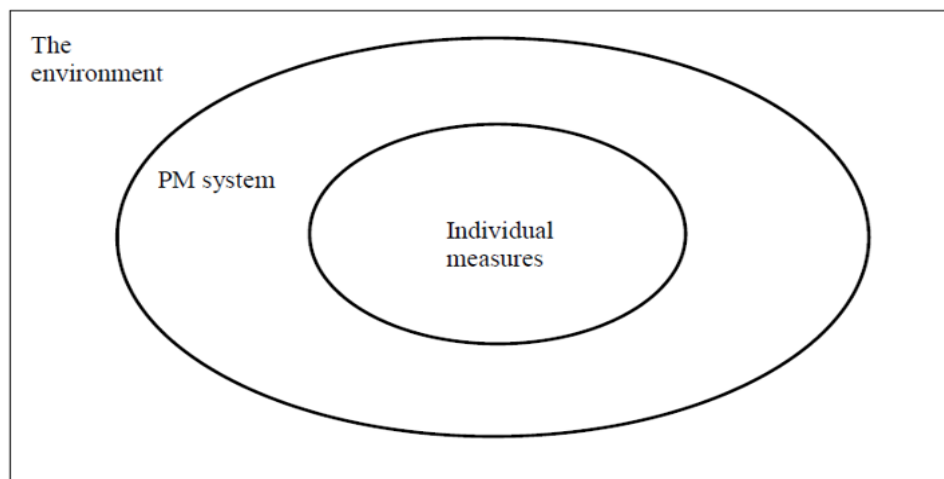


Figure (6)
Framework for performance measurement system (Source: Adapted from Masrom, 2012)

For the improvement of existing method of performance measurement system, Wegelius-Lehtonen (2001) suggested that the participant satisfaction must be included in the construction project measurement. This change is considered to be significant due to the several advantages been

provided by this approach. This approach will boost the business processes and assures for the increased long term profitability. It also measures the perceived value of the customer and identifies the complaints of the customer so that the quality of the product and service can be improved. It was also found to benchmark the organization and its performance. Takim *et al.* (2003) stated that there are four approaches to measure success of the project namely preparing for the future, project efficiency, and impact on business and impact on customer. On the other hand, Sarhan and Fox (2013) noted that apart from the mentioned factors, there are also other factors for the determination of project success such as quality of workmanship, schedule, transfer of technology, meeting the budget, stakeholder's satisfaction, functionality and health and safety.

Most of the frameworks of the project performance measurement been used are developed on the basis of financial aspects despite of the fact that they are covering the indicators that possess lack of strategic focus and that does not provide data on relationships, quality and environment (Alsulamy, 2015). Minier (2014) determined that due to main reasons, the implementation of performance measurement system in the construction field has become one of the most relatively difficult tasks. The first reason is that the construction has become project oriented industry that manufactures product that is unique in nature. The other reason is that the construction projects are usually complex in nature due to the various factors such as involvement of different agents and final product that contains lots of performance attributes. Due to these two reasons, very small number of construction companies has been successful in the implementation of performance measurement. The other proportion of the companies was found to work on the finding of Key Performance

Indicators (KPIs) for the construction industry. For instance, in the year 1998, the Construction Best Practice Programme (CBPP) launched 10 major KPIs which are product and service, productivity, profitability, client satisfaction, safety, defects, time and cost, predictability, construction time and construction cost. In this section of the study, three major studies will be analyzed, which are as follows:

2.6.1 Types of Key Performance Indicators

The evolution of performance measurement has been shifted from the objective means of measurement to the subjective means. The basic difference between these two elements is that the objective method utilizes mathematical calculations determined by cost, speed of construction, construction time and accident rate, whilst the subjective method utilizes individual opinions and personal judgment. (Masrom, 2012). The two aspects of performance can be measured in the construction industry such as either the success of the organization's performance, or the success of the project. Specifically, in the construction industry, the performance measurement is regarded as the organized technique for the evaluation of the performance through the consideration of inputs, outputs and outcome of the final project. The performance measurement of the construction industry aims to improve and evaluate the efficiency and quality of the project execution process along with the identification of potential areas for the future improvement. On the contrary, Pinheiro (2011) stated that the performance measurement can be divided in any one of the three ways namely the efficiency or effectiveness, subjective (qualitative) or objective (quantitative) measures and the process (leading) or result (lagging) parameters measures.

Budawara (2009) explained that the efficiency and effectiveness as the major elements that measures the success of the project. The various processes such as the efficiency in the strategic planning, utilization and management of resources are usually measured under the elements of efficiency that are also interconnected with the outputs of the project. Few of the elements that come under the project efficiency measures are project time, budget of project, project safety, project quality, social obligation, degree of interaction, productivity, external project environment, environmental effects and quality of the working environment. Additionally, the elements of project effectiveness measures are level of effectiveness, client and user satisfaction, freedom from defects, value for money, project functionality and fitness for purpose, absence of legal claims and proceedings, profitability, learning and exploration and generating positive reputation.

Ali *et al.* (2013) set out certain measures that include both objective and subjective indicators for the measurement of the performance of construction projects. The data collection method for objective and subjective measures has been classified into two major groups. The first classification contains the mathematical formulae for the monitoring of the construction speed, construction time, unit cost, time variation, net present value, environmental performance, accident rate and the percentage net variation over final cost. The other classification has been developed from the opinions and personal judgment of the stakeholders of the functionality, quality and satisfaction. The study of Ali *et al.* (2013) also suggested that both the subjective and objective measures must include more comprehensive dimensions.

According to Vyas Gayatri and Kulkarni Saurabh (2013), the lagging measures specifically focuses on the results and do not provide with the opportunity to change the present performance and these measures are used for the historical review. On the other hand, leading measures predicts the activities of future performances along with the provision of changing the current performance. The project process performance can be measured through the leading measures whereas the project outcome can be measured with that of the lagging measures. There are certain simple factors that differentiate lagging measures from the leading measures. Lagging measures are those measures that are related with the results while the determinants are the leading indicators. Lagging indicators are the result of a strategy while driver measures are leading indicators measuring performance when implementing the strategic objectives. Thus, the leading indicators must be linked to enhance the project success. Both the process performance and outcome performance can improve the performance measurement system along with making it more comprehensive.

2.6.2 The use of key performance indicators

D. W. Chan and Chan (2012) explained that the major aim of the KPIs is to enable organizational performance along with the project measurement through the large number of projects. These also provide indications about the construction industry performance. Marković *et al.* (2011) mentioned few of the ways of using KPIs in the construction industry, which are as follows:

- To benchmark the specific company or project performance
- To provide evidence of value for money in procurement

- To provide framework of measurement for the framework and partnering agreements
- To act as a marketing tool
- To provide a health check as part of a continuous improvement program
- To meet the requirements of ISO 9001 quality management systems

Currie and Currie (2005) states that the use of KPI can be explained as the productive method of the identification of small number of indicators that is directly related with the major objectives of the organization. The KPIs are also to provide high level indication that signifies how well the organization is performing against the stated objectives. Ali *et al.* (2013) determined that there is another issue of the performance measurement system, which specifies that it is developed in such manner that all the indicators that have been applied at each level of the organization are partial and specialized. In reference to this statement, indicators can also be specified as the source of division as the specification of the criteria makes the global consistency of the choices impossible. Additionally, it was also studied that the local optimums do not always possess the capacity to lead towards the global optimum.

The study of Minier (2014) differentiated the set of KPIs into the category of quantitative and qualitative indicators. Quantitative indicators are the most accepted because it can be measured in terms of money, unit and the man-hour. Few of the quantitative performance indicators of the construction industry are cost, resource management, on-time completion, percent complete, quality control and rework, earned man-hour, lost time

accounting and the punch list. On the contrary, the qualitative indicators are not commonly used due to their difficulty in measurement. Despite of this, it can also be said that without the qualitative indicators in the construction projects, the opportunity to improve the performance can be missed. Few of the qualitative performance indicators in construction are absenteeism, safety, motivation and turnover.

Beatham *et al.* (2004) recognized that the construction industries prefer the KPIs more than that of the performance measurement. The reason behind this is that the performance measurement lacks certainty in the data and lack of validation of the results. They also argued that in majority of the construction companies, performance measures are used as marketing tool than that of the tool for the improvement. The lack of validation in the results led the companies to develop their own KPIs that make the benchmark aiming at the comparison of data as per the benefits of the clients difficult. Hence, it can be concluded that the construction companies are capable for benchmarking themselves that offers relatively very less opportunity for the improvement.

All these perspectives of the KPIs and the existence of different frameworks give rise to two major questions: first question is why there is need for so many frameworks and the other question is which framework is better and accurate? All the frameworks of KPIs are considered to be valid and correct but all of these have different facets of performance. Some of the common characteristics of the frameworks as mentioned by Budawara (2009) are listed as follows:

1. Continuous measurement of the performance must be encouraged for gaining the best practices.
2. Indicators based on the features of the projects or organizations in various industries need to be developed.
3. Multi-perspective indicators are required to evaluate performance.
4. Real-time feedback is necessary to make on course corrections.

With the above mentioned common features of all the frameworks of performance measurement, the construction companies can select the right approach towards the measurement of their construction projects and raise the profitability index of the organization as well.

2.6.3 Benchmarking

According to Ahcom (2004), benchmarking is one of the major roles that need to be enabled among the companies by the performance measurement. Ahcom (2004) defined benchmarking as the measuring and comparing of organizational performance with that of the other similar organizations in the key business activities and after that using learned lesson to make the target improvements. Benchmarking can also be regarded as the vital element of the planning and on-going review process to assure focus on the external environment and strengthen the system of using the factual information in the developing plans.

Besides, Ramirez *et al.* (2003) determined that benchmarking is used for the improvement of the performance through the understanding of the methods and the practices that is required for the achievement of the higher levels of performance. Costa *et al.* (2006) regarded that the basic aim of benchmarking as the evaluative tool is to provide continuous learning for

both the project organization and project manager. The learning of both these parties are recognized as the challenges that is required to be addressed in more wider sense among the discipline of the project management. Alongside, there were certain difficulties in the course of performing benchmarking such as resource constraints including money, expertise and time, lack of suitable partners for comparing information, staff resistance, and confidentiality of data and lack of data access transparency.

2.7 KPI in Construction Industry

In this section of the study, some of the strengths and weaknesses of the key performance indicators of the construction industry has been analyzed.

2.7.1 Strengths of KPI

Kagioglou *et al.* (2001) listed three basic overall strengths of the key performance indicators, which are as follows:

1. KPIs are very easy and simple in its implementation process.
2. The overall concepts of the KPI can be easily understood by all of them.
3. The KPIs can be used by all the clients, contractors, consultants, suppliers and the sub-contractors.

The report of New Zealand Centre for Advanced Engineering (2005) noted other strengths that was found among the KPI. Those strengths are:

1. KPIs have the capacity to provide specific targets to be achieved and this similar can be used for the systematic measuring, progressing and monitoring of the efforts that can bring in improvement for the company.
2. The key indicators can also be utilized for the comparison of the performance of the construction company of the particular country from one year to the other.
3. With the KPI, the efficiency that the agency uses for the administering of its construction industry tasks can be monitored frequently and effectively.
4. The targets that could be achieved from the indicators can be utilized over the time as numerous factors such as the administering agency gains experience, good progress or the greater executive capacity in the industry development effort.

2.7.2 Weaknesses of KPI

Budawara (2009) highlighted certain complexities that can be encountered in the path of application of KPI. They are as follows:

1. The stakeholders of the company might not be willing to disclose certain information of the project related to monetary value due to their nature of being sensitive and confidential.
2. The total number of labors is difficult to determine as the construction companies have complicated sub-contracting system along with the rapid flow of labor.
3. There arise certain problems in the calculation of the value and profit of the project since due to its confidential nature. Besides, if the

project is funded publicly, the value and profitability concept will be inappropriate.

Alsulamy (2015) also listed some of the weakness that can be faced during the adoption of KPI. Those weaknesses are as follows:

1. The collection and processing of the necessary data for the estimation of the indicators will be relatively difficult in the developing countries due to the poor information system, inadequate and inaccurate data specifically in the construction activity where indicators are difficult to collect.
2. It is necessary for each country to adjust its indicators over the time to make sure of their continual appropriateness since the factors of construction industry development and construction activity is dynamic in nature. This process might not be an easy task for all the countries.
3. The deviation can be discovered and addressed due to the association of KPI with the post results that do not allow for the monitoring of the performance during the execution.
4. KPIs do not meet the strategic need for the comprehensive measures due to its inconsistency with the planning and interest of the entire organization.

2.8 Levels of performance measurement in construction

Ankrah and Proverbs (2005) regarded that the process of performance measurement is basically determined on the basis of selection of indicators that comprising from both financial along with non-financial indicators. The performance measurement in the construction businesses emphasizes on the performance of the project in terms of cost, time and quality. Furthermore, the development in the performance measurement of construction extended its area through focusing on the company level and the project stakeholder level. With the development of performance measurement in construction included more of the performance indicators namely business performance, client satisfaction, environment, safety and health.

Similarly, Wegelius-Lehtonen (2001) also considered that the construction project analyses three levels of performance measurement namely project, organizational, and stakeholder level. In the project level, the initial application of the performance measurement can be found. The reason behind this is that the construction projects are usually complicated, unique and possesses large number of stakeholders. The performance measurement of construction industry involves various aspects, processes, participants and environment. Therefore, with the above study, it can be further regarded that the measuring of the project stakeholders' performance is a necessary consideration at either project level or organizational level.

According to Deng *et al.* (2012) the performance measurement in the construction industry itself is very diverse and it has been developed to meet the three major purposes.

1. **Project purpose:** Most of the construction project organizations is unable to measure insufficient induction of the improvement opportunities within the project, which again leads the project purpose to work over the project lifecycle.
2. **Business purpose:** It measures the performance of the construction industry with the implementation of both continuous measurement and one-time evaluation. Relatively, this purpose was found to be weak due to the lack of non-project budgets for the facilitation of the feedback loops.
3. **Industry purpose:** it assesses the performance of the industry both on the national as well as the international level.

With the intention to meet the aforementioned purposes of the performance measurement, it can be stated that the review of the performance measurement system in the construction industry focuses on project level, company level and stakeholder level. All these levels of PMS will be analyzed in the following section of the study.

2.8.1 Project level

Every construction project is unique in nature. The construction industry has been comparatively found to have several problems with its fragmentation and complexity and these problems were inhibiting the

performance of the construction industry. consequently, the construction industry is always considered to be insufficient in case of litigation, profit, accident record, slow improvement and innovation and the investment in training as compared to that of the other industries (Budawara, 2009).

The study of Yang *et al.* (2010) provided with the information that the performance measurement in the construction was initially conducted at the project level. The largest proportion of the construction projects were conducted on the project level. The performance measurement usually receives various assessments during the judgment of the different aspects, processes, standpoints and environment of the participants due to the reason that the construction projects are normally unique and complicated in nature along with the involvement of large number of stakeholders.

Samee and Pongpeng (2015) defined project performance as the characteristics of the project that attracts the stakeholders such as the contractors, clients and the project managers. The characteristics of the project are indicated by the number of factors, indicators or the measures. These factors will help the stakeholders to measure their level of performance for further improvements that are related with the cost, time and quality. The different countries (for instance, Ali *et al.*, 2013; T. K. Chan, 2009; Ikediashi *et al.*, 2012; Ofori-Kuragu & Baiden, 2008; Samee & Pongpeng, 2015; Yeung *et al.*, 2013) have come along with factors responsible for the performance of the construction project namely client satisfaction, time, cost, quality, communication, environment and safety. Among all of these factors, quality, cost and time are the commonly found factors among all the countries.

Lin (2009) recognized that the selection of appropriate measures of performance is important because it enhances the management to be clear and specific about the priorities of their performance and their existing relationship with the factors of measurement. It also suggested that the criteria of project success can be used for the measurement of the project performance. Abdulrahman (2010) examined the concept of project success in the most extensive manner. In the traditional times, the projects have been successful in terms of criteria such as the project within budget, on time and specified quality. These three criteria provided with adequate information about the project to the organization and also help the researchers of the project management field. One of the significant challenges that were faced by the professionals of the project management that the projects were a failure even if it was finished within budget, on time, and of immense quality. Contradictorily, there were also certain projects that were of huge success despite of the fact that it was delayed and crossed the limit of budget.

Gyadu-Asiedu (2009) defined project as an “investment of resources for return”. A project is instigated to add value to the core business of the organization. This similar definition is applicable for the projects of any sector including the construction sector. In many of the cases the construction projects have been found to be different in terms of types and scopes as per the nature and objectives of the business regardless of the trend that the construction project follows definite activities and phases for the delivery of the required outcomes. The organizations also use projects as the source for the creation of change in quest of the organizational goals. Alsulamy (2015) stated that there are various performance measurement systems with varied components, process and goals depending on the

different requirements of the assessment model. It also said that it is very essential to build a proper framework for the measurement of construction project performance while addressing its uniqueness for meeting the purpose of measuring project performance. The following section will describe five of the scholarly articles that will provide detailed analysis of the performance measurement system at project level.

Ling *et al.* (2008) had investigated the impact of the project management practices among the international corporations regarding construction projects performance in China. In their study, five performance measures have been applied for the determination of international projects success. Those five of the performance measures are cost performance (actual versus budget), quality performance (e.g., technical quality, workmanship quality), time performance (actual versus plan), profit margin (profit margin derived from service) and owner satisfaction (service quality). All of these measures are used for the examining of the extent to which the project management practices can affect the performance of the project that is usually adopted by the international companies, especially that of engineering, architectural and the construction companies. Cost performance signifies the comparison between the actual cost and the budgeted cost of the project. The study of Ling *et al.* (2008) shows that many of the cost performance of the foreign firms in China is predicted by three performance measurement practices such as low extent of claims/ disputes in the contract, strong financial strength and high quality responses to perceived variations. Time performance is the comparison between the planned and actual duration required for the project. It can be improved more if the timing for acceptance, approval and commitment of the schedule is made early by the

project team. Quality performance also signifies the technical, workmanship and functional quality performance. Quality performance of the project can be determined by four performance measurement practices namely high quality responses to perceived variations, sub-division of the contract into smaller components, high quality of technical staff and workmen and non-generous level of compensation to the expatriate staff. In case of the owner satisfaction, it is again determined through five PM practices such as high quality responses to perceived variations, sub-division of the contract into smaller components, high quality of technical staff and workmen, high quality of schedule and high financial strength of the foreign firm. The profit margin in Chinese firms can be determined through the high-quality responses to perceived variations and controlling of the management risks and labor issues.

According to Toor and Ogunlana (2010), project management was divided into performance domain and process domain. The performance domain emphasizes on the performance measurement during input, establishment of performance enhancement strategy, performance goals, and outcome and process stages. On the other hand, process domain deals with the delivery of product during input, devising an adequate project management system, project objectives and the outcome and process stages respectively. In this study, the international firms operating in Thailand, there were certain criteria that deemed the public facility and infrastructure projects to be successful only if they gain energy efficiency, maintainability, operational flexibility, sustainability along with providing of satisfaction of the demands and expectations of the stakeholder and regulations with project success being achieved in several aspects, including management, project, environmental and human. This study of

Toor and Ogunlana (2010) conducted the study depending upon the questionnaire survey in Thailand on 9 KPIs for mega-sized infrastructure projects. The aim of this study was to explore the significance of the KPIs from the perspectives of the employers, consultants and contractors. The findings of this study exhibited that the efficient use of resources, safety, reduced conflicts and disputes and the like have become very important other than that of the time, cost and quality. Ali *et al.* (2013) argued that the construction project success can be determined across the micro and macro level. The micro level relates with the success of the stages and sub-stages of the project and contradictorily, macro level relates with the extent to which the aims and objectives of the project has been achieved. Finally, Ali *et al.* (2013) stated that the public construction projects are important if it has been completed on time and within the budget.

The study of Cha and Kim (2011) determines that the common goal of the performance measurement system (PMS) is to improve cost effectiveness and productivity of the construction industry and to remove its inefficiency. This study also determined that the PMS of the construction companies can be separated into micro and macro level. At the micro level, the project levels are included and the scope of the KPI on this level is to measure the project planning and the progression. On the other side, the macro level represents the company level wherein strategies are required to be measured with scrutiny and analyzing with the aim of development of future business strategy. This study also said that the KPI shall be connected to the quantitative forms such as the quality, cost and time and it should be standardized for the promotion of benchmarking. It is also recommended that the companies must use the PMS databases for benchmarking for the improvement of efficiency among the projects and

the company. The study of Cha and Kim (2011) compiled the KPIs for the customizing of the construction projects. These KPIs has been selected for their practical utilization in the construction branch.

D. W. Chan and Chan (2012) proposed that the success of the project can be determined on the basis of four time periods. The success of the project at execution is considered as the first period. The second period is the success of the project at defect liability period. The determination of the success of the project after the time interval of one to two years is the third level. The success that is determined after three to five years is referred to as the fourth period. Among all these periods, success has been defined as “The first stage is the delivery process: doing it right; the second stage is the post delivery system: getting it right; and the last stage is the post-delivery benefits: getting them right”. In this study, it has also been explained that the success of the project can be determined depending on four major aspects namely accomplishment of the planned goals, add value to the organization, production of benefits for the end user and improvement of the infrastructure. This research study was intended for the purpose of identifying the seven most important KPIs for the evaluation of the performance of guaranteed maximum price contracts and target cost contracts among the construction industries of Hong Kong. Those seven KPIs are time performance, magnitude of disputes and conflicts, mutual trust between project partners, final out-turn cost exceeding the final contract target cost, contractor’s involvement in project design, time required for the settlement of final project account and client’s satisfaction on quality of completed work.

The study of Yeung *et al.* (2013) presented seven of the most essential KPIs for Hong Kong construction firms to measure the performance of their construction projects. The KPIs are cost performance, time performance, quality performance, top management commitment performance, effective communications performance, innovation and improvement performance and trust and respect performance. On the other hand, Yeung *et al.* (2008) also mentioned that the quantitative indicators and quantitative ranges are used for the measurement, evaluation and improvement of the performance of their partnering projects. Yang *et al.* (2010) determined that the indicators are developed through the questionnaire surveys in the other performance indices. For instance, Yeung *et al.* (2008) had proposed a partnering performance index for measuring the construction projects performance in Hong Kong. In this study, it was also specified that analytic hierarchy process (AHP) and principal components analysis (PCA) are usually been adopted for identifying the major indicators along with developing of their accurate weightings.

2.8.2 Organizational level

Odusami *et al.* (2010) explained that very little indication of the overall performance of the organization is been provided by the initiatives of project specific benchmarking, which are availability and validity of data, failure of demonstrating the relationship between measures from a holistic view, the benchmarking measures are not well aligned to organization's strategy, unbalanced proportion resulted from favoring lagging measure over limited leading measures that provide chances for changing performance and little measures related to quality management, employee satisfaction, suppliers' performance, and site management.

Bassioni *et al.* (2005) introduced excellence models have been utilized for the provision of general and wide view of the performance. On the contrary, strategic performance and strategic management focuses on the critical areas that are relevant to the strategic objectives. The performance of strategic objectives can be monitored through the Balanced Scorecard. All the companies need dual type of performance as they need to measure both the status of the business and strategic performance. The balanced scorecard has been adopted in this study due to its nature of possessing established status and commonality. This scorecard is used for measuring of the financial, operational, and strategic characteristics of the firm. In the construction area, this idea is used for the “projectized” organizations and it is often referred to as company in company model.

According to Yu *et al.* (2007), a model was developed for measuring and comparing the performance of the companies in Korea. This study aimed to provide robust benchmarks for the construction companies along with the provision of practical methodology for designing the benchmarking system for the performance measurement of the construction companies. Both the qualitative and quantitative analysis was done for selecting the accurate KPIs. This study used 12 indicators to analyze the performance of the Korean companies. Regardless of the fact that this study provided with the framework for the measurement of the performance of the construction companies, it cannot be still used for the company performance at the project level due to the reason that more of the performance data are required. Yu *et al.* (2007) constructed 12 performance criteria under three perspectives of BSC. The financial perspective consists of growth, stability and profitability. The customer perspective includes market share, external customer satisfaction and

internal customer satisfaction. The perspective of internal business process includes research and development, business efficiency, technological capability. The last perspective that is the learning and growth perspective consists of informatization, human resource development and organization competency. In this study, Rustum (2002) and Yang *et al.* (2010) assumed that these framework could be implemented directly in the construction industries and can also be used as the management technique in the research as well as in the practical implications. The study of Yu *et al.* (2007) also came up with the introduction of AHP model for the evaluation of the performance score of a particular company.

The study of Wadugodapitiya *et al.* (2010) provided with tools such as Balanced Scorecard (BSC) and Analytic hierarchy process (AHP) for the evaluation of performance in the construction companies. It was also signified that in the construction industries, the performance is not been measured qualitatively and quantitatively. In the construction projects, there is a lack of multi-dimensional approach for the quantification of construction project performance. Thus, the development of multi-dimensional approach for the evaluation of construction project performance is highly needed. The major aim and objective served by this study is to introduce multi-dimensional performance measurement model that prioritizes Key Building Project Performance Indicators (KBPPIs) and BSC perspectives for the construction project performance with the use of various criteria for decision making tool as AHP. This study specified that the determination of the BSC perspectives in the construction industries have been extended through the adding of two dimensions namely project team perspective and health, safety and socio-environmental perspective so that the BSC can be made appropriate for the construction industry

status. However, it has been suggested that the above-mentioned factors are the traditional factors of BSC that needs to be expanded and incorporated with the client perspectives. At the end of the study, a new and extended BSC was built for the evaluation of project performance. This extended BSC consists of six perspectives namely client perspective, financial perspective, project team perspective, internal business process perspectives, innovation, learning and growth perspective and health, safety and socio environmental perspective.

The study of Horta *et al.* (2012) served to evaluate the financial performance of the construction companies among the Portuguese construction industries along with the identification of the innovation and excellence in this specific sector. This study also elaborated that besides adopting the popular frameworks, few of the construction companies are found to adopt benchmark for the determination of the overall performance of the construction companies. Similar to that of the previous study, this study also aimed to provide benchmarks for the construction industries. It also aims to design benchmarking system for the practical methodology of the performance measurement of the construction organizations. Horta *et al.* (2010) used the same benchmarking methodology through highlighting that several metrics must be used for the measurement of the efficiency and effectiveness of the organization. The methodological perspective of their study augments the construction of the composite indicators through the application of the principle of the ‘benefit of the doubt ‘weighting. This requires the application of Data Envelopment Analysis in order to calculate weights for aggregating the KPIs of the construction firms. The major findings of the study proposed DEA based method for the assessing of the innovation within the industry along with the identification of innovative

companies and the rate of innovation. From this study, it was found that the construction industry of Portugal had experienced noticeable performance improvement during the 1990s but in the current scenario the growth trend has been lowered. Thus, at the concluding section of the study, it was observed that the performance of the company is highly affected by the context of the national economy and the large contractors and small companies be likely to achieve the best levels of performance.

Lee *et al.* (2013) introduced corporate management performance evaluation that emphasizes on the financial aspects that is very important for the identification and management of those elements that contribute to the increased economic values of the long run. This study stated that the previous researches did not analyze the estimation approaches and weighting for the non-financial elements influencing the financial status. The aim of the study is to develop the evaluation model of management performance among the construction firms of Korea. This evaluation model includes both the financial and non-financial factors. the study conducted quantitative survey for the collection of primary data among the Korean construction companies. It involved two major steps: the first step was the derivation of KPIs for the performance measurement techniques and weights the KPIs and the second step consists of applying of the performance data of the construction industries to the technical aspects. At the end of the study, the major findings that were gained from the study conclude that the first priority for construction industries in Korean is the customers. Also, the feedback of the performance measurement can be used to assist the company to enhance their management plans and re-align their long-term strategies. Thus, this developed model can be useful for the decision makers to effectively revise their plans of management.

According to Ali *et al.* (2013), high competition and slow economic growth are responsible for the need to improve the productivity and performance of the construction companies in Saudi Arabia. This study also demonstrated that despite of the fact that many studies were carried on project performance measurement but in the recent times, the demand for performance management and evaluation has been increased at the organizational level. The aim of this study is to determine a group of KPIs which can be carried out by the construction professionals while assessing the performance at the organization level in Saudi Arabia. The study conducted questionnaire survey on the randomly selected sample size of the large construction companies in Saudi Arabia. There are nine major performance indicators that are been used by the construction firms of Saudi Arabia namely staff experience, planning period, client satisfaction, communication, closeness to budget, safety, payment, profitability and claims. It was also concluded that a set of 47 KPIs were identified in this study that were again classified under five performance perspectives such as:

Financial perspective (profitability, financial stability, growth, cash flow, investment in development of new markets, reliability of financial performance, capital, interest cover).

Customer perspective (customer satisfaction, quality of service and work, number of new customers, external market share, internal customer satisfaction, value of money, competitive price and hassle-free relationship).

Internal business perspective (business efficiency, safety, effectiveness of planning, labor efficiency, successful tenders rate, resource management, managers' competency, number of high-performance professionals, innovation, productivity, technological capability, quality control and rework, defects, research and development).

Learning and growth perspective (Continuous improvement, organization competency in management human resources, investors in people, motivation, human resource training and development, informatization, empowered work force).

Environmental perspective (energy use, impact on biodiversity, impact on society, waste, main water use, competitors, partnership and suppliers, risk control).

2.8.3 Stakeholder level

As per Project Management Institute (2008) project stake holders can be defined as individuals and organizations who are strongly involved in the project, or whose significance is affected positively or negatively as a result of the project execution or successful completion of the project. A stakeholder can be specified as an individual or a group who are involved inside or outside the construction project, which has stake or can influence, the construction performance. For the goal of this study, study can be limited to six groups: clients, contractors, suppliers, consultants, end users and the communities. In accordance to Atkinson *et al.* (1997) successful construction performance is attained by meeting the stakeholder's requirements either individually or collectively. Stakeholders can be categorized into: internal and external. Internal stakeholders are individuals

or groups who reside in the organization and are involved in the decision-making process such as the board members, managers, employees etc.; whereas external stakeholders are parties outside the organization but are directly or indirectly impacted by its activities and decisions such as end users, local community, regulatory authorities etc. (Menoka, 2014). As per Wateridge (1998) it is vital to point out that despite the fact that there are plenty of existing studies implementing the satisfaction concept, they are different with regards to the applications and approaches as they rely upon the types of participants, location, and projects and below are some of the examples that have incorporated stakeholders' perspective to their models.

Love and Holt (2000) stated that it is important that the companies have to understand the economic and moral relationship with the clients, suppliers, lenders and the employees so as to maintain the competitive within the construction companies. Stakeholder perspective measurement (SPM) are used in recognizing the relationship between the customers, employees, financiers, suppliers and wider communities too; as it is observed that all of them are very crucial for business's viability even if it is for short term or long term. In the studies Cordero (1990) did not incorporate the interests of stakeholders in regards to their needs and expectations. Love and Holt (2000) have suggested that for construction companies to maintain their competitive edge in their long run, they have to have a better understanding relation with their employees, lenders, suppliers, customers, and the wider communities. Hence, we can specify that the performance measurement has to integrate stakeholders interest economically as well as morally. Even Love and Holt (2000) mentioned that building a wide-ranging stakeholder mindset approach to performance measurement is vital to accomplish successful strategies so as to carry out

an optimal business performance. In Love and Skitmore (1996) they have mentioned that stakeholder viewpoints should deal with three company perspectives: 1. As a stakeholder entity, incorporating stakeholders and customers interests (service/product performance indicators); 2. As a goal-orientated, profit center (financial performance indicators); and 3. As a system that engages in exchange with the environment and resources garnering (measures of productivity, quality and competitive ability). Adopting the stakeholder's perspective by business measurement will distribute excellent business performance. As per Brignall and Ballantine (1996) the construction companies should not be shortsighted in the way they set their strategies, but should also appreciate the aspirations of their stakeholders, economically and morally and this can be addressed by creating an extensive stakeholder mindset approach to the business performance so that the company can be audited and judged in a socially approved manner.

Pillai *et al.* (2002) designed an integrated Performance Index (IPI) for measuring the performance of R&D projects in India as an assessment system for evaluating the Integrated Guided Missile programme. The model tackles four vital areas which are: the performance measurements, the stakeholders, project phases and performance indicators correlated with each phase. IPI or Integrated Performance Index was recommended by them as it reflects the achievements throughout the entire life cycle of the R&D project, by consolidating the key factors from each project phase. It has been viewed that in this model the relationship between the needs, expectations and achievements of the stakeholders at each and every phase and are reviewed comprehensively. As he has suggested the IPI model draws on a real-life practice and it has been tested and ratified in tracking

the progress of R&D projects to assure an effective resources usage and better coordination between stakeholders' towards completing the project successfully. In this model, we can identify three project phases as follows: the project selection, project execution and the implementation phase. From these three phases, eight prominent factors were listed which are: project status, project preference, risk, benefit, cost effectiveness, production preparedness, customer commitment and decision effectiveness. These prominent keys are blended using mathematical formulae in accordance to their functional relationships to produce an integrated performance index (IPI). One of the major problem in this model is the absence of transparency particularly on how the mathematical formulas are used to establish the integrated performance index. Moreover, it's been viewed that this model is not well received by practitioners.

It has been specified by Takim *et al.* (2003) that existing construction performance fall under one of the following: a)project quality; b) project viability; c)construction productivity and d)construction project performance. These categories are the basis which have been developed to measure the construction performances in different stages of development. they had suggested an "amalgamated-model" that incorporates techniques and best practices from selective models of construction project performance measurement. The model also takes into account both financial and non-financial measures throughout the project phases. A new conceptual model was also scheduled by Takim *et al.* (2003) based on stakeholders' satisfaction during the three stages of project life cycle requirements and they are planning, execution, and termination stage. It is important that stakeholders' performances get measured and judged throughout the project phases, in order to ensure that there do not exist any

dreadful conflicts and disputes by the time the completion stage is attained. The performance of each member has to be measured, evaluated and prioritized in each and every stage of the project in order to understand the extent to which a project is successful. The model incorporated a number of crucial factors of construction projects which are: stakeholders' continual participation, stakeholders' performances and expectations, project performance, effectiveness, efficiency, and the relationship between success factors. Takim and Akintoye (2002) have also recommended a model that helps in identifying the performance of the stakeholders who are involved in a construction project.

From the research performed by Toor and Ogunlana (2010), it has been viewed that meaning of project success is different to different stakeholders that is a project which may be successful to the client may not be successful venture for contractors or the end users. Cooke-Davies (2002) has provided a distinct project success where it is measured against the project's long-term objectives. The project management success is measured against the infamous traditional measures of performance against quality, cost, and time. Success factors can be specified as the aspects that play a role in achieving success on a project whereas success criteria are measured by which the success or the failure of a project are judged. The main factors constituting the success criteria are referred to as the key performance indicators. Actually, KPIs helps in comparing the actual or the estimated performance in terms of capability, efficiency and quality of both workmanship and product. That is success factors can be told as the efforts made or the strategy which are adopted for achieving the success on project. Other researchers have suggested that apart from customer satisfaction, overall satisfaction of stakeholders should also be considered

in regards to the performance evaluation criteria. Project team's ability in managing project risks and resolving problems also encountered on the project for evaluating the project success. Researches done by Freeman and Beale (1992) admits that the five most frequently used criteria in measuring the project success includes: technical achievements, personal growth and manufacturer's ability and business performance, executing efficiency, organizational and managerial implications. Various criteria in measuring the success of projects are: the facility is to be produced to the specification within the budget and on time; the project has to provides an adequate benefits to the owner; the project achieves should be able to state the business purpose; the project should meet the pre-stated objectives so as to enhance the facility; the project has to meet the needs of project team and supporters; the project needs to satisfy the users; and the project needs to satisfy the requirements of stakeholders.

Menoka (2014) has introduced a new structure where it shows how the engagement of stakeholders can be influenced in improving the construction sustainability which would impact in improvising the construction project performance and the different key factors are addressed in this section. As per the studies performed by Menoka (2014), sharing information is the key factor in communicating with stakeholders in the project process and that too in each and every stage of the project. It is better in conveying accurate and real time information to the stakeholders so that a right decision could be taken which helps them in understanding and having a full view of the proposed plan which aid them in the evaluation of the suitability and helps them in deciding whether to approve the project or not. Sharing knowledge is another important aspect that has to be kept in mind. Sharing knowledge can be considered as an

effective communication process which enables in providing strategic and operational inputs for the various project activities. It is required to share knowledge and skills with respective stakeholders in order to understand that the used skills and knowledge is valuable for the current market demands which helps in improving the productivity. As per Menoka (2014), it is important to make the stakeholders understand in regards to the sustainability. It has been specified that the management tries to motivate their stakeholders in increasing their interests for more sustainability by analyzing the risk of the projects and the project value so that the risk and the value can be managed. The management conduct meeting with all the stakeholders and try to make them understand in regards to the risks involved, involves them in discussion for the value management, also try to influence them with some viable and reliable solutions which agrees to the outcome of the meetings conducted. Another important aspect that has to be considered is in educating the stakeholders which actually promotes the sustainability awareness among the stakeholders. If a proper education is provided in regards to Construction Sustainable Development to the stakeholders will increase their knowledge, tools and information which will facilitate them in taking a smart decision for the creation of a sustainable future for all.

2.9 Literature conclusion

The review within this chapter highlighted that measuring performance is regarded as a critical assessment method that companies utilize to excel within a highly competitive environment. Furthermore, the literature revealed that the topic of measuring performance has been extensively studied and as a result, several measurement models and

frameworks were designed to evaluate performance both on project and organizational levels. The improvement of PMSs progressed from focused measures to multi-perspective measures to achieve a balanced view for the organization and reflect a broad collection of performance categories such as leading and lagging, financial and non-financial measures as well as operational and customer driven measures that elevate the performance and promote continuous improvement.

Features of various PMSs were outlined. The review revealed that they covered a wide range of indicators in multi-dimensional frameworks to reflect the organization monitory requirements of its business as presented in Table (2). Moreover, more recent studies (Takim & Adnan, 2009) indicated that measurement systems need to be broaden so that it covers as many stakeholders, including subcontractor, employees, suppliers etc. Although this may cause conflict of interests as the needs of stakeholders might not be in favor of all parties, making compromise inevitable.

Depending on the previous researches reviewed on the construction performance measurement, few of the major discrepancies were found. For tracking of the performance, a framework is needed to assess and measure the construction performance for detecting the positive and negative factors of the project and take correction actions for the further improvement and also to gain efficient control system among the construction projects. Some of the studies on the KPIs for construction are lagging measures. They are used after the project has been completed as a result and also do not provide opportunity to change.

The main construction processes and its outputs are necessary to understand so that a set of constructions KPIs can be developed for the construction industries of Bahrain. This understanding will be an aid in creating a basis for the measurement of the construction processes performance and provides necessary information to the project managers for controlling of the construction stage. The proper adoption of the design model is important for an effective application of Construction KPIs. The construction performance model is an efficient tool for the identification of the factors that affects the performance. Majority of the studies analyzed in the above section proposed a generic conceptual model for the construction stage so that the KPIs can be identified along with clarifying the place of focus of control. This model is built upon the principals of both the KPI and BSC models due their Practical application and increasing reputation in the construction industry (Kagioglou et al., 2001) beside their capability to benchmark the specific company or project performance.

Furthermore, it is very important to measure the various indicators to assess the performance and to determine the priorities of each of the indicator. Those indicators with the highest priorities are termed as the Key Performance Indicators (KPI). All the performance measurement system must be categorized for mapping onto the different project types. Alongside, the scope of the KPIs must be broadened so as to embrace the behavioural aspects of the improvement of job performance.

Table (2)
Summary of KPIs used to measure the performance of construction projects (adapted from Samee & Pongpeng, 2015)

Category		Key Performance Indicators (KPI)	Love & holt	Pillai et al	Takim et al.	Yu et al	Ling & et al	Toor and Ogunlana	Wadugodapitiya	Ogunlana	Horta & et al	Cha & Kim	Chan & Chan	Yeung & et al	Lee & et al	Ali & et al	Menoka	Total number of hits for each KPI identified
			2000	2002	2003	2007	2008	2010	2010	2010	2010	2011	2012	2013	2013	2013	2014	
Time	1	Construction time variance		√			√	√	√	√		√		√			√	8
	2	Overtime Work Rate												√				1
	3	Time to rectify defects										√		√				2
Cost	4	Cost construction variance		√	√		√	√	√	√		√		√			√	9
	11	Cost rate	√	√	√		√	√	√			√		√			√	9
	12	Cost to rectify defects															√	1
Quality	13	Defects (Number / Severity)						√	√	√						√		4
	14	Quality issues at end of defect rectification period		√	√				√	√		√	√	√		√	√	9
	15	Quality management system	√	√								√	√	√				5
	16	Aesthetics																0
Planning	17	construction Time predictability		√	√		√							√		√		5
	18	construction Cost predictability		√	√		√	√	√					√		√		7
	19	Change Cost Factor							√									1
Health & Safety	20	Frequency of Accident									√	√	√	√		√		5
	21	Safety Cost Ratio						√				√						2
	22	Safety Performance		√				√	√	√		√	√	√	√	√		9
	23	Lost time accidents																0

Category		Key Performance Indicators (KPI)	Love & holt	Pillai et al	Takim et al.	Yu & et al	Ling & et al	Toor and Ogunlana	Wadugodapitiya	Ogunlana	Horta & et al	Cha & Kim	Chan & Chan	Yeung & et al	Lee & et al	Ali & et al	Menoka	Total number of hits for each KPI identified
			2000	2002	2003	2007	2008	2010	2010	2010	2010	2011	2012	2013	2013	2013	2014	
Environment	24	Construction Waste Rate							√			√	√	√	√		√	6
	25	Impact on the Environment	√	√					√			√	√	√			√	7
	26	Energy use										√		√				2
Financial	27	Profitability	√		√	√	√		√		√				√	√		8
	28	Growth			√	√									√	√		4
	29	Financial stability				√	√								√	√		4
	30	Cash flow			√				√		√				√	√		5
	31	Capital														√		1
	32	Interest Cover														√		1
	33	Return on Investment														√		1
	34	Outstanding Money														√		1
Internal Business	36	Business efficiency		√		√										√		3
	37	Successful tenders rate																0
	38	Market share		√		√									√	√		4
	39	Innovation		√		√			√						√		√	5
	40	Resource management		√					√	√	√				√			5
	41	Number of high-performance professionals within		√			√	√	√	√	√							6
	42	Technological capability		√	√	√			√						√			5

Category		Key Performance Indicators (KPI)	Love & holt	Pillai et al	Takim et al.	Yu & et al	Ling & et al	Toor and Ogunlana	Wadugodapitiya	Ogunlana	Horta & et al	Cha & Kim	Chan & Chan	Yeung & et al	Lee & et al	Ali & et al	Menoka	Total number of hits for each KPI identified
			2000	2002	2003	2007	2008	2010	2010	2010	2010	2011	2012	2013	2013	2013	2014	
Productivity	43	Management Productivity	√			√	√											3
	44	Labor Productivity	√						√		√	√			√			5
	45	Rate of Subcontract (outsourcing)					√				√							2
Internal Stakeholders	46	employee satisfaction		√	√				√						√		√	5
	47	staff turnover													√			1
	48	sickness absence																0
	49	Motivation							√									1
	50	Human resource training and development	√						√						√			3
External Stakeholders	51	Client's satisfaction	√	√	√		√	√	√	√			√	√	√		√	11
	52	Percentage of Repeat Customers					√	√					√	√				4
	53	subcontractor performance		√	√			√		√			√	√				6
	54	Occurrence and magnitude of disputes and conflicts					√	√					√	√				4
	55	End-user Satisfaction	√	√	√	√		√		√			√	√		√	√	10
	56	Regulatory compliance		√	√			√	√	√			√	√	√		√	9
		Total number of KPIs identified from each publication	9	20	14	9	13	14	22	11	7	13	12	20	16	17	12	209

Chapter 3

Research Methodology

3.1 Introduction

3.2 Methodology Structure

3.3 Development of the Research Model

3.4 Research Hypothesis

3.5 Questionnaire Development

Chapter 3

Research Methodology

3.1 Introduction

In this chapter, the research approaches employed in the study are described. The research process comprises three phases which are preliminary data gathering, secondary information gathering through surveying and model development. This chapter further describes methods of data collection, research population and sampling techniques, structure of the research tools, and lastly analysis of the data.

3.2 Methodology Structure

The structure of the study is composed of three phases: Investigation, synthesis, and development stage as shown in Table (3).

In the investigation and data gathering stage relevant data were acquire to get a sufficient background on construction performance measurement. Through an extensive literature review, previous research models were explored and analysed to find the most suitable model and to decide on what would or would not be included in the study framework.

In the synthesis stage, a list of the potential indicators is identified and aggregated into performance categories. To ensure that the selected KPIs are relevant and valid to the local use, a pilot questionnaire was conducted engaging selected experts who have minimum 15 years of experience in the construction field. Based on the outcome of the pilot survey a set of indicators were nominated and ready to be used for the main questionnaire.

In the development stage the objective was to determine the ranking and the relative weight of the indicators as a basis for the model using the analytical hierarchy process (AHP) as a tool. In order to determine the validity and applicability of the proposed model, expert opinions were gathered through face to face interviews.

Table (3)
Research Methodology Structure

Objective	Task		Methodology stage	Method
(1) Review previous performance assessment models being employed within the construction industry	Explore Existing models and nominate the most suitable ones.	INVESTIGATION	Secondary data collection	Literature Reviews
(2) Investigate the KPI for Building construction project in Bahrain based on accumulative knowledge and judgment of experts	List of indicators were identified	SYNTHESIS	Preliminary data collection	Literature Reviews, Pilot Questionnaire.
	A Pilot Survey to validate the list were prepared and amendment was done to enhance the main questionnaire			
	Analysis of Gathered Data & a screened new list of Indicators was prepared		Results of data collection	Descriptive and Inferential Statistics
(3) Develop a model for Measuring construction performance	Develop the model	APPLICATION	Proposal	Modeling
	Validate the Model through Expert opinions		Validation	Survey questionnaire

3.3 Development of the Research Model

Several models have been established within the construction industry and have coexisted even though each had its unique approach and targets different areas of performance. Hence, in order to establish a comprehensive model, it is more practical to build upon the concepts of the

prevailing models. Extensive literature, coupled with well-recognized frameworks, namely, the Balanced Scorecard (Kaplan & Norton, 1995) and the KPI were utilized to develop the model. Selecting these two frameworks was based on their reputation and strong presence in business as well as academia, thereby strengthening the initial validity of the developed model. the four BSC perspectives: Financial, internal business process, customer and learning and growth are used collectively to monitor the performance of such strategic objectives which made it a great tool for assessing organizational objectives.

However, Construction firms are considered as projectized organizations predominantly focusing on projects (Zavadskas *et al.*, 2014), yet the BSC model do not explicitly emphasize a project focus as criticized by many construction management researchers (e.g., Bassioni et al., 2005; Jin & Deng, 2012; Kagioglou et al., 2001). This emphasis was pursued by Cha and Kim (2011) through determining the nominated performance areas corresponding to the project perspective and their respective indicators. This research refines their suggestion of the project perspective and propose six categories and 18 indicators as a preliminary set of project perspective indicators.

Moreover, the construction industry is also known for the variety of stakeholders that are involved in the process where each has rather different objectives to achieve. According to Love and Holt (2000) the customer perspective within the BSC is insufficient to capture these characteristics of the construction industry, in their study they have introduced ‘stakeholder perspective measurement’ (SPM) to highlights the need to embrace all stakeholders’ interests, including suppliers, customers and

subcontractors. Thus, the customer perspective in the BSC, is reinforced to form an independent level in the model that is devoted to measure stakeholder's performance.

the fourth BSC perspective is the innovation and learning which is intended to develop new processes and technologies that eventually increase efficiencies and decrease costs from an internal business perspective. However, the extent to which innovation can take place is controversial in the construction sector because of its fragmented nature, which made it among the lesser innovative industries (Zhigang Jin *et al.*, 2013). Therefore, the learning and growth perspective will be replaced with a single indicator “innovation” under internal business perspective.

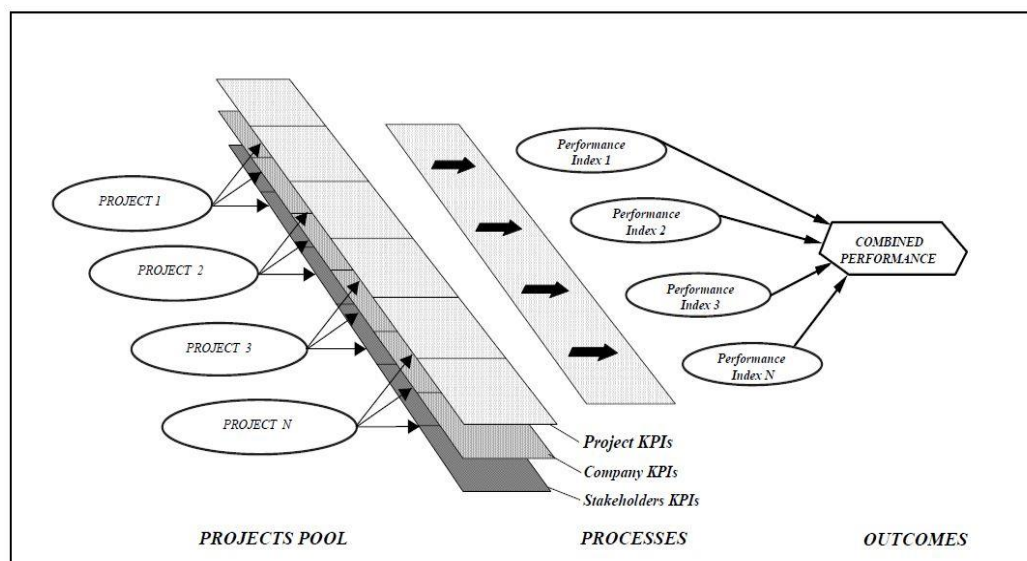


Figure (7)
Proposed Multi-layered performance measurement model

Consequently, the revised framework consists of the three levels: Project, organization and stakeholders level as depicted in Figure (7) and the list on nominated indicators follows in Table (4).

Table (4)
Nominated performance indicators

Project Level	1	Cost	Cost Rate
			Construction cost variance
			Cost to rectify defects
	2	Time	Construction time variance
			Overtime Work Rate
			Time to rectify defects
	3	Quality	Defect Frequency
			Total Field Rework
			Quality Issues at End of D. R. P.
	4	Planning Efficiency	Predictability Cost
			Predictability Time
			Change Cost Factor
	5	Health & Safety	Frequency of Accident
			Safety Cost Ratio
			Safety Performance
	6	Environment	Construction Waste Rate
			Impact on the Environment
			Energy use
Company Level	1	Financial	Profitability
			Growth
			Financial stability
			Cash flow
			Capital
			Interest Cover
			Return on Investment
			Outstanding Money

Stakeholders Level	2	Internal business	Business efficiency
			Successful tenders rate
			Market share
			Innovation
			Resource management
			Number of high-performance professionals within
			Technological capability
	3	Productivity	Management Productivity
			Labor Productivity
			Rate of Subcontract (outsourcing)
	1	Internal Stakeholders	employee satisfaction
			staff turnover
			sickness absence
			Motivation
			Human resource training and development
	2	External Stakeholders	Client Satisfaction
			Percentage of Repeat Customers
			subcontractor performance
			Occurrence and magnitude of disputes and conflicts
			End-user Satisfaction
			Regulatory compliance

Performance is not specified in efficiency but it is also achieving the desired results. For this purpose, wide range of KPIs have been identified and used for the measurement of the success of construction projects. Few of the major KPIs have been discussed as below in brief:

Project Indicators

Project performance can be defined as the project attributes that interest stakeholders such as Managers, Clients, project Engineers, contractors and suppliers. These attributes are often examined through a variety of indicators or measures. These indicators enable stakeholders to evaluate the performance of the project and highlights the area for improvement (Samee & Pongpeng, 2015).

Cost performance: Masrom (2012) states that cost performance is one of the most significant factors in the performance measurement. It refers to the estimate of the budget required for the project from its beginning to its completion. The cost of the construction is usually measured in terms of finance using the local currency and it must focus on the building instead of the land.

Time performance: According to Masrom (2012), time performance signifies that the project has been completed on or before the time that was agreed upon. Time performance is considered as the major determinants of the contract, which again exhibits the timely completion of the project. There are four factors that affect the time performance of the construction. These factors include effectiveness of construction management, complexity of the client and its representatives depending on the creation and maintenance of positive project team relationships with that of the design team and construction management, designing of the team effectiveness in the communication with the construction management and team of the representatives of the clients.

Quality performance: Langston (2012) defined quality performance as the standard of the project that is delivered and also about the project that was specified in the contract no more no less. There is no particular unit to measure the quality of the project but several issues were there that were of both subjective and objective type. Quality is also influenced by several factors namely innovation, building height, environmental performance, extent to fit, standard of finish, compliance, efficiency and supervision levels.

Planning performance: Construction planning can be defined as the process of identifying the optimum procedures, timing sequence and required resources for the project activities. The growing sophistication of the construction industry within a highly competitive market place, along with clients' demands for substantial reductions in outturn costs and delivery times have made the efficiency of planning critical; to accomplishing in order to successfully meet the objectives of the construction project (Faniran *et al.*, 2001).

Safety performance: can be defines as the extent of safety measures that are implemented on the site, rather than the consequences resulted from ignoring those precautions, which is expressed as accident rates. Safety in the work is very necessary during the construction process and also to help the contractors for the mitigation of accidents. For the assessing of project success, the company must ensure management of work safety, identification of hazard and cleanliness and site orderliness. The financial loss and extra cost to be incurred in the project can be minimized through the comprehensive measurement of health and safety during the work (Salminen, 2005).

Environment: The construction industries have been largely impacting the environment. Waste management is one of the major issues of environment during the construction process. In the few years, it has been witnessed that the increasing demand for the construction projects are bringing high range use of materials such as concrete, cement, aluminium and steel that aims at the environmental protection (A. Chan, 2001).

Company Indicators

Measures that reflects the overall performance of organizations from business perspective focusing on a critical few areas relevant to organization's strategic objectives (El-Mashaleh et al., 2007).

Financial: The strength of the company depends on the capacity of the company to carry out the projects. The credibility and reputation of the company is found to increase along with the increase in the financial strength. The ratio of company's liability to its equities measures the financial strength of the company (Işık, 2009).

Business performance: The performance of the construction business can be improved if the contractors raise the standard through their increased level of performance. The high level of business performance can be recognized through the profit value, increased opportunity for the repetition of business, and the project delivery within the budget (Masrom, 2012).

Productivity: Work productivity is one of the common terms in the construction industry. The way to measure productivity in the construction industry is the determination of per unit of work done by the worker in an

hour. The absenteeism, weather, construct design and the size of crew are the other determinants for the analysis of work productivity in the construction industry (Salminen, 2005).

Stakeholders Indicators

The project stakeholders as defined by Project Management Institute (2008) are “*individuals and organisations who are actively involved in the project or whose interests may be affected by the execution of the project or by a successful project.*”

Internal stakeholder: The internal stakeholders of the construction project are the individuals or the organizations that are involved in the project or that their involvement might affect the successful project execution. The performance of internal stakeholders can be measured through the communication effectiveness between the members of the project (Masrom, 2012).

External stakeholders: The clients, partners, sub-contractors, government regulations are the external stakeholders of the construction project. Satisfaction of the external stakeholders is highly responsible for the success of the project. To make the external stakeholders more satisfied, it is very necessary that the projects consider the quality, communication skills and client orientation (Isik, 2009).

3.4 Research Hypothesis

Saunders (2011) stated that hypothesis testing produces a high degree of consistency and reliability of the results through determining

dissimilarities in responses whether confirming or rejecting that the variations resulted coincidentally or as a consequence of random variations within the sample rather than an error occurred while sampling the population. Generalization can be assumed incase the level of significance is low as it reflects a higher level of replications of the results.

H₁: The majority of construction organizations do perceive the concepts of performance measurement.

H₂: There is a no significant difference in perception between the different classes of companies towards ranking the performance indicators.

H₃: There is a no significant difference in perception between the various job titles of the participants towards ranking the performance indicators.

The validity of the above-mentioned hypotheses will be further analysed and discussed in the following chapter.

3.5 Questionnaire Development

Surveys operate function based on statistical sampling; full population surveys are hardly ever conducted because of impracticality, cost and time consuming and often are undesirable. The concept behind statistical sampling are used because they are much faster and economical. Questionnaires and interviews are typical methods by which samples are surveyed through (Fellows & Liu, 2015).

The primary data for the study were acquired through the employment of a survey questionnaire. There are several reasons behind the selection of this instrument highlighted by Roopa and Rani (2012): (1) Questionnaires ensure internal consistency and coherency of analysis through enabling the collection of quantitative data in a standardized way; (2) A questionnaire can target large sample population which will increase the validity and reliability of the findings; (3) A questionnaires may offer participants the choice of anonymity since they are not obliged to provide any identifiable contact details; (4) Questionnaires demand less resources as they are inexpensive and require less time to be conducted; (5) They offer results that could be condensed to statistics.

3.5.1 Questionnaire Structure

The questionnaire was designed based on a combination of several performance assessment studies (Alsulamy, 2015; Shaban, 2008) were adopted in terms of layout format, sequence and questions for assessing participants knowledge on performance measurement. It is divided into three segments as follows:

The objective in the first segment of the questionnaire is to collect demographic information about the respondent's job title, years of expertise, their company classification, the overall value of the projects executed in the last five years. Descriptive statistics were used to analyse data collected in this part as most of it is descriptive in nature. This information is useful for examining the participants' profiles and necessary to establish credibility to the study.

The second part sought to elicit information on the participants' background on performance measurement and their perception of the previous performance models and whether they have previous experience on the matter or not to support the study objective.

In the third part of the questionnaire, the participants were presented with a set of indicators that were considered important for assessing the performance of the company. The list of indicators was refined by rephrasing some items for a clearer understating and by adding some other factors suggest by the pilot survey participants. The nominated 47 indicators previously presented in Table (4) were used as the dependant variables, and the conventional five point Likert rating scale was employed to establish the ranking between the indicators as per their level of importance to the participants (i.e. Business Owner, Construction Manager, Project manager, Civil Engineer) where 1= Very low important, 2= Low important, 3= Medium important, 4= High important, 5= Very high important. While Likert scale is considered to be an ordinal variable, it can be assumed as interval variable if it has a uniform spacing between its ratings as stated by (Ahadzies, 2007). Hence, statistical data such as T-test can be utilized to analyse the data and be incorporated in the proposed model.

3.5.2 Pilot Study

The purpose of a pilot study is to examine the appropriateness of the questionnaire tool before the actual data gathering starts to achieve more accurate information and reducing the risk on uncertainty (Masrom, 2012). Thus, an initial self-administered questionnaire was prepared to test the clarity, understanding of the questions and avoid any inconsistencies. Using a purposive sample of ten expert participants relevant to the construction industry such as project managers, business owners, and site engineers, the profiles of the participants are depicted in Table (5).

Table (5) Profiles of the Pilot survey participants

Designation	Company	Years' of Experience
Projects Director	Class C	34
Project Manager	Class AA	30
Project Manager	Class A	23
Project Manager	Class C	18
Civil Engineer	Class C	15
Civil Engineer	Class C	19
Site Engineer	Class B	16
Site Engineer	Class A	25
Quantity Surveyor	Class A	21
Contracts Manager	Class A	24

Berdie *et al.* (1986) stated that in order to improve the internal validity of pilot studies, the participants should be asked to record time taken to complete the questionnaire, identify any flaws and to disregard any ambiguities. The questionnaires were handed over personally and were collected in May 2016 with the following recommendations:

1. Class of classification should be more precise since a single company may have different classifications for the different construction projects type i.e. (Building, roads, maintenance).
2. Include Class “C” to increase the targeted population.
3. Extend the range of projects value.
4. Include the position of “Construction manager”.
5. Additional measures were identified and added. “successful tend rate” was added as an internal business measure and “Subcontractor performance” was added as another possible to external stakeholders.

The pilot survey offers the opportunity to test the validity and reliability of the questionnaire format (Ali *et al.*, 2013). As a result, a refined version was developed (see Appendix B) and ready to be employed.

3.5.3 Validity test

Validity of instrument can be defined as the recognition of the extent to which the instrument can really exhibit the examined abstract construct. On the other hand, validity can be referred to as the degree of the capacity of the measurement by the instrument as it is supposed to measure. When an instrument is considered to be valid, it actually reflects the elements that it is supposed to measure. High validity is that which refers to the absence of systematic errors existing in the measuring instrument (Pallant, 2007).

The validity distinguishes if the nominated KPIs can sufficiently represent each performance criterion, and whether they are significant enough to achieve a consensus among the respondents (Yu *et al.*, 2007). The below mentioned studies will describe the major elements that will

help to understand the validation process in a detailed manner. The major steps for the validation process of this study have been discussed as below:

1. Content validity

It is the extent to which the topic coverage under the study can be provided. This validity is based on the analysis of required target and also it has been witnessed that it can be drawn on the judgment of the expert. In this instrument, according to Bassioni *et al.* (2008) the content validity can be demonstrated in two ways: (i) the analysis of required target was achieved from the past literature reviews and the theoretical development of the model that is based on the models that are well-established and (ii) the judgment of the expert is based on the questionnaire evaluation through the pilot study and the interviews of the expert. As a result of the pilot study, relevant KPIs were nominated as previously presented in Table (4). Hence, content validity was achieved.

2. Statistical validity

Two of the statistical tests are highly necessary for the ensuring of the validity of the questionnaire. Those two statistical tests are internal validity test or referred as Criterion-related validity test (Pearson test) and structure validity test (Pearson test). The Criterion-related validity test measures the correlation coefficient between the complete field of the study and each of the paragraphs in that similar study. On the other hand, the structure validity test is used for the testing of the questionnaire structure validity through the testing of the complete questionnaire and validity of all fields of construction. Similarly, the structure validity test measures the correlation coefficient between all fields of the questionnaire having level

of similar scales and a particular field (SPSS Tests, 2016). Under this validity, two tests have been explained as below.

a. Internal validity test

This is the correlation coefficients between the entire field and each paragraph of the similar field. In the questionnaire, the internal consistency is usually measured through a scouting sample, which measures the correlation coefficients between the entire field and each paragraph of the similar field (Shaban, 2008). In the following tables, the correlation coefficient and p-value for each field items have been demonstrated. As per the tables, if the p-values are less than 0.05 then the correlation coefficients of this field are significant at $\alpha = 0.05$. Thus, with these values, it can be determined that it is valid and consistent.

Table (6)
Internal validity for the indicators of Cost Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Cost Rate	0.532	0.002**
2.	Construction cost variance	0.657	0.000**
3.	Cost to rectify defects	0.786	0.000**

** Correlation is significant at the 0.05 level

Table (7)
Internal validity for the indicators of Time Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Construction time variance	0.768	0.000**
2.	Overtime Work Rate	0.691	0.000**
3.	Time to rectify defects	0.853	0.000**

** Correlation is significant at the 0.05 level

Table (8)
Internal validity for the indicators of Quality Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Defect Frequency	0.837	0.000**
2.	Total Field Rework	0.870	0.000**
3.	Quality Issues at End of Defect Rectification Period	0.872	0.000**

** Correlation is significant at the 0.05 level

Table (9)
Internal validity for the indicators of Planning Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Predictability Cost	0.851	0.000**
2.	Predictability Time	0.900	0.000**
3.	Change Cost Factor	0.868	0.000**

** Correlation is significant at the 0.05 level

Table (10)
Internal validity for the indicators of Safety Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Frequency of Accident	0.880	0.000**
2.	Safety Cost Ratio	0.872	0.000**
3.	Safety Performance	0.712	0.000**

** Correlation is significant at the 0.05 level

Table (11)
Internal validity for the indicators of Environment Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Construction Waste Rate	0.833	0.000**
2.	Impact on the Environment	0.905	0.000**
3.	Energy use	0.806	0.000**

** Correlation is significant at the 0.05 level

Table (12)
Internal validity for the indicators of Financial Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Profitability (company)	0.506	0.004**
2.	Growth	0.664	0.000**
3.	Financial stability	0.718	0.000**
4.	Cash flow	0.622	0.000**
5.	Capital	0.662	0.000**
6.	Interest Cover (company)	0.630	0.000**
7.	Return on Investment (client)	0.686	0.000**
8.	Outstanding Money (project)	0.303	0.103

** Correlation is significant at the 0.05 level

Table (13)
Internal validity for the indicators of Internal Business Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Business efficiency	0.501	0.005**
2.	Successful tenders rate	0.675	0.000**
3.	Market share	0.432	0.017**
4.	Innovation	0.890	0.000**
5.	Resource management	0.587	0.001**
6.	Number of high-performance professionals within	0.926	0.000**
7.	Technological capability	0.831	0.000**

** Correlation is significant at the 0.05 level

Table (14)
Internal validity for the indicators of Productivity Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Management Productivity	0.819	0.000**
2.	Labor Productivity	0.792	0.000**
3.	Rate of Subcontracting	0.687	0.000**

** Correlation is significant at the 0.05 level

Table (15)
Internal validity for the indicators of Internal Stakeholders Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	employee satisfaction	0.893	0.000**
2.	staff turnover	0.749	0.000**
3.	sickness absence	0.487	0.006**
4.	Motivation and Incentives	0.829	0.000**
5.	Human resource training and development	0.776	0.000**

** Correlation is significant at the 0.05 level

Table (16)
Internal validity for the indicators of External Stakeholders Category

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Client Satisfaction	0.891	0.000**
2.	Percentage of Repeat Customers	0.803	0.000**
3.	subcontractor performance	0.833	0.000**
4.	Number and severity of disputes and conflicts	0.690	0.000**
5.	End-user Satisfaction	0.869	0.000**
6.	Regulatory compliance	0.793	0.000**

** Correlation is significant at the 0.05 level

b. Structure validity test

It is the second statistical test that measures the correlation coefficient between a particular field and all of the other fields of the questionnaire. It is also used to test the validity of the questionnaire structure through the testing of validity of the entire questionnaire. The Pearson correlation or correlation value that is obtained between the item and the total score is termed as the r_{xy} . P-value (2-tailed) was a significance level of 5%, while N is the total of survey respondents (SPSS Tests, 2016). To determine if the item questionnaire is valid or not, the value of significance can be considered or making comparison between r_{xy} value and r table product moment. Table (17) has demonstrated the correlation coefficient value of each of the field and that of the entire questionnaire.

Table (17)
Correlation coefficient of each field and the whole of questionnaire

No.	Field	Pearson Correlation Coefficient	P-Value (Sig.)
1.	Time	0.676	0.000**
2.	Cost	0.703	0.000**
3.	Quality	0.716	0.000**
4.	Planning	0.597	0.000**
5.	Health and Safety	0.759	0.000**
6.	Environment	0.724	0.000**
7.	Financial	0.675	0.000**
8.	Internal Business	0.846	0.000**
9.	Productivity	0.844	0.000**
10.	Internal Stakeholders	0.752	0.000**
11.	External Stakeholders	0.666	0.000**

** Correlation is significant at the 0.05 level

3.5.4 Instrument Reliability

Reliability refers to the degree of consistency and quality in measuring a certain attribute, whether particular techniques will give the same result for multiple measures of a variable (Ofori-Kuragu & Baiden, 2008).

Cronbach's coefficient alpha (α) is one of the most commonly used indicators to test the internal consistency and was employed in this study to test the reliability of the pilot questionnaire between each field. The use of SPSS for measuring Cronbach's coefficient alpha was adopted in this study because of its simplicity.

While values of (α) range between 0.0 and 1.0, Pallant (2007) stated that there are different levels of reliability required based on the type of research, however a rule of thumb can be applied as shown in Table (18).

Table (18)
Cronbach's alpha and internal consistency

Cronbach's alpha	Internal consistency
$0.9 \leq \alpha \leq 1.0$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$0.0 \leq \alpha < 0.5$	Unacceptable

Table (19)
Cronbach's Alpha for each individual filed and all the questionnaire

No.	Field	No. of items	Cronbach's Alpha if item is deleted
1.	Time		.893
2.	Cost		.891
3.	Quality		.893
4.	Planning		.898
5.	Health and Safety		.889
6.	Environment		.894
7.	Financial		.895
8.	Internal Business		.882
9.	Productivity		.882
10.	Internal Stakeholders		.888
11.	External Stakeholders		.893
	Total		0.900

The results presented in Table (19) show alpha values for each construct ranged from 0.892 and 0.898, whereas Cronbach's Alpha for the entire questionnaire equals 0.900 suggesting the reliability of the pilot study was excellent. The detailed results of Cronbach's Alpha can be obtained for each individual field through appendix.

3.5.5 Sample selection and size

The population targeted in this research is the building construction companies in Bahrain, their classification and contact details were retrieved form the 2015 ministry of work (MOW) list of registered construction firms, the selection was restricted to firms classified as "AA, A, B and C" which include a total of 89 building contractors.

To determine the sample size for the research the stratified random sampling was adopted to ensure that each element of the population has an equal probability to be presented (Rustum, 2002), for this purpose the following formula was used for unlimited population:

$$\text{equation} \quad SS = \frac{Z^2 \times P \times (1 - P)}{C^2} \quad (1)$$

where SS = Sample size

Z = Value (e.g. 1.96 for 95% level of confidence)

P = Degree of variance between the element (0.5)

C = Confidence interval (0.05)

$$\begin{aligned} SS &= \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{0.05^2} \\ &= 384.16 = 385 \end{aligned}$$

To get the correction for Finite Population, the formula below was used:

$$NewSS = \frac{SS}{1 + \frac{SS - 1}{POP}} \quad (2)$$

Where POP = Population

$$\begin{aligned} NewSS &= \frac{385}{1 + \frac{385 - 1}{89}} \\ &= 72.44 = 73 \end{aligned}$$

Since the targeted companies are divided into four classes, the random selection was achieved through a random seed number in SPSS application and this will help reducing bias and will establish a balanced mix of participants, Table (20) presents the sample size of each classification according to their percentages of the entire population.

Table (20)
The required sample size per Companies classification

Class	No. of Companies	% of whole Population	No. Required For the sample Size (73)
Grade AA	25	28%	20
Grade A	24	27%	20
Grade B	18	20%	15
Grade C	22	25%	18
Total	89	100%	73

The 73 questionnaires were handed over along with a covering letter describing the nature of the study and assuring them of anonymity and results will be inclusively for academic use. It is worth mentioning that although it was feasible to target the entire population, the remaining group was set aside for validation purposes in order to avoid any bias.

3.5.6 Data Collection administration

The questionnaire administration Stage started in August 2016. Due to the high reliability and large success of the method applied in the pretesting of the pilot survey, the same method was employed in the main questionnaire. with this in mind, questionnaires were handed over personally to professionals of the targeted companies in the sample. A six weeks' period was allowed for the administration of the questionnaires wherein all completed Forms were to be collected back by the end of this

period. Following the allowed period, all other questionnaires that had not been collected back were deemed non-responsive.

Table (21)
Number of respondents

Type	Concerned Sample size	Total No. of respondents	Accepted responses	Percentage
Contracting	73	32	30	41.7%

Initially it was established that a sample size of 73 at 5% confidence interval would be appropriate. However, in practice it is observed that a sample of 30 was actually achieved as presented in Table (21). According to Hair et al (1998) (as cited in Ahadzie, 2007) with a sample of 30 or more the central limit theorem reveals that a normal distribution could be assumed. Moreover, the accepted responses were 30 represented 41.7% response rate, which can be regarded as significant. Akintoye (2000) (as cited in Takim & Adnan, 2009) stated that in the construction field questionnaires a response rate ranging between 20% to 30% are frequent and acceptable. On top of that, similar studies were carried out achieving nearby rates such as Takim and Adnan (2009) in their study had a response rate of 20.9%; Zhigang Jin *et al.* (2013) achieved a response rate of 23.5%. This concludes that the above-mentioned response can be assumed representatives of the target population and provides us a certain level of confidence.

3.5.7 Method of Data analysis

To achieve greater efficiency and reliability while analyzing data, the level of measurement must be well comprehended. In this study, Ordinal scale was employed where data are represented as integers ranked either

descending or ascending order. participants were requested to assess the list of indicators nominated for measuring the performance of building construction projects on a five- point scale as presented in Table (22).

Table (22)
Ordinal scale used for data measurement

Item	<i>Very Low important</i>	<i>Low important</i>	<i>Medium important</i>	<i>High important</i>	<i>Very High important</i>
Scale	1	2	3	4	5

Despite the fact that Likert ranking scales are usually referred to as ordinal measures, they can be regarded as interval measures in case the spacing between them is uniform (Ahadzie, 2007). In view of this, statistical methods for example the t- test could very well be applied to examine the dependent variables in order to integrate them while developing the proposed model.

Chapter 4

Data analysis and Discussion

4.1 Introduction

4.2 One Sample K-S Test

4.3 The Descriptive Method

4.4 Inferential Statistics

Chapter 4

Data analysis and Discussion

4.1 Introduction

Large number of variables has been represented through the conceptual framework in the previous chapter as the determinants of contractor performance with construction projects. The critical review of the relevant literatures provided with the list of variables (both dependent and independent). Few of the other variables have also been presented that were extracted from the interview result with the construction industry professionals and experts. This chapter will discuss about the data that were collected from the respondents that successfully returned the questionnaire. Furthermore, the data were analyzed with the use of IBM Statistical Package for Social Science (SPSS) version 20 along with the use of Microsoft Office to present the charts and graphs for illustrating and comparing the data. This chapter also computed the descriptive statistics, mean and standard deviations. This develops the basis for the subsequent inferential quantitative data analysis that allows for the maximum understanding of the data trends.

4.2 One Sample K-S Test

According to Bryman and Cramer (2002), the purpose of the K-S test is to investigate whether or not the data follows normal distribution. this test is considered essential when testing data through parametric test which in return stipulates data to be normally distributed and it is employed when the sample size is 30 or above (NIST SEMATECH, 2012). Results of the K-S test are presented in Table (23) denotes that the calculates p-values surpasses the significant value that equals 0.05. As a result, this indicates that data follows normal distribution which necessitate the use of parametric tests.

Table (23)
Results of one Sample K-S

Number	section	items No.	Statistic	P-value
1	Time	3	.889	.408
2	Cost	3	.787	.566
3	Quality	3	.877	.426
4	Planning efficiency	3	.828	.500
5	Health & safety	3	1.020	.250
6	Environmental impacts	3	.659	.778
7	Financial performance	8	.655	.784
8	Internal business management	7	.640	.807
9	Productivity	3	.783	.572
10	Internal Stakeholders	5	.837	.485
11	External Stakeholders	6	.969	.305
	Total	47	0.858	0.453

4.3 The Descriptive Method

This chapter demonstrates the data result that were obtained from a structured questionnaire that were distributed among the various professionals of the construction industry of Bahrain such as project managers, quantity surveyors, engineers and construction managers. The data analysis and interpretation of the result served the purpose of quantitative methodology used for the collection of data.

4.3.1 Section 1: Company Profile

1. Year of the Company Establishment

Table (24) illustrates that almost 10% of the companies were established in the year 1963 and 1983. 3.33% of them were established in the year 1954, 1977, 1984, 1988, 1991, 1994, 1998, 2004, 2006 and 2007. Remaining of the 6.67% of them were established in the year 1960, 1975, 1981, 1982, 1987, 2000 and 2008.

Table (24)
Establishment Year of Companies

Year of Establishment	Frequency	Percent %
1954	1	3.33%
1960	2	6.67%
1963	3	10.00%
1975	2	6.67%
1977	1	3.33%
1981	2	6.67%
1982	2	6.67%
1983	3	10.00%
1984	1	3.33%
1987	2	6.67%
1988	1	3.33%

1991	1	3.33%
1994	1	3.33%
1998	1	3.33%
2000	2	6.67%
2004	1	3.33%
2006	1	3.33%
2007	1	3.33%
2008	2	6.67%
Total	30	100

2. Classification of Contracting Companies

Four classes of contracting firms were targeted as shown in Table (25). It was noted from the table that 40% of the contracting firms are of first class “AA”. 26.66% of them are of first class “A” category and 16.67% of them were for both first class “B” and first class “C”.

Table (25)
Classification of Contracting Companies

Classification	Frequency	Percent%
First class “AA”	12	40.0
First class “A”	8	26.66
First class “B”	5	16.67
First class “C”	5	16.67
Total	30	100

3. Company size

Table (26) demonstrated that 30% of the companies have less than 250 employees and the other 20% of them has between 250 to 500 employees. 16.66% of them has employees from 751 to 1000 and 10% of them had both the employees between 1001 to 1500 and from 1501 to 2000. On the other hand, 6.67% of them had both the employees between 501 to 750 and over 2000.

Table (26)
Number of Company Staff

No. of employees	No. of Companies	Percent%
less than 250	9	30
From 250 to 500	6	20
From 501 to 750	2	6.67
From 751 to 1000	5	16.66
From 1001 to 1500	3	10
From 1501 to 2000	3	10
Over 2000	2	6.67
Total	30	100

4. Job title of the respondent

In the Figure (8), it was observed that 46.67% of the respondents were the project managers. 16.67% of them were the civil engineer and those holding other designations. Remaining of the 6.67% of them were business owners or the directors, construction managers and quantity surveyor.

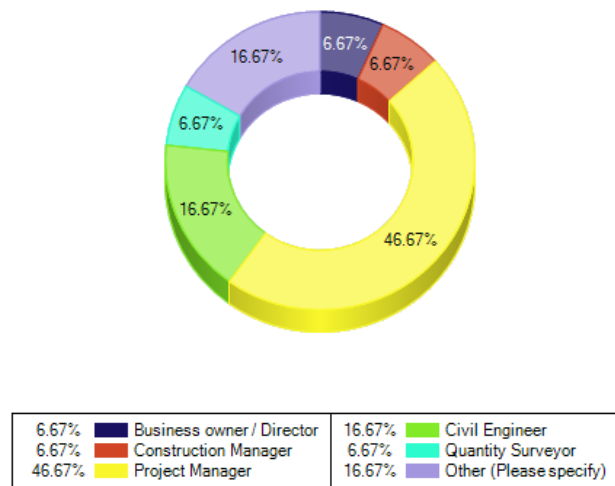


Figure (8)
Position of respondent

5. Respondent's years of experience

Table (27) illustrates that among the total respondents, 23.33% of them had the work experience of 10 to 20 years. On the other hand, 60% of them had the experience of more than 20 years and 16.67% of them had less than 10 years of work experience.

Table (27)
Years of experience of the respondent

No. of employees	No. of Companies	Percent%
less than 10 Years	5	16.67
From 10 to 20 Years	7	23.33
Over 20 Years	18	60
Total	30	100

6. Number of projects executed in the last five years

Figure (9) shows the number of projects that were handled by the respondents during the last five years. 36.67% of the respondents had handled 1 to 10 projects and the other 36.67% of them handled 11 to 20 projects in the last five years. Similarly, 23.33% of them had done more than 30 projects and 3.33% of them had done 21 to 30 projects.

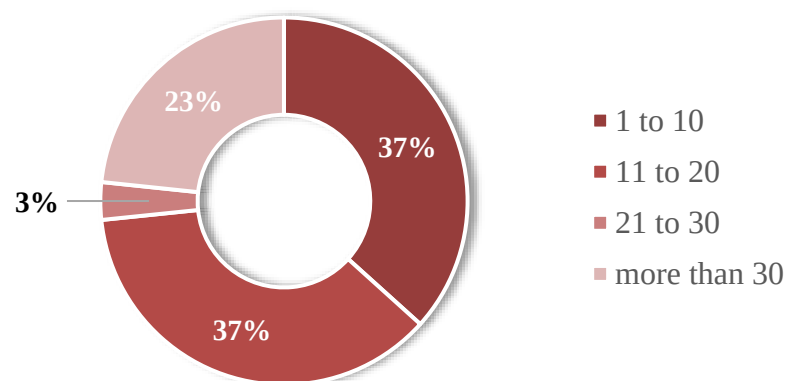


Figure (9)
Number of projects executed in the last five years

7. Value of executed projects in the last five years

From Figure (10), it can be noticed that 40% of the respondents had executed projects worth of more than 15 million BD in the last five years. Both 26.67% of them had executed projects of 1 to 15 million BD and also of 5 to 10 million BD. The remaining of 6.67% of them had executed projects that worth less than 5 million BD.

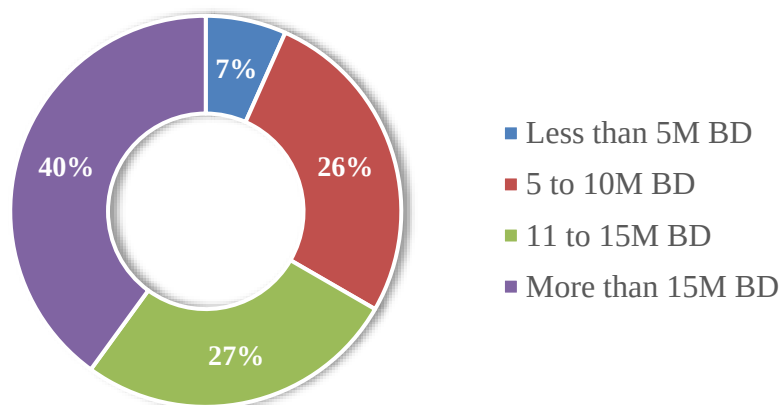


Figure (10)
Value of projects executed in the last five years

4.3.2 Section 2: Performance in the organization

Under this section, six questions were used for the collection of data to investigate the awareness of the construction companies regarding the concept of performance measurement. The questions are related to training, experience and practice of PMS. The questions were framed in a manner that compelled the respondents to ask if they have practiced measuring performance, have past experiences in it or they have gone through any training on this particular area. The results of the questions have been shown as follows:

Table (28)
Contractor's perceptions of PMSs

Contractors Classification	No.	Training	Experience	Practice
Class AA	12	10%	13.33%	16.66%
Class A	8	6.66%	6.66%	13.33%
Class B	5	0%	6.66%	6.66%
Class C	5	0%	0%	0%
Total	30	16.66%	26.65%	36.65%

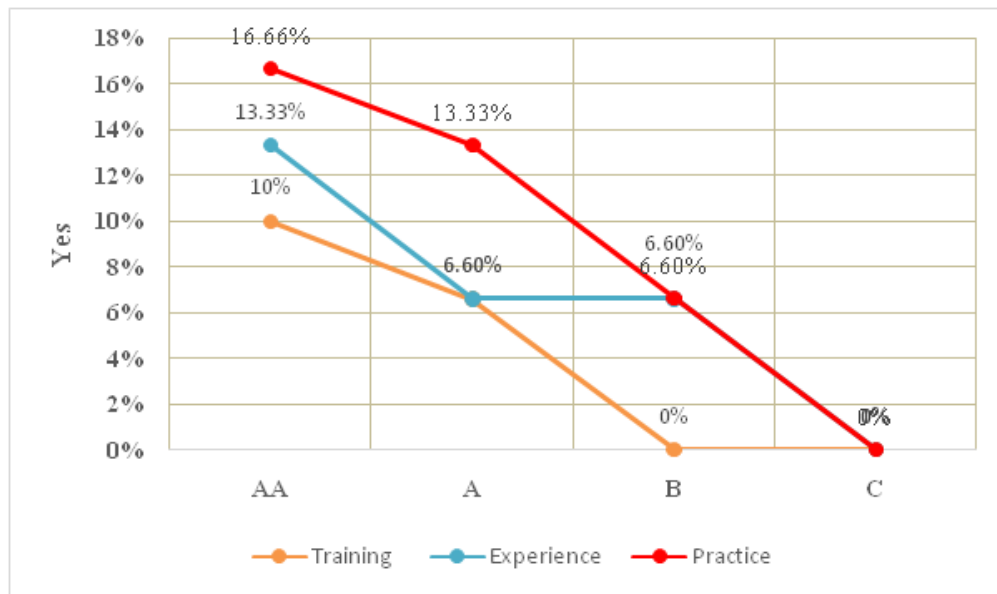


Figure (11)
Comparison of Contractor's perceptions of PMSs

8. Training received

Regarding this section, the participants were asked to signify whether or not they had gone through any kind of training in PMS or not. If the answer of the respondent was “yes”, they were asked to elaborate in more details the kind of training that they had received. The results signified that Class “AA” contractors represent the highest number of 10% that were provided with the training. Class “A” had received training that specified the value of 6.6% and on the other hand, both the class “B” and “C” never received any training in PMS. These results were much shocking as the

PMS are the substantial element for any organization pursuing success. Moreover, there is an obvious lack of proper training among the Bahraini construction industry.

9. Experience

This following part made the respondents to answer whether team members of the construction companies have experience in the PMSs or not. From the result, it was found that contractors of “AA” again got the lead with 13.33%, 6.0% is the share of Both the class “A” and “B” and not any worth mentioning percentage for class “C” contractors indicating that they had adequate experience in the measurement of performance of the construction projects. All the four categories of the participants had minimal background on measuring construction project performance.

10.Practice

In this part, respondents were asked whether they practiced any of the PMSs in the context of their management or not. None of the participants in Category “C” answered positively to this question. Whereas grade “B” and “A” organizations scored merely 6.66 % and 13.33% respectively. Even Grade “AA” respondents revealed the lack of PMS practice with as minor percentage as 16.6%. Interestingly, percentages related to the practice of PMS among the respondents surpasses those of who got trained or have previous experience. as an essential prerequisite for a proper practice. This indicates that there is a misconception about the concept of performance measurement between construction organizations in Bahrain.

11.Previously Known or Used PMSs

This question asked the participants to indicate if they are familiar with the following performance measuring systems:

- Key performance indicators
- Balanced scorecard
- European Foundation Quality Management
- The Malcolm Baldrige National Quality Award

The participants were presented with a number of performance system used internationally in the field of construction and were asked whether they have any background about these systems and whether or not they have used them previously. The below mentioned table (4.6) indicates the results about the percentage of known and used PMS by the various classes of the construction companies.

Table (29)
Known and Used PMSs by the variant construction company's classes

		EFQM		BSc		KPIs		MBNQA	
		Known	Used	Known	Used	Known	Used	Known	Used
AA	Mean	10%	0%	10%	0%	26.67%	6.67%	10%	0%
	N	3	0	3	0	8	2	3	0
A	Mean	3.33%	0%	6.67%	0%	13.33%	6.67%	3.33%	0%
	N	1	0	2	0	4	2	1	0
B	Mean	6.67%	3.33%	6.67%	0%	10%	0%	6.67%	3.33%
	N	2	1	2	0	3	0	2	1
C	Mean	0%	0%	0%	0%	6.67%	0%	0%	0%
	N	0	0	0	0	2	0	0	0
Total	Mean	23.34%	3.33%	20%	0%	56.67%	13.33%	20%	3.33%
	N	6	1	7	0	17	4	6	1

12. Performance Measurement Areas Practiced

The below mentioned Table (30) indicates the performance measures that are been practiced. It showed that 93.8% of the contractors used the time measure and 88.8% of them used cost measure. Similarly, 54.3% of them used productivity, 61.3% of them used quality, 58.6% of them used health and safety. On the other hand, 34% of them used planning efficiency, 22.5% of them used environmental impacts, 46.7% used financial performance, 12.1% used internal business management and remaining 24.6% of them used stakeholder's satisfaction.

Table (30)
Practiced Performance measures by construction companies

Measures	Contractors Classification				
	AA (N=12)	A (N=8)	B (N=5)	C (N=5)	Overall Percentage
	Used	Used	Used	Used	Used
Time	1.0	0.75	1.0	1.0	93.8%
Cost	1.0	0.75	1.0	0.8	88.8%
Productivity	0.67	0.5	0.6	0.4	54.3%
Quality	0.75	0.5	0.4	0.8	61.3%
Health & safety	0.917	0.625	0.6	0.2	58.6%
Planning efficiency	0.583	0.375	0.4	0.0	34.0%
Environmental impacts	0.25	0.25	0.4	0.0	22.5%
Financial performance	0.417	0.25	0.6	0.6	46.7%
Internal business management	0.083	0.0	0.4	0.0	12.1%
Stakeholders' satisfaction	0.333	0.25	0.4	0.0	24.6%

These results show that there is a lack of awareness and a noticeable weakness among the measures that are practiced, this confirms the results of the previous question regarding the measures Known and Used. The table also signified the extent to which the respondents focused primarily on the financial and traditional measures on the aspect of construction projects such as cost and time.

Table (31)
Testing significance

		Category	N	Observed Prop.	Test Prop.	Sig. (2-tailed)
If Training received	Group 1	No	25	.83	.50	.000
	Group 2	Yes	5	.17		
	Total		30	1.00		
Experience	Group 1	No	22	.73	.50	.016
	Group 2	Yes	8	.27		
	Total		30	1.00		
Practice	Group 1	No	19	.63	.50	.200*
	Group 2	Yes	11	.37		
	Total		30	1.00		
KPIKNOWN	Group 1	No	13	.43	.50	.585*
	Group 2	Yes	17	.57		
	Total		30	1.00		
KPIUSED	Group 1	No	26	.87	.50	.000
	Group 2	Yes	4	.13		
	Total		30	1.00		
BSCKNOWN	Group 1	No	24	.80	.50	.001
	Group 2	Yes	6	.20		
	Total		30	1.00		
BSCUSED	Group 1	No	30	1.00	.50	.000
	Group 2	Yes	0	.00		
	Total		30	1.00		
EFQMKNOWN	Group 1	No	23	.77	.50	.005
	Group 2	Yes	7	.23		
	Total		30	1.00		
EFQMUSED	Group 1	No	29	.97	.50	.000
	Group 2	Yes	1	.03		
	Total		30	1.00		
MBNQAKNOWN	Group 1	No	24	.80	.50	.001
	Group 2	Yes	6	.20		
	Total		30	1.00		
MBNQAUSED	Group 1	No	29	.97	.50	.000
	Group 2	Yes	1	.03		
	Total		30	1.00		

The research question:

Do construction companies perceive the concepts of performance measurement?

The research hypothesis:

The majority of construction organizations do not perceive the concepts of performance measurement.

The null hypothesis:

The majority of construction organizations do perceive the concepts of performance measurement.

Statement of hypothesis testing:

For testing this hypothesis, ‘majority’ was presumed to be value above 50% Table (31) present the result of a binomial test where binomial proportion is 50:50, the null hypothesis to be deemed acceptable when P-value are more than the significant level of 0.05 ($P\text{-value} > 0.05$). Hence, the null hypothesis was accepted concluding that construction organizations do not perceive the concepts of performance measurement. (most P-value are greater than 0.05).

The results confirm that the underperformance of construction organization in Bahrain is linked to poor performance measurement, companies as found by the test of hypothesis lacks the essential competencies and knowledge like for instance the roles and applications of performance measures which is necessary for the success of delivering project objectives and reaching the organization goals.

4.3.3 Section 3: Performance indicators for measuring building construction projects

This section of the questionnaire was developed to evaluate the performance indicators that measure the construction projects. The scores of the major factors have been represented in Table (32) in the order of highest score to the lowest score.

Table (32)
Scores of indicators contributing to the overall performance of
construction organizations

No.	Category	Performance Indicators	Score
1.	Cost	Cost Rate	130.00
		Construction cost variance	122.00
		Cost to rectify defects	108.00
2.	Time	Construction cost variance	124.00
		Cost to rectify defects	102.00
		Time to rectify defects	100.00
3.	Quality	Defect Frequency	107.00
		Total Field Rework	108.00
		Quality Issues at End of Defect Rectification Period	117.00
4.	Planning	Predictability Cost	113.00
		Predictability Time	113.00
		Change Cost Factor	108.00
5.	Health & Safety	Frequency of Accident	113.00
		Safety Cost Ratio	99.00
		Safety Performance	122.00
6.	Environment	Construction Waste Rate	103.00
		Impact on the Environment	94.00
		Energy use	98.00
7.	Financial	Profitability	135.00
		Growth	126.00
		Financial stability	130.00
		Cash flow	130.00
		Capital	123.00
		Interest Cover	114.00
		Return on Investment	116.00

		Outstanding Money	125.00
8.	Internal Business	Business efficiency	123.00
		Successful tenders rate	103.00
		Market share	102.00
		Innovation	95.00
		Resource management	119.00
		Number of high-performance professionals within	102.00
		Technological capability	100.00
9.	Productivity	Management Productivity	108.00
		Labor Productivity	123.00
		Rate of Subcontracting	117.00
10.	Internal Stakeholders	employee satisfaction	109.00
		staff turnover	103.00
		sickness absence	89.00
		Motivation and Incentives	101.00
		Human resource training and development	102.00
11.	External Stakeholders	Client Satisfaction	136.00
		Percentage of Repeat Customers	125.00
		subcontractor performance	122.00
		Number and severity of disputes and conflicts	103.00
		End-user Satisfaction	132.00
		Regulatory compliance	127.00
Total Score			5321

To get the relative weight of each of the main categories, the summation of scores of each indicator is divided by total score. For instance,

$$\begin{aligned} \text{The Relative weights for "Cost"} &= [(130+122+108) / 5321] \times 100 \\ &= 6.77\% \end{aligned}$$

The relative weights for the main categories are presented in Table (33) in descending order.

Table (33)
Relative weights of the key performance categories

No.	Performance Categories	Percentage
1	Financial	18.77%
2	External Stakeholders	14.0%
3	Internal Business	13.98%
4	Internal Stakeholders	9.47%
5	Cost	6.77%
6	Productivity	6.54%
7	Health & Safety	6.28%
8	Planning	6.28%
9	Quality	6.24%
10	Time	6.13%
11	Environment	5.54%

Table (33) shows the preliminary weights of each performance dimensions based on the perception of the respondents. The financial perspective topped the list with 18.77% of the overall performance weight, external stakeholders and internal business came in second ranked with almost equal value of 14% and 13.98% respectively, in the third rank came internal stakeholders' perspective with 9.47%. focusing on project level components, results were consistent with the findings of (Cha & Kim, 2011; Luu *et al.*, 2008; Skibniewski & Ghosh, 2009) as cost leads the projects categories with 6.77%.

To verify whether or not the result varies according to the classification of the organization, each category was splitted into four groups representing the four selected classes of construction firms to verify if the result varied as per the firm class and to yield the average weight as presented in Figure (12). The priority of each group resembles that of the

average of the overall firms. It was also ascertained that the relative importance was very much close between the four groups. However, a consensus of ranking the categories was missing. For example, the weight of internal business for class “AA” and class ”C” organizations was ranked 2nd whereas the same category was ranked 3rd for the other two classes. Additionally, class ”B” organizations exhibited relatively higher weight with regards to ‘external stakeholders’ category than other firms. For determining of whether the difference is significant, Inferential statistics through t-test analysis is to be conducted.

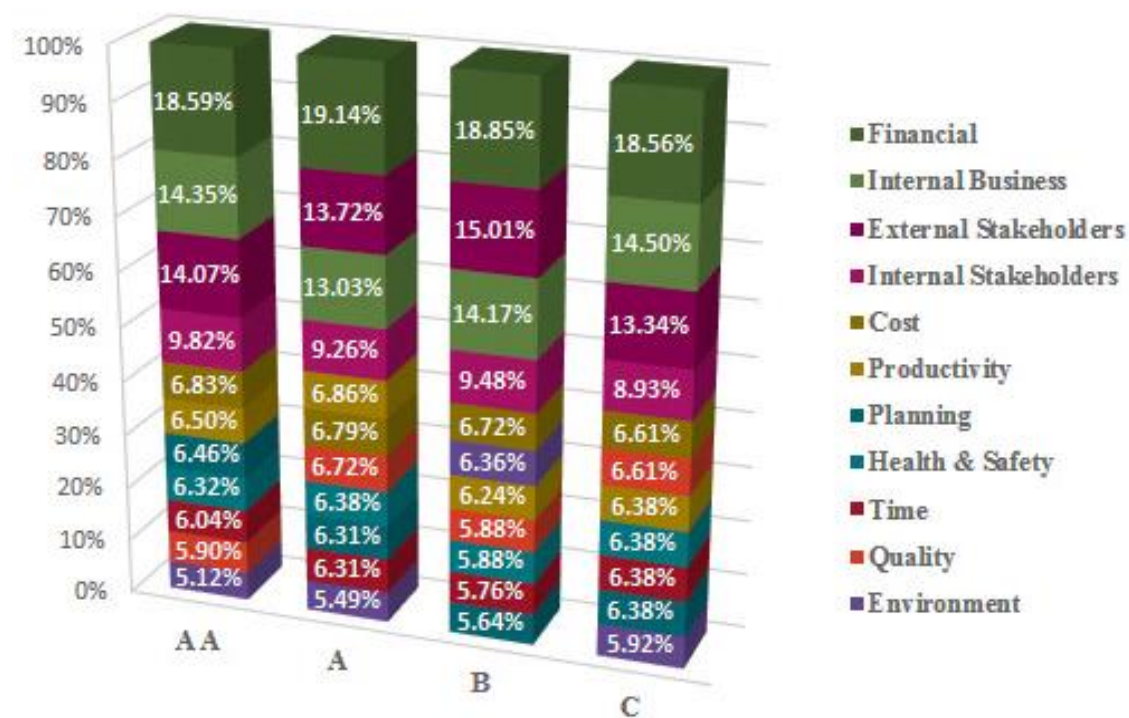


Figure (12)
Relative weights of performance areas according to company size

4.4 Inferential Statistics

The basic elements in the structure of questionnaire have been verified with the use of the necessary statistical testing. Summary of the testing have been represented as below:

4.4.1 Independent Samples T-test

In this study, the independent sample t-test was carried out with the intention of finding out the significant difference between the importance of performance indicators and the classifications of contracting. T-test was conducted on the main categories average weight resulted in Table (33).

The research question:

Do different Classification of companies (AA, A, B, C) perceive PMS differently?

The research hypothesis:

There is a no significant difference in perception between the different classes of companies with regard to factors contributing to the overall performance of construction organizations.

The null hypothesis:

There is a significant difference in perception between the different classes of companies with regard to factors contributing to the overall performance of construction organizations.

Statement of hypothesis testing:

According to Table (34), all of the classes possess similar attitude towards the ranking of the majority of performance indicators. It also signifies that all of them work under similar conditions and also, they possess similar experience through the implementation of the several stages of the construction projects. Table (34) also illustrates an analysis of the method to verify the difference in the survey result among the four groups to be statistically significant. As per the table below, the value of t-test was well above the significance level ($\alpha=0.05$) in all of the cases. This particular test did not find any significant differences among the groups among the categories of quality, cost and environment. In the process of verifying the importance of each of the performance category, it was found that the class of company is not influential.

The only exception is presented Table (35) was in ‘Growth’ with values less than 0.05 indicating that organizations consider ‘Growth’ as an important measure as far as to top their class but not to upgrade to the next as it stipulates certain requirements to be meet at first, which might be a burden to the organization and takes more than it offers.

Hence, the hypothesis was accepted with the conclusion that all the contracting companies of all the classifications do not perceive factors affecting performance differently. (All P-value are greater than 0.05).

Table (34)
Comparison analysis according to company classification

Performance Area	AA vs A		AA vs B		AA vs C		A vs B		A vs C		B vs C	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Cost	-.078	.939	1.251	.230	1.134	.275	1.161	.270	1.090	.299	-.132	.898
Time	-.663	.516	1.113	.283	-.103	.920	1.212	.251	.439	.669	-.875	.407
Quality	-1.533	.143	.456	.655	-.576	.573	1.230	.244	.923	.376	-.632	.545
Planning	.182	.858	1.684	.113	.668	.514	1.279	.227	.420	.683	-.848	.421
Health & Safety	-.173	.864	.931	.367	.315	.757	.929	.373	.455	.658	-.540	.604
Environment	-.500	.623	-.721	.482	-.529	.605	-.337	.742	-.121	.906	.195	.850
Financial	-.911	.374	1.572	.137	.834	.417	1.963	.075	1.198	.256	-.242	.815
Internal Business	.997	.332	.933	.365	.424	.677	.046	.964	-.437	.671	-.448	.666
Productivity	-.930	.365	1.233	.236	.715	.486	1.707	.116	1.287	.225	-.368	.723
Internal Stakeholders	.455	.654	.837	.415	1.249	.231	.378	.713	.650	.529	.150	.884
External Stakeholders	.203	.841	.242	.812	1.293	.216	.000	1.000	.644	.533	.816	.438

* Significant at 0.05 level

Table (35)
Comparison analysis according to company classification

Performance Area	AA vs A		AA vs B		AA vs C		A vs B		A vs C		B vs C	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Cost Rate	.390	.701	.355	.728	2.115	.052	-.055	.957	1.136	.280	1.342	.217
Construction cost variance	-.341	.737	1.049	.311	1.049	.311	1.263	.233	1.263	.233	0.000	1.000
Cost to rectify defects	-.182	.858	1.019	.324	-.247	.808	1.108	.291	-.101	.921	-1.000	.347
Construction time variance	.385	.705	.985	.340	.162	.874	.553	.591	-.183	.858	-.649	.535
Overtime Work Rate	-.960	.350	.918	.373	.568	.579	1.593	.139	1.543	.151	-.408	.694
Time to rectify defects	-.710	.487	.682	.506	-.694	.498	1.008	.335	.040	.969	-1.033	.332
Defect Frequency	-.382	.707	.272	.790	.383	.707	.471	.647	.787	.448	0.000	1.000
Total Field Rework	-2.119	0.088	.192	.850	-.397	.697	1.742	.109	1.156	.272	-.400	.700
Quality Issues at End of Defect Rectification Period	-1.253	.226	.800	.436	-1.538	.145	1.294	.222	-.337	.742	-1.265	.242
Predictability Cost	-1.159	.262	1.977	.067	.075	.941	2.628	0.073	1.043	.319	-1.443	.187
Predictability Time	.879	.391	1.735	.103	1.106	.286	.912	.381	.296	.773	-.566	.587
Change Cost Factor	.726	.477	.753	.463	.468	.647	.160	.876	-.217	.832	-.309	.766
Frequency of Accident	-.149	.883	.957	.354	.451	.659	1.073	.306	.597	.563	-.422	.684
Safety Cost Ratio	-.547	.591	.769	.454	.247	.808	1.056	.314	.757	.465	-.525	.614
Safety Performance	.391	.700	.621	.544	-.075	.941	.268	.793	-.354	.730	-.485	.641
Construction Waste Rate	-1.208	.243	-.208	.838	.073	.943	.871	.403	1.417	.184	.258	.803

Performance Area	AA vs A		AA vs B		AA vs C		A vs B		A vs C		B vs C	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Impact on the Environment	-.428	.674	0.000	1.000	-.558	.585	.314	.760	-.245	.811	-.408	.694
Energy use	.197	.846	-1.914	.075	-.906	.379	-1.947	.078	-.992	.342	1.342	.217
Profitability (company)	-.737	.471	.539	.598	1.614	.127	.939	.368	1.861	.090	.667	.524
Growth	1.060	.303	4.564	<u>0.00*</u>	2.697	<u>0.017*</u>	2.646	<u>0.023*</u>	1.295	.222	-1.134	.290
Financial stability	.443	.663	.906	.379	1.375	.189	.394	.701	.777	.453	.343	.740
Cash flow	-.151	.881	.415	.684	-.200	.844	.622	.546	-.083	.935	-.632	.545
Capital	-1.242	.230	.443	.664	-.558	.585	1.295	.222	.622	.546	-.756	.471
Interest Cover (company)	-.133	.896	.648	.527	.083	.935	.793	.445	.183	.858	-.447	.667
Return on Investment (client)	-.766	.454	.570	.577	.075	.941	1.239	.241	.682	.509	-.447	.667
Outstanding Money (project)	-1.867	.078	-1.069	.302	-.306	.764	.746	.471	1.847	.092	1.000	.347
Business efficiency	.664	.515	-.468	.647	1.733	.104	-.767	.459	.695	.501	1.706	.126
Successful tenders rate	-.108	.915	.928	.368	.815	.428	1.055	.314	1.512	.159	-.272	.792
Market share	-.743	.467	.568	.579	.659	.520	1.144	.277	1.512	.159	0.000	1.000
Innovation	.918	.371	1.340	.200	-.925	.369	.399	.698	-1.455	.174	-1.897	.094
Resource management	.879	.391	.520	.611	-.306	.764	-.068	.947	-.816	.432	-.485	.641
No. of high-performance professionals within	.839	.413	.704	.492	-.030	.976	-.110	.914	-.689	.505	-.730	.486
Technological capability	1.897	.074	.618	.546	.521	.610	-1.061	.311	-.925	.375	0.000	1.000
Management Productivity	-.824	.420	.154	.879	-.181	.859	.737	.477	.563	.585	-.254	.806

Performance Area	AA vs A		AA vs B		AA vs C		A vs B		A vs C		B vs C	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
Labor Productivity	-.365	.719	.906	.379	1.538	.145	1.024	.328	1.695	.118	.283	.784
Rate of Subcontracting	-.754	.461	2.232	0.061	.443	.664	2.946	0.063	.909	.383	-1.134	.290
employee satisfaction	.369	.716	.690	.501	.818	.426	.285	.781	.337	.742	0.000	1.000
staff turnover	.630	.537	.733	.475	1.003	.332	.236	.818	.346	.736	0.000	1.000
sickness absence	.188	.853	.876	.395	.184	.857	.597	.563	0.000	1.000	-.590	.572
Motivation and Incentives	.654	.521	.284	.781	.976	.345	-.202	.844	.369	.719	.459	.659
HR training and development	-.081	.936	.663	.518	1.438	.171	.572	.579	1.175	.265	.525	.614
Client Satisfaction	-.352	.729	-.355	.728	.292	.774	.048	.962	.393	.702	.426	.681
Percentage of Repeat Customers	.809	.429	.315	.757	.743	.469	-.446	.664	0.000	1.000	.535	.608
subcontractor performance	.321	.752	1.233	.236	1.233	.236	.553	.591	.553	.591	0.000	1.000
Number and severity of disputes and conflicts	-.713	.485	.193	.849	1.738	.103	.617	.550	1.656	.126	1.109	.299
End-user Satisfaction	.875	.393	-1.120	.280	.782	.447	-1.062	.311	-.104	.919	1.134	.290
Regulatory compliance	.243	.811	.315	.757	.743	.469	.116	.910	.531	.606	.343	.740

* Significant at 0.05 level

4.4.2 One-Way ANOVA Test

This test is done to find out if there is any difference in the position of the respondent that participated in the questionnaire survey. This test is usually used if there is more than one group belonging to one variable. It is similar to this particular study as the groups of Directors, project manager, civil engineers, construction manager and quantity surveyor are related to one variable which is position. The average weighted factors resulted from the ranking of the sub-factors affecting quality are used in this test.

The research question:

Does the job title of the respondent affect the ranking of the performance indicators?

The research hypothesis:

There is a no significant difference in perception between the Director, construction manager, project manager, civil engineer and quantity surveyor towards ranking the performance indicators.

The null hypothesis:

There is a significant difference between the Director, construction manager, project manager, civil engineer and quantity surveyor towards ranking the performance indicators.

Statement of hypothesis testing:

Table (36)
One-Way ANOVA Results for the Main Categories

		Sum of Squares	df	Mean Square	F	Sig.
Time	Between Groups	.502	4	.125	.384	.818
	Within Groups	8.165	25	.327		
	Total	8.667	29			
Cost	Between Groups	.558	4	.140	.252	.906
	Within Groups	13.827	25	.553		
	Total	14.385	29			
Quality	Between Groups	1.542	4	.386	.381	.820
	Within Groups	25.332	25	1.013		
	Total	26.874	29			
Planning	Between Groups	1.504	4	.376	.564	.691
	Within Groups	16.659	25	.666		
	Total	18.163	29			
Health Safety	Between Groups	5.139	4	1.285	1.528	.225
	Within Groups	21.024	25	.841		
	Total	26.163	29			
Environment	Between Groups	5.346	4	1.336	1.263	.311
	Within Groups	26.451	25	1.058		
	Total	31.796	29			
Financial	Between Groups	.412	4	.103	.518	.723
	Within Groups	4.968	25	.199		
	Total	5.380	29			
Inter Business	Between Groups	.713	4	.178	.364	.832
	Within Groups	12.242	25	.490		
	Total	12.955	29			
Productivity	Between Groups	.483	4	.121	.225	.922
	Within Groups	13.429	25	.537		
	Total	13.911	29			
Int Stakeholders	Between Groups	2.811	4	.703	1.055	.399
	Within Groups	16.661	25	.666		
	Total	19.472	29			
Ext Stakeholders	Between Groups	1.209	4	.302	.591	.672
	Within Groups	12.795	25	.512		
	Total	14.005	29			

The results obtained in the Table (36) shows that the p-value is greater than 0.05 among all the factors, which specifies that there is no significant difference among the means of the ranking obtained for four groups namely manager, deputy manager, project engineer and site engineer. The result also states that the hypothesis can be accepted. The result seems that there is an overall agreement regarding the performance factors among all the groups. It also signifies that the position of the respondent does not affect their attitude in the ranking of the performance factors. It can also be attributed that all of the four groups have the similar experience in the construction process.

Table (37)
One-Way ANOVA Results for Individual PIs

		Sum of Squares	df	Mean Square	F	Sig.
Cost Rate	Between Groups	2.795	4	.699	1.472	.241
	Within Groups	11.871	25	.475		
	Total	14.667	29			
Cost Var	Between Groups	2.095	4	.524	1.340	.283
	Within Groups	9.771	25	.391		
	Total	11.867	29			
Defects Cost	Between Groups	2.329	4	.582	.471	.756
	Within Groups	30.871	25	1.235		
	Total	33.200	29			
Time Var	Between Groups	.824	4	.206	.309	.869
	Within Groups	16.643	25	.666		
	Total	17.467	29			
Overtime Rate	Between Groups	4.343	4	1.086	2.111	.109
	Within Groups	12.857	25	.514		
	Total	17.200	29			
Rectidefects Time	Between Groups	3.581	4	.895	.638	.640
	Within Groups	35.086	25	1.403		
	Total	38.667	29			

Defect Freq	Between Groups	4.138	4	1.035	.950	.452
	Within Groups	27.229	25	1.089		
	Total	31.367	29			
Field Rework	Between Groups	1.214	4	.304	.190	.941
	Within Groups	39.986	25	1.599		
	Total	41.200	29			
Quality at End	Between Groups	1.986	4	.496	.358	.836
	Within Groups	34.714	25	1.389		
	Total	36.700	29			
Predi Cost	Between Groups	1.081	4	.270	.257	.903
	Within Groups	26.286	25	1.051		
	Total	27.367	29			
Predi Time	Between Groups	3.224	4	.806	.910	.473
	Within Groups	22.143	25	.886		
	Total	25.367	29			
Change Cost Factor	Between Groups	1.557	4	.389	.552	.700
	Within Groups	17.643	25	.706		
	Total	19.200	29			
Accident Freq	Between Groups	8.738	4	2.185	1.414	.258
	Within Groups	38.629	25	1.545		
	Total	47.367	29			
Safety Cost Ratio	Between Groups	5.786	4	1.446	1.112	.373
	Within Groups	32.514	25	1.301		
	Total	38.300	29			
Safety Perf	Between Group s	6.024	4	1.506	1.579	.211
	Within Groups	23.843	25	.954		
	Total	29.867	29			
Waste Rate	Between Groups	10.010	4	2.502	2.287	.088
	Within Groups	27.357	25	1.094		
	Total	37.367	29			
Environment impact	Between Groups	4.038	4	1.010	.556	.697
	Within Groups	45.429	25	1.817		
	Total	49.467	29			
Energy Use	Between Groups	7.310	4	1.827	1.185	.342
	Within Groups	38.557	25	1.542		
	Total	45.867	29			
Profitability	Between Groups	1.629	4	.407	.857	.503
	Within Groups	11.871	25	.475		
	Total	13.500	29			
Growth	Between Groups	2.214	4	.554	.745	.571
	Within Groups	18.586	25	.743		
	Total	20.800	29			

Fin Stability	Between Groups	2.010	4	.502	.992	.430
	Within Groups	12.657	25	.506		
	Total	14.667	29			
Cash Flow	Between Groups	1.181	4	.295	.986	.433
	Within Groups	7.486	25	.299		
	Total	8.667	29			
Capital	Between Groups	2.714	4	.679	1.415	.258
	Within Groups	11.986	25	.479		
	Total	14.700	29			
Interest Covr	Between Groups	1.714	4	.429	.966	.443
	Within Groups	11.086	25	.443		
	Total	12.800	29			
Return On Inves	Between Groups	.752	4	.188	.281	.887
	Within Groups	16.714	25	.669		
	Total	17.467	29			
Out Money	Between Groups	3.395	4	.849	1.130	.365
	Within Groups	18.771	25	.751		
	Total	22.167	29			
Busi Efficiency	Between Groups	.471	4	.118	.162	.956
	Within Groups	18.229	25	.729		
	Total	18.700	29			
Tenders Rate	Between Groups	2.495	4	.624	.682	.611
	Within Groups	22.871	25	.915		
	Total	25.367	29			
Market Share	Between Groups	.643	4	.161	.381	.820
	Within Groups	10.557	25	.422		
	Total	11.200	29			
Innovation	Between Groups	1.152	4	.288	.218	.926
	Within Groups	33.014	25	1.321		
	Total	34.167	29			
Resource MGT	Between Groups	1.381	4	.345	.337	.850
	Within Groups	25.586	25	1.023		
	Total	26.967	29			
Num of Pro	Between Groups	2.257	4	.564	.456	.767
	Within Groups	30.943	25	1.238		
	Total	33.200	29			
Techno Capability	Between Groups	4.510	4	1.127	1.078	.389
	Within Groups	26.157	25	1.046		
	Total	30.667	29			
MGT Product	Between Groups	2.786	4	.696	.613	.657
	Within Groups	28.414	25	1.137		
	Total	31.200	29			

LAB Product	Between Groups	1.571	4	.393	.465	.761
	Within Groups	21.129	25	.845		
	Total	22.700	29			
Rate of Subcon	Between Groups	2.186	4	.546	.827	.520
	Within Groups	16.514	25	.661		
	Total	18.700	29			
Empl Satisfaction	Between Groups	3.538	4	.885	.662	.625
	Within Groups	33.429	25	1.337		
	Total	36.967	29			
Staff Turnover	Between Groups	4.095	4	1.024	.939	.458
	Within Groups	27.271	25	1.091		
	Total	31.367	29			
Absence	Between Groups	4.181	4	1.045	1.147	.358
	Within Groups	22.786	25	.911		
	Total	26.967	29			
Motivations	Between Groups	8.052	4	2.013	1.628	.198
	Within Groups	30.914	25	1.237		
	Total	38.967	29			
HR training	Between Groups	3.343	4	.836	.617	.654
	Within Groups	33.857	25	1.354		
	Total	37.200	29			
Client Satisfaction	Between Groups	1.810	4	.452	.828	.520
	Within Groups	13.657	25	.546		
	Total	15.467	29			
Repeat Custom	Between Groups	.510	4	.127	.180	.946
	Within Groups	17.657	25	.706		
	Total	18.167	29			
Subcon Performance	Between Groups	3.810	4	.952	1.483	.237
	Within Groups	16.057	25	.642		
	Total	19.867	29			
Disputes	Between Groups	1.210	4	.302	.198	.937
	Within Groups	38.157	25	1.526		
	Total	39.367	29			
User Satisfaction	Between Groups	1.214	4	.304	.345	.845
	Within Groups	21.986	25	.879		
	Total	23.200	29			
Regul Compli	Between Groups	4.281	4	1.070	2.045	.119
	Within Groups	13.086	25	.523		
	Total	17.367	29			

The above mentioned resonate with the results of Toor and Ogunlana (2010) who ascertained that the perception of all the KPIs do not differ among the several construction stakeholders. This finding was reasonable due to the involvement of the vested interests of several stakeholders in the project. The ranking of the KPIs in this particular study illustrates that the KPIs perceived as highly significant consists of on-time completion, quality control, cost and safety. The findings also strengthened the fact that the project performance must be measured beyond its “on-time” and “under budget” completion. It can also be suggested that with the application of the groups rather than the individual indicators demonstrates an easier approach for the employment of KPIs for the purpose of performance measurement as well as benchmarking, this is particularly true for the companies with minimal or no experience in practicing benchmarking.

Chapter 5

Model Development

5.1 Extraction Criteria for the proposed Framework

5.2 Weighting Methods

5.3 KPI Targets

5.4 Validating the Measurement Framework

Chapter 5

Model Development

Fellows and Liu (2015) stated that a model is the symbolic or physical representation of the relevant aspects of the system of the organization or the reality. It is the source of exhibiting the reality of the concern or the system to the decision makers.

According to Franceschini *et al.* (2007), to model a process is to describe it, to consider the objectives that has to be met. this process starts with turning the expectations of clients and customers into firm targets, and the targets successively are turned into operative responses. They further indicated that a suitable PMS has to be established to investigate whether responses are in line with requirements. The literature presents a variety of methods for the purpose of examining and aggregating performance measures. This representation is essential for analysing the process and effectively controlling it. In other words, the right choice of indicators will determine how successful their put to represent the process.

5.1 Extraction Criteria for the proposed Framework

Alarcón *et al.* (2001) noted that the variables that are to be applied for the project implementation have to be shortlisted to the essential ones. Likewise, it was also suggested that the variables that are applied in the construction project management must be focused upon the most critical aspects of output. It should also be limited and managed in number and it

must be maintained for the regular use. With regards to this, a one sample t-test is used to identify whether the sample mean is significantly unexpected from a hypothesized mean (Ahadzie, 2007).

5.1.1 One Sample T-test for Ranking Dependent Variables

The one sample t-test is commonly employed to determine whether the tested mean is significantly deviant from the hypothesized mean. In this study, the value of μ is fixed at '3.42', which again represent the critical rating specified by the null hypothesis. The reason for this is that ratings above 4 as noted by Budawara (2009) represent "important" the attributes according to the scale. The details of this fact have been represented in the below mentioned Table (38).

Table (38)
“Likert weighted ranking”

Mean value range	Rank	Interpretation of rank
1.00 - 1.80	1	Not Important
1.81 - 2.61	2	Low Important
2.61 - 3.41	3	Moderately Important
3.42 - 4.21	4	High Important
4.22 - 5.00	5	Extremely Important

If the observed t value (t_0) of the mean ratings by the respondents' is greater than the critical value (t_c) and $t_{(31-1,.05)} = 1.697$ at 95% confidence level, then the null hypothesis (H_0) is rejected and the alternative hypothesis has been accepted.

$$t_o = \frac{\bar{x} - \mu}{S/\sqrt{n}} \quad (3)$$

$$t_c = t_{(n-1, \alpha)} \quad (4)$$

$$t_o > t_c \quad (5)$$

The T-test have been performed with the use of SPSS 20 package (by checking whether $t_o > t_c$, where t_c equals 1.697) to check the confidence level. The results have been displayed in Table (39) where the shaded areas represent unqualified indicators. In the table, the df column presents the degrees of freedom. The mean difference is gained through the subtractions of the critical rating (μ value = 3.42) from the individual sample means.

Table (39)
One-Sample T-test to extract significant variables

Test Value = 3.42								
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval		Relative Weight	Rank
					Lower	Upper		
Client Satisfaction	10.032	29	0	1.147	0.91	1.38	0.907	1
Profitability (company)	8.67	29	0	1.08	0.83	1.33	0.9	2
End-user Satisfaction	8.413	29	0	1.047	0.79	1.3	0.88	3
Cash flow	9.151	29	0	0.913	0.71	1.12	0.867	4
Cost Rate	7.034	29	0	0.913	0.65	1.18	0.867	5
Financial stability	7.034	29	0	0.913	0.65	1.18	0.867	6
Regulatory compliance	5.757	29	0	0.813	0.52	1.1	0.847	7
Growth	5.045	29	0	0.78	0.46	1.1	0.84	8
Percentage of Repeat Customers	5.167	29	0	0.747	0.45	1.04	0.833	9
Outstanding Money (project)	5.613	29	0	0.78	0.5	1.06	0.833	10
Construction time variance	4.908	29	0	0.68	0.4	0.96	0.827	11
Capital	5.231	29	0	0.68	0.41	0.95	0.82	12

Test Value = 3.42								
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval		Relative Weight	Rank
					Lower	Upper		
Business efficiency	4.638	29	0	0.68	0.38	0.98	0.82	13
Labour Productivity	4.21	29	0	0.68	0.35	1.01	0.82	14
Construction cost variance	5.537	29	0	0.647	0.41	0.89	0.813	15
subcontractor performance	4.279	29	0	0.647	0.34	0.96	0.813	16
Safety Performance	4.036	29	0	0.68	0.34	1.02	0.813	17
Resource management	4.513	29	0	0.647	0.35	0.94	0.793	18
Rate of Subcontracting	3.274	29	0.003	0.48	0.18	0.78	0.78	19
Quality Issues at End of Defect Rectification Period	3.951	29	0	0.613	0.3	0.93	0.78	20
Return on Investment (client)	3.152	29	0.004	0.447	0.16	0.74	0.773	21
Interest Cover (company)	3.133	29	0.004	0.38	0.13	0.63	0.76	22
Predictability Cost	2.347	29	0.026	0.38	0.05	0.71	0.753	23
Predictability Time	2.458	29	0.02	0.38	0.06	0.7	0.753	24
Frequency of Accident	1.973	29	0.058	0.413	-0.02	0.84	0.753	25
employee satisfaction	1.035	29	0.309	0.213	-0.21	0.63	0.727	26
Change Cost Factor	1.627	29	0.115	0.213	-0.05	0.48	0.72	27
Cost to rectify defects	1.169	29	0.252	0.213	-0.16	0.59	0.72	28
Management Productivity	1.528	29	0.137	0.247	-0.08	0.58	0.72	29
Total Field Rework	1.751	29	0.091	0.313	-0.05	0.68	0.72	30
Defect Frequency	1.528	29	0.137	0.247	-0.08	0.58	0.713	31
Successful tenders rate	1.183	29	0.246	0.147	-0.11	0.4	0.687	32
staff turnover	0.07	29	0.945	0.013	-0.38	0.4	0.687	33
Construction Waste Rate	0.064	29	0.949	0.013	-0.41	0.44	0.687	34
Number and severity of disputes and conflicts	0.063	29	0.95	0.013	-0.42	0.45	0.687	35
Market share	-0.176	29	0.861	-0.02	-0.25	0.21	0.68	36
Overtime Work Rate	-0.142	29	0.888	-0.02	-0.31	0.27	0.68	37
Number of high-performance professionals within	0.273	29	0.787	0.047	-0.3	0.4	0.68	38

Test Value = 3.42								
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval		Relative Weight	Rank
					Lower	Upper		
Human resource training and development	-0.097	29	0.924	-0.02	-0.44	0.4	0.68	39
Motivation and Incentives	-0.252	29	0.803	-0.053	-0.49	0.38	0.673	40
Technological capability	-0.462	29	0.648	-0.087	-0.47	0.3	0.667	41
Time to rectify defects	-0.411	29	0.684	-0.087	-0.52	0.34	0.667	42
Safety Cost Ratio	-0.434	29	0.667	-0.087	-0.49	0.32	0.66	43
Energy use	-0.668	29	0.51	-0.153	-0.62	0.32	0.653	44
Innovation	-1.278	29	0.211	-0.253	-0.66	0.15	0.633	45
Impact on the Environment	-1.202	29	0.239	-0.287	-0.77	0.2	0.627	46
sickness absence	-2.575	29	0.015	-0.453	-0.81	-0.09	0.593	47

So as to reflect their priority, weights of the indicator are calculated based on the questionnaire survey according to the following formula:

$$RW_i = \frac{\overline{M}_i}{\sum M} \quad (6)$$

In Table (39), the rankings of the 47 nominated KPIs are portrayed in descending order. The research disclosed that the top rated KPIs were centered around two perspectives which are External Stakeholders and financial alternately. Such results are highly consistent with the results of Ali *et al.* (2013) who conducted his study on Saudi firms in neighboring country with conditions that very much resembles the Bahraini construction environment. Compared to other studies, the research revealed that there are two measures that are alternately vies for precedence, the first is Client satisfaction as in this study and the studies of

both (Jastaniah, 1997; Roberts & Latorre, 2009), the second measure is profitability which was ranked 1st in each of (Ali *et al.*, 2013; Wadugodapitiya *et al.*, 2010; Wang *et al.*, 2010; Yu *et al.*, 2007). The findings in these studies showed that construction companies came to the realization that traditional measures which focus only on financial aspects are no longer the sole measure of company performance. The gap in the traditional measures triggered the interest for non-financial measures, including Client satisfaction, Health & Safety and end-user satisfaction.

The reliance on the financial perspective by construction professionals was seen through the high means four financial measures received namely profitability, cash flow, Financial stability and growth which reserved the 2nd, 4th, 6th and 8th ranks in the list as they are the results of improvements in the cost, quality, time, productivity and safety. The financial performance indicators according to Kaplan and Norton (1995) helped the executives of construction companies to determine the accurate actions that are to be taken by their employees and adopt particular measures to see whether the employees have taken those actions or not.

Several construction organizations nowadays embrace a corporate mission which targets the customer. The way an organization performs from the perspective of its customers has grown to become, a priority for executives and decision makers. The results signified contractor's emphasis on the stakeholder's perspective where the three indicators namely client satisfaction, end-user satisfaction and Regulatory compliance was ranked 1st, 3rd and 7th respectively, this shows that

organizations are becoming more aware of the importance of their well-established image through the eyes of their customers.

Focusing on the project traditional measures namely Cost, time, and quality, these attributes necessarily interact. It is unanimously agreed in construction practice as well as in the literature body that the success of a project is dependent upon the efficiency to control Trade-offs occurring in the process of optimizing the outcomes for any of these KPIs (Langston, 2012). For instance, improving quality specifications will require additional time to handover, speeding up project completion will most likely entail further cost, and lowering cost will have a tendency to reduce quality. This went in line with the findings of Al-Sehali (2001) stating that in Bahrain projects are awarded according to the lowest bids as the predominant competitive condition jeopardizing quality outcomes which was clearly reflected by respondents through the lower rating of quality measures that was rated the 20th as opposed to Cost and Time measures which were ranked 7th and 11th respectively.

The excellence of the company performance can be determined from the actions, processes, leadership, resources and its people. The managers are also suggested to emphasize on the internal operations such as resource management, technological capability, market share and business efficiency for the satisfaction of the customer needs. The results indicated that within the internal business perspective respondents had shown interest to two measures only which are business efficiency that was ranked 13th, and resource management which came 18th in the order. operational capability is regarded as the major determinant to gain competitive

advantage in the construction field. The adoption of technology as Masrom (2012) declared entails investing extra money which in turn might put extra burden on their overall budget. As a result, this will likely raise the expense and decrease profits.

With the huge development and increased complexity in construction industry, safety has become one of the serious issues in the construction companies as the injury caused to the workers lead to huge loss. Safety was ranked 16th among the 47 indicators by respondents. If the construction project does not provide safe working conditions to its workers, it cannot be said that the project is successful.

Furthermore, it was also stated that it is not enough to focus only on the above-mentioned factors but it is also equally important to look after the issues related with productivity and planning efficiency. The respondents felt that labor productivity was rather a competitive factor, labor productivity was ranked 14th among the list. according to Doloï and Jin (2008) Employee output is one of the most significant driver guiding to organizational success. The labor dependent nature of the construction sector made relies quite heavily on its labor force in order to stay profitable and competitive.

Within the context of the BSC, financial measures are complemented with operational indicators on internal business, customer satisfaction, organization innovation and employee improvement. which are the drivers of a remarkable organizational performance. The findings unveiled that measures categorized under internal stakeholder's perspective and innovation measure received less importance by respondents. While it is

argued that in the field of construction industry innovation is rather difficult to be achieved. innovation in the construction industries can lead to the reduced cost and increased efficiency from the internal business. However, the construction industries have to depend on the other companies for innovation such as the development of newer materials, processes and methods of construction. Some of the common innovations in the construction industries are development of financing methods, alternative structures of the corporate (Zhigang Jin *et al.*, 2013).

similarly, results concerning the internal stakeholder's perspective were alarming and not consistent with the results observed in the literature (See for example, Deng *et al.*, 2012; Nudurupati *et al.*, 2007; Rustum, 2002) as none of the indicators belonging to this perspective was regarded as important to the respondents. Employees are considered to be the social capital of the organization and a great contributor to its success. when people within the company feels appreciated they tend to be more creative and productive. Thus, encouraging a team work environment and build trust relationship with the managers (Işık, 2009).

Another interesting result was revealed by the questionnaire was although managers and other professional who took part in the survey were keen about the idea of performance measurement, management productivity was not among their nominated indicators. In their study on the application of PMS in the construction industry, A. Neely *et al.* (2000) stated that a major barrier behind the limited use of such systems in construction was the weak commitment of senior managers. In consistence with their findings, Mäkilä (2014) declared that performance measures

might be perceived threatening by some managers. Due to the fact that performance systems enhance visibility of actions. They might believe that improvements will lead them to lower their authority and lose their hierarchical positions.

Furthermore, Construction Waste Rate, impact on the environment, and Energy use as indicators belonging to the environment category are among the lowest ranked among the 47 indicators. Comparing with the findings of other research's in various regions, environment indicators achieved decent rates. However, in this study as in many developing countries the idea of environmental friendliness still has to go a long way to be considered as potential success factor (Ahadzie *et al.*, 2008).

To conclude with, the major findings of this study were that out of the 47 indicators aggregated from the literature 26 performance indicators are the most important indicators which can be used to assess the construction company's performance and also be considered as the basis for benchmarking. Table (40) shows the final indicators with a proposed performance measures that can be used for each KPI.

Table (40) Selected indicators for Building Construction Performance model

Level	Perspective	No.	Key Performance Indicator	Source	Measurement Method
Company Level	Financial	A1	Profitability	(Yu <i>et al.</i> , 2007)	Profitability = Profit before tax and interest/Total revenues
		A2	Financial Stability	(Yu <i>et al.</i> , 2007)	Debt Ratio = Total debt/Total assets
		A3	Cash Flow	(Ali <i>et al.</i> , 2013)	Cash flow generated from operations / Current liabilities Cash flow from operations / Net income Cash flow from operations + fixed cost / Fixed cost Current assets / Current liabilities
		A4	Capital	(ZG Jin & Deng, 2012)	(Revenue year _n – Revenue year _{n-1}) / Revenue year _n
		A5	Growth		
		A6	Outstanding Money	(KPI Working Group, 2000)	Amount of the total final account outstanding at Available for Use (point C) and at End of the Contractually Agreed Period for Rectifying Defects (point D) expressed as a percentage of the total final account at Available for Use (point C).
		A7	Return on investment	(KPI Working Group, 2000)	earnings before interest and tax/Total capital employed ×100
		A8	Interest Cover	(KPI Working Group, 2000)	Company profit (before interest and tax) expressed as a percentage of interest payable.
	Internal Business	B1	Business efficiency	(Yu <i>et al.</i> , 2007)	Efficiency Ratio = Expenses / Revenue
		B2	Resource Management	(Kim & Huynh, 2008)	five-point Liker-type mark (from 1 = “very bad performance” to 5 = “very good performance”)
	Productivity	C1	Labor Productivity	(Cha & Kim, 2011)	Budgeted Cost Direct Hours / Cost Real Direct Hours Labour Productivity = Revenue/Labour Work Hour
		C2	Rate of subcontracting	(Ramirez <i>et al.</i> , 2003)	Amount Sub-contracted / Sale Final Contract

Level	Perspective	No.	Key Performance Indicator	Source	Measurement Method
Project Level	Cost	D1	Cost Rate	(Cha & Kim, 2011)	Expense/Revenue
		D2	Construction Cost Variance	(Cha & Kim, 2011)	(Actual total cost – Initial predicted cost/ Initial predicted cost) x 100
	Time	E1	Construction time variance	(Cha & Kim, 2011)	(Actual total time – Initial predicted time/ Initial predicted time) x 100
		Quality	F1	Quality issues at end of D.L.P.	(D. W. Chan & Chan, 2012)
	F2		Total Field Rework	(Marković <i>et al.</i> , 2011)	Total Direct Cost of Field Rework/Actual Construction Phase Cost
	Planning	G1	Cost Predictability	(KPI Working Group, 2000)	(Revenue-Planned Revenue) /Planned Revenue
		G2	Time Predictability	(KPI Working Group, 2000)	(Performed Schedule-Planned Schedule)/Planned Schedule x100
	Health & Safety	H1	Safety Performance	(Costa <i>et al.</i> , 2004)	(Number of items complied in the checklist / Total number of applicable items form the checklist) x 10
		H2	Frequency of Accident	(Cha & Kim, 2011)	Number of Accident*200,000/Total Work Hour
	Stakeholders Level	External Stakeholders	I1	Client Satisfaction	(KPI Working Group, 2000)
I2			End-user Satisfaction	1 to 10 score	10-point Likert-type mark (from 1 = “extremely dissatisfied” to 10 = “extremely satisfied”)
I3			Sub-contractors Performance	(Alarcón <i>et al.</i> , 2001)	Subcontracted Costs / Total Project Cost
I4			Percentage of repeated customers	(El-Mashaleh <i>et al.</i> , 2007)	Number of repeated customers/Total number of customers
I5			Regulatory Compliance	(El-Mashaleh <i>et al.</i> , 2007)	Number of Regulations Non-Conformities

5.2 Weighting Methods

Numerous techniques for determining the relative weights for the selected criteria in the model have been discussed in literature. Statistical methods, including regression analysis among other descriptive statistics are utilized for this matter. For instance, Rustum (2002) used Factor analysis and multiple regression to predict the quality performance of construction projects Gaza. Although statistical tools such as multiple regression has a strong theoretical basis, and capable of providing substantial data interpretation, a serious limitation is that it merely analyze a single output each time and the regression analysis has to be repeated as frequently as the total number of criteria (Yang *et al.*, 2010), another limitation stated by Ofori-Kuragu and Baiden (2008), is that for using multiple regression, the required sample size has to be between 200 and 500 in order to achieve a rigorous analysis.

The other technique which received a significant interest in the literature is Multiple Criteria Decision analysis. The reason behind favoring such methods is the advantage of being easily applicable, combining both quantitative as well as qualitative data. Among the (MCDA) methods, analytical Hierarchy Process is by far the most frequently used tool (Yildiz *et al.*, 2011).

The employment of the AHP method explicitly acknowledges and incorporates the expertise of the participants within the priority allocation process, by utilizing their subjective judgments (Forss, 2013), In the study of Budawara (2009), it was studied that AHP can be used for the

measurement of the priorities of the design performance indicators that have been selected for the purpose of heavy construction projects.

The researcher decided to use the AHP as an analysis tool for this study because through pair-wise relative comparison it allows to assign relative weights in a very practical and logical way. Moreover, with the availability of computer software's that perform the calculation process, a maximized internal consistency of the designed model could be achieved.

5.2.1 Analytical Hierarchy Process (AHP)

The Analytic Hierarchy Process was initially developed by Saaty (2008). It is also regarded as one of the most renowned techniques that are widely used in the process of making decisions. The use of AHP in the decision-making process begins from the ability to combine the individual and group preferences and the ability of integrating the stochastic and deterministic so that the model interdependencies can be captured (Ssebuggwawo *et al.*, 2009).

AHP consists of mainly three main steps: 1) Selection of criteria and structuring a decision problem, 2) Assigning the criteria priorities through pairwise comparison (weighing), 3) Obtaining an overall relative score for each option (Saaty, 2007). These procedures are carried out as follows.

Model Hierarchical Structure

This stage entails developing the AHP hierarchy structure and determining the weights in each level. The established AHP model, based on the levels of measurement, proposed perspectives within each level and

selected performance indicators forms a four-level structure that would be the basis of the comparison process see Figure (13). The levels are as follows:

- Level (1) - Goal: is to assess the performance of for building construction organizations in Bahrain.
- Level (2) - Criteria: composed from three main criteria: Project Context; Company Context and Stakeholders Context.
- Level (3) - Sub Criteria: Each of the three context is further splitted into a number of perspectives.
- Level (4) - Sub Sub Criteria: within each perspective there are a list of nominated KPIs.

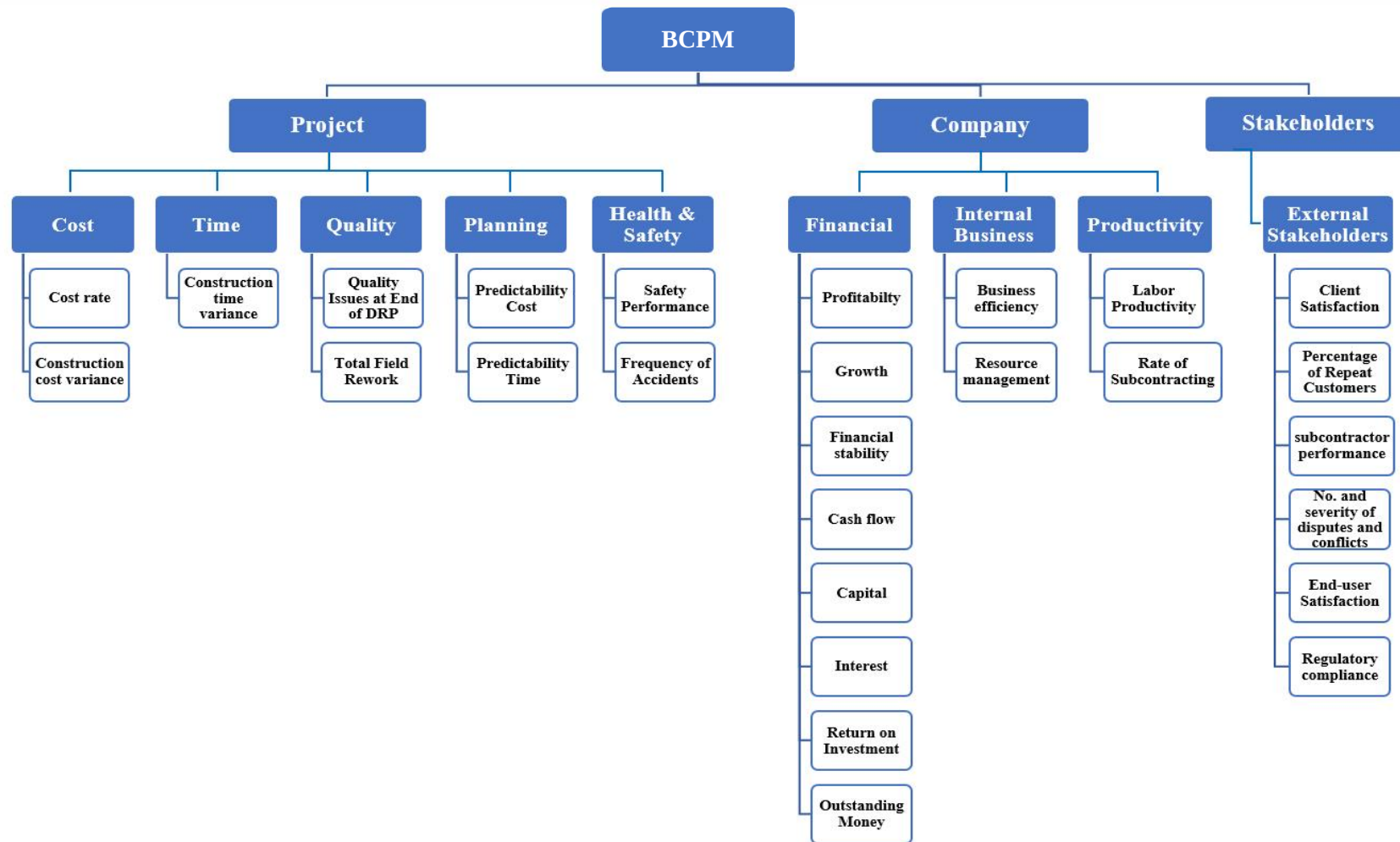


Figure (13)
Hierarchical structure of the BCPM main categories and their sub-categories

Assigning Performance Indicator Intensities

Given that the questionnaire results in this study received high levels of reliability and validity, the relative importance score were rendered as a basis for setting priorities between the different criteria in the AHP session. Both (Bassioni *et al.*, 2008; Yang *et al.*, 2010) supported this approach by stating that indicators and their weightings can be obtained through empirical questionnaire surveys, and the importance rating of each criterion. this method reduces the level of subjectivity, and reflects the actual preferences of the participants which eventually helps to reach a consensus about model.

The difference in ranking between the performance indicators is to be reflected with the intensity scale developed by Saaty (2008) as presented in Table (41).

Table (41)
Scale of relative importance for pair-wise comparison (Saaty, 2008)

Intensity	Definition
1	Equal importance
3	Moderate importance
5	Essential or strong importance
7	Demonstrated importance
9	Extreme importance
2,4,6,8	Intermediate Values

Matrix of Comparisons

The two groups of matrix calculation as well as performance data analysis are performed by the mathematical computation software

BPMMSG-AHP Online System that is customized for multi-criteria decision analysis problems. it is a free AHP software developed by Goepel (2014). The program application features custom decision matrix, priorities, and most importantly provide consistency ratios immediately and interactively which helps to achieve more consistent results.

To illustrate, assuming that the relative weight for the project level is required, since it consist of five indicators a 5x5 matrix is formulated and each sub-criterion is pair-wise compared against the rest of the group in its strength of influence. The comparison matrix needs to be filled in the upper half only since the remaining values are reciprocals of their corresponding match above the main diagonal as presented in Table (42).

Table (42)
Pair-wise comparison matrix for project level criteria

	Time	Cost	Quality	Planning	H&S
Time	1	1/3	2	2	2
Cost	3	1	4	4	4
Quality	1/2	1/4	1	2	1/2
Planning	1/2	1/4	1/2	1	1/2
H&S	1/2	1/4	2	2	1
Total Sum	5.5	2.083	9.5	11	8

The following step is computing the "principal vector" by summing the elements in each column to find the total. Then, each element in a particular column are divided by the principal vector within the same column, this procedure is called normalization. So, for the first column, each cell is going to be divided by $(1+3+0.5+0.5+0.5) = 5.5$. Therefore, the new values of the first column shall be $(1/5.5) = 0.182$, $(3/5.5) = 0.545$, $(0.5/5.5) = 0.091$, $(0.5/5.5) = 0.091$ and $(0.5/5.5) = 0.091$. Values in the

remaining columns are acquired in a similar manner. The resulted normalized matrix is presented in Table (43).

Table (43)
“Normalized matrix of paired comparisons”

	Time	Cost	Quality	Planning	H&S
Time	$1/5.5 = 0.182$	0.160	0.211	0.182	0.250
Cost	$3/5.5 = 0.545$	0.480	0.421	0.364	0.500
Quality	$0.5/5.5 = 0.091$	0.120	0.105	0.182	0.063
Planning	$0.5/5.5 = 0.091$	0.120	0.053	0.091	0.063
H&S	$0.5/5.5 = 0.091$	0.120	0.211	0.182	0.125

Lastly, the elements in each row are added together and the sum divided by the total number of elements to get the average. The resulted value acquired is the relative weight for the criteria represented by that row. Reflecting this on the first row, the relative weight is $(0.182+0.160+0.211+0.182+0.250)/5 = 0.1987$. the same calculation is repeated to get the weights for the remaining elements. Table (44) show the final result.

Table (44)
Relative weights for project level criteria

Levels	Time	Cost	Quality	Planning	H&S
Relative weights	0.199	0.466	0.109	0.082	0.144

Consistency Ratio

The inconsistency ratio according to Saaty (2007) is for determining the priority weighting level of acceptance based on Maximum Eigenvalue, which can be acquired by summing the product of each element in the Eigenvector Table (44) by the total of the respective column of the initial matrix Table

(42). the calculation of Maximum Eigenvalue (λ_{Max}) is demonstrated in Table (45).

Table (45)
Calculating the Maximum Eigenvalue

Eigenvector	0.1987	0.4661	0.1089	0.0824	0.1440
Total (Sum)	5.5	2.083	9.5	11.00	8.00
Maximum Eigenvalue (λ_{Max})	[(0.1987x 5.5) +(0.4661x 2.083) +(0.1089x 9.5) +(0.0824x 11) +(0.144x 8)] = 5.156				

$$CI = \frac{\lambda_{Max} - n}{n - 1} \quad (7)$$

CI refer to the Consistency Index, λ_{Max} is the Maximum Eigenvalue and n is the number of criteria in the matrix.

For the project level criteria, the Consistency Index (CI) is

$$CI = \frac{\lambda_{Max} - n}{n - 1} = \frac{5.156 - 5}{5 - 1} = 0.039$$

As a way to confirm whether the Consistency Index (CI) is sufficient, Saaty (2007) recommends a Consistency Rate (CR), which can be determined by the dividing the Consistency Index by the Random Consistency Index (RI). The matrix will be deemed consistent if the ratio is below 10%.

The formula for calculating of the Consistency Index is as follows:

$$CR = \frac{CI}{RI} < 0.1 \sim 10\%$$

The RI value is fixed value and depends on how many criteria being evaluated, as demonstrated in Table (46).

Table (46)
Random Consistency Indices Table (RI) (Saaty, 2008)

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Thus, the consistency ration for project level criteria is:

$$CR = \frac{0.039}{1.12} = 0.0348 \approx 3.5 \%$$

Considering that the (CR) value is under 10%, the matrix can be regarded as consistent.

Figure (14) shows the result of the previous comparison, the eigenvalue, consistency ratio (CR), the relative weights and ranking performed in Goepel (2014) AHP Tool which follows the same principles and thus will be used for calculating the other matrices, Results can be reviewed in Appendix C.

With respect to **Project Level**, which criterion is more important, and how much more on a scale 1 to 9 for Performance Measurement Index (PMI)?

A - wrt Project Level - or B?			Equal	How much more?
1	☐ Time	or ☒ Cost	☐ 1	☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
2	☒ Time	or ☐ Quality	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
3	☒ Time	or ☐ Planning	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
4	☒ Time	or ☐ Health & Safety	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
5	☒ Cost	or ☐ Quality	☐ 1	☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
6	☒ Cost	or ☐ Planning	☐ 1	☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
7	☒ Cost	or ☐ Health & Safety	☐ 1	☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
8	☒ Quality	or ☐ Planning	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
9	☐ Quality	or ☒ Health & Safety	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
10	☐ Planning	or ☒ Health & Safety	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

CR = 3.5% OK

☒ AHP
 ☐ Balanced scale

Resulting Priorities

Category	Priority	Rank
1 Time	19.9%	2
2 Cost	46.6%	1
3 Quality	10.9%	4
4 Planning	8.2%	5
5 Health & Safety	14.4%	3

Figure (14)
Pair-wise comparison matrix for project level criteria

The global priority for each sub-criterion is determined by multiplying each priority on the initial level by its respective priority on the subsequent levels. The final results are depicted on Figure (15), whereas Table (47) present Building Construction performance model.

Decision Hierarchy				
Level 0	Level 1	Level 2	Level 3	Global Priorities
Performance Measurement Index (PMI)	Project Level 0.1958	Time 0.1987		3.9 %
		Cost 0.466	Cost Rate 0.6667	6.1 %
			Construction cost variance 0.3333	3.0 %
		Quality 0.1089	Total Field Rework 0.1429	0.3 %
			Quality Issues at End of Defect Rec 0.8571	1.8 %
		Planning 0.0824	Predictability Cost 0.5	0.8 %
			Predictability Time 0.5	0.8 %
		Health & Safety 0.144	Frequency of Accident 0.25	0.7 %
			Safety Performance 0.75	2.1 %
	Company Level 0.4934	Financial 0.7778	Profitability 0.2509	9.6 %
			Growth 0.1326	5.1 %
			Financial stability 0.1602	6.1 %
			Cash flow 0.1602	6.1 %
			Capital 0.0974	3.7 %
			Interest Cover (company) 0.0454	1.7 %
			Return on Investment (client) 0.0463	1.8 %
			Outstanding Money (project) 0.1069	4.1 %
		Internal Business 0.1111	Business efficiency 0.6667	3.7 %
			Resource management 0.3333	1.8 %
		Productivity 0.1111	Labor Productivity 0.6667	3.7 %
			Rate of Subcontracting 0.3333	1.8 %
	Stakeholders Level 0.3108	Client Satisfaction 0.323		10.0 %
		Percentage of Repeat Customers 0.1376		4.3 %
		subcontractor performance 0.0973		3.0 %
		End-user Satisfaction 0.2604		8.1 %
		Regulatory compliance 0.1816		5.6 %
				1.0

Figure (15)
Composite priority weights for Building Construction performance model

Table (47)
Building Construction performance model

<i>Performance Level</i>	<i>Performance Indicators</i>	<i>Pairwise Score</i>	<i>Global Score %</i>
A. Project Level 19.58%	(1) Cost	0.4660	9.13%
	Cost Rate	0.6667	6.08%
	Construction cost variance	0.3333	3.04%
	(2) Time	0.1987	3.89%
	Construction time variance	1	3.89%
	(3) Quality	0.1089	2.13%
	Quality Issues at End of D.R.P.	0.8571	1.83%
	Total Field Rework	0.1429	0.30%
	(4) Planning	0.0824	1.61%
	Predictability Cost	0.5	0.81%
	Predictability Time	0.5	0.81%
	(5) Health & Safety	0.1440	2.82%
	Safety Performance	0.75	2.11%
	Frequency of Accident	0.25	0.70%
B. Company Level 49.34 %	(1) Financial	0.7778	38.37%
	Profitability (company)	0.2509	9.63%
	Growth	0.1326	5.09%
	Financial stability	0.1602	6.15%
	Cash flow	0.1602	6.15%
	Capital	0.0974	3.74%
	Interest Cover (company)	0.0454	1.74%
	Return on Investment (client)	0.0463	1.78%
	Outstanding Money (project)	0.1069	4.10%
	(2) Internal Business	0.111	5.48%
	Business efficiency	0.6667	3.65%
	Resource management	0.3333	1.83%
	(3) Productivity	0.111	5.48%
	Labour Productivity	0.6667	3.65%
	Rate of Subcontracting	0.3333	1.83%
C. Stakeholders Level 31.08 %	(1) External Stakeholders	1.00	31.08%
	Client Satisfaction	0.3230	10.04%
	Percentage of Repeat Customers	0.1376	4.28%
	subcontractor performance	0.0973	3.02%
	End-user Satisfaction	0.2604	8.10%
	Regulatory compliance	0.1816	5.65%

5.3 KPI Targets

Any kind of business aims to fulfill all of the requirements laid down by the owners and customers. The performance level that is needed to achieve the business objective can be determined from the goodness of its competitors. According to A. Neely *et al.* (1997) There must be an appropriate target for each of the measure, out of which some examples are as follows:

- 15% of improvement after each year
- 20% reduction in the coming one year
- 97% delivery performance to be achieved by the end of next year

The below mentioned figure (4.7) demonstrate the boundary box or the KPI target where the normal preference meets the target of $\pm 10\%$. In the construction projects, urgent attention must be focused if the boundary box reaches target below than that of 20%.

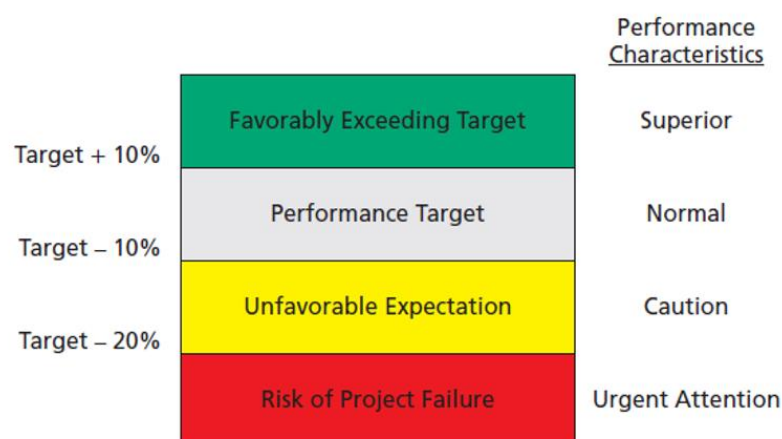


Figure (16)
Boundary box or KPI target (Kerzner, 2011)

In the earlier sections, it was studied that for the successful designing and evaluation of the performance measures, it is very necessary that the targets must be set and the good and bad performance must be differentiated. However, on the other hand, the target setting has witnessed one disadvantage of lack of analysis depth related to the subject. Any controlled system needs to design goals and objectives against which its performance can be determined. These requirements are crucial because the gaps existing between the present states of processes can be identified by the targets along with the determination of the desired performance level and the need for action. In the previous study of Mäkilä (2014), it was found that the target levels have overall effect on the performance management system.

5.4 Validating the Measurement Framework

The process of determining the degree of the accuracy of the framework for the practical implementation is termed as the validation. This external validity also helps in ensuring that if the framework is implemented in the real world under similar conditions, it will yield similar result. Hence, in the public construction projects, the experts' acceptance is regarded as the major determinant of the framework's success. (Fellows & Liu, 2015).

5.4.1 External Validation Analysis

According to Ahadzie (2007) there are four major techniques that can be undertaken for the external validation such as:

1. The use of independent variables through the application of surrogate variables.
2. Splitting the variables for utilizing one part for the model estimation and the other part for validation.
3. Extracting repeated samples from the original one, re-sampling and refilling of the model.
4. Meeting with the experts so that they can provide comments on the relevant aspects of the model through the potential benefits.

In this study, the use of independent verification cannot be perceived as a result of resource constraints. The re-sampling procedure can also be not used in this study as this procedure is usually used in the research of social sciences and carries insufficient data for the performance analysis. The sample splitting is also unsuitable as it contains the similar problem as that of the re-sampling. Looking into this problem, the study of (Bassioni *et al.*, 2005) suggested that “pool aside” which determines that some of the data must be set aside for the validation. In line with this concept, it was decided in the sampling stage not to target the entire population even though it was feasible, where organizations whom were not included in the primary survey are kept for this stage as external validators to increase the validity of the results and minimize bias.

As stated by Luu *et al.* (2008), the validated model has to attain at least 50% agreement rate on ability to measure the performance of construction organizations. In line with this, it is suggested that the model can be considered valid when experts reach a consensus about the model acceptance. Having said that, in order to achieve a realistic and effective assessment model, the characteristics of the nominated panel of experts are vital aspects that has to be carefully looked after (Pidd, 1997). The semi-

structured interview approach has been encouraged since it is recognized as a suitable method since it provides a clear set of previously prepared questions for interviewers and can provide reliable, comparable qualitative data. The semi-structured interview is employed in this section to evaluate the degree of applicability of the model.

5.4.2 Design of validation interview questions

In the main questionnaire, the 5-point scale was suitable as the sample size was enough to generate variability in responses. whereas in this section the validation usually involves small number of participants, therefore in order to improve the validity and reliability of the research the 7-point scale was decided to be used for the sake of increasing the variability. The Likert scale ranges from 1=Strongly Disagree, 2=Disagree, 3=somewhat Disagree, 4=Undecided, 5= somewhat agree, 6= Agree and 7=Strongly Agree. On the other side, the interview questions were categorized in three segments, which are as below:

1. The interviewees were asked about their personal background such as their experience, job title and nationality of origin.
2. In the second segment, the experts were requested to review the relative weights of the model and whether any of the measures were missing from the initial list. Even they were asked to express the reason behind the adding or deletion of the measures.
3. In the third segment, they were asked whether the PMS was practical, applicable, comprehensive and clear or not. They were also requested to propose performance measurement framework for the construction projects.

5.4.3 Experts Participants

Among the critical aspects to ensure the effectiveness of validation process is choosing the right participants. The nomination is limited to professionals who've got extensive knowledge and solid experience in managing construction projects to prevent any error in the data. The number of expert in the panel was decided to be 10% of the sample size used in the primary questionnaire which consisted of 73 participants. Thus, the panel involved 7 experts with solid experience ranging between 17 and 37 years, nonetheless, their collective average was 25.85 years of experience. All of them are directly involved with planning, managing, and evaluating project activities. Table (48) shows the job title, years of experience and the organization class each of participants belongs to.

Table (48)
Expert personal background

No.	Expert organization class	Job Title	Years of Experience	Experience average
1	C	General Manager	37	25.85
2	AA	Project Manager	18	
3	A	Chief of Engineers	35	
4	AA	Project Manager	17	
5	C	Project Manager	20	
6	B	Construction Manager	28	
7	B	Director	26	

5.4.4 Performance model components

In this study, SPSSV 20 statistical software was considered for the implementation of validation analysis. The mean technique was adopted for the determination of necessary framework components. All of the

respondents of this study agreed to all of the framework elements as mentioned above through their positive answers to the agreement of the frameworks. The below mentioned Table (49) exhibited 26 of the valid KPIs that are also related to the three level of construction performance measurement i.e. (Project, Organization and stakeholders). During the interview with the experts, it was also extracted that KPIs are necessary for the determination of the progress of the project. The mean scores of these measures was between the range of 5 (somewhat agree) to 7 (extremely agree).

To investigate whether this difference is significant or not, the standard deviation of sample means known as the standard error is analysed, according to Bryman and Cramer (2002), small standard error indicated the means are aligned to the population mean and can be considered accurate in reflecting the population. On the other hand, Large standard errors point that there are a lot of variability among the different means and agreement cannot be assumed.

The fact that most of the standard deviation values are below 1.0 reflects that data has low variability and suggests high consistency in the participants responses and agreement of opinions (Bryman & Cramer, 2002).

The results in Table (49) shows that the experts provided with the consensus of opinions regarding the significance of performance model.

Table (49)
Results of Expert Evaluation

Level	Perspective	Key Performance Indicator	N	Expert Ratings							Mean	Min	Max	Standard Deviation
				1	2	3	4	5	6	7				
Company Level	Financial		7	6	7	6	7	7	6	7	6	7	6.57	0.535
			7	6	7	5	7	6	6	7	5	7	6.29	0.756
		Profitability	7	7	7	7	7	7	7	7	7	7	7.00	0.000
		Financial Stability	7	7	7	7	7	7	6	7	6	7	6.86	0.378
		Cash Flow	7	7	7	7	6	7	7	6	6	7	6.71	0.488
		Growth	7	7	7	7	6	6	7	7	6	7	6.71	0.488
		Outstanding Money	7	7	7	7	7	7	7	6	6	7	6.86	0.378
		Capital	7	7	7	7	7	6	6	6	6	7	6.57	0.535
		Return on investment	7	7	7	7	7	7	7	7	7	7	7.00	0.000
		Interest Cover	7	7	7	7	7	7	7	7	7	7	7.00	0.000
	Internal Business		7	6	7	6	7	6	6	6	6	7	6.29	0.488
		Business efficiency	7	7	6	7	6	7	7	6	6	7	6.57	0.535
		Resource Management	7	7	6	7	6	7	7	6	6	7	6.57	0.535
	Productivity		7	6	7	5	7	6	6	6	5	7	6.14	0.690
		Labour Productivity	7	7	6	6	6	6	6	7	6	7	6.29	0.488
		Rate of subcontracting	7	7	6	6	6	7	6	7	6	7	6.43	0.535

Stakeholders Level		7	6	7	7	7	7	6	6	6	7	6.57	0.535
	External Stakeholders	7	7	7	7	7	7	7	6	6	7	6.86	0.378
	Client Satisfaction	7	7	6	7	7	7	7	7	6	7	6.86	0.378
	End-user Satisfaction	7	6	6	7	5	7	6	6	5	7	6.14	0.690
	Sub-contractors Performance	7	7	7	7	5	6	6	7	5	7	6.43	0.787
	Percentage of repeated customers	7	6	7	7	7	6	6	7	6	7	6.57	0.535
	Regulatory Compliance	7	7	6	7	7	7	6	6	6	7	6.57	0.535
Project Level		7	6	7	5	7	7	6	6	5	7	6.29	0.756
	Cost	7	7	7	6	7	7	7	7	6	7	6.86	0.378
	Cost Rate	7	7	7	7	5	7	7	7	5	7	6.71	0.756
	Construction Cost Variance	7	7	7	7	5	7	7	7	5	7	6.71	0.756
	Time	7	6	7	7	7	7	6	6	6	7	6.57	0.535
	Construction time variance	7	7	7	7	7	7	7	7	7	7	7.00	0.000
	Quality	7	6	5	5	6	5	5	5	5	6	5.29	0.488
	Quality issues at end of D.L.P.	7	7	7	7	7	7	7	7	7	7	7.00	0.000
	Total Field Rework	7	7	7	7	7	7	7	7	7	7	7.00	0.000
	Planning	7	6	5	5	6	6	6	7	5	7	5.86	0.690
	Cost Predictability	7	6	6	7	5	6	7	6	5	7	6.14	0.690
	Time Predictability	7	6	6	7	5	6	7	6	5	7	6.14	0.690
	Health & Safety	7	6	5	5	6	5	5	5	5	6	5.29	0.488
	Safety Performance	7	7	7	7	7	7	7	7	7	7	7.00	0.000
	Frequency of Accident	7	7	7	7	7	7	7	7	7	7	7.00	0.000

5.4.5 Framework Evaluation

The below-mentioned Table (50) ascertains the framework in terms of clarity, cost effectiveness, applicability and comprehensiveness. As per the table, the mean that was obtained were 6.00, 6.86 6.71 and 6.14. From the table, it can be observed that the highest mean score was that of cost effectiveness which referred to as the value of 6.86, followed by applicability with the value of 6.71. On the other hand, the comprehensiveness and clarity possessed close amounts of mean scores which are 6.14 and 6.00 respectively.

Table (50)
Experts level of endorsement for the proposed framework

Criteria	N	Minimum	Maximum	Mean	Std. Deviation
Clear	7	5	7	6.00	0.577
Cost Effective	7	6	7	6.86	0.378
Applicable	7	6	7	6.71	0.488
Comprehensive	7	5	7	6.14	0.690

The maximum and minimum method in the table determines the collective and correspondent acceptance of all the experts. The perception scores of the respondents were between the range of 6 and 6.86. All the means of the frameworks are close the mean value of 6.43 and the average of the four criteria were close to the highest rating of the mean score. This value shows that there was no difference in the perception of the respondents. It also depicted that all of the experts opined that all of the framework components can be adopted as they are highly practical, valid and reliable in regards to its components and constructions.

Chapter 6

Discussion and Conclusions

6.1 Conclusions

6.2 Recommendations

6.3 Future Work

Chapter 6

Discussion and Conclusion

6.1 Conclusion

The overall performance of construction firms relies substantially on its ability to formulate a success strategy and most importantly how to evaluate how far that strategy was accomplished. Therefore, adapting a performance system offers an essential support for the success of any construction organization. The goal of this study was to build a model that will assist building construction companies in Bahrain to assess their performance. This goal was realized with the aid of three objectives. The first objective was Reviewing established models of construction performance measurement. An extensive literature review was conducted to have a comprehensive knowledge of construction performance systems. The literature review concentrated on two aspects: a) previous performance measurement models and b) construction key performance indicators of various studies to compose a list of nominated indicators.

A model for assessing the performance of construction organization that combined the merits of Both the BSC and KPI was developed while explaining methods that were employed. the overall structure was composed to form three main layers, the project level, the company level and thirdly the stakeholders level on which all of them are required to be oriented with the company objectives. The Project level measures are utilized to track, evaluate and gradually improve overall performance. It comprises six perspectives: Cost; Time; Quality; Planning; Health & safety and finally Environment. The Company level measures are intended to

monitor the overall performance which refines the organization's processes to be in line with organization's long-term objectives. The stakeholder's levels which refers to managing the interrelating interests of a number of internally and externally involved participants seeking to accomplish their desired objectives within the overall project objectives.

The second objective was to investigate the key performance indicator for of Building construction projects in Bahrain based on the selected indicators in objective 1. A survey questionnaire was structured, piloted, and distributed to 73 construction organizations in Bahrain in order to determine the key performance measures for the three levels. With 30 completed responses forming respond rate of 41.7% an independent sample t-test was utilized to determine the significance of performance indicators through the use of SPSS 20.0 statistical package.

The third and final objective was to establish a building construction performance model by using the nominated key performance indicators, the outcome in objective 2 was used to construct a hierarchy structure for the AHP tool in order to determine the relative weights of the selected indicators. The AHP model was selected because of its flexibility in providing a balanced incorporation of objective as well as subjective criteria.

A significant result of this study pointed out that, there is paradigm shift in the construction industry in conceiving present challenges of business environment while pursuing success and there exists a major shift in the perceptions of the construction organizations. Although traditional elements of success such as profitability and finance that happen to be short

term still dominate the interest of construction companies, long term strategic aspects of success such as client and customer satisfaction as well as safety performance are strongly present and received relatively high attention by industry professionals.

Although innovation, environment and internal stakeholders perspective was heavily promoted in the literature as important aspects for performance assessment, the results revealed that the importance level of the particular perspectives was below the cut-off threshold. As it may still a debatable matter in the literature whether innovation is an appropriate perspective for the construction industry which is known for its dependency on the innovations of other sectors. On the other hand, the absence of a single indicator relating to either environment or internal stakeholders pointed out a major drawback in building construction practice in Bahrain and confirmed Al-Sehali (2001) that this was a main reason for the underperformance of the construction industry in Bahrain.

The proposed model was validated through expert judgment from the industry professionals in Bahrain. The validation process employed a semi-structured interview involving a total of seven construction professionals who were requested to offer their critical reviews and grants approval for the suggested model. Therefore, a comprehensive and valid performance assessment model was presented for construction organizations to evaluate their current performance which will help them to reorient their strategies for long term excellence.

6.2 Recommendations

It is essential for organizations to be aware before adapting the proposed model as with other models, that having a measurement system alone is not sufficient to improve the performance of the organization. And so, the suggested model is just a tool which points out what requires attention and improvement, and it certainly cannot guarantee organizational success. For instance, should the top management strive for an inconsistent strategy, the company's overall performance would most definitely be disturbed, regardless of how successful the models it employs. Nevertheless, the effective use of the proposed model is likely to increase the organization chances of success compared with other competitors.

Another supporting matter would be assigning a KPI team that would be responsible for reporting activities on a regular basis i.e. (monthly/quarterly/annually) according to their importance, and such assessments must cover the critical issues. The typical shortcoming noticed while working with measurement assessment systems were staff rejection attributable to the insufficient perception of their advantages and rejection because of fear of being penalized for underperformance. Therefore, the team has an important role to ensure that the workforce perceives performance measurement in a positive way by explaining the procedures to all staff and get them involved in the process.

It is also recommended to incorporate computer technology into the PMS, a computerized PMS will help automating the process of collecting, sorting and archiving performance data which emphasize the need to create a KPI database for construction building projects evaluations. These

information, which are required to be frequently updates should consist of: (a) definitions, methods and frequency of calculating all KPIs; (b) recorded reviews of finished projects to act as a benchmark for similar projects which by time will turn into a best practice that will contribute not only for the success of the organization but for the development of the whole industry.

6.3 Future Work

While progressing in this study, certain areas were identified as limitations. Upon these limitations, related topics are recommended for future investigation.

The suggested model was initially designed in correspondence to organizations need to track their overall performance. However, a fast track business such as the construction industry which is constantly subjected to frequent changes requires adaptability and flexibility from the organization to meet the highly competitive business environment demands. Therefore, in the future, it is necessary to constantly maintain the performance measures which requires regular updates and further investigation to re-evaluate the relations between the indicators and perhaps redesign the model to catch new developments.

Further in-depth research would be examining this research framework to other types of construction projects e.g. (industrial, Roads and bridges) by carrying out an empirical case study research. Case study approach is known for its solid conclusions resulted from subjecting the theoretical findings to real world application.

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Appendices

APPENDIX A

Cronbach alpha reliability test

Variable	Reliability (α)	Inter-Item Correlation Matrix				
(A) Cost	0.893	Indicator A	A1	A2	A3	
		A1	1.000	.177	.032	
		A2	.177	1.000	.309	
		A3	.032	.309	1.000	
(B) Time	0.891	Indicator B	B1	B2	B3	
		B1	1.000	.401	.590	
		B2	.401	1.000	.349	
		B3	.590	.349	1.000	
(C) Quality	0.893	Indicator C	C1	C2	C3	
		C1	1.000	.411	.428	
		C2	.411	1.000	.507	
		C3	.428	.507	1.000	
(D) Planning	0.898	Indicator D	D1	D2	D3	
		D1	1.000	.542	.476	
		D2	.542	1.000	.669	
		D3	.476	.669	1.000	
(E) Health & Safety	0.889	Indicator E	E1	E2	E3	
		E1	1.000	0.678	0.375	
		E2	0.678	1.000	0.342	
		E3	0.375	0.342	1.000	
(F) Environment	0.894	Indicator F	F1	F2	F3	
		F1	1.000	0.704	0.448	
		F2	0.704	1.000	0.586	
		F3	0.448	0.586	1.000	

Variable	Reliability (α)	Inter-Item Correlation Matrix								
(G) Financial	0.895	Indicator G	G1	G2	G3	G4	G5	G6	G7	G8
		G1	1.000	.358	.284	.092	-.106	.380	.391	.066
		G2	.358	1.000	.630	.149	.423	.257	.357	-.064
		G3	.284	.630	1.000	.503	.545	.292	.208	.064
		G4	.092	.149	.503	1.000	.532	.475	.271	.249
		G5	-.106	.423	.545	.532	1.000	.262	.399	.216
		G6	.380	.257	.292	.475	.262	1.000	.548	.014
		G7	.391	.357	.208	.271	.399	.548	1.000	.163
		G8	.066	-.064	.064	.249	.216	.014	.163	1.000
(H) Internal Business	0.882	Indicator H	H1	H2	H3	H4	H5	H6	H7	
		H1	1.000	.209	.055	.257	.427	.348	.334	
		H2	.209	1.000	.588	.382	-.073	.383	.362	
		H3	.055	.588	1.000	.256	.014	.379	.324	
		H4	.257	.382	.256	1.000	.270	.870	.783	
		H5	.427	-.073	.014	.270	1.000	.378	.271	
		H6	.348	.383	.379	.870	.378	1.000	.871	
		H7	.334	.362	.324	.783	.271	.871	1.000	
(I) Productivity	0.882	Indicator I	I1	I2	I3					
		I1	1.000	.485	.340					
		I2	.485	1.000	.306					
		I3	.340	.306	1.000					
(J) Internal Stakeholders	0.888	Indicator J	J1	J2	J3	J4	J5			
		J1	1.000	0.698	0.400	0.633	0.604			
		J2	0.698	1.000	0.256	0.493	0.375			
		J3	0.400	0.256	1.000	0.166	0.107			
		J4	0.633	0.493	0.166	1.000	0.751			
		J5	0.604	0.375	0.107	0.751	1.000			
(K) External Stakeholders	0.893	Indicator K	K1	K2	K3	K4	K5	K6		
		K1	1.000	.638	.657	.408	.814	.785		
		K2	.638	1.000	.614	.480	.554	.554		
		K3	.657	.614	1.000	.470	.677	.621		
		K4	.408	.480	.470	1.000	.301	.343		
		K5	.814	.554	.677	.301	1.000	.767		
		K6	.785	.554	.621	.343	.767	1.000		

Appendix B



UNIVERSITY OF BAHRAIN

Department of Mechanical Engineering

**M.Sc. in Engineering Management
(Questionnaire)**

**Performance Assessment of Construction Management
Provisions in Building Projects in Bahrain**

Submitted by

Sayed Fadhel Abbas Hadi

Supervised by

Prof. Dr. M.P. Saka

February, 2016

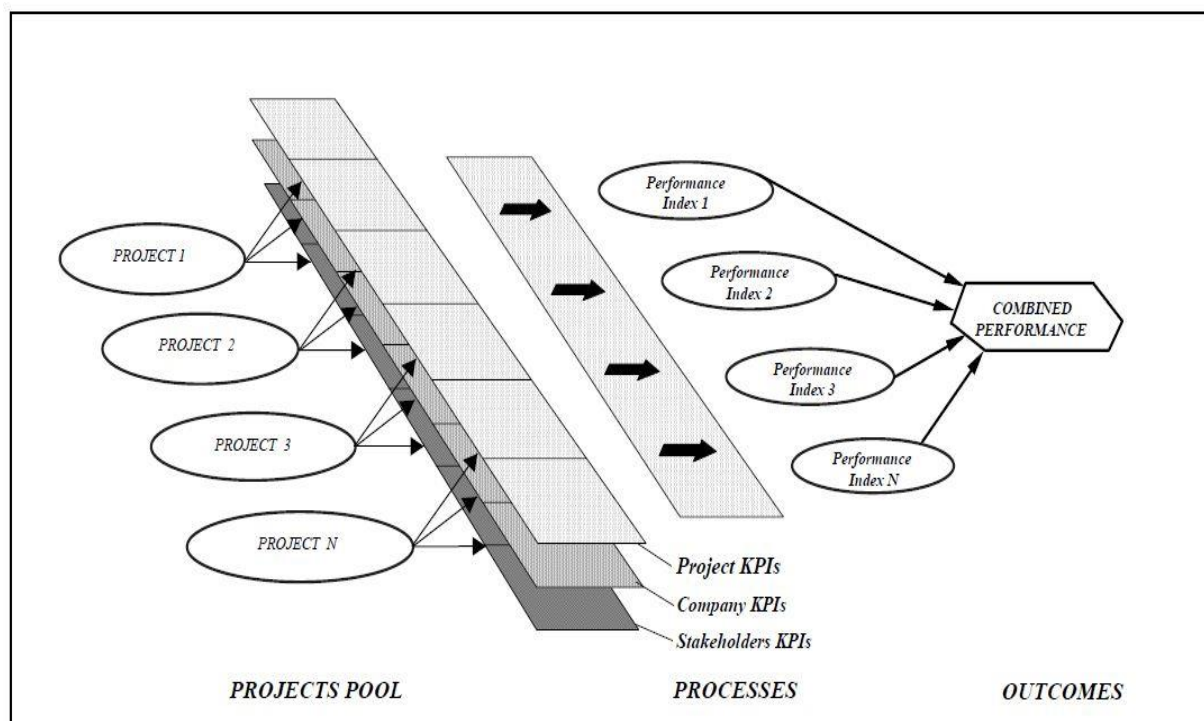
Introduction

Dear sir,

The objective of this questionnaire is to develop a system to measure the performance of construction companies in Bahrain. The initial framework consists from three main levels with a total of 11 performance areas along with their 47 performance indicators (PIs). It is assumed that, those parameters which have the tendency to influence performance are:

- **Project Level:** Cost, Time, Quality, Planning, Health & safety and Environment.
- **Company Level:** Financial, Internal business and Productivity.
- **Stakeholders Level:** Internal stakeholders, External stakeholders.

This questionnaire should be filled in by a business owner, general manager, project manager or person who is qualified and entitled to answer such questions about the company. All information included in this questionnaire will be solely for academic purposes and will be strictly confidential. After the collection and analysis of data, interested participants of this study will be given feedback on the overall research results.



Part One: Company profile: Please add (✓) as appropriate:

1. Year of establishment.

.....

2. Class of classification (According to ministry of works buildings construction classification).

- ☐ Grade AA
☐ Grade A
☐ Grade B
☐ Grade C

3. Company size: (number of employees):

Number of employees in your company is employee

4. Job title of the respondent:

- | | |
|--|--|
| ☐ Business owner / Director | ☐ Construction Manager |
| ☐ Project Manager | ☐ Civil Engineer |
| ☐ Architect | ☐ Others (specify) |

5. Years of experience of the respondent:

- | | |
|--------------------------------------|---------------------------------------|
| ☐ Less than 5 | ☐ 5 to 10 |
| ☐ 11 to 15 | ☐ More than 15 |

6. Number of projects executed in the last **five** years:

- | | |
|-----------------------------------|---------------------------------------|
| ☐ 1 to 10 | ☐ 11 to 20 |
| ☐ 21 to 30 | ☐ More than 30 |

7. Value of executed projects executed in the last five years: (in million BD)

- | | |
|---|--|
| ☐ Less than 5 Million BD | ☐ 5 to 10 Million BD |
| ☐ 11 to 15 Million BD | ☐ More than 15 Million BD |

8. Have you received any training about performance measurement systems?

☐ Yes ☐ No If yes please specify:
.....

9. Do you have experience in measuring performance?

☐ Yes ☐ No If yes please specify
.....

10. Do you practice any performance measurement systems in the construction projects?

☐ Yes ☐ No

11. Which of the following performance measurement systems you have known or used in past?

	Performance Measurement Systems	Known to you	Used by you
1	Key Performance Indicators		
2	Balance Scorecard		
3	European Foundation Quality Management		
4	Malcolm Baldrige National Quality Award		

Please list any other systems which you might be aware of but are not listed:

.....

12. Which of the following performance measures are used by your organization and what forms of assessment techniques do you use to evaluate project performance?

	Performance Measures	Tick If measured	Assessment Techniques
1	measures on project time		
2	Measures on project cost		
3	Measures on project productivity		
4	Measures on project quality		
5	Measures on health & safety performance		
6	Measures on planning efficiency		
7	Measures on the environmental impacts		
8	Measures on financial performance		
9	Measures on internal business management		
10	Measures on stakeholders' satisfaction		

Please list others which are relevant (in your views) but not listed here

.....

Part Two: KPIs to measure the Performance of Construction companies.

Below are numbers of indicators that are meant to measure the performance of construction companies. From your experience, please express your opinion on the importance of each indicator to represent the overall performance of construction companies in Bahrain. (Questions will be answered in a 1 to 5 Scale. The meaning of the numbers in the Scale should be considered as:

1: Very low important

2: Low important

3: Medium important

4: High important

5: Very High important

<i>Performance Indicators</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
A. Project Level					
(1) Cost					
Cost Rate					
Construction cost variance					
Cost to rectify defects					
(2) Time					
Construction time variance					
Overtime Work Rate					
Time to rectify defects					
(3) Quality					
Defect Frequency					
Total Field Rework					
Quality Issues at End of Defect Rectification Period					
(4) Planning					
Predictability Cost					
Predictability Time					
Change Cost Factor					
(5) Health & Safety					
Frequency of Accident					
Safety Cost Ratio					
Safety Performance					
(6) Environment					
Construction Waste Rate					
Impact on the Environment					
Energy use					

<i>Performance Indicators</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
B. Company Level					
(1) Financial					
Profitability (company)					
Growth (Revenues and volume of works growth rate)					
Financial stability (Debt ratio)					
Cash flow					
Capital					
Interest Cover (company)					
Return on Investment (client)					
Outstanding Money (project)					
(2) Internal Business					
Business efficiency (Revenues over Expenses)					
Successful tenders rate					
Market share (company projects value /all market projects value)					
Innovation (Saving through usage of new materials / techniques)					
Resource management					
Number of high-performance professionals within					
Technological capability					
(3) Productivity					
Management Productivity					
Labor Productivity					
Rate of Subcontracting (% of work given to subcontractors)					
C. Stakeholders Level					
(1) Internal Stakeholders					
employee satisfaction					
staff turnover					
sickness absence					
Motivation					
Human resource training and development					
(2) External Stakeholders					
Client Satisfaction					
Percentage of Repeat Customers					
subcontractor performance					
Occurrence and magnitude of disputes and conflicts					
End-user Satisfaction					
Regulatory compliance					

Appendix C

Breakdown by nodes

Node: Performance Measurement Index (PMI)

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

Category	Priority	Rank
1 Project Level	19.6%	3
2 Company Level	49.3%	1
3 Stakeholders Level	31.1%	2

Number of comparisons = 3

Consistency Ratio CR = 5.6%

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3
1	1	0.50	0.50
2	2.00	1	2.00
3	2.00	0.50	1

Principal eigen value = 3.054

Eigenvector solution: 4 iterations, delta = 2.1E-8

Node: Project Level

Consolidated Priorities

Consistency Ratio CR: 3.5%

Category	Priority	Rank
1 Time	19.9%	2
2 Cost	46.6%	1
3 Quality	10.9%	4
4 Planning	8.2%	5
5 Health & Safety	14.4%	3

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2	3	4	5
1	1	0.33	2.00	2.00	2.00
2	3.00	1	4.00	4.00	4.00
3	0.50	0.25	1	2.00	0.50
4	0.50	0.25	0.50	1	0.50
5	0.50	0.25	2.00	2.00	1

Node: Cost

Consolidated Priorities

Consistency Ratio CR: 0.0%

Category	Priority	Rank
1 Cost Rate	66.7%	1
2 Construction cost variance	33.3%	2

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2
1	1	2.00
2	0.50	1

Node: Quality

Consolidated Priorities

Consistency Ratio CR: 0.0%

Category		Priority	Rank
1	Total Field Rework	14.3%	2
2	Quality Issues at End of Defect Rec	85.7%	1

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2
1	1	0.17
2	6.00	1

Node: Planning

Consolidated Priorities

Consistency Ratio CR: 0.0%

Category		Priority	Rank
1	Predictability Cost	50.0%	1
2	Predictability Time	50.0%	1

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2
1	1	1.00
2	1.00	1

Node: Health & Safety

Consolidated Priorities

Consistency Ratio CR: 0.0%

Category		Priority	Rank
1	Frequency of Accident	25.0%	2
2	Safety Performance	75.0%	1

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2
1	1	0.33
2	3.00	1

Node: Company Level

Consolidated Priorities

Consistency Ratio CR: 0.0%

Category		Priority	Rank
1	Financial	77.8%	1
2	Internal Business	11.1%	2
3	Productivity	11.1%	2

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2	3
1	1	7.00	7.00
2	0.14	1	1.00
3	0.14	1.00	1

Node: Financial

Consolidated Priorities

Consistency Ratio CR: 4.6%

	Category	Priority	Rank
1	Profitability	25.1%	1
2	Growth	13.3%	4
3	Financial stability	16.0%	2
4	Cash flow	16.0%	2
5	Capital	9.7%	6
6	Interest Cover (company)	4.5%	8
7	Return on Investment (client)	4.6%	7
8	Outstanding Money (project)	10.7%	5

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2	3	4	5	6	7	8
1	1	1.00	3.00	3.00	2.00	4.00	4.00	2.00
2	1.00	1	0.50	0.50	2.00	3.00	3.00	1.00
3	0.33	2.00	1	1.00	2.00	3.00	3.00	2.00
4	0.33	2.00	1.00	1	2.00	3.00	3.00	2.00
5	0.50	0.50	0.50	0.50	1	4.00	3.00	0.50
6	0.25	0.33	0.33	0.33	0.25	1	1.00	0.50
7	0.25	0.33	0.33	0.33	0.33	1.00	1	0.50
8	0.50	1.00	0.50	0.50	2.00	2.00	2.00	1

Node: Internal Business

Consolidated Priorities

Consistency Ratio CR: 0.0%

	Category	Priority	Rank
1	Business efficiency	66.7%	1
2	Resource management	33.3%	2

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2
1	1	2.00
2	0.50	1

Node: Productivity

Consolidated Priorities

Consistency Ratio CR: 0.0%

	Category	Priority	Rank
1	Labor Productivity	66.7%	1
2	Rate of Subcontracting	33.3%	2

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2
1	1	2.00
2	0.50	1

Node: Stakeholders Level

Consolidated Priorities

Consistency Ratio CR: 4.3%

Category		Priority	Rank
1	Client Satisfaction	32.3%	1
2	Percentage of Repeat Customers	13.8%	4
3	subcontractor performance	9.7%	5
4	End-user Satisfaction	26.0%	2
5	Regulatory compliance	18.2%	3

Consolidated Decision Matrix

Aggregation of individual judgments for 1 Participants

	1	2	3	4	5
1	1	2.00	2.00	2.00	2.00
2	0.50	1	2.00	0.50	0.50
3	0.50	0.50	1	0.33	0.50
4	0.50	2.00	3.00	1	2.00
5	0.50	2.00	2.00	0.50	1

Global Priorities

Participa nts	Time	Cost Rate	Construct ion cost variance	Total Field Rework	Quality Issues at End of Defect Rec	Predictab ility Cost	Predictab ility Time	Frequenc y of Accident	Safety Performa nce	Profitabili ty	Growth	Financial stability	CR
PMAA01	3.9%	6.1%	3.0%	0.3%	1.8%	0.8%	0.8%	0.7%	2.1%	9.6%	5.1%	6.1%	0.4%

cont'd

Participa nts	Cash flow	Capital	Interest Cover (company)	Return on Investme nt (client)	Outstand ing Money (project)	Business efficiency	Resource managem ent	Labor Productiv ity	Rate of Subcontr acting	Client Satisfacti on	Percenta ge of Repeat Customer s	subcontr actor performa nce	CR
	6.1%	3.7%	1.7%	1.8%	4.1%	3.7%	1.8%	3.7%	1.8%	10.0%	4.3%	3.0%	0.4%

cont'd

Participa nts	End-user Satisfacti on	Regulator y complian ce	CR
	8.1%	5.6%	0.4%

Appendix D



UNIVERSITY OF BAHRAIN
Department of Mechanical Engineering

M.Sc. in Engineering Management
(Questionnaire)

Performance Assessment of Construction Management
Provisions in Building Projects in Bahrain

Submitted by
Sayed Fadhel Abbas Hadi

Supervised by
Prof. Dr. M.P. Saka

February, 2016

Interview Questions for Validating Building Projects Performance Model for Construction Companies in Bahrain

Section 1: Personal Background

- 1.1. Name:
- 1.2. Job Title/Position:
- 1.3. Years of work experience:
- 1.4. Classification of your organization ☐ AA ☐ A ☐ B ☐ C
- 1.5. Contact Number:

Section 2: Components of Proposed Model:

2.3. Performance models Levels

To what extend do you agree with relative weight distribution of the main levels.

Ranking
1 = Strongly Disagree - 7 = Strongly Agree

1	2	3	4	5	6	7
---	---	---	---	---	---	---

- 1 **Company Level (49.34%)**
- 2 **Stakeholders Level (31.08%)**
- 3 **Project Level (19.58%)**

A. Company Level Components

1 **Financial (77.78%)**

- 1-1 Profitability (25.1%)
- 1-2 Financial Stability (16%)
- 1-3 Cash Flow (16%)
- 1-4 Growth (13.26%)
- 1-5 Outstanding Money (10.69%)
- 1-6 Capital (9.74%)
- 1-7 Return on investment (4.63%)
- 1-8 Intrest Cover (5.54%)

2 **Internal Business (11.11%)**

- 2-1 Business efficiency (66.67%)
- 2-2 Resource Management (33.33%)

3 **Productivity (11.11%)**

- 3-1 Labor Productivity (66.67%)
- 3-2 Rate of subcontracting (33.33%)

B. Stakeholders Level Components

1 **External Stakeholders (100%)**

- 1-1 Client Satisfaction (32.30%)
- 1-2 End-user Satisfaction (26.04%)
- 1-3 Regulatory Compliance (18.16%)
- 1-4 Percentage of repeated customers (13.76%)
- 1-5 Sub-contractors Performance (9.73%)

B. Project Level Components**1 Cost (46.60%)**

1-1 Cost Rate (66.67%)

1-2 Construction Cost Variance (33.33%)

2 Time (19.87%)

2-1 Construction time variance (100%)

3 Quality (10.89%)

3-1 Quality issues at end of D.L.P. (85.71%)

3-2 Total Field Rework (14.29%)

4 Planning (8.24%)

4-1 Cost Predictability (50%)

4-2 Time Predictability (50%)

5 Health & Safety (14.40%)

5-1 Safety Performance (75%)

5-2 Frequency of Accident (25%)

Section 3: Evaluation of Proposed Model Components

To what extent do you agree that the proposed Model including first part which involves the main performance measurement and sub measure are:

Ranking

1 = Strongly Disagree - 5 = Strongly Agree

1	2	3	4	5	6	7
---	---	---	---	---	---	---

1 Applicable

2 Cost effective

3 Clear

4 Comprehensive

Are there any performance indicators needed to be added?

Yes ☐ No ☐ If Yes please clarify.....

Part4: General Comments:

1. What are the limitations of proposed model?

.....

2. In your opinion, how can it be improved?

.....

3. Any Further Comment?

.....

Thank you very much for your Participation

ملخص الرسالة

تتطوي صناعة البناء والتشييد في طبيعتها على مستوى من التعقيد لكونها تشرك الكثير من أصحاب المصلحة والعملاء والمقاولين والجهات التنظيمية وغيرها. تعاني مشاريع البناء في البحرين من العديد من المشاكل والأمور المعقدة في الأداء مثل تجاوز التكلفة والوقت فضلا عن العديد من قضايا الجودة. الهدف الرئيسي من هذه الدراسة هو تحديد مقاييس الأداء الأكثر تأثيرا في المراجعات الأدبية الخاصة بإدارة المشاريع وتجميعها في نموذج شامل. تم إجراء تحليل يستهدف قطاع تشييد المباني مع التركيز على خصائص السوق البحرينية. وجرى استعراض الدراسات التي تعنى بالأداء لدراسة النماذج السابقة لمجاراتها كأساس للتكيف والتعرف على مؤشرات الأداء الأكثر أهمية لبناء مشاريع البناء. ولمحاذاة مخرجات التقصي مع الاحتياجات المحلية أجريت دراسة تجريبية للاستبيان من خلال عينة كشفية مكونة من 10 نماذج تم على إثرها إضافة اثنين من مؤشرات القياس كما أوصى بذلك خبراء محليين. تبع ذلك إجراء مسح بياني وتم تحديد 47 مؤشرا مصنفا إلى 11 مجموعة، قيمت من قبل شركات البناء ذات التصنيف الأربع الأولى وفقا لقائمة وزارة الأشغال. في هذه الدراسة، تم الافتراض أن ضعف أداء شركات المقاولات المحلية يرجع إلى قلة الوعي بمفاهيم قياس الأداء. وأن كل من اختلاف التصنيف بين الشركات وتعدد المسمى الوظيفي للمستجيبين لا يؤثران على تقييم مؤشرات الأداء الرئيسية. وقد أجمعت الشركات باختلاف تصنيفها على أن المؤشرات الخمسة الأكثر أهمية هي: رضا العملاء، الربحية، رضا المستخدمين النهائيين، التدفق النقدي وسعر التكلفة. وعلاوة على ذلك، تم التأكيد على أن قلة الوعي بمفاهيم قياس الأداء كان أحد الأسباب الرئيسية لضعف أداء قطاع البناء والتشييد. كما لم يكن من المستغرب غياب الإجماع بين الشركات كونها اختلفت في الترتيب كل وفقا لأولوياتها. ومع ذلك، للتحقق مما إذا كانت الفروق بينها كبيرة أم لا تم اخضاع نتائج الاستبيان لاختبار المقارنة بين متوسطين واختبار تحليل التباين وتبين أن هذه الاختلافات ضئيلة ويمكن اعتماد النموذج المقترح ليخدم مختلف شركات البناء. تم فحص منهجية تقييم الأداء جنبا إلى جنب مع التحليل من خلال اسلوب تحليل القرارات متعددة المعايير (MCDA) باستخدام عملية التحليل الهرمي (AHP) وعليه، فإنه يمكن أن نخلص إلى أن هذه الدراسة قد قدمت نموذجا لقياس أداء شركات الإنشاء على ثلاثة مستويات شملت كل من الناحيتين الموضوعية (النوعية) والذاتية (الكمية). اقترح النموذج مجموعة شاملة لمقاييس أداء المشاريع التي تغطي الوقت، التكلفة، الجودة، الصحة والسلامة والتخطيط. بالإضافة إلى ذلك، أدرج النموذج أبعاد بطاقة الأداء المتوازن (BSC) لتمثيل أداء الشركات، فضلا عن الاستجابة لتوصيات العديد من الباحثين بخصوص إشراك جميع أصحاب المصلحة المعنيين من خلال التركيز على تلبية توقعاتهم. كما ساهمت نتائج الدراسة لتفيد كل من مجال البناء البحريني والمجال البحثي إدارة المشاريع مما يفتح المجال لإجراء مزيد من البحوث لتشمل مراحل مختلفة من دورة حياة المشروع.

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إعداد

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