KEY PERFORMANCE INDICATORS FOR CONSTRUCTION CONTRACTORS IN SAUDI ARABIA

BY

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DEDICATION

To my beloved family, this is for you..

I dedicate this work to my parents; my beloved father Eng. Zakaria Izzat Zaben, who always stood by my side and never let me down, whom has constantly been there when I needed him, without asking nor judging. You have always been my idol; your love and support cannot be described in words; but words are all I have for now to say Thank you! I love you!

To my unconditionally beloved amazing mother, Donyaz Mahmoud Jbara, the one whom have carried me through hardship and difficult times. You are my angel, my friend, my everything. I cannot think of any person in my life whom have been so sincere in their love and support to me as you are. I wish you could be here today, I know it is all in English, not your favorite topic; but I also know you will feel every word I say and are with me by your heart. I want to tell you that I love you mama! I am the luckiest son on earth to have you as my mom.

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GDP:	Gross Domestic Product.
CBR:	Case Based Reasoning.
FL:	Fuzzy Logic.
GA:	Genetic Algorithm.
MOMRA:	Ministry of Municipal and Rural Affairs.
NN:	Neural Network.
PCA:	Principal Component Analysis.
SMART:	Specific, Measurable, Attainable, Relevant, and Timely.
SMEs:	Small and Medium Enterprises

THESIS ABSTRACT

Student Name: Yasar Zakaria Izzat Zaben

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This study addresses the issue of the lack of a Key Performance Indicators (KPIs) Model for construction contractors' performance assessment that is developed to match the needs of the Saudi construction market. KPIs are widely known and implemented in developed construction markets. The objectives of the study were to (1) identify the most commonly used KPIs that are also relevant to the needs and condition of Saudi construction market, and (2) develop a KPIs model for the use of Saudi construction contractors. Hence, the literature reviewed several exemplary KPI models from various markets and developed an initial set of 14 KPIs that are relevant to construct the proposed Saudi model. To establish their significance to Saudi contractors, we distributed a survey questionnaire incorporating a Likert scale spanning from 0 to 5, with 0 representing the least significant and 5 the most significant.

A total of 53 respondents from 49 different building contractor firms participated in the study. The obtained data was processed using IBM SPSS Statistics. The reliability of the model was proven and the significance of each KPI was assessed. A KPIs model consisting of 13 elements was developed for Saudi construction contractors as follows, ordered according to their respective significance: Cost of Construction, Time of Construction, Quality and Defects, Client Satisfaction, Health and Safety, Productivity, End User Satisfaction, People, Regulatory Compliance, Construction Time Predictability, Profitability, Construction Cost Predictability, Business Performance. Correlations between the KPIs were evaluated and the model was divided into 5 groups: Performance, Satisfaction, Actual Metrics, Estimated Metrics, and Compliance. The results were validated through experts' review. This model presents Saudi construction contractors and their clients with a tool to measure and assess their performance.

ملخص الرسالة

الاسم الكامل: **يسار زكريا عزت زين**

عنوان الرسالة: **مؤشرات الأداء الأساسية لمقاولي الإنشاءات في المملكة العربية السعودية**

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يتناول هذا البحث قضية عدم وجود نموذج لمؤشرات الأداء الرئيسية لتقييم أداء مقاولي البناء تم تطويره ليتناسب مع احتياجات سوق الإنشاءات السعودي. مؤشرات الأداء الأساسية هي أدوات معروفة على نطاق واسع ويتم استخدامها لتقييم الأداء في أسواق الإنشاءات المتقدمة. يهدف هذا البحث إلى: (1) تحديد مؤشرات الأداء الرئيسية الأكثر شيوعًا والتي تتناسب مع احتياجات سوق البناء السعودي وتشريعاته (2) تطوير نموذج لمؤشرات الأداء الرئيسية لاستخدام مقاولي البناء السعوديين. وبناء على ذلك، استعرضت المراجعة الأدبية العديد من نماذج مؤشرات الأداء الأساسية التي هي قيد الاستخدام في الأسواق المختلفة وطورت مجموعة أولية تتكون من 14 مؤشرًا للأداء يمكن اعتمادها لتكوين النموذج السعودي المقترح. لتقييم مدى مواءمتها لنشاط المقاولين السعوديين ، قمنا بتوزيع استبيان يعتمد على مقياس ليكرت كأداة تقييم. المدى القيمي للمقياس يمتد من 0 إلى 5 ، بحيث يمثل 0 الأقل أهمية و 5 الأكثر أهمية.

شارك في البحث 53 مشاركاً ينتمون إلى 49 شركة مقاولات بناء مختلفة. تمت معالجة البيانات المستقاة باستخدام برنامج (آي بي إم – إس بي إس إس). من خلال البرنامج، تم إثبات موثوقية النموذج المقترح إضافة لتقييم جدارة كل مؤشر أداء. تم تطوير النموذج ليشمل 13 مؤشرًا معياريًا للأداء وفق البيانات المستقاة من مقاولي البناء السعوديين على النحو التالي، مرتبة وفق الأهمية: التكلفة اللازمة للبناء، المدة اللازمة للبناء، الجودة والعيوب، رضا

العميل، الصحة والسلامة، الإنتاجية، رضا المستخدم النهائي، العناصر البشرية، الامتثال التنظيمي ، صحة تقدير الوقت اللازم للبناء، الربحية، صحة تقدير التكلفة اللازمة للبناء، الأداء العملاني. تم تقييم العلاقات البينية التي تربط مؤشرات الأداء الأساسية داخل النموذج ببعضها البعض. وعليه تم تقسيم النموذج إلى خمس مجموعات كالتالي: الأداء ، الرضا، المؤشرات الفعلية ، المؤشرات التقديرية، والانضباط. تم التحقق من صحة النتائج من خلال استعراضها مع مجموعة من المهنيين والأكاديميين الخبراء. تكمن أهمية هذا البحث في توفيره نموذجًا لمقاولي البناء السعوديين وعملائهم يمكنهم من قياس وتقييم الأداء.

CHAPTER 1

INTRODUCTION

As the Kingdom of Saudi Arabia is looking forward to diversifying its economy and put an end to its dependence on oil revenues, the importance of improving performance and practice in all economic sectors arises. Though construction is amongst the major industries in any major economy, the Saudi construction industry overall performance it is still below the global standard regarding efficiency and outputs compared to other construction markets comparable in size and nature such as the UAE construction market (Deloitte and Touche, 2017).

Despite the overall significant improvements in performance and operations in the Saudi construction market, delays and defects in construction projects are still common. In addition to negatively impacting the economy and misusing national resources, cost overruns, delays in projects' delivery, defects in delivered units of work, disputes between stakeholders, and unsatisfactory outcomes are some of the most common results of underperformance in the Saudi construction market (Al-Sahli, 2001). It is not uncommon for construction clients in Saudi do not fully realize the anticipated objectives of their projects.

Most Saudi construction contractors, including those with international affiliations and participants in international projects, do not have a long-term strategy to achieve the firm's long-term and mid-term business objectives (Al-Sahli, 2001). Furthermore, they often lack adequate tools and measures to assess their business performance and operations. As a result, identification of flaws and deficiencies in performance are usually accomplished too late and retroactive measures of correction, rather than proactive ones, are the norm (Deloitte and Touche, 2017).

Improving the business practice through the employment of effective performance measurement and assessment tools will undoubtedly be of great benefit for all stakeholders in the construction market including contractors. In addition to enabling them to assess their projects' performance accurately, it helps them cut in costs, better utilize their valuable resources, keep track of work progress towards business objectives, and lessen the occurrence of work defects and hence save in unnecessary, avoidable cost overruns (Egan, 1998). Consequently, the construction contractor's business capacity and qualifications will be improved, enabling them to be on an equal footing with their potential international competitors and engage in global world-class projects.

According to (Salaheldin, 2009), efficient implementation of performance measurement and benchmarking systems by contractors can ensure them a continuous improvement of performance. Being able to act proactively to deal with changes and challenges in the construction market gives them the edge over their typical competitors and hence improves their competitive position in the market.

Implementing Key Performance Indicators (KPIs) to assess performance in construction projects is one of the most effective, yet a straightforward, construction management practices in developed economies (Construction Excellence, 2011). However, each construction market has its unique characteristics according to which a specially customized set of KPIs is developed. Nonetheless, construction markets around the world have a lot in common, and therefore KPIs used in a specific construction market may be useful and relevant to other markets (Alarcon, Grillo, Freire and Diethelm, 2001).

Developing a set of KPIs for the use of Saudi construction contractors, as the purpose of this research, can positively contribute to construction management practices is designed according to the needs, experiences, and aspirations of local contractors. Identifying the most critical KPIs that are aligned with the needs and objectives of Saudi construction contractors may be achieved through the utilization of KPIs systems from developed markets coupled with local contractors' input.

CHAPTER 2

LITERATURE REVIEW

2.1. Construction Industry in Saudi Arabia

Construction is a vital component of the Saudi economy. The Gross Domestic Product (GDP) from construction in Saudi Arabia exceeded SAR29 bn. in the fourth quarter of 2017 making it one of the largest in the region (IEconomics, 2018). According to Deloitte (2017), the total value of construction contracts awarded in Saudi Arabia in 2017 was around USD24 bn. And though the commencement of some of them have been postponed or delayed due to recent drops in oil prices and the government's program of financial reforms, that does not negate the fact that the construction market in Saudi is one of the major catalysts for domestic economic development and growth. Saudi construction contractors are the largest and most spending clients in various sectors of the economy, such as materials, equipment, and logistic services.

However, there is an undoubtedly need to bring improvements to Saudi construction contractors' performance and work output, in addition to implementing the means of performance assessment. The need arises from the fact that despite the enormous values of contracts awarded to construction contractors, there seem to be many major projects still being delivered with noticeable defects either in specifications or functionality (Deloitte and Touche, 2017).

According to Kwame, Baiden and Badu (2012), construction contractors in developing economies often lack the capacity to compete with foreign contractors. Their use of obsolete technologies, equipment, and outdated training programs for staff and employees are among the factors that negatively affect local contractors' performance in many economies.

The Saudi Ministry of Housing is planning to initiate an ambitious project to build 100,000 housing units in Riyadh alone over the next five to seven years (Deloitte and Touche, 2017). Besides, the Saudi government has already awarded tens of contracts for massive infrastructure projects that serve various areas around the kingdom.

According to Deloitte and Touche (2017), the Saudi construction and engineering market are about to, and in some sectors is already, witness radical changes in the business operations are executed. The long-term continuity of any contractor in the Saudi market is highly reliant on the ability to optimize operational performance and raise the standards of products and services delivered to clients. Hence, implementation of performance measurement tools will be vital for the sustainability of contractors' business models.

The Saudi Ministry of Housing has its own contractors' pre-qualification and training program which aims to qualify housing and infrastructure contractors for the ministry's projects across the kingdom. However, it does not implement any form of performance assessment measures or indicators in the evaluation of potential contractors other than the values of executed projects by contractors during the past five to seven years (MOH, 2017).

The Ministry of Municipal and Rural Affairs (MOMRA), on the other hand, has established a set of criteria for the classification of Saudi contractors in all various sectors. Nonetheless, the criteria are mainly concerned with financials, staff, and workforce, and values of projects executed. The classification of contractors as per MOMRA's guidelines does not address contractors' performance (ACC, 2018).

For many construction projects in the kingdom, especially those awarded by the government or other major clients, like Saudi Aramco, the submittal of a prequalification portfolio along with the bidding documents is compulsory. Yet, indicators of contractors' performance in previous projects remain vague to some extent. A prequalification portfolio does not typically include metrics of performance assessment but rather briefs of projects' outcomes and deliverables.

2.2. Performance

According to Kuragu, Baiden, and Badu (2014), "performance" is "a system's valued, useful output of goods or services." The use of the term "performance" is an indication of the relative desire to satisfy certain measures and metrics to fulfill the needs and demands of potential clients. However, "performance" can also be described, in competency terms, as the project-based organizations' behavioral competencies relevant to achieving the organizational long and short-term business objectives (Ahadzie, 2014).

In the field of management, the term performance is broadly used and referred to. Kennerley and Neely (2002) indicated that performance:

- Could be evaluated through figures and expressions, which can reflect the actual status of the project.
- Is to complete something with a definite intent in order to create value.
- Reflects the outcome of an activity/action after creating a value.

- Can support or boost the establishment of an outcome.

- Can be used to compare the internal and external outcomes in accordance with some standards.

Performance evaluation is usually used as a practical method to evaluate the performance of management (i.e. work and corporative strategy and human resources). Modern work and management environment mark the significance of performance evaluation in a single statement: "if you cannot measure it, you cannot control it" (Niven, 2006).

Performance measurement includes a set of standards employed to measure the effectiveness of the action. Hence, it can be defined as the process of measuring the effectiveness and efficiency of an activity/action, or an indicator or metric used to measure the effectiveness and efficiency of that activity/action.

According to Neely et al. (1995), there are three general approaches for measuring performance:

- Individual performance, which is based on personal experience and proficiency.

- Performance measurement systems, which includes a set of metrics and standards.

- Relating the performance measurement system to the working environment.

Commonly, companies use performance measurement for the following purposes:

- Evaluation: measuring performance help the company to observe project's outputs and outcomes, which indicate vital information on the status of the project and the amount of progress made pertaining to its objectives. Besides, it is used to assess and compare the company with other competitors in the market (Behn, 2003).

- Regulations and control: project activities can only be controlled by defining performance standards, which are used to organize work and recognize deficiencies. During the evaluation process, if a certain indicator shows a deviation from an established standard, then a problem is there (Sink and Tuttle, 1995).

- Review: measurement indicators are usually utilized to set the initial diagnosis before carrying out an intervention to improve the workflow within a project or an organization as a whole. Such indicators aim at identifying strengths, weakness, and dysfunctions. During this phase, priorities are given to implementing improvement activities (Sink and Tuttle, 1995).

- Motivation: performance measures could also be used for motivating staff, increase their work capacity, and maintain continuous improvements during their work through continuous follow-up and individual feedback (Sink and Tuttle, 1995).

- Promotion: performance measurements could be utilized to ensure success, recruit additional resources, satisfy customers, staff and stakeholders in a way that reflects the outcomes achieved. In addition, it can aid in recognizing and planning staff's roles inside and outside the organization (Behn, 2003).

- Learning: performance measurements provide information, which could be utilized not only to evaluate but also to learn and improve. The objective of measurement is to identify what is done and working and what is not. For instance, the objective of learning would become to determine why (Behn, 2003).

- Improvement: measurements are also used to examine the impact of improvement activities on the performance of an activity (Sink and Tuttle, 1995). Organizations launch activities after establishing targets through indicators (i.e. using benchmarks as a reference) (Sink and Tuttle, 1995).

The significance of performance measurement is concurrently reflected in the standards of the measures as well as the discipline involved in the correlation analysis amid clients, activities, and results. Realizing the connections between measures lead to a better concentration on attaining the organization's objectives, mission, vision, and goals.

In the literature reviewed for this study, performance is classified into diverse types. Products and services, customer-focused, financial and marketplace, and operational are the main four typed of performance as per NIST (2014). Nonetheless, a common theme for the definition of performance is the description of it in terms of the ability to fulfill and satisfy business goals and objectives, and clients' demands and expectations.

2.3. Performance Measures and Indicators

There is a consensus in the literature reviewed to deal with a performance measure as a short-term assessment tool that provides users with indications of performance. And while some literature distinguishes between measures and indicators, NIST (2014) suggests that they are both numerical metrics that quantify the input and output of an organization’s processes or operations. However, the implementation of such measures aligns with the concept of SMART (specific, measurable, attainable, relevant, and timely) management practice (Robinson, Carrillo, Anumba and Ghassani, 2005).

The implementation of performance measures in construction management is challenged by the availability of a considerable number of measures and metrics used in the industry across the world. It is for the construction managers to select the performance measures that serve the business objectives of their organizations. However, Robson (2014) suggests that the number of performance measures or indicators to use in the assessment of organizational performance is highly irrelevant. He further suggests that the best approach is to use the minimum number of performance measures that can efficiently provide the management with an insight into the health and quality of business operations. Furthermore, the implementation of specific performance measures should be in accordance with a long-term strategic plan to achieve a state of sustainable development and improvement of the business process.

Though the implementation of performance measures in business operations management contributes positively to the business profitability and competitiveness, the lack of consensus on which measures are the most effective prevents many organizations from benefiting from the available performance measures (Tangen, 2003).

According to Kuragu, Baiden, and Badu (2014), an effective approach to choosing appropriate performance measures to implement is to review existing sets of measures to either adopt them or develop new ones per the business characteristics of interested organizations. Shen (2003) studied key competitiveness indicators for Chinese construction contractors. Through an analytic hierarchy process (AHP) approach, they derived a performance prediction model for construction contractors in the UK market. The model's effectiveness was proven and therefore is being widely used in the UK construction market.

In this section, some of the performance measures reviewed in preparation of this study are discussed:

2.3.1. English Small and Medium Enterprises (SMEs)

The English Small and Medium Enterprises (SMEs) use the following set of performance measures as the bases for business performance assessment (Kuragu, Baiden and Badu, 2014):

1. Productivity
2. Innovation.
3. Quality performance.
4. Customer performance.

5. Customer satisfaction.
6. Financial.
7. Meeting customer requirements.
8. Delivery for the customer.
9. Employee learning.

Because of their focus on a broad range of performance types, those measures establish the basis for evaluating the performance of business organization of various sizes and specialties.

2.3.2. Harvard Business Review Balanced Scorecard

The Harvard Business Review Balanced Scorecard enlists four broad types of performance measures as follows (Kaplan and Norton, 1992):

1. Financial.
2. Learning and growth.
3. Internal processes.
4. Customer.

The Balanced Scorecard performance measures have a broad definition which renders them vague and unspecific concerning their ability to measure particular performance characteristics. Hence, Kuragu, Baiden and Badu (2014) suggest that an organization would require prior experience of performance measures and indicators to effectively implement them.

2.3.3. MBNQA Performance Measures

The Malcolm Baldrige National Quality Award (MBNQA) is a world-class award that recognizes US organizations in the various sectors of business and non-profit operations for performance excellence. NIST (2014) outlines the following performance measures that are the basis for the nomination for the award:

1. Leadership.
2. Strategic planning.
3. Analysis and knowledge management results.
4. Operations focus.
5. Workforce focus.
6. Customer focus.
7. Measurement.

2.4. Benchmarking

The term benchmarking is derived from the word “benchmark”, which was first used by Xerox Company. Benchmarking could be defined as the ongoing process of evaluating and comparing an organization's products, practices, and services with other strong competing organizations in the market (AEP, 2006).

Typically, organizations consider the strongest competitors as benchmarks for the level of standards that they should achieve. Sometimes, organizations from different sectors or businesses may also be used as benchmarks. The objective of benchmarking is to boost the organizational performance and facilitate development by learning from others.

AEP (2006) elaborated on some of the basic attributes pertaining to the process of benchmarking. They are as follow:

- Systematic: benchmarking is performed in accordance with structural steps to collect information; it could not be done randomly. It is done step by step to assess the work practices of the best organization in a certain field. Following a systematic process enables the organization to make a good and profound comparison with the competitors in the market.
- Ongoing: to be effective, benchmarking, like most of the other managerial processes, must be done continuously in order to collect as much relevant information as possible. Benchmarking is not intended to be developed for just one time and that its results to be used for an extended period of time. It must be carried out on a periodic basis as the practices of other companies are changing and developing every day, and hence the results of each individual benchmarking process.
- Evaluation: the direct objective of benchmarking is to evaluate a process. Therefore, it is critical to measure and asses the health of the practices of other organizations before taking them as a benchmark.
- Products, Services, and Processes: benchmarking could be applied to all aspects of business (i.e. basic services, products, working processes and all other process and practices that help an organization achieve its objectives).
- Best practices: benchmarking deal with best practices and activities applied by the best organizations. In other words, the benchmarking process is not limited to competitors; it could be directed to other organizations who are well known of

their best practices (i.e. taking banks as a benchmark with regard to their best practices in data processing).

- Improvement: the goal of benchmarking is to improve the organization through the commitment to the concept of ongoing development. It should enable an organization to benefit from the compiled information in various ways to make meaningful changes in the organization' processes.

Along with the aforementioned basic attributes of benchmarking, there is one more important principle that should be considered to well realize this process. The practice of benchmarking is based on reciprocity where all involved persons benefit from the shared information. This is crucial for everyone involved so that none of the partners give up due to lack of realization of outcomes from participating and sharing valuable date with others (AEP, 2006).

There are some main benefits that organizations could obtain from the process of benchmarking (AEP, 2006):

- Increasing the probability of fulfilling the customers' needs by dealing with managing their affairs as an individual and measurable organizational process.
- Establishing attainable objectives by pushing the organization to maintain a continuous focus on the external environment and confirming their adaptation.
- Achieving true productivity by involving employees from all managerial levels in the resolution of the organization complications.
- Ensuring their competitiveness through better understanding of competitors and customers.

- Enabling the implementation of the best practices into organization's processes by understanding best practices employed by other organizations – that are recognized for their best practices.
- Motivating and encouraging the organization to pursue convincing objectives and improve existing work practices.
- Facilitating the internalization of practices needed for change through enhancing human resources and giving a sense of urgency to develop.

Benchmarking is vital for performance measurement and it helps construction companies to retrieve key performance indicators by comparing their own data with other companies. In addition, benchmarking helps construction companies to make better decisions based on the comparisons made (Beatham et al. 2004).

2.5. Key Performance Indicators (KPIs)

According to Maya (2016), a Key Performance Indicator (KPI) is “a measure of the performance quality in relation to an enterprise-critical to organizational and project success." However, different KPIs are used in different markets and by different organizations. The choice of which KPIs to be implemented in the construction management practices of construction contractors is highly dependent on the business objectives and needs of each contractor (The KPI Working Group, 2000). Nonetheless, contractors who operate within the same construction market would often share many characteristics. Hence, they would opt to use KPIs sets prepared by third parties such as governmental, academic or regulatory bodies that are often tailored to match the general business requirements in a specific market. This would eventually save them the time and effort required to prepare their own KPIs, in addition to benefiting from the shared practical experience with other construction contractors through the collaborative effort to build and refine national sets of KPIs (Alarcon, Grillo, Freire and Diethelm, 2001).

In this section of the literature review, some of the KPIs groups used in developed construction markets are discussed:

2.5.1. UK Construction Industry KPIs

The UK Construction Industry KPIs that are published in the annual UK Industry Performance report by the Construction Excellence organization are among the most prominent performance measures used in the construction industry nowadays (Construction Excellence, 2011). The KPIs are categorized into separate groups as follows:

1. Economic Indicators (All Construction)
    a. New build (Housing).
    b. New build (non-Housing).
    c. Repair, Maintenance and Refurbishment (Housing).
    d. Repair, Maintenance and Refurbishment (non-Housing).
    e. Infrastructure.
2. Respect for People Indicators.
3. Environment Indicators.
4. Consultants Indicators (Construction).
5. M&E Contractors Indicators.

2.5.2. Danish BEC KPIs

According to BEC (2013), the Danish government made construction benchmarking compulsory in August 2003. The Danish Construction Sector Centre for Benchmarking (BEC) developed a set of KPIs that is now a requirement for construction contractors who wish to bid for state construction projects to demonstrate their business capacity and capabilities through. Those KPIs are:

1. Defects' total economic value.
2. Defects in delivery.
3. The number of defects to be investigated further.
4. The number of serious and critical defects.
5. The number of less serious defects.
6. The number of minor defects.
7. The frequency of accidents.
8. Actual construction time compared to planned construction time.
9. Client satisfaction.
10. Client loyalty.

They are, however, classified into four groups that are Deadlines, Defects, Health and Safety, and Client Satisfaction (Mortensen and Hesdorf, 2013).

2.5.3. UK Rethinking Construction KPIs

The UK Construction Task Force developed the Rethinking Construction report on the purpose of providing means of performance, quality, and efficiency improvement for construction contractors in the UK. The report aimed at encouraging the

UK government, as the primary construction client in the UK, to lead a nationwide program to raise the standards in the construction industry in particular (Egan, 1998). In preparation of the report, the UK Construction Task Force studied the accumulated experience gained from similar industry improvement programs that could successfully achieve their intended goals in the UK market.

The Rethinking Construction Report identified seven KPIs through which construction contractors can work towards improving their business performance and output quality. Those indicators are as follows:

1. Construction Time.
2. Capital Cost.
3. Predictability.
4. Productivity.
5. Defects.
6. Accidents.
7. Turnover and Profit.

According to Kuragu, Baiden, and Badu (2014), the performance indicators enlisted in the report are the basis of several developments of other KPIs for the UK construction industry by various bodies. Such KPIs include the KPI Working Group KPIs, Construction Excellence KPIs, and Scottish Construction Industry KPIs.

Some of those KPI groups were reviewed in the preparation of this study and are illustrated in Table 1.

2.5.4. Construction Institute of the USA KPIs

In the US construction market, one of the largest in the world, the federal government does not enforce the implementation of a specific set of performance measures or KPIs as a prequalification for bidding for the federally funded project (Maya, 2016). However, the Construction Industry Institute of the USA has developed a KPIs group for construction contractors, of all subsections, through which they can assess the health of their business execution against the rest of industry's (Maya, 2016).

The Construction Institute of the USA’s KPIs group is comprised of the following performance indicators:

1. Performance.
2. Construction Productivity.
3. Engineering Productivity.
4. Engineering Practices.

2.5.5. UK KPI Working Group KPIs

The UK KPI Working Group KPIs came in response to Egan report which challenged the UK construction industry players to assess their business performance to meet the country’s ambitious improvement goals (The KPI Working Group, 2000). The KPI working group developed a comprehensive framework for performance assessment through which construction firms would be able to measure their organizational and project performance against the rest of the industry. The framework is comprised of seven groups into which KPIs are classified. Those are Cost, Time, Quality, Business Performance, Client Satisfaction, Client Changes, and Health and Safety. However, the

KPIs within those groups are further categorized into three levels: Headline Indicators which measure the well-being of an organization, Operational Indicators that pertain to certain features of the organization's operations and are meant to provide the management with the necessary information to focus on specific areas and units of business, and Diagnostic Indicators which are concerned with rigorous analysis of causes of change in the other two levels (The KPI Working Group, 2000).

Table 1 summarizes the KPIs groups reviewed in preparing this literature review.

Table 1 - KPI Groups from Literature Review

KPI Group	KPIs	Source
New Build (Housing)	Time, Cost, Profitability, Client Satisfaction, Quality & Defects, Time Predictability, Cost Predictability, Productivity, Safety.	(Construction Excellence, 2011)
New Build (non-Housing)	Time, Cost, Profitability, Client Satisfaction, Quality & Defects, Time Predictability, Cost Predictability, Productivity, Safety.	(Construction Excellence, 2011)
R & M & R (Housing)	Time, Cost, Profitability, Client Satisfaction, Quality & Defects, Time Predictability, Cost Predictability, Productivity, Safety.	(Souza, 2010)
R & M & R (non- Housing)	Time, Cost, Profitability, Client Satisfaction, Quality & Defects, Time Predictability, Cost Predictability, Productivity, Safety.	(Souza, 2010)
Infrastructure	Time, Cost, Profitability, Client Satisfaction, Quality & Defects, Time Predictability, Cost Predictability, Productivity, Safety.	(AEP, 2006)
Respect for People	Employee Satisfaction, Staff turnover, Sick Absence, Safety, Working Hours, Qualification & Skills, Equality & Diversity, Training, Pay, Investors in People.	(Alarcon, 2001)
Environment	Environmental Impact, Energy use, Utilities water use, Commercial vehicles movements, Area of habitat created/preserved, waste, Biodiversity Impact, whole life performance.	(Heravi & Ilbeigi, 2012)
BEC	Actual construction time, Economic Value of defects, Defects in delivery, Number of defects to be investigated, Number of serious defects, Number of less serious defects, Number of minor defects, Frequency of Accidents, Customer satisfaction, Customer Loyalty.	(Mortensen and Hesdorf, 2013)
Rethinking Construction	Construction time, Capital cost, Predictability, Defects, Productivity, Accidents, Turnover & Profit.	(Egan, 1998)
Construction Institute of the USA	Performance, Productivity, Engineering productivity, Engineering practices.	(Maya, 2016)
KPI Working Group	Cost, Time, Business Performance, Quality, Change Orders, Client Satisfaction, Health & Safety, Environment.	(KPI working group, 2000)
English SMEs	Quality performance, Productivity, Financial, Employee learning, Innovation, Customer Requirements, Customer Satisfaction, Delivery to Customer.	(Kuragu, 2014)

CHAPTER 3

PROPOSED KEY PERFORMANCE INDICATORS FOR SAUDI CONTRACTORS

Through the preparation of the literature review for this study, the most commonly used KPIs across the different KPIs groups were identified. Those KPIs will be used as the basis of the proposed set of KPIs for assessing construction projects' success for Saudi construction contractors. However, some KPIs were used as parts of different KPIs groups under different semantics or names, such as "Business Performance" which was referred to in the BEC group as "Customer Loyalty". Hence, a more indicative designation was used for them. The KPIs of choice are as follows:

1. Cost of Construction.
2. Time of Construction.
3. Quality and Defects.
4. Clients' Satisfaction.
5. End-Users' Satisfaction.
6. Regulatory Compliance.
7. Construction Cost Predictability.
8. Construction Time Predictability.
9. Productivity.
10. Profitability.

11. Business Performance.

12. Health and Safety.

13. People.

14. Environment (Environmental Performance).

In this chapter of the study, each of the selected 14 key performance indicators to be the basis for the study's survey will be discussed and illustrated.

3.1. Cost of Construction

The term "cost" stands for the expenditures incurred by the construction project's contractor in executing the project including materials, labor, utilities, services etc. In addition, contractor's profit and overheads should be included too in the cost calculations, along with all other expenditures incurred from project's inception to completion, such as those resulted from modifications and variations, or others that may be encountered as part of legal claims (Vasista, 2017). A good management of project's expenses significantly contributes to the success of the project. Managing project's costs requires a broad range of engineering and managerial skills pertaining to financial administration such as negotiations, decision making, value engineering, and timely responses to fluctuations of project's cost throughout the project execution. Wisely employing those skills, whenever and however needed, can keep the cost of the project in accordance with its projected budget (Olaoluwa, 2013).

Takim and Ankintoye (2002) defined cost management as the process of controlling the expenses throughout all stages of the construction project within the provided budget from work commencement to completion. Accurately measuring the cost of construction can enhance spending efficiency throughout the project. Usually, Cost Performance Index (CPI) is used to measure the cost. CPI is a process in which cumulative actual costs and cumulative earned values are measured and compared, it is an indicator for the efficiency of the cost of construction (Olaoluwa, 2013). Vasista (2017) provided the following formula for calculating CPI:

Formula 1 - Cost Performance Index (CPI) (Vasista, 2017)

$$Cost\ Performance\ Index\ (CPI) = \frac{Earned\ Value\ (EV)}{Actual\ Cost\ (AC)}$$

The process of managing the project's cost goes along the whole duration of the project, and hence is comprised of the following phases (DoF, 2009):

Initial phase.

Planning phase.

Execution phase.

Controlling phase.

Completion phase.

Cost management includes cost estimation and resources planning. That is, manpower, equipment, and materials are provided along with the precise quantities of demand of each resource to perform units of work as part of the construction process (PMBOK, 1996). The estimated cumulative cost of the utilized resources is what makes the projected budget. Construction managers should ensure that cost estimates are within a realistic budget (Jainendrakumar, 2015).

Vasista (2017) defined the cost of construction as a performance indicator as “the degree to which the general conditions promote the completion of a project within the estimated budget” (p. 45). On the other hand, KPI working group report (2000) defined the cost of construction as “the change in current normalized construction cost of a project compared with one year earlier” (p.15). That is, the percentage of difference in incurred costs of construction between two consecutive years for a comparable construction projects or units of work out of the construction cost of the earliest of them.

3.2. Time of Construction

Time of construction is essentially the time needed to complete the contracted construction project. A construction project’s delivery date is of a crucial importance to both the client and contractor likewise, as it marks the date at when clients can make use of the premises. It is the definite time that is measured as per the number of working (or calendar) days since the commencement of work on site until the substantial or full completion of the project (Chan and Chan, 2001). According to Vasista (2017), construction time could be measured as per the following formula:

Formula 2 - Construction Time (Vasista, 2017)

$$Construction\ Time = Practical\ Completion\ Date - Project'sCommencement\ Date$$

On the other hand, the variation in the contracted time of construction, that is due to delays or variations, could also be calculated as a percentage of the revised contract period according to the following formula:

Formula 3 - Time Variation (Vasista, 2017)

$$Time\ Variation = \left(\frac{Consruction\ Time - Revise\ Contract\ Period}{Revised\ Contract\ Period}\right) \times 100$$

Where: *Revised contract period = original contract period + Extension of Time*.

Many published papers that discussed the success factors of construction projects mention the time of construction in association with project efficiency. It could also be noticed that most researchers mention the time of construction along with the cost of construction as the two most prominent success factors for construction projects (Heravi and Ilbeigi, 2012). According to Chan and Chan (2001), the computation of the time of construction should consider the estimated needed time to execute contracted units of work, productivity rates, manpower, as well as incurred delays, extensions, and overrun of time after construction works are initiated. A schedule performance index was proposed by Heravi and Ilbeigi (2012) to measure the efficiency of construction time. It takes into consideration the aforementioned attributes to effectively and objectively asses contractors' utilization of contracted time in association with their planning and scheduling proficiency.

The KPI working group report (2000) identified time of construction, as a KPI for construction projects, as "the change in current normalized construction time of a project compared with one year earlier" (p.13). The difference in the time needed to complete each of two comparable construction projects over two consecutive years is expressed as a percentage of the total time needed to complete the earliest project. However, the projects are not necessarily executed on different years to be comparable.

3.3. Quality and Defects

In construction projects, quality of work and delivered products is very important, and maintaining a high level of quality to achieve customers' satisfaction could be a real challenge to many contractors. However, succeeding in that would eventually bring long-term business survival for the company as well as enhance its competitive position in the market. Moreover, the application of quality control standards in construction projects promotes the company's stand and increase its market share. Many researchers tackled the issue of quality control in construction companies especially the application of ISO standards, which have become a fundamental mean of development in most industries including the construction industry (Tan and Abdul Rahman, 2011).

The implementation of procedures of quality control in construction projects begins at the very early stages of the project, upon the pre-tender phase and the preparation of tender documents, working drawings, and specification. The maintenance of quality control and standards should, however, be kept throughout all the following phases of the project. In other words, quality should be maintained during the construction projects from the beginning of the design phase until the accomplishment of construction activities including the period dedicated for post hand-over warranty and maintenance (Mallawaarachchi and Senaratne, 2015).

In construction projects, Quality Assurance programs should cover the different activities pertaining to the execution of the project to ensure the provision of quality throughout all of project's stages. Quality Assurance involves setting policies related to the type of project as well as setting standards, guidelines, training and the systems necessary for following up and maintaining the desired level of quality. Such an attitude provides protection against defects and quality flaws since the early stages through raising awareness of indicators of performance defaults. Implementing a comprehensive and efficient quality control protocol can significantly reduce the possibility of occurrence of construction defaults and hence resultant changes and modifications (Mallawaarachchi and Senaratne, 2015).

Construction defects were defined by Prahl (2002) as the parts of the performed work, which are perceived as less than the promised or expected standards by clients or procurers of products or services. The term "construction defects" is very broad and could be used in reference to a broad variety of unsatisfactory building conditions i.e. leaky windows, unsuitably fitted doors, or the existence of what is known as the toxic mold (Mazier, 2001). The causatives of construction defects vary between lack of experience, lack of knowledge, lack of skills, building difficulties, improper design, missing information, unforeseen conditions, force majeure and so on (Atkinson, 1999). Construction defects are a mixture of inadequate technical support, inadequate administrative and operation skills. To avoid such defects, construction contractors would impose and consider quality control procedures before, during and after the completion of the construction project.

According to the Souza (2010), a KPI for construction projects pertaining to quality and defects can be defined as the condition of the delivered (handed over) construction product or facility in terms of quality and defects.

3.4. Clients' Satisfaction

In recent years, criticism has been drawn to mega players in the Saudi construction industry because of delayed project completion, poor project performance, costs overruns and high accident rates (Deolitte and Touche, 2018). Such defaults are due to contractors' poor quest for quality as well as insufficient investment in quality requirements. Clients are exerting pressure on construction contractors to attain higher quality standards (Al-Momani, 2000).

Research in the field of clients' satisfaction has highlighted various issues related to the evaluation of quality towards assessing the clients' satisfaction in the field of construction industry. Ling and Chong (2005) and al-Momani (2000) have identified the quality of construction projects/services as a key component for addressing and evaluating the clients' satisfaction.

The quality of the project, services, and manner are the three main quality elements that should be considered for achieving clients' satisfaction (Tang et al., 2003). In order to deliver a quality product to their clients, construction contractors need to internally follow reliable quality reassurance standards, such as ISO 9000 (Ekambaram, Thomas, and Mohan, 2006). ISO 9000 includes a set of standards and quality principles upon which the quality management is built within the organization. It aims to provide a broadly accepted standard to ensure the quality of work and services provided by business organizations and, thus, attain customers' satisfaction. The outline for clients' satisfaction is included in the ISO 9000's 2000 version of quality standards (Tang et al, 2003).

Souza (2010) defined client’s satisfaction as KPI for construction projects as simply the degree to which the client is satisfied with the delivered product or facility. It is important here to highlight the difference between clients and end-users of construction projects in the context of this study. A client of a construction project, who is typically its owner, is not exclusively its end-user, such as in the cases of real estate developers who purchase the services of construction contractors to resell housing building units to end-users, who will be the actual occupants and beneficiaries of the premises.

3.5. End-Users' Satisfaction

End-users' satisfaction refers to the happiness level of the anticipated occupants and direct beneficiaries of the project after its completion (Chan et al., 2002). End-users are usually satisfied when the project is completed on the announced time and with high quality and reliability. Besides, the level of services and cost efficiency play a key role in achieving end-user satisfaction (Bititici, 1994).

End-users' satisfaction in construction projects is usually measured post the completion and delivery of the project contracted. At such a stage, the contractor would have typically been paid most of the contract value. According to Torbica and Stroh (2001), if end-users' satisfaction is measured only at the very late phases of the project administration, upon or near its delivery, key information pertaining to different phases could be missed. They put up with the fact that stakeholders' satisfaction is supposed to be assessed during the primary phases of project management in addition to the project's accomplishment. Such a full assessment helps contractors to retrieve further knowledge concerning where they must increase their customers' satisfaction. This is a mutual process and the responsibility of carrying it falls on both the project's owner and contractor. Project's briefing is one effective approach to have potential end-users involved in the decision-making process before, during and after the construction of the project (Torbica and Stroh (2001). In addition, making use of questionnaires designed to retrieve feedback from end users would result in a better end-users' satisfaction, as flaws in the outcomes of managerial decisions by contractors can be recognized and hence immediately amended. In addition, while client's requirements of the project are what mainly sets the standards for the construction contractor, meeting end-users' requirement is what ultimately marks the project a success or failure.

According to Atkinson (1999), if only two criteria are to be applied to assess the projects' success, they should ultimately be end-users' satisfaction with the product delivered to them the and its functional efficiency (Atkinson, 1999). If the manufactured goods, delivered services, or handed over premises do not fulfill their needs in terms of perceived quality and functionality, end-users would be unsatisfied. Torbica and Stroh (2001) stated that the project is considered successful only and if only if end-users are satisfied with it. Accordingly, Souza (2010) defined end-users' satisfaction as KPI for construction projects as the degree to which the end-user is satisfied with the delivered product or facility.

3.6. Regulatory Compliance

Regulations are the set of norms and rules outlined by the established government and supported by the negative threat of sequence i.e. penalties, fines, punishments etc. (Edinburgh, 2003). Those negative threats are applied to enforce regulations. In the construction industry, regulations are established to regulate the workflow and organize the implementation activities in accordance with quality standards and the public interest of the community (Edinburgh, 2003).

Regulations surround the construction industry and entail that all related legislative documents are made and ready to administer the workflow. Construction regulations are significant for identifying the factors needed for promoting and determining the future regulation process of the construction project. In addition, they regulate the construction process and enforce the application of standards during all project stages (Architect and Quantity Surveyors Act, 2010).

Construction regulations are based on the emergent developments, which are associated with the economic, social and urban growth occurring on the local and international levels; they come in response to communities' organic needs as well as technological and societal changes. The regulatory factors include urban planning, resources conservation, climate changes, biodiversity and health, waste management and well-being of individuals and community involved and affected by the construction project. Globally, the association between regulations, construction practices, economic growth, social prosperity factors, and environment has been recognized (Christensen, 2009).

As a KPI for construction projects, regulatory compliance is defined as the extent to which the execution of the units of work is compatible with the local regulation and requirements.

3.7. Construction Cost Predictability

In construction projects, researchers and practitioners have emphasized the importance of producing cost estimates and needs assessments, that are as accurate as possible, using cost estimation models prior to projects' implementation (Bala, Bustani, and Waziri, 2014).

Considerable efforts have been exerted to develop and improve cost estimation models. Such efforts came up with various conceptual models, which have been used.

Some of these models include neural network (NN), regression analysis, probabilistic approach, fuzzy logic (FL), case-based reasoning (CBR) and genetic algorithm (GA). Researchers studied and documented the advantages and disadvantages of various cost estimation techniques. Hence, it is hard to say that there exists a perfect and flawless estimation method in the construction market (Sonmez, 2004). The estimation process is highly dependent on the professional experience of estimators, and the historical data the construction firm makes available to them.

Li, Shen and Love (2005) suggested a stepwise model based on linear regression to be used for building offices. Trost and Oberlender (2003) developed a multivariate regression model, and Lowe, Emsley, and Harding. (2006) built linear regression models to estimate the construction cost in the United Kingdom using data from 286 real buildings. Clearly, the literature about the cost estimation models is abundant, where many researcher and experts developed various models in this regard.

In a study conducted by Siquira (1999), NN technique was utilized to estimate the cost of constructing low-rise manufactured structural steel construction in Canada, it was clear that NN is efficient in cost estimation, yet the researcher recommended developing it further to obtain better and more accurate results and avoid potential shortcomings.

Regardless of the tools and techniques used to estimate construction cost, it remains an essential part of the successful planning for any construction process. It contributes to the contractor’s ability to win the contract and deliver units of work as per the specifications and within budget. Cost overruns due to improper or inaccurate estimation can result in substantial losses in capital for construction contractors if not covered through change orders. The KPI working group report (2000) defined construction cost predictability, as a KPI for construction projects, as “the change between actual construction cost and the estimated construction cost, as a percentage of the estimated cost” (p. 13).

3.8. Construction Time Predictability

Proper management of construction projects requires the establishment of a precise schedule for all units of work to be executed as part of the project over its contracted duration. The duration of a construction project is basically the number of months, week or days from the project’s commencement until completion. Time is critical for all project's stakeholders; owners, contractors, managers, clients, end-users and even neighbors to the site. Thus, it is important to establish a precise, yet achievable, schedule and timeline and ensure an adequate constant updating process of them in accordance with the progress of work on site.

The completion of projects according to the established schedule is a key factor indicating projects’ success, as construction contractors are subject to penalties in cases of delays (Kumaraswamy and Thorpe, 1996). In addition, exceeding the estimated duration of a construction project means employing contractor’s resources for longer than anticipated period which translates to additional costs, decreased profitability and even losses in a variety of scenarios. Time growth, which is also called time overrun, is a negative indicator where the project could be judged unsuccessful if the time overrun negatively affect the clients’ intended objectives, and hence end-users’ satisfaction.

In construction projects, it is critical to deliver the project on time, as projects’ stakeholders attribute the success of the project to a large extent to the overall cost and time required to complete it (Lim and Mohamed, 2000). There are various techniques for assessing and estimating the construction time like the time variance techniques (Salter and Trobett, 2003), (Odeh and Battaineh, 2002).

Observing the time of activities implementation help construction project managers to judge whether the project is running efficiently and on schedule. Ensuring timely delivery of contracted projects is of an essence for the business position of construction contractors (Latham, 1994). Construction time is the period elapsed since the commencement of the project's site works until completing and handing over the project to clients. Construction time, schedules, and anticipated delivery date are among the most prominent details included in construction contract documents. The KPI working group report (2000) identified construction time predictability, as a KPI for construction projects, as the “change between actual construction time and the estimated construction time, as a percentage of the estimated time” (p. 15).

3.9. Productivity

Productivity in the construction industry stands for labor efficiency, which is the units work produced per person-hour. Halligan, Demsetz, Brown, and Pace (1994) indicated that the converse of labor efficiency, person-hours per unit (unit rate), is also frequently used.

The concept of earned hours is commonly used in the U.S.A. and is increasingly becoming more popular in the U.K. as well. This concept relies on specifying output standards for every unit of operation. Therefore, the number of earned hours is directly linked to the work units completed in the field. Accordingly, productivity could also be defined as the proportion of realized productive work hours to the projected ones. This concept is, however, problematic with establishing reliable setting standards and norms. Besides, this concept is influenced by the techniques used to evaluate efficiency as well as to what extent other factors that might affect it are taken into consideration (Horner and Talhouni 1996).

Diverse measures of productivity are used for various objectives. Therefore, it is crucial for the success of the assessment process to select a measure that is suitable for the intended objectives (Thomas, Maloney, Horner, Smith, Handa, and Sanders, 1990). Hence, as a KPI for construction projects' success, productivity stands for the contractor's value added per worker on job site (Souza, 2010).

3.10. Profitability

Profitability reflects the financial success of a construction project along with the fact the project is substantially accomplished and submitted as per the contracted specifications (Parfitt and Sanvido, 1993). An increment upon which revenues exceed costs, profitability is calculated as the total revenue over the total costs (Norris, 1990).

Profitability is calculated during post-construction stage where all final accounts are settled between the paid and paying parties (Chan et al, 2002). Maloney (1990) discussed profitability as all the proceeds made by an organization beyond the expenditures for generating that proceeds.

Managing construction improperly would eventually lead to low productivity and ultimately affect the success of the project. Accordingly, it is critical for contractors and project directors to familiarize with the latest and most reliable techniques for assessing labor work's and equipment's productivity on work sites. To attain the expected income from a construction project, and hence the anticipated profit, it is imperative to grow a strong regulatory hand over productivity features, which contribute to the production integration i.e. labor, cash flow, equipment and so on (Parfitt and Sanvido, 1993). Profitability of a construction project cannot be dissociated from other attributes, such as productivity, quality control, proper planning and scheduling of units of work, and value engineering.

However, in order to be implemented as a KPI and a performance measure, Souza (2010) suggested that profitability of a construction project is the gross profit realized as a percentage of sales, or expenditures.

3.11. Business Performance

The issue of evaluating business success and failure is subjective, to a certain extent, and differs from a manager to another since it is based on individual's professional experiences and indices used by the project manager. In other words, for the same project and using the same data, it is rare that two project managers would give the exact same performance assessment. The difference in judgment is justified by variations in appraisal procedures and techniques. Generally speaking, if a project is completed with high quality, excellent safety records, and high customers' satisfaction, it could still be considered a success even if it was behind schedule or over budget (Bannerman, 2008).

Improving the quality of delivered products and service by an organization translates into future projects for the company which would eventually result in progressive effects such as better competitive position in the market, more future projects, and enhanced revenues and profitability (Kärnä, 2014). In the context of key performance indicators for construction projects, Masrom (2012) attributed a combination of several qualities to the business performance: profit value, opportunities for being awarded future projects, ability to deliver projects as per the contracted specifications and within time and budget, and the achievement of business objectives through projects executed.

3.12. Health and Safety

In construction projects, health and safety could be defined as the level to which precautionary measures and conditions are promoted during a project's implementation to avoid any major accidents or injuries (Bubshait and Almohawis, 1994). Measuring the safety of a project focuses primarily on the construction phase since major incidents usually happen within that phase particularly. Globally, construction industry is considered among the highest in rates of work-related accidents, where hundreds of workers, people, and assets are affected by them each year. Construction workers around the world are subject to fatal incidents on job sites three times more than workers of any other economic activity (Sousa and Teixeira, 2004).

Over the years, according to Sousa and Teixeira (2004), traditional measures of construction safety performance showed that the sector has already reached a plateau. There are strong standards in this sector, and it includes strict process along with advanced management system for competency. Nonetheless, that does not negate the need for further efforts to be exerted to further develop health and safety performance on construction sites; as accidents are still being reported daily across them around the world. Taking into consideration the fact that construction industry would probably remain among the most hazardous industries for decades to come (Fleming and Lardner, 2008), additional focus should be made on compliance with health and safety documents, legal and regulatory frameworks, safety data, quantifications, changeable technical systems, and empowerment of workers exposed to risks.

In accordance with that, Fleming and Lardner (2008) stated that the level of cultural awareness of construction environment along with described safety standards are vital for promoting health and safety standards on work sites. Authors has also stressed the need for improving workers' acquaintance, and hence their attitude, towards achieving the positive change desired. Furthermore, labors and workers who execute tangible construction work activities on site should be part of any health and safety development process; their feedback is of a crucial importance to the process.

As a KPI for the success of construction projects, health and safety pertains to the general health and safety conditions on job sites, occurrence of work-related accidents, injuries and fatalities, security, hazard avoidance, and safety measures on job sites.

3.13. People

The process of identifying key performance indicators for people is a challenging process for some construction contractors. Construction contractors typically seek to recruit and retain the best human cadres to manage their resources in a highly effective manner. And as working partners exert efforts to achieve radical improvements on construction sites around the hour, such improvements are organically accomplished through people; whether those who are directly involved in the construction activities of the project of concern i.e. labors, engineers, project managers, or others who are involved in supporting activities that are indirectly influencing the performance of their coworkers i.e. senior managers, project coordinators, contract administrators, etc. Supporting the endeavors of those people is essential for the success of any construction project. Considering people amongst the projects, KPIs should reflect contractors' respect for both individual and collective interests of their workforce (Chan and Chan 2004).

However, and concurrently, a state of equilibrium should be achieved between their interests and the business interests of the organization represented in the job duties and responsibilities assigned to them. For instance, workers’ fulfillment of their job-related tasks is what makes them entitled of the set of benefits and pays the company provides them with (Thomas et al., 1990). Investing in contractors’ workforce contributes positively to the progress of contracted projects’ and accomplishment of their objectives. Personnel morale is among the most influential factors that affect the overall productivity, and hence profitability and even the success, in a construction project.

Though there is a verity of rules of thumb that are intended to simplify the process of managing workforce on construction sites, especially when it comes to calculating the ideal amount of manpower needed to accomplish certain units of work or issues related to overtime pay and productivity, there remains no golden rule for project managers and contractors to follow. Hence, managing construction teams’ personnel requires a fair degree of interpersonal skills, acumen, empathy, and at the same time, rigor. The best formula to be used is to basically build an atmosphere of trust and cooperation between employees and employer (Horner and Talhouni 1996).

People KPIs that are used in construction include some sub criteria as follow (Ofori-Kuragu, Baiden, and Badu, 2016):

1. **People Management:** concerned directly with the affairs of employees directly or indirectly engaged in output-related activities.

2. **People Satisfaction:** concerned with staff's overall satisfaction as well as incidents' rates.

3. **Leadership:** concerned with the roles that senior managers play in modeling the organization through outlining its value, culture, mission, and vision along with behavior.

4. **Policy and Strategy:** concerned with staff and employees as a component of the planning and implementation of organizations' policies, work strategies, and long-term business objectives.

5. **People Results:** concerned with measuring techniques implemented to and achieve employee' satisfaction for comparative purposes.

6. **Society Results:** concerned with ethical standards and social responsibilities of organizations towards their staff, and the community they operate within in general.

People indicators are intended to complement the requirements needed for developing people culture and community. Hence, as a KPI for construction projects' success, "People" is pertaining to employees' training and learning, qualifications, skills, pay, working hours, morale, absences, workforce and human resources management. Proper consideration of those indicators provides construction contractors with the guidance and support for developing work areas and the surrounding community (Horner and Talhouni 1996). Furthermore, using people KPIs provides underpinning measures, which enable the company to evaluate its performance and work progress.

3.14. Environment (Environmental Performance)

In recent years, governments, organizations, and communities have been paying more attention to the environment and exerting considerable efforts to preserve its wellbeing. In the construction industry, environmental performance should be considered not just for the fact that environment is where we live and work, but also for the evident significance of it to the wellbeing of the community as a whole on the long run. Environmental performance is an integral part of sustainability. In a study conducted by Chan and Chan (2001), the significance of environmental performance in construction industry was concluded, and evident was the need to develop scores for measuring contractors' environmental performance. In this regard, Heravi and Ilbeigi (2012) developed an environmental performance index that includes guidelines concerning contractors' consideration towards environment-related issues. Besides, it notifies of the additional expenses to the community and environment, which are widely unforeseen or ignored, that are to be disbursed in indirect ways due to normal construction activities during the construction phase.

Practically, and in the construction management context and as a KPI for construction contractors, environmental performance stands for the level of excellence in handling or minimizing potential and actual negative consequences affecting the environment as a result of projects' execution. For instance, it includes waste reduction and management, energy conservation, water conservation, greenhouse gases' emissions and other pollutants as by-products for construction services, and direct and indirect contribution to deforestation (Heravi and Ilbeigi, 2012). This could be subjectively assessed using some commonly used measures.

CHAPTER 4

METHODOLOGY

4.1. Research Problem

Traditional approaches to performance measurement in organizations may not aid in improving the organization's performance. They fail to provide clear indicators of what needs to be changed in the way an organization is managed and operated. Instead, they focus on aspects that are more associated with financial feasibility and profitability of the business instead of the best practice and performance assessment. However, integrating different approaches of performance measurement into a unified single more comprehensive approach can render the performance assessment process more efficient and its output more beneficial for the users (Robson, 2004).

The ever-increasing number of newly developed performance measures does not make the selection of appropriate non-financial measures an easy task for companies. Companies would usually need assistance in compiling sets of measures that are most appropriate for their own conditions and situation or a set of criteria to help them chose performance measures based on (Tangen, 2003).

It is therefore undoubtedly crucial to developing a set of KPIs that are relevant to the needs and objectives of local construction contractors. Such a set should incorporate both financial and non-financial indicators, as reliance on financial indicators only can be highly misleading to the decision-makers in the contemporary construction market. Furthermore, the number of KPIs in such a set should be the minimum that can yield to a proper assessment of the performance of a construction contractor in a particular project, whether satisfactory or not.

4.2. Research Question

- What KPIs are the most prominent and which of them are relevant for implementation by Saudi construction contractors to assess their business performance?

4.3. Research Objectives

The objectives to be achieved by conducting this study are the following:

1. Identifying the most commonly used KPIs that also recognize the needs and conditions of the Saudi construction market.
2. Developing a KPIs Model that is relevant for the use of Saudi construction contractors.

This study is expected to be of a benefit for Saudi construction contractors as it will provide them with a set of KPIs that serves their business demands and objectives. Besides, such a set would eventually help them improve their performance and hence their competitive position in the market. Contractors would be able to effectively and efficiently assess their business performance on a periodic basis. Measures of correction can, therefore, be taken proactively in future projects to compensate for any deficiencies and weakness in business operation.

4.4. Research Limitations

Following is a set of the limitations of this study:

1. The study will be constrained to Saudi Arabia’s Eastern Province.
2. The contractors to be surveyed are building construction contractors.
3. The contractors to be surveyed are in grades 1, 2, and 3 as per MOMRA’s classification.
4. Evaluation of KPIs will be based on the contractors' perspective.
5. To avoid hesitance and unwillingness of contractors to provide business related information, the questionnaire survey clearly indicates that the collected information will only be used for academic research.

4.5. Importance of the Research

The implementation of a performance measurement system is a strategic decision for construction contractors to take. On the long term, it may enable them to improve business processes, outputs, resources management and raise the standard to which they perform their business tasks (Robinson, Carrillo, Anumba and Ghassani, 2005). However, the lack of a locally adapted performance measurement model or a set of KPIs deprives many construction contractors of those potential gains.

The preparation of a set of KPIs in correspondence with input from local contractors, as the primary objective of this study, would provide the construction market with a valuable tool to assess predominant business practices. Those KPIs will also serve as a construction management tool through which construction managers and professionals would be able to more efficiently control business operations and gauge the impact of their managerial and engineering decision on the progress of projects towards desirable objectives.

The importance of the research stems from the fact that it is the first to investigate KPIs applicability in the Saudi building construction industry. And since such work has not been commenced earlier, it can be the foundation for further future works in this field.

4.6. Methodology

In order to accomplish the intended objectives of this research, a systematic study methodology should be followed. At first, literature concerning performance measures and KPIs will be carried out to identify the most popular KPIs. Using those KPIs, a questionnaire survey form will be prepared in which respondents will be asked to rate the elected KPIs, based on their experience and opinion as construction professionals. The rating of the KPIs is an indicator of their perceived relevance for the Saudi construction market from contractors' perspective. The questionnaire will be distributed both electronically and by hand among building contractors of grades 1, 2, and 3 situated in the Eastern Province of the Kingdom. The survey's results will be analyzed and then validated through interviews with construction experts, who would preferably be selected from diverse backgrounds (e.g., industry, market, regulatory). According to Moriarty and Smallman (2009), such an approach would give an indication of the validity and relevance of the conducted literature review, from which the KPIs in question are elected.

4.6.1.Study Population and Sample Size

The study's population will be construction contractors based, or active, in Saudi Arabia's Eastern Province. However, they are to be of either grade 1, 2, or 3 according to MOMRA's classification and engaged in building construction projects.

According to MOMRA's database of classified contractors, there are 81 building contractors in grades 1, 2 and 3 located in the Eastern Province. (MOMRA, 2018).

Classification of the contractors is based on several factors including the following (ACC, 2018):

- Financials: Capital, Budget, Turnover, Shares, and Assets, Working capital, Profit, Revenues, Revenues from contracts, liquidity ratio, debts, and cost-effectiveness ratio.
- Staff and Manpower: Engineers, Managers, Specialists, Technicians and jobs localization.
- Equipment.
- Projects: Projects' budgets and size, Project types, Megaprojects executed and Works continuity.

Only building contractors of grade 1 are permitted to undertake projects with a value exceeding SAR200 million. On the other hand, grade 2 building contractors are permitted as per MUMRA's regulations to go for projects with a total value up to SAR200 million. Grade 3 building contractors can take projects valued up to SAR70 million (ACC, 2018).

As the population size (N) for this study is 81, which is finite, Kish (1965) suggested using the following formula to calculate the effective sample size (n):

Formula 4 - Effective Sample Size (Kish, 1965)

$$n = \frac{m}{1 + (\frac{m-1}{N})}$$

Where n is the sample size of the finite population, m is the sample size for the infinite population, and N is the sample size for the available population. However, m can be calculated using the following equation (Kish, 1965):

Formula 5 - Infinite Population Sample Size (Kish, 1965)

$$m = \frac{z^2 \times p \times (1 - p)}{\varepsilon^2}$$

Where z is the confidence level's statistic value, p is the value of the proportion of the population being estimated, and ε is the sampling error.

Table 2 illustrates z values associated with commonly used confidence levels.

Table 2 - z Values in accordance with confidence levels

Confidence Level	***Z* Value**
99%	2.575
95%	1.96
90%	1.645

However, since the p-value is undetermined, Hogg, Tannis, and Zimmerman (2015) suggest the use of a conservative value of 0.5 to ensure that the sample size is satisfactory.

Babbie (2000) suggests that using a confidence level of 90% or less increases the risk of the sample not to be representative of the population, whereas using a confidence level of 99% reduces that risk. 95% would be a reasonable confidence level for this study.

Using formula 5 with a confidence level of 95%, significance level (ε) of 0.05 and a p-value of 0.5, the value of *m* can be calculated as follows:

$$m = \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{0.05^2} = 384.16$$

Hence, and considering N value of 81, the effective sample size n can be calculated using formula 4 as follows:

$$n = \frac{384.16}{1 + (\frac{384.16 - 1}{81})} = 67$$

The effective sample size obtained is 67. Therefore, for the sample to be precise and representative, at least 67 contractors need to be surveyed.

However, since the population size of this research is less than 200, a complete census of all the 43 grades 1 and 2 building contractors in the eastern province may alternatively be considered. Collecting data from the entire population of the study, whenever possible, has the advantage of eliminating sampling errors in addition to providing information about all individual respondents (Israel, 1992). Israel (1992) further suggests that sampling the whole population is the answer to achieve the desired level of precession in small populations.

Even though a complete census implies no-sampling approach, if a decision is taken to survey the entire population in this study, it may still be considered a case of purposive sampling according to (Smith, 1983). However, the survey of all the 81 building contractors might not be feasible in terms of time and effort. Therefore, the sample size obtained, 67, will be the basis of the survey.

Certain characteristics in respondents are sought after and hence the decision to survey contractors of specific grades and in one geographic location was taken. Such a specification of the scope of the evaluation process would result in a better quality of the collected data. Larger contractors are more likely to be interested in implementing performance measuring systems and KPIs in their business (Alarcon, Grillo, Freire and Diethelm, 2001). Therefore, surveying grades 1, 2, and 3 building contractors would likely result in a higher returns rate in addition to providing insights on the potential beneficiaries of a set of KPIs designed for the Saudi market.

4.6.2.Questionnaire Design

For the purpose of the study, data was collected through a specially designed questionnaire survey form that evaluates the significance of different KPIs for respondents’ business operations. The form consists of two sections. In the first section, respondents were asked to provide basic information about themselves and their firm’s characteristics and business operations. In the second, respondents were asked to assess the significance of selected KPIs’ and their relevance for Saudi construction contractors using a Likert scale grading system. The relative score of each KPI is an indicator of whether they should be included in the proposed set of KPIs from the respondents' perspective.

The scale used in the survey form gives the option to assign a score between 1 and 5 for each KPI, where:

1 = Not Significant, 2 = Low Significance, 3 = Significant, 4 = High Significance and 5 = Very High Significance.

An initial draft of the questionnaire was distributed among 33 construction professionals of different backgrounds to assess its clarity and convenience. Hence, minor modifications were made including adding a descriptive table of the KPIs in question. The questionnaire survey form can be found in Appendix A.

An online version of the questionnaire was also prepared using Google Forms (https://goo.gl/forms/4cnmWjlkGnoVljuP2) and distributed through email and professional groups on social media.

4.6.3. Data Collection

As the final draft of the survey was ready, a total of 67 building contractors were invited to participate in the study. They were chosen from MOMRA's published database of classified contractors in the Eastern Province of Saudi Arabia. Participants were approached through visits to offices and construction sites, phone calls, emails, and means of electronic communications. Responses were received from a total of 49 contractors whom are: 15 contractors of grade 1, 18 contractors of grade 2, and 16 contractors of grade 3. All of them are either registered or active in the Eastern Province. Hence, the response rate to this study is 73% out of the used sample size of 67. However, more than a single response was received from some contractors, as more than a single construction professional contributed to the survey. Such that the total number of responses is 53.

According to McNeill and Chapman (2005), Gillham (2000), a response rate of 30-40% is required. On the other hand, Babbie (2000) required a response rate of not less than 50% to accept the results a survey. Accordingly, with 49 responses from 67 surveyed contractors, which amounts to 73%, the response rate to the questionnaire is sufficient.

The participants target for this study were mostly in senior positions with a professional experience of 10 years or more in the construction field. However, some other senior level construction professionals were also approached for the purpose of reviewing the survey results.

4.6.4. Data Analysis

In this study, a 5-point index ranking system is used to identify the most significant KPIs to Saudi construction contractors. However, Dominowski (1980) and Fugar and Agyakwah-Bahh (2010) suggest, that in such an approach, to evaluate the importance of each KPI relative to other KPIs using an index, which would eventually allow for ranking them according to their relative importance as per the survey’s results. Correspondingly, the Relative Importance Index (RII) technique can be used. The RII score of each KPI can be calculated through the following formula:

Formula 6 - Relative Importance Index (RII) (Fugar and Agyakwah-Bahh, 2010)

$$RII\ (\%) = \frac{5(n5) + 4(n4) + 3(n3) + 2(n2) + n1}{5(n1 + n2 + n3 + n4 + n5)} \times 100$$

Where in this formula:

N1= the number of respondents that assigned a score of 1 to the KPI

N2 = the number of respondents that assigned a score of 2 to the KPI

N3 = the number of respondents that assigned a score of 3 to the KPI

N4 = the number of respondents that assigned a score of 4 to the KPI

N5 = the number of respondents that assigned a score of 5 to the KPI

According to Hassanain and Juaim (2011) and Dominowski (1980), the use of an appropriate calibration allows for the quantification of the importance index (I) for each of the evaluated KPIs. Hence, the importance index can be classified based on the ranking system illustrated in Table 3 (Hassanain and Juaim, 2011).

Table 3 - Importance Index Ranking System (Hassanain and Juaim, 2011)

Importance Index (Value)	Ranking
0 - < 12.5%	Not Significant
12.5% - < 37.5%	Low Significance
37.5% - < 62.5%	Significant
62.5% - < 87.5%	High Significance
87.5% - 100%	Very High Significance

The relative importance index should provide a linear transformation for the results over the range [0.1]. However, examining the RII equation shows that it converts the results over [0.2,1] which casts doubts over the proposed range in Table 3. Hence, an adjusted relative importance index RII $_{adj\ (5)}$ as per Holt (2014) will be used. Formula 7 is used to calculate RII $_{adj\ (5)}$:

Formula 7 - Adjusted Relative Importance Index (Holt, 2014)

$$RII_{adjust\ (5)}\ (\%) = (125\ \times RII) - 25$$

Accordingly, the classification system in Table 3 must be changed. Table 4 shows the new classification system that will be used throughout our analysis. If the RII $_{adjust(5)}$ score of a certain KPI falls below 25%, the KPI should be excluded from the proposed KPIs list. This preliminary assessment should allow to exclude the irrelevant KPIs off the proposed model.

Table 4 - Adjusted Importance Index Ranking System (Holt, 2014)

Adjusted Importance Index (Value)	Ranking
0 – < 25%	Not Significant
25% - < 50%	Low Significance
50% - < 75%	Significant
75% - < 87.5%	High Significance
87.5% - 100%	Very High Significance

Furthermore, IBM SPSS 16 is used as a statistical analysis tool to further analyze the obtained data. Principal Component Analysis (PCA) is performed as a dimensionality reduction technique (Field, 2009). It serves to assort the eligible KPIs, as per their respective Adj. RII scores, into major groups through building a linearly uncorrelated set of variables [Principal Components] (Field, 2009). However, as the validity of such an approach needs to be assessed, both Kaiser–Meyer–Olkin (KMO) and Bartlett's tests are also performed.

Finally, 15 expert interviews are conducted with senior professionals, members in the Saudi Council of Engineers, and academics in the field of construction engineering and management, to validate the proposed KPIs model. They were presented with the survey results, after analysis, and asked to provide their insights on them. The interviewees were carefully selected to include contractors, consultants, construction professionals, and academics such that the feedback obtained comes from different perspectives. In addition, they should also have at least 15 years of experience in the field of construction and projects' engineering and management.

CHAPTER 5

RESULTS AND ANALYSIS

5.1. Demographic Analysis

Looking at the obtained data from the survey distributed, it is noted that responses were received from 49 different contractors who operate in the Eastern Province of Saudi Arabia. And as mentioned earlier, more than a single response were received from some of those contractors, and hence the total number of respondents is 53. Hence, the response rate of the questionnaire is 73% considering 49 responses, or 79% considering 53 responses.

Although all the them work in building construction firms, their respective positions in their firms vary. Among them, there are 11 in engineering positions, 12 directors and coordinators, 25 managers of different divisions and specialties, 1 consultant engineer and 4 in senior executive positions. The distribution of respondents according to their positions is illustrated in figure 1.

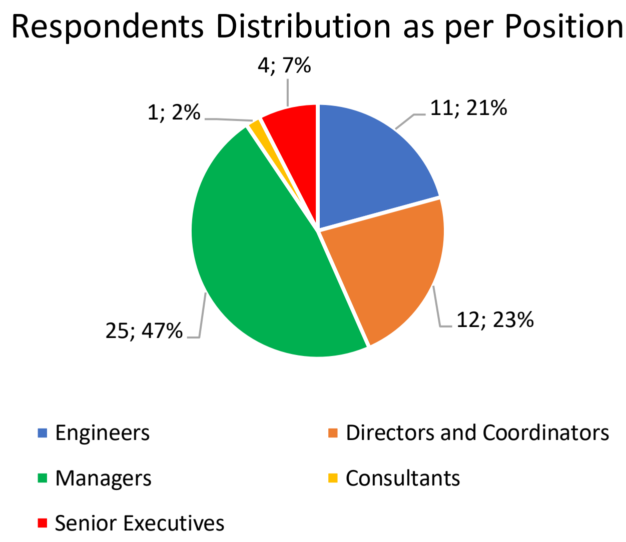

Figure 1 - Respondents' Distribution According to Position

The data collected also reveals other important characteristics pertaining to the sample of the study. The minimum amount of years of experience of the respondents is 9 years, while the maximum is 37 years. The average of respondents' input is 20.34 years of experience. Hence, we can claim that the sample included construction professionals who have considerable experience in the field of building contracting, whom as well are familiar with the nature of the market, its flaws, performance measurement and benchmarking.

With the study sample restricted to be taken from building contractors of classifications 1, 2, and 3 as per MOMR's ranking, it is also worth noting that 16 participant contractors are of grade 1, 20 of grade 2, and 17 of grade 3. Figure 2 shows the distribution of surveyed contractors based on their respective obtained grade from MOMRA.

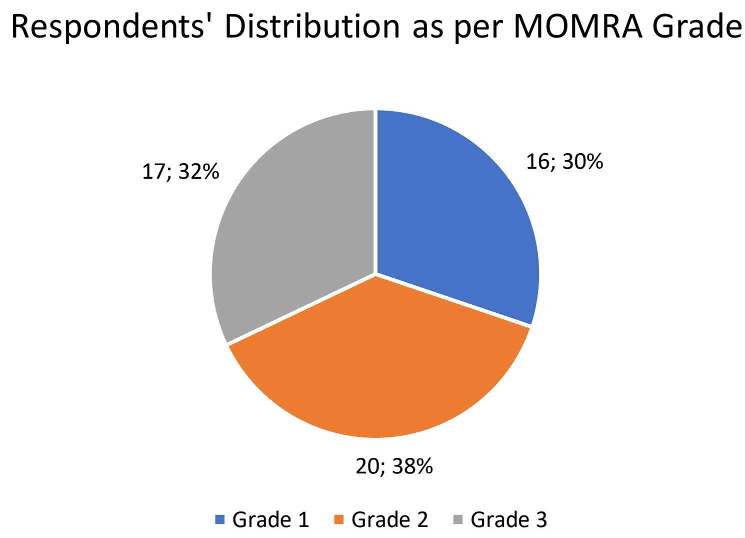

Figure 2 - Respondents' Distribution According to MOMRA's Grade

It is also noticeable that amongst the 53 responses to the survey received, only 11 claimed that their firms adopt or deal with performance measurement tools, representing 20.75% of the sample size as illustrated in Figure 3. Among the answers, there were respondents who suggested that that their firms use post construction measures as a mean to asses performance. For instance, they mentioned assessment of the extent to which units of work executed comply with contracted specifications in addition to revision of work logs to identify points of strength or weakness. An approach that goes in line with basic concept of KPIs but with minimal consideration for other major influencing factors as it would be elaborated upon in section 10.4 of discussion.

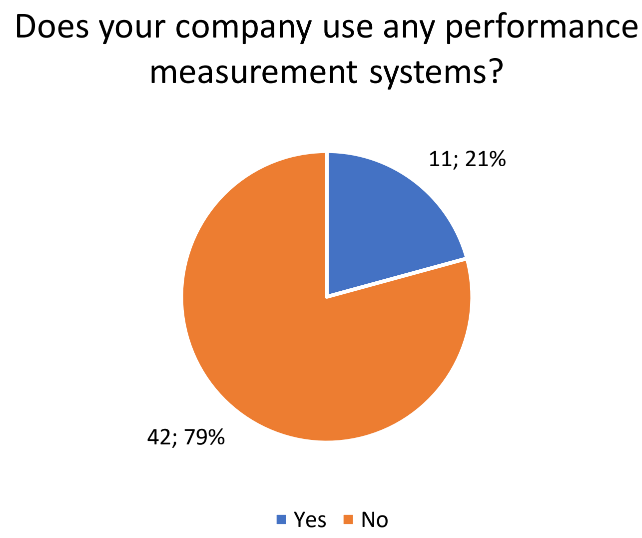

Figure 3 - Percentage of Respondents Who Use Performance Measurement Systems

5.2. Results Analysis

Table 5 summarizes the results of the survey obtained. It shows the RII and the adjusted RII values for each KPI. Besides that, the mean, median, mode, variance, and standard deviation for each KPI are included. The various KPIs are ranked according to their adjusted RII.

Table 5 - Descriptive Statistics for Proposed KPIs

KPI	Rank	RII (%)	Adj. RII%	Mean	Median	Mode	Variance	St. Dev.
Cost of Construction	1	86.038	82.547	4.302	5	5	0.638	0.799
Time of Construction	2	83.774	79.717	4.189	4	5	0.887	0.942
Quality and Defects	3	82.642	78.302	4.132	4	5	0.925	0.962
Client Satisfaction	4	80.377	75.472	4.019	4	4	0.827	0.909
Health and Safety	5	76.981	71.226	3.849	4	5	1.092	1.045
Productivity	6	76.604	70.755	3.830	4	4	0.798	0.893
End-user Satisfaction	7	76.226	70.283	3.811	4	3	0.887	0.942
People	8	73.585	66.981	3.679	4	4	0.953	0.976
Regulatory Compliance	9	73.208	66.509	3.660	4	4	1.229	1.108
Construction Time Predictability	10	72.075	65.094	3.604	4	4	0.590	0.768
Profitability	11	70.566	63.208	3.528	3	3	0.831	0.912
Construction Cost Predictability	12	69.811	62.264	3.491	4	4	0.601	0.775
Business Performance	13	67.925	59.906	3.396	3	3	0.782	0.884
Environment	14	38.491	23.113	1.925	2	2	0.610	0.781

The preliminary assessment using RII $_{adjust(5)}$, and considering the classification from Table 4, deemed the KPI of "Environment", with an adjusted RII of 23.113% as not significant, as per the proposed ranking system illustrated in Table 4. It falls below the significance threshold of Adj. RII of 50% and is even within the non-significance classification which tops up at 25% as an Adj. RII score. Hence, the proposed model will include 13 KPIs as illustrated in Table 6.

Table 6 - Significant KPIs

KPI	Rank	RII (%)	Adj. RII%
Cost of Construction	1	86.038	82.547
Time of Construction	2	83.774	79.717
Quality and Defects	3	82.642	78.302
Client Satisfaction	4	80.377	75.472
Health and Safety	5	76.981	71.226
Productivity	6	76.604	70.755
End-user Satisfaction	7	76.226	70.283
People	8	73.585	66.981
Regulatory Compliance	9	73.208	66.509
Construction Time Predictability	10	72.075	65.094
Profitability	11	70.566	63.208
Construction Cost Predictability	12	69.811	62.264
Business Performance	13	67.925	59.906

5.3. Principal Component Analysis (PCA)

After the preliminary assessment using the adjusted RII, Environment's KPI was dropped from the KPIs model. And in order to reduce the remaining KPIs into major groups, Principal Component Analysis (PCA) is used. However, the validity of the approach must be verified, hence, the Kaiser–Meyer–Olkin (KMO) test for sampling adequacy coupled with Bartlett's test of sphericity are used. We used SPSS 16 to analyze the data. Table 7 shows the results of the KMO measure of sampling adequacy and Bartlett's test of sphericity.

Table 7 - KMO and Bartlett Tests' Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.671
Bartlett's Test of Sphericity	Approx. Chi-Square	535.343
	Df	78
	Sig.	.000

The KMO reading is 0.671, a mediocre level. The minimum acceptable level is 0.5 according to Field (2009). Bartlett's test of sphericity χ^2 (78) = 535.343, $p < .001$ indicates that correlation matrix of the inputs is sufficiently large and are significantly different from the identity matrix. As the KMO value Indicates that the sample size is adequate and Bartlett's test value shows that correlation between variables is significant, the PCA approach to extract the themes among the various KPIs is justified.

To determine the number of factors to extract, an initial analysis is run to obtain eigenvalues for each component in the dataset in hand. Kaiser Rule (Eigen value greater than 1) suggests the extraction of three factors. The scree plot in Figure 4 confirmed the three factors scenario yet showed another possibility of taking out five factors. Hence, further examination of the commonalities table showed that there are almost four variables that have common variance of less than 0.7.

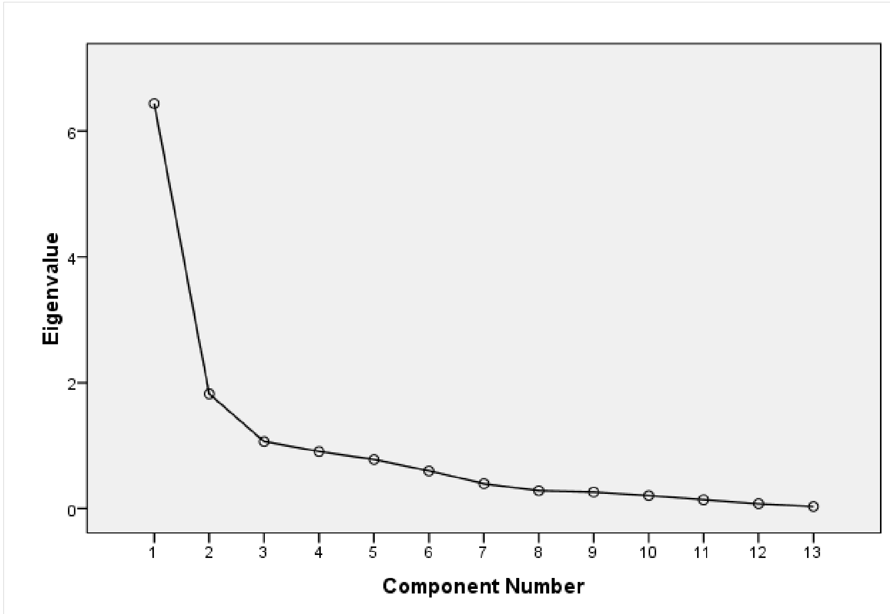

Figure 4 - Eigen Value Greater than 1 Scree Plot

Furthermore, inspecting the reproduced correlation matrix showed that there are 41 (52.0%) non-redundant residuals with absolute values greater than 0.05, the maximum proportion that is allowed is 50% and the lower the better the representation is, which cast doubts over the grounds of the model representation of the original data (Field, 2009). Hence, another criterion is used where Eigen values greater than 0.7 are extracted (Jolliffe, 2014) This resulted in extracting five factors, in accordance with the other observation of the scree plot. However, examining the IBM SPSS produced commonalities matrix of the data in Table 8 indicates that all KPIs communalities after extraction have a value greater than 0.7, where the average community is 0.846.

Table 8 - Communalities

	Initial	Extraction
Cost of Construction	1.000	.904
Time of Construction	1.000	.834
Quality and Defects	1.000	.947
Client Satisfaction	1.000	.857
End User Satisfaction	1.000	.855
Regulatory Compliance	1.000	.736
Construction Cost Predictability	1.000	.886
Construction Time Predictability	1.000	.837
Productivity	1.000	.705
Profitability	1.000	.824
Business Performance	1.000	.922
Health and Safety	1.000	.842
People	1.000	.858

Besides that, there are 20 (25.0%) non-redundant residuals with absolute values greater than 0.05 as shown in Table 9. And hence, the current number of factors extracted is adequate. The percentage of variance explained in total by the five extracted factors, as explained in Table 10, amounts to 84.677% of the overall variance. We used oblique rotation to better align the factor loadings with respect to each component/factor, and the method of rotation used is Direct Oblimin. The pattern matrix in Table 11 shows the factor loadings after rotation. It must be noted that factor loadings below 0.4 are suppressed, and that factor loadings are arranged in descending order. The reliability statistics associated with each factor from 1 to 5 are illustrated in Tables 12 to 16 respectively.

Table 9 - Reproduced Correlations

		Cost of Construction	Time of Construction	Quality and Defects	Client Satisfaction	End User Satisfaction	Regulatory Compliance	Construction Cost Predictability	Construction Time Predictability	Productivity	Profitability	Business Performance	Health and Safety	People
Reproduced Correlation	**Cost of Construction**	.904[a]	.764	.361	.337	.066	.403	.276	.377	.382	.366	.231	.105	.213
	Time of Construction	.764	.834[a]	.560	.332	.031	.656	.225	.443	.518	.227	.303	.358	.438
	Quality and Defects	.361	.560	.947[a]	.634	.297	.662	.542	.752	.486	.317	.375	.748	.524
	Client Satisfaction	.337	.332	.634	.857[a]	.702	.360	.453	.456	.212	.722	.486	.610	.471
	End User Satisfaction	.066	.031	.297	.702	.855[a]	.144	.443	.268	.199	.773	.684	.538	.536
	Regulatory Compliance	.403	.656	.662	.360	.144	.736[a]	.215	.451	.542	.162	.411	.610	.627
	Construction Cost Predictability	.276	.225	.542	.453	.443	.215	.886[a]	.777	.528	.492	.593	.487	.382
	Construction Time Predictability	.377	.443	.752	.456	.268	.451	.777	.837[a]	.583	.335	.473	.579	.427
	Productivity	.382	.518	.486	.212	.199	.542	.528	.583	.705[a]	.235	.623	.516	.617
	Profitability	.366	.227	.317	.722	.773	.162	.492	.335	.235	.824[a]	.628	.422	.447
	Business Performance	.231	.303	.375	.486	.684	.411	.593	.473	.623	.628	.922[a]	.647	.794
	Health and Safety	.105	.358	.748	.610	.538	.610	.487	.579	.516	.422	.647	.842[a]	.747
	People	.213	.438	.524	.471	.536	.627	.382	.427	.617	.447	.794	.747	.858[a]

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 20 (25.0%) nonredundant residuals with absolute values greater than 0.05.

Residual[b]	**Cost of Construction**		-.074	.012	.000	.012	-.046	-.023	.010	-.012	-.061	.005	.043	.037
	Time of Construction	-.074		-.036	-.022	.031	-.077	.041	-.019	-.021	-.009	-.025	.063	-.015
	Quality & Defects	.012	-.036		.001	-.036	-.006	-.011	-.029	.011	.019	.037	-.019	-.007
	Client Satisfaction	.000	-.022	.001		-.002	-.048	.025	-.087	.147	-.084	-.041	-.040	.013
	End User Satisfaction	.012	.031	-.036	-.002		-.004	-.024	.025	.060	-.094	-.038	.018	-.059
	Regulatory Compliance	-.046	-.077	-.006	-.048	-.004		.028	.043	-.077	.096	.043	-.141	-.054
	Construction Cost Predictability	-.023	.041	-.011	.025	-.024	.028		-.089	-.044	-.022	-.013	-.014	.033
	Construction Time Predictability	.010	-.019	-.029	-.087	.025	.043	-.089		-.095	.053	.017	-.008	.016
	Productivity	-.012	-.021	.011	.147	.060	-.077	-.044	-.095		-.076	-.074	-.008	-.085
	Profitability	-.061	-.009	.019	-.084	-.094	.096	-.022	.053	-.076		.037	-.034	-.015
	Business Performance	.005	-.025	.037	-.041	-.038	.043	-.013	.017	-.074	.037		-.019	-.021
	Health & Safety	.043	.063	-.019	-.040	.018	-.141	-.014	-.008	-.008	-.034	-.019		-.004
	Cost of Construction		-.074	.012	.000	.012	-.046	-.023	.010	-.012	-.061	.005	.043	.037

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations. There are 20 (25.0%) nonredundant residuals with absolute values greater than 0.05.

Table 10 - Total Variance

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.436	49.510	49.510	6.436	49.510	49.510	4.060
2	1.822	14.015	63.524	1.822	14.015	63.524	3.524
3	1.064	8.187	71.711	1.064	8.187	71.711	2.861
4	.907	6.978	78.689	.907	6.978	78.689	4.039
5	.778	5.988	84.677	.778	5.988	84.677	2.483
6	.599	4.605	89.282				
7	.395	3.035	92.317				
8	.284	2.186	94.503				
9	.261	2.011	96.514				
10	.205	1.580	98.094				
11	.140	1.075	99.170				
12	.076	.582	99.751				
13	.032	.249	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 11 – Classification 1 Pattern Matrix

	Component				
	1	**2**	**3**	**4**	**5**
People	.800				
Business Performance	.723				
Productivity	.578				
Regulatory Compliance	.462				-.459
End User Satisfaction		-.832			
Profitability		-.830			
Client Satisfaction		-.773			
Cost of Construction			.960		
Time of Construction			.782		
Construction Cost Predictability				-.915	
Construction Time Predictability				-.810	
Quality and Defects				-.418	-.697
Health and Safety	.453				-.498

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
Rotation converged in 21 iterations.

Table 12 – Classification 1 Reliability Statistics (Factor 1)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.829	.835	4

Table 13 - Classification 1 Reliability Statistics (Factor 2)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.860	.860	3

Table 14 - Classification 1 Reliability Statistics (Factor 3)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.810	.816	2

Table 15 - Classification 1 Reliability Statistics (Factor 4)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.815	.815	2

Table 16 - Classification 1 Reliability Statistics (Factor 5)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.841	.843	2

A thorough revision of Table 11 leads us to say that the KPIs that load into component 1 are: People, Business performance, Productivity, and Regularity Compliance. While the KPIs clustering into component 2 are: End User Satisfaction, Productivity, and Client Satisfaction. The KPIs under component 3 are: Cost of Construction and Time of Construction. And the KPIs following component 4 are: Construction Cost Predictability and Construction Time Predictability. Whereas, the KPIs following factor 5 are: Quality and Defects, in addition to Health and Safety. The reliability of scale is measured using Cronbach's α test. The test is conducted separately for each factor's respective KPIs, as recommended by Cronbach (1951). The test results indicate high reliabilities. All the resulted Cronbach's α have values equal to .81 and above. The detailed reliabilities for each factor are tabulated into Table 17.

Table 17 – Classification 1: Summary of PCA results for Contractors' KPIs Questionnaire (N = 53)

	Component				
	1	**2**	**3**	**4**	**5**
People	**0.8**	-0.204	0.03	0.05	-0.155
Business Performance	**0.723**	-0.347	-0.008	-0.2	0.215
Productivity	**0.578**	0.211	0.214	-0.384	0.051
Regulatory Compliance	**0.462**	0.089	0.325	0.061	**-0.459**
End User Satisfaction	0.233	**-0.832**	-0.156	-0.019	0.026
Profitability	0.049	**-0.83**	0.196	-0.079	0.144
Client Satisfaction	-0.11	**-0.773**	0.139	-0.075	-0.371
Cost of Construction	-0.102	-0.139	**0.96**	-0.057	0.132
Time of Construction	0.196	0.054	**0.782**	0.03	-0.192
Construction Cost Predictability	0.009	-0.134	-0.053	**-0.915**	0.103
Construction Time Predictability	0.004	0.051	0.09	**-0.81**	-0.229
Quality and Defects	-0.007	-0.092	0.123	**-0.418**	**-0.697**
Health and Safety	**0.453**	-0.239	-0.162	-0.191	**-0.498**
Eigen Values	3.288	-3.185	2.48	-3.007	-1.93
% of Variance	49.51	14.18	8.187	6.978	5.988
Cronbach's α	0.829	0.86	0.81	0.815	0.841

Rotation Method: Direct Oblimin Oblique, delta =0

Another attempt has been investigated using oblique rotation but with delta being negative. The results yielded another classification of the KPIs model, which is shown by the pattern matrix in Table 18. The reliability of scale for the new formation has also been assessed for each set of KPIs under one factor at a time. The results associated with each factor from 1 to 5 are illustrated in Tables 19 to 23 respectively. In general, all reliabilities are at level 0.81 and above.

Table 18 – Classification 2 Pattern Matrix

	Component				
	1	**2**	**3**	**4**	**5**
People	.772				
Business Performance	.724				
Productivity	.576				
End User Satisfaction		-.830			
Profitability		-.828			
Client Satisfaction		-.766			
Cost of Construction			.956		
Time of Construction			.778		
Construction Cost Predictability				-.904	
Construction Time Predictability				-.792	
Quality and Defects					-.717
Health and Safety	.432				-.522
Regulatory Compliance	.438				-.481

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 21 iterations.

Table 19 - Classification 2 Reliability Statistics (Factor 1)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.829	.829	3

Table 20 - Classification 2 Reliability Statistics (Factor 2)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.860	.860	3

Table 21 - Classification 2 Reliability Statistics (Factor 3)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.810	.816	2

Table 22 - Classification 2 Reliability Statistics (Factor 4)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.815	.815	2

Table 23 - Classification 2 Reliability Statistics (Factor 5)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.824	.829	3

Though, the new classification of the KPIs did not change significantly from the initial one, the KPI of Quality and Defects is shifted from Component 1 to Component 5. We believe it is a much better fit in component 5 group and provides a more realistic representation of the realities of the construction industry. Hence classification 2 is adopted. The detailed results are shown in Table 24.

Table 24 – Classification 2: Summary of PCA Results for Contractors' KPIs Questionnaire (N = 53)

	Component				
	Performance (1)	**Satisfaction (2)**	**Actual Metrics (3)**	**Estimated Metrics (4)**	**Compliance (5)**
People	**0.772**	-0.205	0.033	0.04	-0.197
Business Performance	**0.723**	-0.358	0.001	-0.218	0.18
Productivity	**0.574**	0.197	0.224	-0.383	0.016
End User Satisfaction	0.232	**-0.829**	-0.154	-0.034	0.009
Profitability	0.062	**-0.827**	0.196	-0.099	0.132
Client Satisfaction	-0.122	**-0.76**	0.136	-0.072	-0.388
Cost of Construction	-0.088	-0.138	**0.954**	-0.073	0.124
Time of Construction	0.182	0.057	**0.776**	0.025	-0.215
Construction Cost Predictability	0.034	-0.15	-0.034	**-0.896**	0.081
Construction Time Predictability	0.007	0.041	0.104	**-0.78**	-0.257
Quality and Defects	-0.035	-0.085	0.127	-0.385	**-0.73**
Health and Safety	**0.42**	-0.235	-0.157	-0.176	**-0.537**
Regulatory Compliance	**0.425**	0.094	0.322	0.067	**-0.494**
Eigen Values	3.186	-3.198	2.528	-2.984	-2.276
% of Variance	49.51	14.02	8.19	6.98	5.99
Cronbach's α	0.829	0.86	0.81	0.815	0.824

Rotation Method: Direct Oblimin Oblique, delta <0

Based on classification 2, the following structure will be used for the proposed KPIs model to assess contractors’ performance in the construction industry in Saudi Arabia:

- **Performance Group:**
    - People
    - Business Performance
    - Productivity
- **Satisfaction Group:**
    - End-User's Satisfaction
    - Profitability
    - Client's Satisfaction
- **Actual Metrics Group:**
    - Cost of Construction
    - Time of Construction
- **Estimated Metrics Group:**
    - Construction Cost Predictability
    - Construction Time Predictability
- **Compliance Group:**
    - Quality and Defects
    - Health and Safety
    - Regulatory Compliance

5.4. Discussion

The data analysis along with the model regression using IBM SPSS revealed various correlations between the KPI elements of the proposed model. A sound assessment of contractors' performance in construction projects relies heavily on their performance in certain aspects, which their significance could be proven through the Adjusted Relative Importance Index scores. In the following, a discussion of the various KPIs along with their respective adjusted relative importance index scores will be outlined:

The "Cost of Construction" and "Time of Construction" turned out to be the most significant KPIs for performance assessment with scores of 82.547% and 79.717% respectively. The same results have been reported by Chan and Chan (2001), Heravi and Ilbeigi (2012), Olaoluwa (2013), Jainendrakumar (2015), and Vasista's (2017). This asserts that that contractors' ability to accomplish projects' objectives within a reasonable budget and time, in comparison with past or current analogous projects, is a significant determinant for the success of any construction venture.

Meeting contracted standards either unit wise or as a whole is also a major KPI in the building construction market. This is reflected by "Quality and Defects" KPI with an Adj. RII score of 78.302% (High Significant). According to Mallawaarachchi and Senaratne (2015), Souza (2010), and Tan and Abdul Rahman (2011) presented, the ability of the contractor to hand over the contracted units of works in accordance with contracted standards and specifications is a major indicator of a successful execution.

Client and End user satisfaction are significant factors for projects' success. The Adj. RII score for the first is 75.472% (High Significant), and 70.283% (Significant) for the later. The importance of post-delivery and post occupancy satisfaction with the executed facilities has also been emphasized by AlMomani (2000), Bititici (1994), Deolitte and Touche (2018), Tang et al. (2003), and Torbica and Stroh (2001). It is the ultimate objective of all building construction projects to be of a best fit for their owners and occupants' goals, needs, and functions.

Contractor's ability to include precise cost and duration estimations for projects' execution in their tender bids cannot fall short of importance when it comes to the assessment of performance. Their bid documents should accurately represent the foreseen critical metrics of unit works' execution cost and timeframes to incur. Results showed that both "Construction Time Predictability" and "Construction Cost Predictability" are significant KPIs of contractors' performance and hence projects' success. "Construction Time Predictability" scored 65.094% on the Adj. RII index, while on the other hand, "Construction Cost Predictability" scored 62.264%. Both fall in the significance region. A supporting evidence from the literature can be also be found at Bala, Bustani, and Waziri (2014), KPI working group report (2000), Lim and Mohamed's (2000).

Other KPIs have also proven their significance with Adj. RII scores higher than the minimum significance threshold adopted in the study and recommended by Holt (2014). "Health and Safety" (71.226%), emphasizes the importance of keeping track and maintaining proactive measures to insure the welfare of manpower on site. "Productivity" (70.755%) in accordance with Horner and Talhouni (1996), and Souza's (2010) analogy is the prominence of the value added per worker to the overall performance of the contracting firm. People (66.981%) highlights the conception of perceiving personnel as the most valuable asset for construction contractors. This is in line with Chan and Chan (2004), and Ofori-Kuragu, Baiden, and Badu (2016). Yet, as the goal for any business entity active in the market is to flourish and develop, the significance of project's Profitability (63.208%) for the contractor cannot be underestimated.

Maloney (1990) and Souza (2010) considered that Business Performance (59.906%) is the contractors' most prevalent KPI to assess their own self-satisfaction over in most scenarios. Like other KPIs that can add, whether positively or negatively, value to building contractors' portfolios, "Business Performance" is a significant KPI that determines future possibilities for contracting firms' competitive position in the industry. This is an undoubtable fact gained by experience in the field according to Bannerman (2008) sand Masrom (2012). Finally, contractors' ability to operate within the standards and regulations enforced by authorities of concern remains a determinant for the health of their performance (Edinburgh, 2003). Results suggest that contractors cannot ignore such a fact, and hence, Regulatory Compliance (66.506%) is also another significant KPI that must be considered.

However, "Environment" KPI failed to achieve a score that would deem it eligible for inclusion in the proposed model with an Adj. RII score of 23.113%. This score falls below the significance threshold of 50%. This is due to the ambiguity and confusion this KPI reflects within the contracting community. Heravi and Ilbeigi (2012) suggested that the topic of the environmental impact of construction works remains of certain degree of ambiguity to most construction contractors. The assumption that their focus would shift towards more environmentally friendly practices overtime is faced with the dilemma of profitability, previously acquired expertise, and contemporary domestic regulations versus reputation, desire to pioneer and acquire advanced knowledge, and compliance with community's long-term collective benefits (Chan and Chan, 2001) (Heravi and Ilbeigi, 2012).

The correlations between different KPIs within the proposed model were assessed using IBM SPSS. Hence comes their classification into distinct groups in order to better represent the various, and sometimes conflicting, interests of the different projects' stakeholders. The five groups, namely Performance, Satisfaction, Actual Metrics, Estimated Metrics, and Compliance should allow the model's user contractor to assess their performance in a certain project with a higher degree of objectivity and neutrality. AEP (2006), and Robinson, Carrillo, Anumba and Ghassani (2005) suggested that such classification can serve in the favor of the user should it be distributed between different business departments within a firm according to their respective specialty department if needed.

Araujo et al. (2016) asserts that subdivided assessment models for construction contractors are more efficient in practice compared to conventional comprehensive uncategorized tools. The possibility of assigning distinct evaluation tasks to different divisions within the same construction firm provides the mean for internal peer-to-peer review of performance. An approach through which quality standards can be assessed from an experienced yet more objective points of view. However, it is important to highlight the ultimate objective of the whole assessment process to the work team. In order to avoid polarity and unhealthy competition between coworkers, they should be assured that the goal is improve performance and productivity without compromising essential elements in the team (Best and Langston, 2006).

The homogeneous nature of KPIs within a distinct group provides the user with a relative easiness comprehending the correlations between similar, yet what could be perceived as possibly mutually exclusive, performance indicators (Schwarzbichler and Steiner and Turnheim, 2018) For instance, in our model, the Satisfaction Group comprises three different KPIs namely: Client's Satisfaction, End-users' Satisfaction, and Profitability. To the comprehension of some surveyed construction contractors, profitability is inversely proportional to the degree of satisfaction expressed by the client. An arguable assumption that can be deemed invalid upon finding a point of balance between the interests of different project's stakeholders. And although ensuring clients' satisfaction with the delivered units of work may sometimes require iterations that result in cutoff of profit, it contributes positively to the professional learning curve and mastering much demanded performance skills in the market. Hence, it influences other aspects that contribute to the success of contractor such as Business Performance, Productivity, Cost and Time predictability, and ultimately the overall business Profitability in the long run. A conception that is essential for successful strategic planning in business. (Jones and George, 2011)

5.4.1.Experts’ Review

As a part of the validation process of the proposed KPIs model, it was presented to 15 different experts to obtain their feedback and insights concerning its reliability in light of their significant experience in the field and in academia.

The feedbacks were somehow identical to a certain degree. Interviewees recommended the model and emphasized its significance as a potential tool to assess building construction contractors to evaluate their performance and projects’ success. They also consider it a reliable foundation for developing similar performance indicator models to serve other sectors within the construction market or out of it. However, 3 interviewees proposed the inclusion of “Environment” KPI in the model suggesting that it would become an incentive for contractors to give it more consideration as they come across it during the evaluation process. But as the model is supposed to be highly adaptive in nature, we believe that it would be more efficient the more it reflects their contemporary business needs and considerations. Shall the topic of “Environment” become of a more significance in the domestic construction practice, weather due to municipal regulations, market demands, or for the purpose of acquiring a better competitive position, it can be included in the model.

The interviewees have also expressed their satisfaction with the proposed classification of KPIs into groups within the model. Highlighting the importance of distinguishing between different KPIs’ groups for the purpose of enabling users to maximize the benefits they can obtain from applying it as a performance assessment tool.

CHAPTER 6

CONCLUSION

The topic of performance assessment in construction industry was discussed for a long time in the field of construction engineering and management. And despite the significant amount of published works and literature dealing with this subject, there was never a consensus about what ultimately establishes the probability of a construction project's success. It is due not to lack of evidence but to the various conditions, expertise, and requirements characterizing different construction markets. Hence, the application of a specific performance assessment tool that is designed based on input obtain from a certain environment could fit some markets and contractors while failing others. Developing a locally accustomed KPIs model benefiting from existing reliable and tested ones is therefore a more productive approach, and accordingly it was adopted in this study.

The study reports the statistical results of a survey questionnaire that aimed at collecting relevant data from participating building contractors. Their assessment of the significance of various proposed KPIs, upon which the survey questions were designed, contributed to the development of the final model. Using scientific statistical analysis tools, such as IBM SPSS, the reliability of the survey questionnaire was proven, and significance and correlations between elements in the model were established, resulting in a refined version of it. From 14 different KPIs in the original model that the participants were presented with, 13 KPIs were deemed significant. Classified into 5 groups based on the results of Principal Component Analysis (PCA), they constitute the final model proposed for construction contractors' performance assessment:

- **Performance Group:**
    - People
    - Business Performance
    - Productivity
- **Satisfaction Group:**
    - End-User's Satisfaction
    - Profitability
    - Client's Satisfaction
- **Actual Metrics Group:**
    - Cost of Construction
    - Time of Construction
- **Estimated Metrics Group:**
    - Construction Cost Predictability
    - Construction Time Predictability
- **Compliance Group:**
    - Quality and Defects
    - Health and Safety
    - Regulatory Compliance

The proposed KPIs model should establish a scientifically based tool to aid building construction contractor assessing their performance in real time, during the execution of projects or even post construction for business development and retrofitting purposes.

CHAPTER 7

RECOMMENDATIONS FOR FUTURE WORKS

Scientific research is a progressive process in which previous and present knowledge is utilized and built upon to advance towards better comprehension of experimental subjects. Hence, this study can be the foundation for future works concerning Key Performance Indicators (KPIs) in construction. The limitations identified while progressing through this study can be the basis for future investigation.

For instance, the study focused on building contractors in the Eastern Province of Saudi Arabia. Future works can expand to include contractors of other construction sectors (engineering, industrial, infrastructure, etc.). Contractors in other regions of the kingdom, or from around the globe, can also be surveyed to obtain more comprehensive and applicable outcomes. Furthermore, an empirical case study based on the KPIs model produced in this research can be carried out to investigate its reliability and effectiveness in real world applications. Volunteering contractors can be of a great benefit shall they participate in such an endeavor availing their actual business data and logs.

In the span of a few years, the research outcomes could be reestablished in accordance with the prospective developments in the construction market in the region. An updated survey could be used to re-assess the applicability of existing, and possibly future, KPIs to construction contractors. KPIs that were not considered relevant at the meantime, such as the “Environment”, will possibly be among the most applicable ones considering the ongoing economic, social, and technological development the kingdom is going through.

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APPENDEX

Questionnaire:

Dear Participant,

Information collected through this questionnaire will be used only for research purposes and will not be shared with other business entities. Personal and contact information provided by participants will be kept confidential and may only be used for research purposes or future communication with the research participants.

This research aims to develop a set of Key Performance Indicators (KPIs) for Saudi construction contractors. These KPIs are expected to be of a benefit for contractors as they will enable them to assess their business performance better.

Your Contribution and aid are highly appreciated.

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Part 1: Company and Professional Profile:			
Company Name:			
Projects' Type:	☐ Residential Building	☐ Commercial Building	☐ Industrial Building
	☐ Other (please specify):		
MOMRA Grade:	☐ 1	☐ 2	☐ 3
	☐ 4	☐ 5	
Respondent's Name (Optional):			
Position/Job Title:			
Years of experience in construction:			
Does your company use any performance measurement systems (e.g., Key Performance Indicators [KPIs])? (if Yes, please specify.)			
Respondent's email:			

Respondent's Fax:	
Respondent's Mobile:	

Part 2: Evaluation of KPIs as measures of performance in construction projects:
Please assess the significance of the following Key Performance Indicators (KPIs) for Saudi construction contractors. Based on your experience as a construction professional, please specify the significance of each KPI, which implies your opinion on whether it has to be part of the of KPIs set to be designed for Saudi construction contractors. Kindly give each KPI the appropriate score (in your opinion), where: 1 = Not Significant 2 = Low Significance 3 = Significant 4 = High Significance 5 = Very High Significance

Key Performance Indicators		**Score** (Please add [√] as appropriate)				
		1	**2**	**3**	**4**	**5**
1	Cost (of construction)					
2	Time (of construction)					
3	Quality and Defects					
4	Client Satisfaction					
5	End-User Satisfaction					
6	Regulatory Compliance					
7	Construction Cost Predictability					
8	Construction Time Predictability					
9	Productivity					
10	Profitability					
11	Business Performance					
12	Health and Safety					
13	People					
14	Environment					

Clarifications:	
Cost (of construction)	"Change in the current normalized construction cost of a project compared with one year earlier." (As a percentage of the one year earlier cost). (KPI Working Group, 2000, p. 15)
Time (of construction)	"Change in the current normalized construction time of a project compared with one year earlier." (As a percentage of the one year earlier time). (KPI Working Group, 2000, p. 13)
Client Satisfaction	How satisfied the client is with the delivered product or facility. (Souza, 2010)
End-users' Satisfaction	How satisfied the end-users are with the delivered product or facility. (Souza, 2010)
Quality & Defects	The condition of the delivered (handed over) product or facility in terms of quality and defects. (Souza, 2010)
Regulatory Compliance	The extent to which the execution of construction and the delivered units of work are compatible with the local regulation and requirements.
Construction Cost Predictability	"Change between the actual construction cost and the estimated construction cost." (As a percentage of the estimated cost). (KPI Working Group, 2000, p. 13)
Construction Time Predictability	"Change between the actual construction time and the estimated construction time." (As a percentage of the estimated time). (KPI Working Group, 2000, p. 15)
Productivity	Contractor's value added per worker. (Souza, 2010)
Profitability	Contractor's gross profit as a percentage of sales. (Souza, 2010)
Business Performance	Business performance may be evaluated through profit value, opportunities for repetition of business, ability to deliver the project as per the contracted specification and within time and budget, and achievement of business objectives through projects. (Masrom, 2012)
Health & Safety	General health & safety conditions on job site, the occurrence of work-related accidents, injuries & fatalities, security, hazard avoidance, and safety measures on job sites.
People	Employees training & learning, qualifications, skills, pay, working hours, morale, absences, workforce and human resources management.
Environment	Construction's Impact on the Environment, waste reduction & management, energy consumption, water consumption, etc.

VITAE

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