Developing a Corporate Sustainability Performance Evaluation Model of the UAE Construction Contractors

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ABSTRACT

It is widely accepted that construction project success correlates positively with contractors' qualifications, including their sustainability performance; this performance has to be measured to inform clients' decisions during contractor prequalification and selection. While a significant number of sustainability evaluation systems has been developed at the project level, limited research and practice exists in sustainability evaluation of construction organisations including contracting companies. In the UAE, the accelerated policy-making process and sustainability movement represent both an opportunity to accelerate the change, and a challenge for construction companies to adapt to this change in an efficient and effective way. Clients in the UAE are thus in urgent need of selecting the right contractor for successful delivery of their sustainable projects and for design of their sustainable supply chain. The main aim of this study is to develop a multi-criteria evaluation model of the UAE construction contractors based on their sustainability performance.

This study undertakes a critical review of existing corporate sustainability standards and similar studies. The existing criteria suggested by previous studies are reviewed, cross-referenced and categorised to compose a conceptual framework for the model. The model criteria and domains are then validated and updated through expert interviews followed by expert survey. The updated model is further refined and validated through exploratory and confirmatory factor analyses of the main contractors' questionnaire survey. First order, second order and bifactor models for the five domains have been evaluated and contrasted prior to the assessment of higher-order models.

Factor analysis results reveal a poor fit of the multi-scale third-order models and suggest the adoption of 'independent' bifactor models for five performance evaluation scales namely: 1) policy and governance, 2) corporate workplace, 3) management of employees, 4) procurement and supply chain and 5) project delivery. The present study contributes to the academic fields of corporate sustainable construction and scale development. In practice, the developed model can be adopted by local authorities as a sustainability classification system for contractors. It can also be used by clients as a supporting decision-making tool during the prequalification stage and as part of their sustainable supply chain design. The evaluation model can also help contractors track and benchmark their performance and provide clear evidence of their sustainability performance and identify areas of necessary improvement.

Keywords: Corporate, sustainability, performance, scale, bi-factor, factor analysis, construction contractors, UAE

Dedication

To the soul of my beloved husband…

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LIST OF ABBREVIATIONS

AED : Arab Emirates Dirham

AHP : Analytic Hierarchy Process

AMOS : Analysis of a Moment Structures

AVE : Average Variance Extracted

BREEAM : Building Research Establishment Environmental Assessment Method

BSI : British Standards Institution

CFA : Confirmatory Factor Analysis

CFI : Comparative Fit Index

EFA : Exploratory Factor Analysis

ENR : Engineering News Record

GFI : Goodness of Fitness Index

GOF : Goodness-of-Fit

GRI : Global Reporting Initiative

ILO : International Labour Organisation

ISO : International Organization for Standardization

KMO : Kaiser-Meyer-Olkin

KPI : Key Performance Indicator

LEED : Leadership in Energy and Environmental Design

LISREL : Linear Structural Relations

SCM : Supply chain Quality Management

SEM : Structural Equation Modelling

SME : Subject Matter Expert

SPSS : Statistical Package for the Social Sciences

TBL : Triple Bottom Line

UAE : United Arab Emirates

UK : United Kingdom

LIST OF PUBLICATIONS AND PRESENTATIONS

Published Papers:

- Al-Hajj, A. and Hamani, K., 16 Nov 2011, Material Waste in the UAE Construction Industry: Main Causes & Minimisation Practices, Architectural Engineering and Design management. **7**, 4, p. 221-235 15 p.

- Al-Hajj, A and Hamani, K, Waste minimisation in the UAE construction industry, Proceedings of the CIB Joint International Symposium, 15-17 Nov.2008, Dubai.

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- Mohamed, H and Hamani, K, Implementation of Integrated Project Delivery (IPD) Method in the UAE Healthcare Construction Projects, Lean and Agile Middle East Summit 2017, Dubai

Submitted papers (Under Review)

- Warid, O & Hamani, K, Implementation of Last Planner System in the UAE construction Industry, submitted to Engineering, Construction and Architectural Management Journal.

In progress

- Hamani, k & Nielsen, Y, A conceptual model for sustainability evaluation of the UAE construction contractors, to be submitted to Engineering, Construction and Architectural Management journal.

Chapter 1: Introduction

1.1 Research Background

The construction industry has a significant impact on the three dimensions of sustainable development. On the environment side, the built environment is considered the largest contributor to climate change (Glass et al., 2011). This resource depleting sector consumes one-third of overall global energy, one third of global natural resources and 12% of water resources, and it generates 40% of solid waste (UNEP, 2009). Economically, the construction industry is estimated to be worth 10% of global GDP (Betts and Farrell, 2009) and employs more than 111 million people worldwide (ILO, 2001). Therefore, the construction industry is facing the challenge of managing trade-offs between economic viability, social integrity and environmental protection. In an era where both environmental and economic climates are dramatically changing, the industry needs to shift from the 'business as usual' methodologies of project delivery to sustainable and integrated delivery systems.

In addition to the traditional iron triangle (on time, on budget and as per specifications), project success is currently based on sustainability performance (Alzahrani and Emsley, 2013). Moreover, it is widely recognised that project success is highly dependent on selecting the right contractors (Banki et al., 2009; Ng et al., 2009; Palaneeswaran and Kumaraswamy, 2001; Yaweli et al., 2005). It is thus essential to carefully evaluate contractors' overall performance, and particularly their sustainability performance, for project success factors to be satisfied.

Contractors operating in the construction industry face fierce competition that requires continuous performance improvement. Performance measurement and benchmarking are thus necessary to achieve competitive advantage and long-term prosperity (Horta and Camanho, 2014). However, performance measurement of contractors has been conventionally based on financial indicators only. Ranking systems such as the Engineering News Record (ENR) list of the top construction companies are based exclusively on gross revenues. While this sole criterion of performance evaluation was valid prior to the start of the sustainable construction movement, the new trend now is to consider sustainability performance as the most important competitive advantage (Montgomery, 2010). Results of a study by McGraw-Hill (2013) in partnership with United Technologies show that ‘green’ is becoming a business opportunity and imperative rather than being merely a perspective for ‘doing the right thing’.

1.2 Research Rationale

During the last two decades, several sustainability assessment and rating systems have been developed for the building sector. More than 600 rating systems are available worldwide (BRE, 2009). However, much of the focus of the most popular sustainability rating systems is on building performance, which includes water efficiency, energy efficiency and indoor environment quality, with limited focus on the sustainability performance of construction organisations (Trusty et al., 2002). LEED and Estidama, the two commonly used rating systems in the UAE, demonstrate the low importance given to contractors’ sustainability performance as part the building certification process. While LEED does not include any requirement related to contractor selection based on sustainability criteria, Estidama allows projects to earn two points if the contractor is ISO 14001 certified, but this is still a limited requirement when it comes to holistic corporate sustainability performance.

Although sustainability organisations and policymakers have made significant efforts to promote green building and sustainable construction movements, construction contractors that are critical to successful implementation have been largely absent from these efforts (Tan, Shen and Yao, 2011). The sustainable construction change agenda has been primarily led by upstream construction supply chains; however, the role of downstream supply chains is increasingly being recognised as crucial. Sustainability strategies during the construction stage such as waste management and sustainable procurement cannot be implemented without a genuine commitment from contractors and their supply chains (Al-Hajj and Hamani, 2011; Oo and Lim, 2011). Riley et al. (2003) conducted an extensive review of green building case studies in the United States (US), highlighting that contractors have the potential to contribute to all phases and areas of green building projects including sustainable material procurement, waste management, jobsite recycling and indoor air quality. In his report about carbon footprint of the construction process, Joan Ko (2010) emphasises the prominent role played by contractors in reducing carbon emissions generated from different site-related activities, such as the use of the plant and equipment, powering site accommodations, freight transport and business travel. This recognition justifies the importance given to sustainability integration in contractor prequalification and the tender evaluation process (Sarkis, Meade and Presley, 2012).

Studies about corporate sustainability in the construction sector range from narrow to broader scopes, whether in terms of types of companies studied or the geographical areas covered. Key papers about contractors' attitude to sustainability were published by Jones, Shan and Goodrum (2010) regarding the US construction industry, Myers (2005) about the UK construction industry and by Oo and Lim (2011) for companies in Singapore. While Oo and Lim (2011) presented positive results about contractors' attitudes towards environmental sustainability with few differences based on types and sizes of firms, Myres (2005) was pessimistic about the status of corporate sustainability adoption, stating that even though the construction industry has its own sustainability agenda, relatively few companies have changed their business paradigm. This difference in results could be caused by the research method used and the study period, as six years could be a sound period for performance improvement. Jones et al. (2010) conveyed the situation in the US as being very fragmented, and they recommended construction companies to form partnerships to achieve common corporate sustainability objectives. These studies all call for an urgent change in construction companies' attitudes and implementation systems of their corporate sustainability agenda. A recent study by Zuo et al. (2012) claims that the number of construction companies reporting sustainability issues is increasing, especially among highly ranked companies in the ENR. Similarly, Barlow (2014) emphasises that the drive towards sustainability in the construction industry is occurring at a fast pace, and it is impacting every level within the construction supply chain. At the contractor level, sustainability starts to affect the contractors' competitiveness and their bidding success rate. Barlow (2014) states that sustainability is positively reversing today's price paradigm because sustainable companies have created a competitive advantage that gives them a valid reason to charge price premiums for their qualifications and capabilities to deliver sustainable projects.

UNEP (2014) claims that the drivers for adopting sustainability practices in construction companies include (a) sustainability reporting (SR) and accounting obligations, (b) stakeholder and peer-group pressure, (c) the need to comply with sophisticated building codes and standards, and (d) the desire to obtain a green and/or sustainable building label or certificate and to participate in one of the various sustainability indexes and benchmarking initiatives. These drivers, particularly the third and fourth ones, have a significant impact on contractors' competitiveness within the new green building market.

Researchers have developed many contractor pre-qualification models (Russell and Skibniewski, 1990; Russell et al., 1996; Nguyen, 1985; Hatush and Skitmore, 1997; Munaif; 1995), using different modelling techniques and considering a set of criteria including financial stability, management and technical ability, contractor's experience, resources, quality management, and health and safety performance (Nieto-Morote and Ruz-Vila, 2012; El-Sawalhi, Eaton and Rustom, 2007). However, these criteria miss out one of the key success factors in construction projects today: sustainability performance. Noticing this gap, Sarkis et al. (2012) introduced a decision-making model for subcontractor and team formation based on sustainability criteria. However, the social and economic criteria used in their model are limited and fail to include some of the important aspects of corporate sustainability. Moreover, the environmental indicators used were based on LEED credits, which is a building rating system rather than an organisational certification system. Therefore, a clear gap remains in the literature related to integrating corporate sustainability performance in contractor prequalification systems.

In the construction industry, corporate activities and strategies are mainly implemented in the form of projects, which leads to a strong correlation between project sustainability performance and corporate sustainability strategies adopted by companies contributing to project delivery (Hope and Moehler, 2014). To be efficient and consistent, these roles need to be played by proactive organisations with high corporate sustainability performance levels. Despite the significant efforts made by sustainability organisations and policymakers to promote green building and sustainable construction movements, construction contractors that are critical to successful implementation have been largely absent from these efforts. While a great number of sustainability evaluation systems has been developed at the project level, limited research and practises exist in the sustainability evaluation of construction organisations, and more specifically in contracting companies.

Sustainability movement in the UAE differs notably from other countries. McGraw-Hill (2013) showed that regulation is considered the prime trigger driving sustainable construction in the UAE, while the first driver is client demand in other countries. The UAE is considered a pioneer among Middle Eastern countries in terms of promoting green building and sustainable development; two-thirds of the LEED certified buildings in the Middle East are within the UAE (Jones Lang LaSalle, 2013). This change in green building credentials has been witnessed in a short period compared to advanced countries. While legislation such as The Energy Act in the UK took seven years (2011-2018) to be fully implemented, the Estidama rating system was made mandatory in Abu Dhabi after just one year of piloting. The accelerated policymaking process and the strong leadership of the UAE government represent not only an opportunity to accelerate the change but also a challenge for construction companies to adapt to this change in an efficient and effective way. Furthermore, clients have an urgent need to select the right contractor for successful delivery of their sustainable projects. The present study thus makes a significant academic and practical contribution to the fields of corporate sustainability and sustainable construction because it builds on existing corporate sustainability systems and best practices to develop a holistic sustainability evaluation system specifically tailored to contractors and to the UAE construction market.

1.3 Aim and Objectives

The overall aim of this research is to develop a multi-criteria evaluation model of the UAE construction contractors based on their sustainability performance.

To achieve the research aim, the following four key objectives have been set:

Objective 1: To review the corporate sustainability concept and its implementation in the construction industry.

Objective 2: To review the existing corporate sustainability evaluation systems and assess the need for a specific evaluation system for construction contractors.

Objective 3: To develop a conceptual model for sustainability evaluation of the UAE construction contractors.

Objective 4: To empirically assess the validity of the proposed model through factor analysis.

These objectives will be achieved through the process of tasks depicted in figure 1.1.

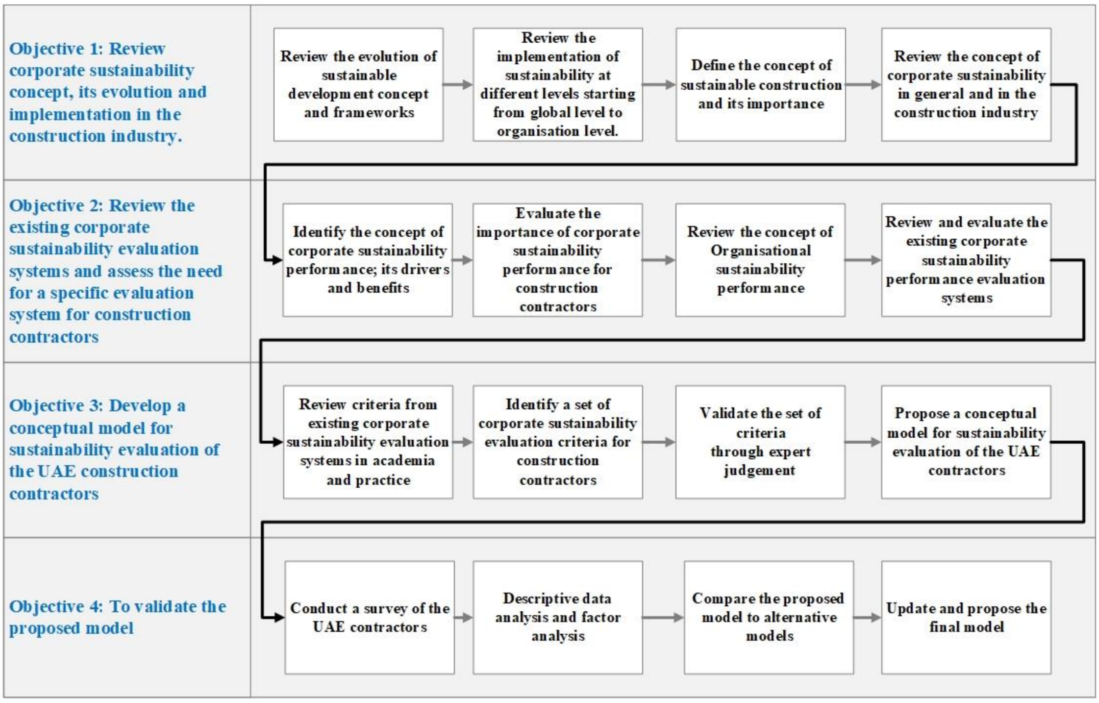


Figure 1.1: Research roadmap

1.4 Scope of the study

The goal of this study is to develop a sustainability performance evaluation model of contracting organisations in the UAE. In his review of corporate sustainability assessment studies, Grunda (2011) states that empirical studies could be divided in two groups: one group evaluating corporate sustainability for one or more companies based on sustainability reports using a case study approach , and the second group is focused on evaluation of companies using a set of criteria and data gathered through a survey. The current study belongs to the second group as it uses a set of criteria to evaluate corporate sustainability performance of contractors.

The following boundaries and definitions are used to delimitates the scope of this research and define the unit of analysis:

- The definition adopted for corporate sustainability is "integrating social and environmental impact into the business, using that integration to drive economic value and to meet the needs of the firm's direct and indirect stakeholders without compromising its ability to meet the needs of future stakeholders". Therefore, the content of the developed assessment model will be based on the components of this definition and the dimensions to be covered by the model are the three dimensions of the TBL: economic, environment and social.

- The population frame is contracting companies operating in the seven emirates of the UAE, and the unit of analysis is an individual contracting company. The analysis is based on perceptions of the companies' senior managers including managing directors, CSR managers or HSE managers. The study is based upon perceptions because of absence of sustainability reporting data and indexes among contracting companies as very few contracting companies in the UAE publish their sustainability reports. Corporate sustainability assessment literature has enough examples where managers' perceptions are used in model development and validation (Aguezzoul, 2014; Waris et al., 2014; Zabihi et al., 2012; Yunus and Yang, 2011).

- Stakeholder perspective: different steps of this study are eliciting perceptions and opinions of different construction stakeholders. While the validation of evaluation criteria was based on sustainability experts from different types of organisations such as clients, consultants, contractors, subcontractors, suppliers, public authorities and NGOs; validation of the model structure was solely based on perceptions of managers and professionals working with contracting companies.

- Organisational levels: the model developed is focused on both business strategy and operational strategy. It is agreed that these strategies overlap and affect each other. The model will thus evaluate the sustainability performance at strategic level and how it is translated into tactical management approaches for supply chain, facilities, human resources management and community involvement. While the model does not evaluate the sustainability performance of contractors for a specific project, it considers the methods, systems and plans adopted by a contractor for a sustainable project delivery. Therefore, it is assumed that the proposed model covers the three organisational levels: strategic, tactical and operational.

1.5 Contribution to knowledge and practice

The main contribution expected from this research can be divided into theoretical and practical contributions. Theoretically, this study addresses the importance of corporate sustainability performance in construction companies in general and contracting companies in particular. Moreover, the study contributes to existing knowledge by identifying sustainability performance criteria suitable for construction contractors and developing a scale for measuring the sustainability performance of the UAE contractors.

In practice, the developed model can be adopted by local authorities as a sustainability classification system for contractors. It can also be used by clients as a supporting decision-making tool during the prequalification stage and as part of the design of their sustainable supply chain. The evaluation model can also help contractors track and benchmark their performance and provide clear evidence of their sustainability commitment and competitive advantage in corporate responsibility.

1.6 Outline research methodology

To address the aforementioned research objectives, this study adopts a mixed methods research design combining quantitative and qualitative methods. Prior to conducting research related to the items and criteria to be used in the evaluation model, a review of literature was conducted to identify the gaps in the industry and in existing literature by evaluating the need for a sustainability performance evaluation in the construction industry and reviewing the existing corporate sustainability performance systems. By reviewing the specific needs in the contracting business and in the construction industry, the scope and domains of the theoretical have been delineated. The output of this step is a clear explanation of the importance of the new model and how it differs from existing evaluation systems. Subsequently, a literature review was conducted to generate the initial list of items (evaluation criteria). This study follows the same approach used by many studies with the same purpose (Aguezzoul, 2014; Waris et al., 2014; Zabihi et al., 2012; Yunus and Yang, 2011).

The preliminary set of criteria identified was based on studies undertaken in different countries and for other industries. A qualitative method employing expert interviews was used to test the applicability and suitability of the identified list of criteria to the UAE construction market and to complement the list based on expert judgement. The identified criteria based on input from the literature review and interviews were integrated in a questionnaire survey to elicit a broader perception from sustainability professionals in the UAE about the proposed evaluation criteria. The developed model was then validated through a set of statistical analysis methods including descriptive analysis and reliability testing, and construct validity and criterion validity was conducted through exploratory (EFA) and confirmatory factor analyses (CFA). For each scale of the five scales composing the model, first order, second order and bi-factor models are tested and validated. The next step is to test the proposed higher order level model and two alternative higher order models combining bi-factor models. The study concludes by recommending the best fitting model and explaining a example of its practical implementation to measure sustainability performance of contractors. Table 1.1 provides a summary of the research objectives, steps and methodologies adopted for the study objectives and associated steps.

Table 1.1Research methodology summary

Objective	Tasks	Research method	Data analysis method
Review corporate sustainability concept, its evolution and implementation in the construction industry.	Review the concept of sustainability and its implementation at different levels	Literature review	Archival analysis
	Identify the concept of corporate sustainability performance; its drivers and benefits	Literature review	Archival analysis
	Review and evaluate the importance of corporate sustainability performance for construction contractors	Literature review	Archival analysis
Review the existing corporate sustainability evaluation systems and assess the need for a specific evaluation system for construction contractors	Review the concept of Organisational sustainability performance evaluation	Literature review	Archival analysis
	Review and evaluate the existing corporate sustainability performance evaluation systems	Literature review	Archival analysis
Develop a conceptual model for sustainability evaluation of the UAE construction contractors	Identify a preliminary set of corporate sustainability evaluation criteria	Literature review	Archival analysis
	Validate the set of criteria through expert judgement	Expert interviews	Qualitative analysis
		Expert Survey	Relative Index Analysis
Validate the proposed model	Explore the structure of domain scales	Main Survey	Exploratory Factor Analysis
	Evaluate construct validity of the proposed model	Main Survey	Confirmatory Factor Analysis
	Assess competing models	Main Survey	Confirmatory Factor Analysis
	Recommend the best fitting model	Main Survey	Confirmatory Factor Analysis
	Provide example of implementation of the measurement model	Main survey	Composite score calculation

1.7 Dissertation structure

This thesis is divided into eight chapters structured as follows:

Chapter 1 offers background and rationale for the study and introduces the general roadmap and methodology of the research. The chapter highlights the theoretical and practical contributions expected from the current study.

Chapters 2 provides a review of the literature relevant to this study, which includes a discussion of sustainable development, sustainability frameworks and sustainability in the built environment. The chapter also addresses how sustainability cascades from the country level to the organisational level to explain the importance of having a sustainability evaluation system that is adapted to the national sustainability agenda of the UAE. The chapter also discusses corporate sustainability concepts and performance, its drivers and implementation in the construction industry.

Chapter 3 introduces the concept of corporate sustainability performance followed by the first step of the scale development process, item generation. A review of literature is conducted to generate a list of sustainability criteria that will form the basis of the subsequent validation steps.

C**hapter 4** discusses the methodology used in this study, including the philosophical foundations of the research methodology adopted to achieve the research objectives. This chapter also includes a discussion on paradigm issues and implications in research design. The last section of the chapter outlines the research design used in the study and describes the scale development process in detail. The next three chapters discuss the results of the research according to the scale development process explained in Chapter5.

C**hapter 5** analyses the expert interviews and survey and interprets the findings. The changes made by experts to the list of items and the wording of the items are also presented. Content validation of the model is subsequently reinforced through an analysis of the findings from the experts' survey. The outcome of this chapter is the updated list of sustainability performance criteria and the conceptual model that forms the basis of the next step of the scale development.

Chapter 6 addresses the second and third stages of scale development. In this chapter, validation is undertaken using EFA and CFA. The proposed model structure is then compared with alternative models and the recommended model is explained, analysed and discussed.

Chapter 7 provides a summary of the research and main findings and draws conclusions from the study in line with the research objectives. The chapter also describes the study limitations and proposes recommendations for further research.

Chapter 2: Corporate sustainability and the construction industry

2.1 Introduction

The next stage after defining the topic, its background, rationale, aim and objectives is to review the relevant literature and set a clear theoretical foundation for the study. This chapter is focused on the first objective of this research as it will cover the concepts of sustainable development, sustainability, corporate sustainability and how they relate to each other and to the construction industry.

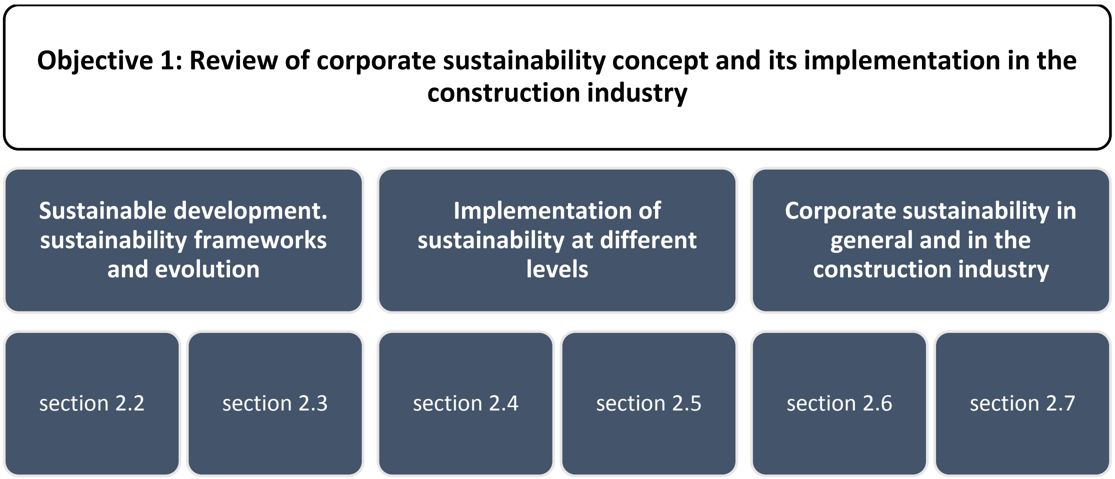


Figure 2.1: Chapter 2 structure

As shown in figure 2.1, the structure of this chapter follows a breakdown of the first objectives into three parts. Section 2.2 and section 2.3 present the background to sustainable development and sustainability concepts and discusses the evolution of these concepts and the myriad of frameworks developed for their definition and implementation. Section 2.4 focuses on the application of sustainability at different levels, ranging from the global level to the organisational or corporate level. Section 2.5 discusses the concept of sustainability within the construction industry at international level and in the UAE. Section 2.6 defines the concept of corporate sustainability and its related models while section 2.7 addresses its adoption in the construction business and the drivers leading to the increasing importance of corporate sustainability performance in the construction business, particularly by contractors.

2.2 Sustainable development and sustainability concepts

The concept of sustainability was introduced by the 'World Conservation Strategy' in 1980, and it initially related to sustainable approaches to preserve the long-term productivity of forestry and fisheries (IUCN, 1980). Subsequently, and with the publication of 'Our Common Future' by the World Commission on Environment and Development (WCED) in 1987, sustainable development was widened to cover all types of developments and human activities. According to the Brundtland report, 'sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987).

Further to the official definitions introduced by international reports and commissions, the plasticity and wide-ranging principles of sustainable development have opened doors for unceasing interpretations by academia, politicians and social organisations. In 1984, the former director of the United Nations Environment Program (UNEP), Mustafa Tolba, stated that sustainable development had become 'an article of faith, a shibboleth; often used, but little explained' (Le´le´, 1991). This statement has been reiterated since then: in 1989, the World Bank published 60 different definitions of sustainable development (Pezzy, 1989), and Ciegis et al. (2009) reported that a review of economic literature revealed over 100 published definitions applied to different sectors or disciplines.

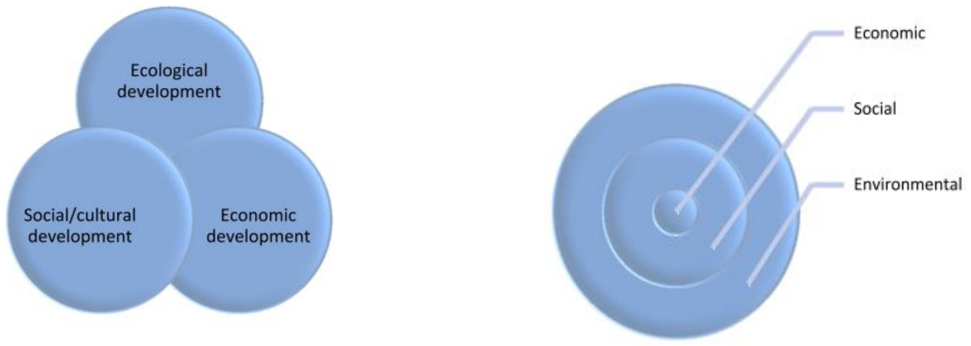
Tremendous and diversified attempts have been made to narrow down the broad and ambiguous concept of sustainable development to make it understandable and operational. A more focused and comprehensive formulation of sustainable development was drawn up with the global programme for the 21st century, thereafter, known as Agenda 21, which contained 27 principles of sustainable development. A multitude of interpretations of these principles have been generated. In their sustainability metrics report, UNEP (2014) developed five protection targets based on the principles of protection which relate to the protection of (1) the natural environment/ecosystem, (2) natural resources, (3) human health, (4) social values and public goods and (5) capital and material goods. The precautionary principle is also considered a key element in different interpretations and applications of sustainable development; the principle states that ‘lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation’. This principle ‘demands action where the consequences of inaction are uncertain’ (Batterham, 2003). Existing literature considers sustainability as the end state or ultimate goal of the sustainable development process. The simplistic interpretation of this distinction is to consider sustainable development as a dynamic process and sustainability as a static state (Haberl et al., 2001). However, sustainability is an evolutionary concept not with fixed but with moving targets, depending on the circumstances (Proops et al., 1996). Governments and populations are increasingly becoming aware of the negative side of the economic, technological and social progress achieved by humanity, especially in the developing world. The prosperity and growth achieved have had a long-lasting impact on the natural environment that can be seen in issues such as climate change, ozone depletion, desertification, acid rain and asbestosis. Humankind is thus facing a big challenge to ‘reverse unsustainable trends’ (Halliday, 2008, p.5). For three decades, sustainability has been considered by many opponents as a restraint to prosperity and developments. Only in the last few years has this understanding shifted to consider sustainability as a restraint on inappropriate development and a legitimate driver for increasing quality of life while considering the triple bottom line (TBL). Currently, sustainability is anonymously based on the three pillars also known as the three dimensions; the three P’s refer to social, economic and environmental strands. However, this concept has been criticised and other frameworks emerged to replace it by giving the highest priority to one dimension over the others.

2.3 Sustainability frameworks and principles

The report of United Nations on the changes from Brundtland to Rio 2012 points out that 20 years is a short timeframe in which to make radical changes in sustainable development. However, progress has been witnessed at different levels. On the social side, advances have been made in reducing poverty by halving the number of people whose income is less than US $1 per day and by improving access to electricity. The environmental protection has been increasingly integrated into economic decision-making through legislative initiatives such as carbon taxation, greater investment in green technologies and a reduction in resource extraction per unit of GDP (Drexhage and Deborah, 2012). Despite this slight progress, it is widely recognised that an unsustainability trend is still continuing; striking examples are that the richest 1% of the world's population owns 40% of the worlds' wealth while the poorest 50% has barely 1% of the world's wealth (Davies et al., 2006), and the environmental aspect is witnessing decreasing biodiversity and water stress and depleting natural resources (Drexhage and Deborah, 2012). Some possible underlying causes of the less than expected sustainability progress are a prevalent focus on the environmental dimension, competing agendas of different countries and a difficulty to move from economic growth as the main development paradigm (Drexhage and Deborah, 2012).

2.3.1 Triple Bottom Line (TBL)

Sustainable development requires a balance between economic and social aspects with ecological considerations. The TBL is presented as two main models (Figure 2.2). The first model considers the three dimensions as being on the same level (Figure 2.2a) and the second model considers environment as the dominant aspect, with the economic activity depending on social aspects and resources, which are both affected by and affect the environmental factors (Lützkendorf and Lorenz, 2005; Persson, 2009).



(a) (b)

Figure 2.2: models of triple bottom line
(Persson, 2009)

Another TBL evaluation claims that this differentiation is just a conceptual device for organising our thinking and that real life issues seldom fall into only one category (M.LeLe, 1991). Balancing the three dimensions of sustainability has always been a challenge Halliday (2008, p.7) states that oversimplification of the concept has led to one-dimensional solutions, and he suggests that 'we need to move from the present rhetoric that sustainability involves environmental, economic and social aspects to actively making and demonstrating those links'. Gallopin (2003) also points out that sustainable development should not be based on distinct dimensions but rather on an integrated whole. Guido, Farzaneh and Guo (2012) defend this system approach to sustainable development. To understand the links and the integration means between the three dimensions, it is essential to understand their differences and underlying foundations. The following sections describe two distinct contexts or thinking approaches to sustainable development which are labelled ecocentric and anthropocentric. From a system thinking perspective, these dimensions are interrelated and mutually reinforcing and thus cannot be achieved separately.

2.3.2 Ecocentric concept

As its name indicates, the ecocentric concept of sustainable development (figure 2.3) focuses on the ecologic dimension and centres on the natural environment; the proponents of this thinking consider that man's development is a legitimate right as long as it does not violate the natural ecosystems coherence and integrity (Hoffman and Sandelands, 2005). An ecocentric position means protecting the ecological system, even if it requires eliminating or rearranging the human component (Gallopin, 2003; Hoffman and Sandelands, 2005). The proponents of the idea that ecological sustainability is above and beyond economic and social sustainability also embrace the concept of 'very strong sustainability' (Gallopin, 2003; Pohl, 2006) and compatible with a steady-state economy called for by the Club of Rome four decades ago.

Figure 2.3: The extreme ecocentric position (Gallopin, 2003).

2.3.3 Anthropocentric concept

This concept is another extreme position that considers natural sustainability important only as far as it is required for social and human sustainability (figure 2.4). Also known as 'very weak sustainability', this concept, if taken to its radical form, could lead to a completely industrialised planet and could transform the ecological system as a mere servant of the human system by providing natural resources and receiving generated waste (Gallopin, 2003). This human-centred perspective encourages the exploitation of natural resources (Warhurst, 2002) and considers it a question of survival (Schaad, 2012).

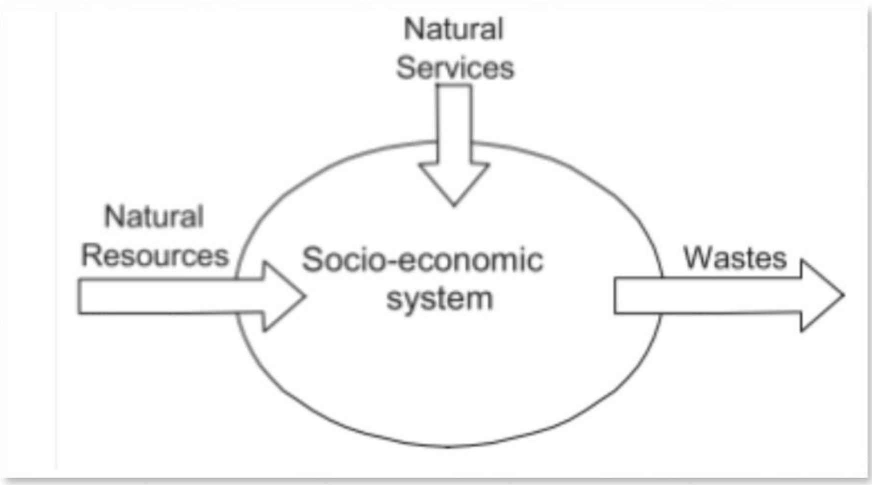


Figure 2.4: The extreme anthropocentric position

(Gallopin, 2003).

From the definitions and frameworks of sustainability reviewed above, it can be concluded that there is no universally agreed definition or framework for sustainability. However, the integration and balance of the three dimensions of sustainability is more logical and reasonable than the two eccentric models of 'very strong' or 'very weak' sustainability. Therefore, for the purpose of this study, sustainability is defined as "meeting the needs of the present without compromising the needs of the future and while maintaining a balance between environmental, social and economic dimensions". This definition is a combination of the universally used Brundtland definition and the TBL framework of sustainability.

2.4 Sustainability Cascade

Implementation of the sustainable development agenda commenced with the popularisation of the concept in the Brundtland report. Sustainability development strategies and initiatives emerged as a response to this call for change. The change was witnessed at different levels that mutually interact with and react to each other, following the hierarchy illustrated in Figure 2.5. It is obvious from the section below that policies and goals at one level affect and drive the sustainability agenda in lower levels.

Figure 2.5: Sustainability cascade

2.4.1 Sustainability at a global level

Since the emergence of sustainable development concept, many international initiatives started to flourish reflecting different focuses, understandings and agendas. The most known initiatives are the Sustainable Development Goals and the United Nations Millennium Goals. Sustainable Development Goals was the outcome of the Rio+20 Conference in 2013, which aimed to set global sustainable development goals that should be adopted at a global level and developed through an intergovernmental process agreed by the global community. The United Nations developed the Millennium Development Goals (MDGs), gaining commitment from world leaders in 2000. Table 2.1 summarises other global initiatives that have been launched by different global organisations with the same goal of enhancing awareness, understanding and implementation of global sustainability agenda. As a response to these global initiatives, countries worldwide have set targets to integrate sustainable development at all levels and in all domains.

Table 2.1: List of Global Sustainability Initiatives

Initiative	Launched by	When
Green Growth Indicators	OECD	2011
Green Economy Initiative	UNEP	2008
Inclusive Green Growth: The Pathway to Sustainable Development	World Bank	2012
Green Economy Roadmap	International Chamber of Commerce	2010
Global e-Sustainability Initiative	UNEP	2001

2.4.2 Sustainability at the country level

The Rio Summit and the resulting sustainable development initiatives established a guiding vision for the development efforts of all countries (OECD, 2009). It is hard to find national public policies today that do not refer to the concept of sustainable development (Happaerts, 2012; RUSSOTTO & BERNASCONI, 2014). Almost all countries intensified their efforts and subsequently adopted new or revised National Summit on Sustainable Development (NSDS) shortly before or after the World Summit on Sustainable Development (WSSD) in 2012. A document issued by the UNCSD (2002, p.8) to prepare for the WSSD explained that 'a national sustainable development strategy is a coordinated, participatory and iterative process of thoughts and actions to achieve economic, environmental and social objectives in a balanced and integrated manner'. Most countries worldwide have developed national sustainable development strategies in accordance with the mandate of Agenda 21 and have issued incentives policies or sector agreements on common sustainability targets. Rebeco & RobecoSAM (2013) developed a country ranking system evaluating 59 countries – 21 developed and 38 emerging – against a broad range of sustainability indices covering the three sustainability dimensions. Figure 2.6 presents the results of the ranking process. This ranking and indexing of countries act as a strong incentive for governments to enforce and incentivise different sectors and organisation to adopt more sustainable policies, strategies and initiatives.

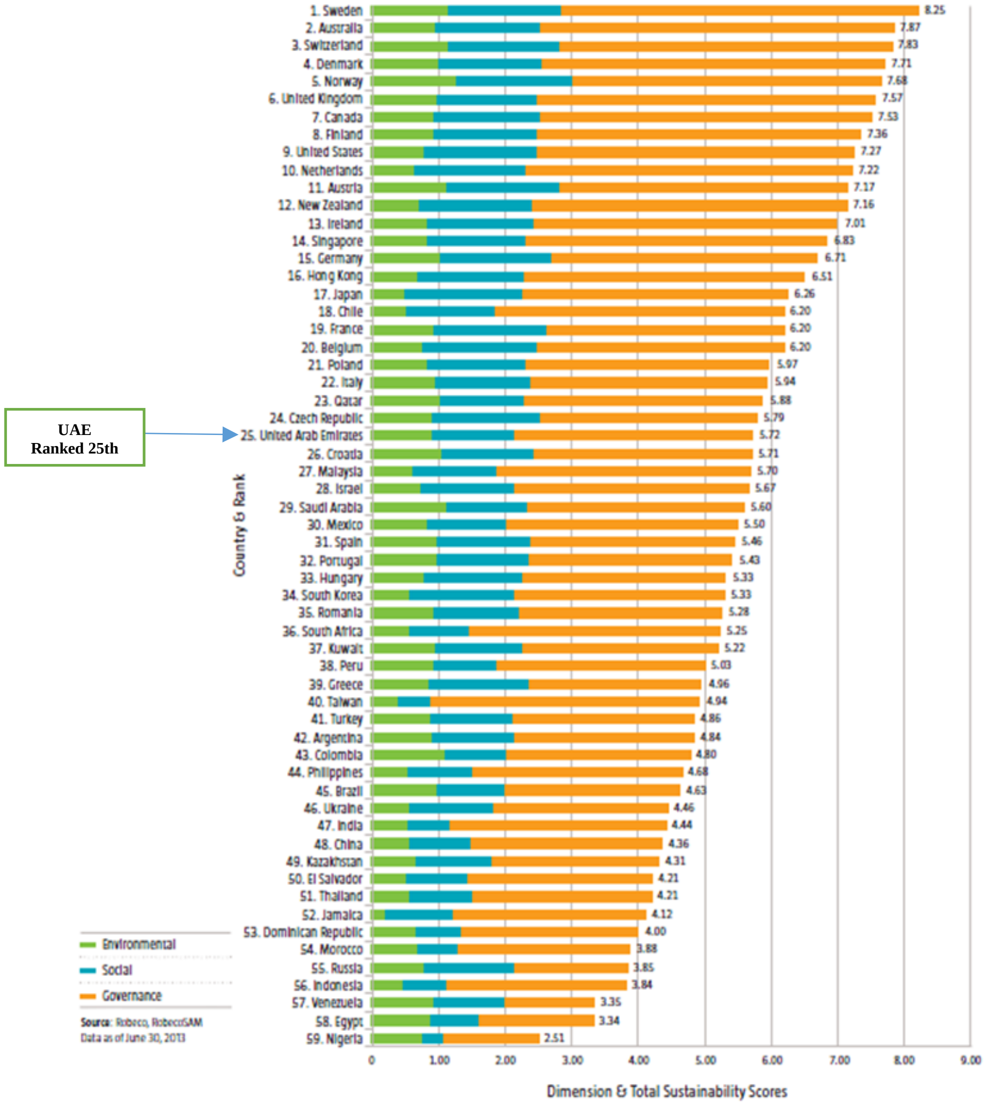


Figure 2.6: Country sustainability scores and rankings

(Robeco and RobecoSAM, 2013)

2.4.3 Sustainability at industry level

Industrialisation has been the main driving force behind the economic growth and dramatic increases in living standards seen in the past 200 years in the developed world. However, it is becoming more obvious that the developed world's system of doing business and managing consumption and production processes is against the global sustainability goals (UNIDO, 2011). Globally, industry accounts for one-third of the total energy consumption and for almost 40% of worldwide carbon dioxide (CO2) emissions. The International Energy Agency (IEA) has shown that, globally, industry will need to reduce its current direct emissions by about 24% of the 2007 levels if it is to halve global emissions from 2005 levels by 2050.

KPMG' survey of corporate responsibility reporting has been tracking sustainability reporting in different industries since 1993. In 2017, they published their most comprehensive survey of 4900 companies in 49 countries (KPMG, 2017). The report shows that for the first time in the survey's history, over 60% of companies across all industry sectors are reporting on sustainability. Sectors with high sustainability impact such as Oil and Gas, Chemicals and Mining have the highest reporting rates of 81%, 81% and 80% respectively, however, Construction and Materials sector is falling behind, with a rate of 69% despite its high environmental and social impacts (KPMG, 2017).

It is proved that industries are not able to achieve levels of excellence and maturity in understanding and implementing a balanced approach to sustainability without a commitment of the companies operating in these industries. In some cases, leading and proactive organisations act as pioneers and game changers for the whole industry and eventually shape the industry's policies and codes of practices. This can apply to all performance areas including quality, safety, ethics and sustainability is no exception.

2.4.4 Sustainability at the organisational level

As a legitimate response to the sustainable development agenda at the levels discussed above, organisations are required to shift from the business as usual approach to a more eco-efficient, more resource-efficient system (Nelson, Jenkins and Gilbert, 2015). Esty and Simmonsn (2011) consider that sustainability at the corporate level is often used to refer to the TBL approach to business through which companies seek to deliver not only profits and solid economic results but also good performance from an environmental and social perspective. 'All organizations whether for profit or otherwise have to create and successfully implement a sustainability strategy' (John, 2012).

‘Developments in the sustainability arena have significant implications on the strategic decision-making process of the firm as the sustainability challenge requires the revision of current management practices’ (Schrettle et al., 2014). Schrettle et al. (2014) divided the drivers for sustainability adoption in organisations into two main categories: exogenous drivers, including environmental regulation, societal values and norms and market drivers; and endogenous drivers, including strategy, culture and resource base. The World Business Council for Sustainable Development (WBCSD) was launched during the run-up to the 1992 United Nations Summit on Environment and Development in Rio de Janeiro. During the preparations for the 2002 World Summit on Sustainable Development in Johannesburg, the WBCSD restated its vision of the relationships between responsible companies and the goal of sustainable human progress (World Business Council for Sustainable Development, 2002). The Sustainability Imperative is a game changing trend that affects the competitiveness and even survival of organisations (Montgomery, 2010). According to the WBCSD (2000), sustainability involves “the simultaneous pursuit of economic prosperity, environmental quality and social equity. Companies aiming for sustainability need to perform not against a single, financial bottom line but against the triple bottom line’.

The sustainability cascade explained above sets a clear rationale for the importance of adopting and measuring sustainability at corporate level. While global sustainability shapes the trend and direction at other levels. The bottom-up implementation of sustainability is the most efficient method to evaluate the feasibility and effectiveness of global, national, and industrial sustainability policies and strategies. To evaluate the importance of corporate sustainability for construction companies, it is essential to understand the application of sustainability in the construction sector at global level and in the UAE.

2.5 Sustainability in the Built Environment

2.5.1 Sustainable construction

Sustainability depends on establishing a consensus that its principles will be adopted by all sectors. Within the broader and holistic concept of sustainability, construction has a major role to play. However, similar to sustainable development, sustainable construction means different things to different interest groups; thus, Brundtland's definition can be applied to any activity and would lead to a 'common' but vague definition. The construction industry is considered a key factor in achieving sustainable development due to its size, range of activities, number of employees, natural resources depletion and waste generated. The construction industry involves a complex process and an extended supply chain. Therefore, shifting towards sustainable construction principles requires a holistic process re-engineering by integrating sustainability within all stages of projects lifecycle (Asad, 2007).

2.5.2 Rationale for Sustainable Construction

Pearce (2003) states that the contribution of the construction industry to sustainable development is trifold: contribution by man-made (built facilities), human capital (labour force) and social capital (human wellbeing). The construction industry is shaping our life and has a significant impact on people's quality of life. We use roads and bridges to move between houses, offices, schools and shopping centres which are all products of this eternal industry. The bilateral impact between the built environment and natural environment is significant. On the other side of the equation, the construction and built environment are considered one of the least sustainable sectors in the world. The sector uses around 50% of all non-renewable resources. Figure 2.7 shows the level of resource depletion and global pollution attributed to buildings.

Resource	(%)
Energy	45–50
Water	50
Materials for buildings and roads (by bulk)	60
Agricultural land loss to buildings	80
Timber products for construction	60 (90% of hardwoods)
Coral reef destruction	50 (indirect)
Rainforest destruction	25 (indirect)

Pollution	(%)
Air quality (cities)	23
Climate change gases	50
Drinking water pollution	40
Landfill waste	50
Ozone depletion	50

Figure 2.7: Global resource depletion and pollution attributed to buildings (Willmott Dixon, 2010)

As one of the industries that will be most impacted by climate change, the construction industry has to respond to climate change pressure and adopt mitigation and adaptation strategies (Moreno and Skea, 1996). The construction sector has been identified as one of the highest in terms of sustainability lifecycle impact, accounting for 40% of overall energy use. On the social side, it is estimated that the amount of time we spend in the built environment and on it – in vehicles – ranges from 80% to 90% (UNEP, 2003). The construction industry is complex and has massive effects on the natural environment that can be irreversible if building sustainably is not embraced throughout buildings lifecycle.

2.5.3 Sustainable construction in the UAE

The construction sector in the UAE was heavily affected by the worldwide financial recession in 2009. However, its diversified economic strategy and strongly standing financial infrastructure helped the economy to regain stability, and more specifically enabled the real estate and construction sectors to pick up in a slow yet steady pattern (Trade, 2016). Despite the oil prices decreasing by 55% in less than a year, and especially the economy relying on hydrocarbons, where oil and gas revenues constitute 25% of the national GDP (UAE Ministry of Economy, 2016), the building and construction sector is still considered a major employer in the UAE employing 20% of all state employees (Figure 2.8). In recent years, emerging countries such as the UAE have been experiencing the increasing growth of sustainability awareness shaped by the development of large-scale and stringent sustainability policies. In the UAE, the response to the global sustainability trend started later than industrialised countries because the country was focused more on economic growth and infrastructure development. However, in the last decade, many initiatives have been launched at both federal and emirate levels. Abu Dhabi Vision 2030 was published in 2007 to encompass all the strategic policies for the development of the emirate and one of the key objectives of this vision is environmental sustainability. Dubai, the second-largest emirate in the UAE, has also launched initiatives related to green building, environmental tourism and sustainable energy (Government of Dubai, 2012). At the federal level, UAE Vision 2021, to match the Golden Jubilee of the Union, was announced in 2010 by His Highness Sheikh Mohammed Bin Rashid Al Maktoum, UAE Vice President, Prime Minister and Ruler of Dubai. This vision aims to unify efforts made by different emirates and to set clear pillars for sustainable development in UAE (Vision 2021, 2014). Moreover, a long-term national initiative was launched in 2012 under the name of ‘Green Economy for Sustainable Development’ (The Official Portal of the UAE Government, 2012).

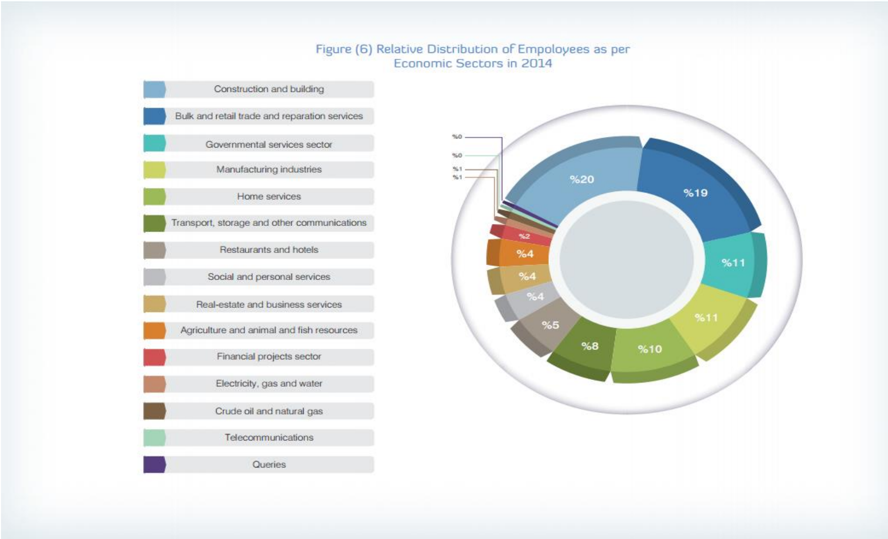


Figure 2.8: Distribution of employees by economic sector

(UAE Ministry of Economy, 2016)

The number of highly green-involved firms in the UAE in 2012 was 4.8 times higher than in 2009. An additional 54% expect to be at these high levels of green by 2025. This rapid acceleration points to a market that has embraced ‘green’ in recent years. In the UAE, 73% have new green institutional projects planned (UAE Ministry of Economy, 2016), making it the largest sector for planned green building activity in the country. The only other country with more than half of its firms planning green work in this sector is the US. A recent report by Core Savills showed that the UAE ranks in the top 10 countries worldwide in terms of LEED certification outside the US (Figure 2.9), and Dubai ranks among the top three cities in terms of the number of certified green buildings under LEED and BREEAM (Figure 2.10). Sustainability movement in the UAE differs notably from other countries either in terms of pace or drivers. This achievement in green building credentials has been witnessed in a short period compared to advanced countries. While legislation such as The Energy Act in the UK took seven years (2011-2018) to be fully implemented, the Estidama rating system was made mandatory in Abu Dhabi after just one year of piloting.

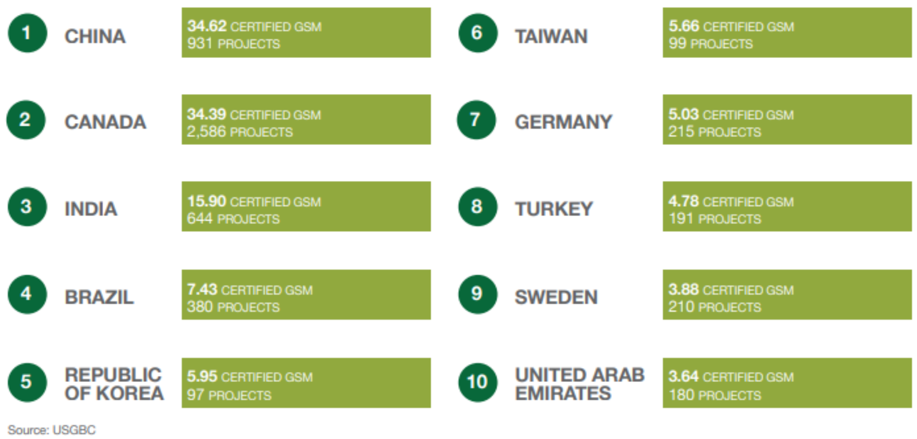


Figure 2.9: Top 10 countries for LEED certification outside the US (Core Savills, 2017)

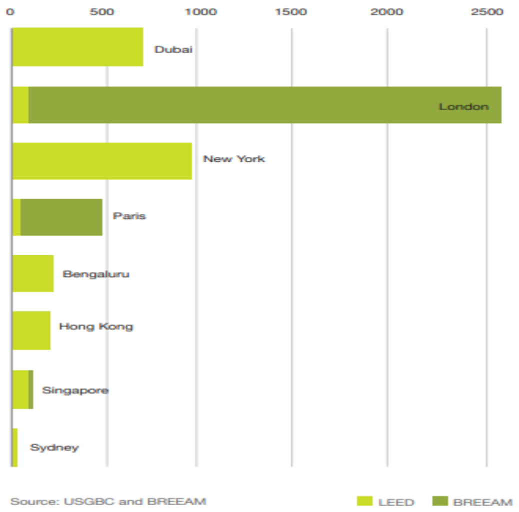


Figure 2.10: LEED and BREEAM buildings in global cities

(Core Savills, 2017).

The accelerated policymaking process and the strong leadership of the UAE government represent not only an opportunity to accelerate the change but also a challenge for construction companies to adapt to this change in an efficient and effective way. Clients have an urgent need to select the right contractor for successful delivery of their sustainable projects. Furthermore, the impact of the construction sector on the three dimensions of sustainability and on the UAE strategic path towards sustainable development justify the need for rethinking the level of implementation of sustainability to go beyond the industry and project level to include the corporate or organisational level; a concept that will be addressed in greater detail in the next section.

2.6 Corporate Sustainability

As discussed in the previous sections, it is essential for the concept of sustainability to be implemented at the corporate level if global sustainable development challenges are to be addressed. Corporate sustainability is a set of 'strategies and practices that aim to meet the needs of stakeholders today while seeking to protect, support and enhance the human and natural resources that will be needed in the future' (Firestone, Hadders and Cavaleri, 2004, p.5). A series of theories and approaches have been proposed to understand corporate sustainability and to implement its underlying foundation in organisations (Figure 2.11). The following sections explain the most popular of these theories.

2.6.1 Corporate Social Responsibility (CSR)

CSR emanates from the corporate responsibilities pyramid introduced by Carroll (1978), which focuses mainly on managing the dynamics between the organisation and the society. CSR is based on stakeholder theory and it is regarded as a continuous engagement process with stakeholders (Frederick, Post and Davis, 1988).

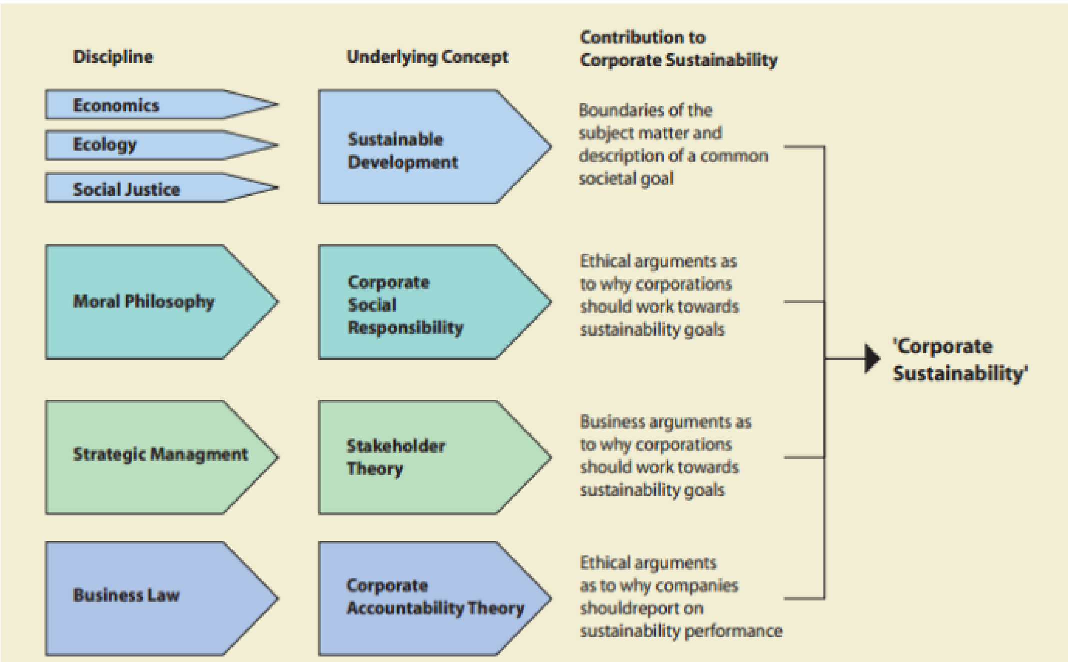


Figure 2.11: The underlying theories of corporate sustainability

(Wilson, 2003)

The WBCSD defines CSR as 'the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large' (WBCSD 1998, p.3). The recent ISO26000 definition of CSR states that 'social responsibility is a multi-faceted approach that, like quality, should be integrated into all aspects of how a company conducts its business' (ISO, 2009).

2.6.2 Creating Shared Value (CSV)

Porter and Karmer (2006) in their game changing article 'Creating Shared Value', argued that profits are not similar. Profit involving shared values with society and communities enables society and companies to grow and advance faster. There is a continuing debate about the difference between CSR and CSV. Moore (2014, p.4) maintains that the fundamental difference between the two concepts is that 'CSR is about doing something separate from the business and CSV is about integrating social and environmental impact into the business, using that integration to drive economic value'.

2.6.3 Sustainability Accounting (SA)

In parallel with financial accounting, cost accounting and management accounting, a new term emerged that is focused on the integration of social, environmental and economic dimensions of organisational activities. That term is SA, and it describes a subset of the accounting discipline which involves recording, analysing and reporting the environmental and social impacts of business activities while considering the trade off and interactions between the social, environmental and economic issues constituting the three dimensions of sustainability. SA can be developed as an entirely new system or as an extension or modification to the conventional accounting systems (Schaltegger and Burritt, 2010). These two approaches are reflected in the publication of a separate sustainability report or an integrated report adopted by organisations. 'In a world where companies are expected to demonstrate their performance in terms of contributions towards sustainability, accountability and transparency have become major prerequisites to enabling a cooperative and constructive' (Schaltegger and Burritt, 2010, p.377); however, no clear approach is currently available for SA. Schaltegger and

Burritt (2010) listed some drivers for the adoption of SA by companies including green-washing, mimicry and industry pressure, legislative pressure, stakeholder pressure, self-regulation, corporate responsibility and ethical reasons, and managing the business case for sustainability.

2.6.4 Sustainability Reporting (SR)

Disclosing sustainability reports has become a common trend and a legitimate part of corporate reporting. SR is now mandatory in many countries and even in voluntary situations, the number of companies publishing their sustainability reports has significantly increased in the last two decades (Figure 2.12).

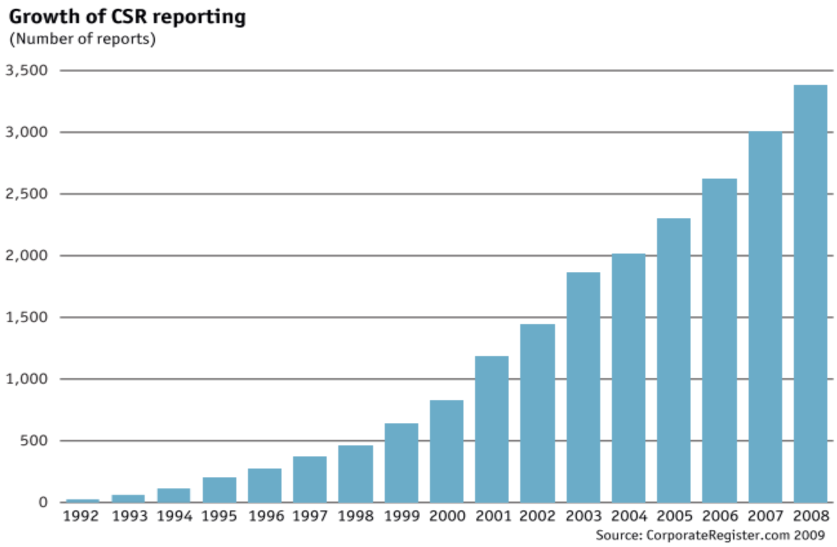


Figure 2.12: The Evolution of Corporate Sustainability Reporting (GRI, 2009)

Lozano and Huisingh (2011) claimed that SR is based on a holistic perspective which includes TBL and time dimensions. They investigated synergies and interlinks between the two sets of dimensions and recommended a holistic and integrative approach to SR.

In line with the definition of sustainability adopted for this study, corporate sustainability for this research will be based on the concept of CSV (Common Shared Value) which is about integrating social and environmental impact into the business, using that integration to drive economic value. CSR, SR and SA would be considered as important but not necessary components of a CSV based corporate sustainability.

For this study, the definition adopted for corporate sustainability is a combination of CSV concept and the definition proposed by Dyllick and Hockerts (2002, 131) as "integrating social and environmental impact into the business, using that integration to drive economic value and to meet the needs of the firm's direct and indirect stakeholders without compromising its ability to meet the needs of future stakeholders".

2.7 Corporate sustainability and construction companies

2.7.1 The construction business

The construction industry plays a major role in global socio-economic development. As a fundamental sector that permeates most other sectors, the construction industry converts different resources and products into built spaces and infrastructure that are essential for socio-economic development. The contribution of the construction industry is around 10% of the global GDP. It is also considered a significant employment generator because it employs almost 111 million employees worldwide, accounting for approximately 7% of the total employment and 28% of all industrial employment (MCVET, 2008). Construction has always been described as a heterogeneous and widely dispersed industry, where products are unique, with limited scope for learning curve benefits and innovative practices (Valence, 2004). Many academic research studies and government reports (Latham, 1994; Egan, 1998; National Audit Office, 2001; Fairclough, 2002; HM Government, 2008; Cabinet Office, 2011) have reported performance issues in the construction industry and have highlighted the inefficiency caused by complexity and fragmentation of the construction industry.

The construction market system is different from other markets. As concluded by Drew and Skitmore (1997, p.470): 'the construction industry is highly fragmented, with the dominant firm being the small contractor'. Dubois and Gadde (2002) added that the construction industry can be described as a loosely coupled system suffering from the absence of inter-firm adaptations. They also listed the following central features that make the construction industry different from other industries: a focus on single projects, local adjustments, competitive tendering, market-based exchange and companies having multiple roles.

According to Adnan et al. (2012), the construction industry is considered to be one of the most susceptible to unethical practices because it involves substantial capital investments, providing large scale opportunities for rent extraction as well as investments that usually cannot be redeployed after implementation. Unethical practices can take place at every phase of a construction project'. Ethical issues in the construction industry concern not only bribery or corruption but also conflicts of interest and collusive tendering. Transparency International (2005) illustrates how corruption can add up to 25% of the cost of public contracting, generating a waste of public resources, missed development opportunities and an unstable environment for businesses. The true extent of the industry is broader than its on-site activities and includes the quarrying of construction raw materials, the manufacture of building materials, the sale of construction products, and the various associated professional services (Pearce, 2003).

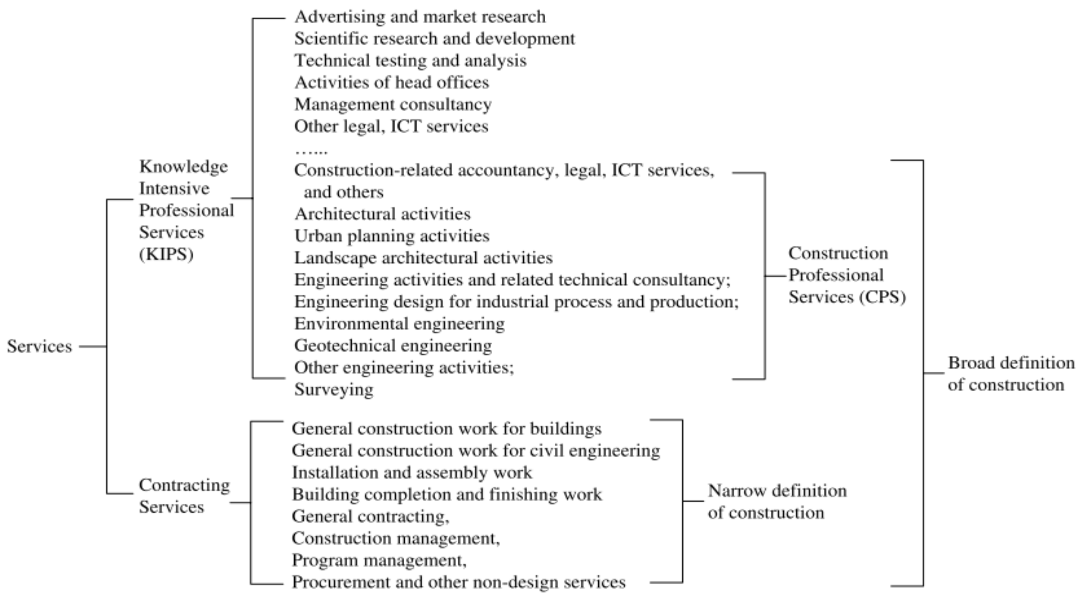


Figure 2.13: Construction professional services and contracting services (Lu et al., 2014).

The AEC industry comprises three main business sectors: Architecture, Engineering, and Construction or contracting. Architecture and engineering are known professional services. However, as shown in **Error! Reference source not found.**, contracting is also a service sector, although it has often been mistakenly perceived as a production sector, likely because 'its outcome is similar to manufactured goods, which cannot be stored, marketed, and sold off-the-shelf' (Lu et al., 2014).

2.7.2 Drivers for construction companies to go sustainable

Taicchi et al. (2013) state that, nowadays, there are many motivations and drivers for corporate sustainability that have different levels of importance and effectiveness depending on the company location, type of activity and the company's stakeholder strategy (Figure 2.14).

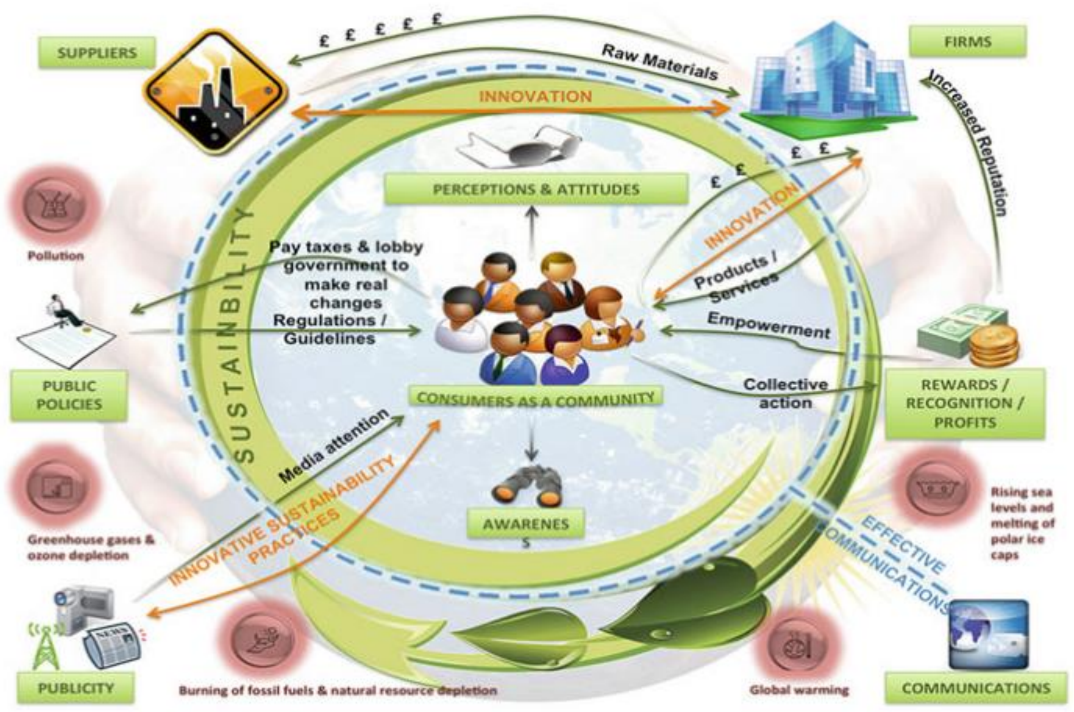


Figure 2.14: Sustainability motives and drivers

The same motives and drivers apply to construction companies. Construction contracting is regarded as a competitive and high-risk business. The drive towards sustainability in the construction industry is occurring at a very fast pace and it is impacting every level within the construction supply chain (Barlow, 2014). At the contractor level, sustainability starts to affect the contractors' competitiveness and their bidding success rate (Barlow, 2014). Sustainability driven construction requires a genuine move towards full disclosure and accountability throughout the construction supply chain.

Barlow (2014) states that 'sustainability is positively reversing today's price paradigm' because sustainable companies have created a competitive advantage that gives them a valid reason to charge price premiums for their qualifications and capabilities to deliver sustainable projects. Nevertheless, some contractors perceive sustainable construction methods, materials and technologies as a threat to their traditional working practices and as a requirement to work outside their comfort zone (Clarke, 2013). Myers (2005) analysed public disclosures of the United Kingdom's (UK) construction organisations and outlined that only a few large-sized companies have shown positive commitments for the increased emphasis on sustainable development in their construction activities. Their finding is line with Mills and Glass (2009) who outlined that skill deficit is one of the reasons of this slow implementation.

Tan, Shen and Yao (2011) reported that Hong Kong contractors are not adopting sustainability because (i) cost and time are the main performance criteria, (ii) the clients do not support the extra cost of sustainability and (iii) contractors do not have capacity to implement environmental management systems. The change requires a paradigm shift as depicted in figure 2.15. Christini et al. (2004) had similar findings and reported that only few construction companies have adopted Environmental Management System (EMS) in their business operation due to limited organisational resources and lack of a mutual commitment from industry partners. According to UNEP (2014), SR, accounting obligations, stakeholder and peer-group pressure, the need to comply with sophisticated and continuously changing building codes and the desire to be part of the different sustainability benchmarking and sustainability indexes are the main drivers for adoption of corporate sustainability.

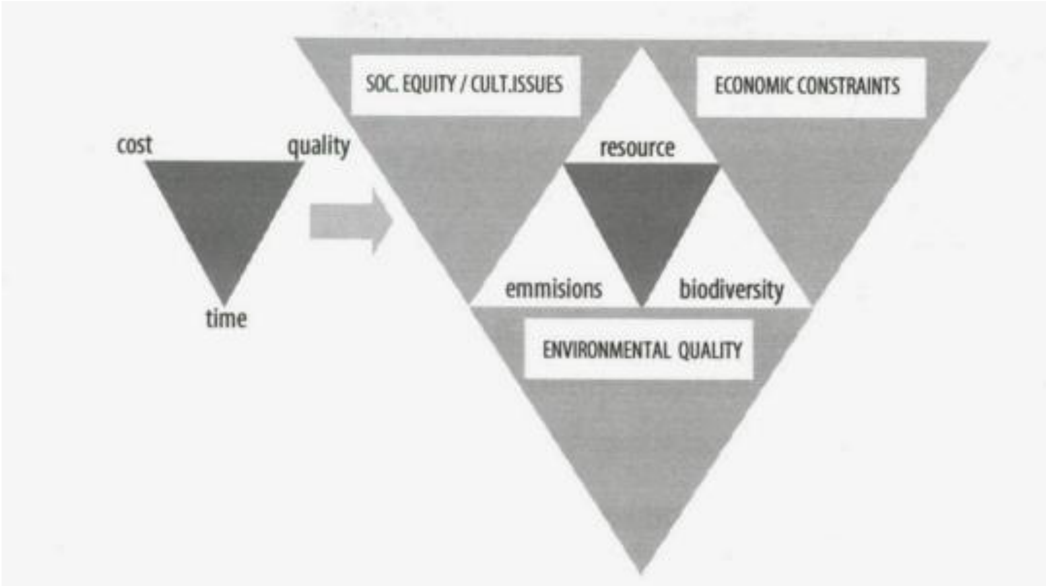


Figure 2.15: Extending the conventional construction project goals to the sustainability (Srdić & Šelih, 2011).

Contractors are also pushed to embrace sustainability in their business to be able to comply with the new environmental and sustainability contractual clauses emerging as a response to sustainability requirement of clients. For example, Clause 4.18 of the FIDIC Red Book is entitled, 'Protection of the Environment' and states that:

> *"The Contractor shall take all reasonable steps to protect the environment (both on and off the site) and to limit damage and nuisance to people resulting from pollution, noise and other results of his operations. The Contractor shall ensure that emissions, surface discharges and effluent from the Contractor's activities shall not exceed the values indicated in the Specification and shall not exceed the values prescribed by the Applicable Laws."*

Similarly, Clause 16 of the JCT 2007 Form, headed, 'Sustainable Development and Environmental Considerations', states that 'The Provider (contractor) will assist the Employer and the other Project Participants in exploring ways in which the environmental performance and sustainability of the Tasks might be improved and environmental impact reduced'.

Corporate sustainability performance is becoming an imperative in all industries and the construction industry is no exception. A strong corporate sustainability is increasingly considered as a competitive advantage in this profit driven and competitive sector. However, evaluation of corporate sustainability performance requires a system characterised by clarity, consistency and comprehensiveness acting as a decision aid for clients and as benchmarking tool for contractors.

2.8 Summary

This chapter presented the different concepts developed for understanding sustainability and sustainable development and discussed how these controversial theories apply to the construction industry. This chapter highlighted the need for a holistic and system approach to understand and implement sustainability in the built environment. The chapter also discussed how the global sustainability goals and policies affect and shape sustainability at the country, industry and company levels. This chapter shed light on the outstanding evolution of sustainability movement in the UAE and the main characteristics of this trend, especially the speed of decision-making, policy enforcement and sustainability implementation. The impact of the construction sector on the three dimensions of sustainability and on the UAE strategic path towards sustainable development justify the need for rethinking the level of implementation of sustainability to go beyond the industry and project level to include the corporate or organisational level; a concept that was reviewed and explained in this chapter.

It can be concluded from the reviewed studies that corporate sustainability is a multifaceted concept that has been studied, understood and implemented differently in academia and practice. Companies in different domains including the construction industry are starting to grasp the strong link between sustainability performance and long-term financial standing. Many factors have been reported as the driving forces for companies to go sustainable in an integrated way. The most common drivers are regulations, employees, investors, customers and NGOs/ media. These drivers align with stakeholder theory, which forms the basis of corporate sustainability strategies. The chapter concluded by confirming the necessity for construction contractors to adopt corporate sustainability as a competitive advantage if they aim to survive in such a highly competitive market. Evaluation of corporate sustainability performance requires a system characterised by clarity, consistency and comprehensiveness acting as a decision aid for clients and as benchmarking tool for contractors. This need will be discussed further in the next chapter and a review of existing corporate sustainability evaluation systems will be conducted before proposing a conceptual model for corporate sustainability evaluation of contractors.

Chapter 3: Conceptual framework for the model

3.1 Introduction

This chapter is focused on the second objectives and contributes partially to the third objective of the research. The previous chapter addressed the concept of corporate sustainability and how it relates not only to overall corporate performance but also to harnessing the competitive advantage of companies in general and construction companies particularly. This chapter provides a clear rationale for corporate sustainability performance evaluation and highlights the need for an evaluation model.

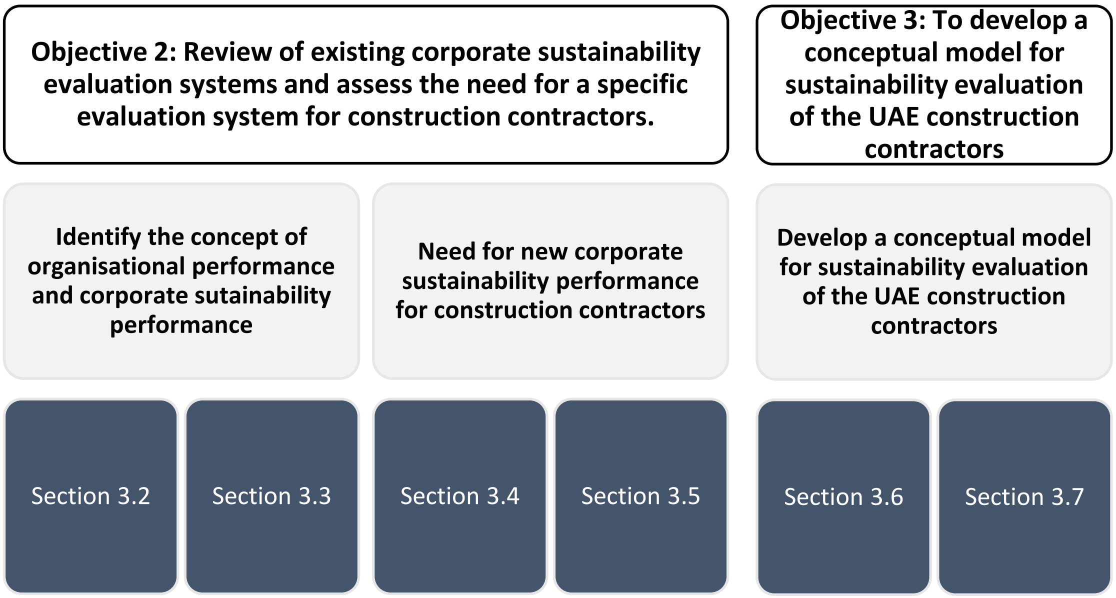


Figure 3.1: Structure of chapter 3

As illustrated in figure 3.1, section 3.2 and section 3.3 provide a review of organisational performance evaluation in general, and corporate sustainability performance as a sub-category. The chapter moves on to provide a review of the available performance evaluation systems (section 3.5) and it then presents the output list of evaluation criteria for sustainability contractors (section 3.6) that will be further validated in the next stage of the research. The proposed framework of the conceptual model is then presented in section 3.7 and its coverage of the three dimensions of sustainability was addressed and discussed at the end of this chapter.

3.2 Organisational Performance evaluation

Performance management and performance measurement are concepts that are extensively researched in management and business fields. According to James (2012), organisational performance is related to "how successfully an organised group of people with a particular purpose perform a function". Researchers have studied organisational performance from different perspectives such as information technology (Li and Tan, 2013), trust (Zanini and Migueles, 2013), client involvement in environmental issues (Junquera, del Brío and Fernández, 2012), organisational structure (Claver-Cortés, Pertusa-Ortega and Molina-Azorín, 2012; Claver-Cortés et al., 2012), customer knowledge management (Yang, Huang and Hsu, 2014), organisational innovation and technological capabilities (Camisón and Villar-López, 2014), diversification strategy (Boz, Yiğit and Anıl, 2013) and the seven learning organisation dimensions (i.e. continuous learning opportunities, inquiry and dialogue, employee empowerment, establish systems to capture and share learning, connect the organisation to its environment, collaboration and team learning, strategic leadership) (Qawasmeh and Al-Omari, 2013).

Despite the agreement on the necessity of measuring organisational performance, researchers and managers alike debated the best measurement for performance (Taha, 2014). Designing and using the right performance measurement system is crucial since it enables organisations to measure, manage and improve their levels of effectiveness and efficiency is achieving their business objectives. Traditional performance measurement models have been criticised for being financially focused, internally oriented and mainly based on lagging rather than leading indicators. This has led to the emergence of new performance evaluation frameworks in the late 1980s and early 1990s with an aim of more balanced and forward-looking indicators. Examples are Keegan et al.'s performance measures matrix (1989), the SMART pyramid (Cross and Lynch, 1989), Results and Determinants Framework (Fitzgerald, Johnston, Brignall, Silvestro, & Voss, 1991), Balanced Scorecard (Kaplan & Norton, 1992), and Performance and European Foundation for Quality Management Business Excellence Model, EFQM (European Foundation for Quality Management, 1999). According to Rojas and Laidlaw (2015), selection of the most suitable performance measurement framework "depends on the nature of the organisation, on the purpose of the assessment, and on the context in which the assessed organisation operates". The purpose of the assessment can be any one or many strategic objectives including financial and non-financial objectives. Corporate sustainability has become one of the integral parts of companies' business strategies and thus an important focus of performance evaluation.

3.3 Corporate sustainability performance evaluation

The information presented in the previous chapter indicate that achieving a sustainability future requires nations, governments, organisations and individuals to embrace the holistic approach to sustainability. An increasing body of evidence shows that companies which take a more sustainable approach enjoy significantly positive benefits (Oakley, 2006). Searcy and Elkhawas (2012) emphasise that for engagement with corporate sustainability to be a source of value creation, firms must define and measure their sustainability performance. Many factors impact corporate sustainability performance. Among those, Lourenço and Branco (2013) found that financial characteristics have a higher impact on companies' sustainability performance in emerging markets.

In their report on the global trends of sustainability performance measurement and management, the Economist Intelligence Unit (2010) highlights the following key drivers for the increasing trend in corporate sustainability performance:

- **Regulations:** Regulations have always been a powerful force for moving towards sustainability. According to KPMG (2014), there are currently 1,700 regulations related to climate change worldwide and despite economic pressures, more regulations are set to be created to deal with the rife social and environmental disasters.
- **Public opinion and consumer preferences:** Consumers' awareness about sustainability issues has increased significantly. A US survey revealed that 46% of the respondents are more inclined to buy 'green' products.

- **NGOS and the media:** Organisations such as the Shared Value Initiative at FSG Social Impact Advisors, Business for Social Responsibility, the WBCSD, the Clinton Global Initiative, Business in the Community and the Aspen Network of Development Entrepreneurs have an impact on companies' sustainability strategies because they act as awareness champions and informal reporters of any unsustainable actions.
- **Employees:** In their survey titled 'Six Growing Trends in Corporate Sustainability', Ernst & Young (2012), in cooperation with GreenBiz, reported that 'employees can be cheerleaders of their company's sustainability efforts'.
- **Investors:** Corporations integrating sustainability into their business operations are recognised to have better access to capital**.** Research shows that being added to a sustainability index does not increase a company's share price, but when a company is removed, firms were shown to lose more than 1.2% of their market values in only two days following the announcement of their removal (KPMG, 2014).

In line with this survey findings, results of a study by McGraw-Hill in partnership with United Technologies show that 'green' is becoming a business opportunity and imperative rather than a mere perspective of 'doing the right thing'. Companies are being proactive in adopting sustainability in their business and project delivery, motivated by many drivers that are encouraging organisations to adopt sustainability approaches. Companies can embrace sustainability by following the process illustrated in Figure 3.2.

According to Epstein (2008), few organisations are capable of qualifying their companies or products as sustainable because of a lack of a sustainability measurement system (Epstein, 2008). According to Savitz and Weber (2007), a company is sustainable when it generates profits for shareholders, protects the environment and improves the lives of the people with whom it interacts (Munck, Dias and Borim-de-souza, 2012).

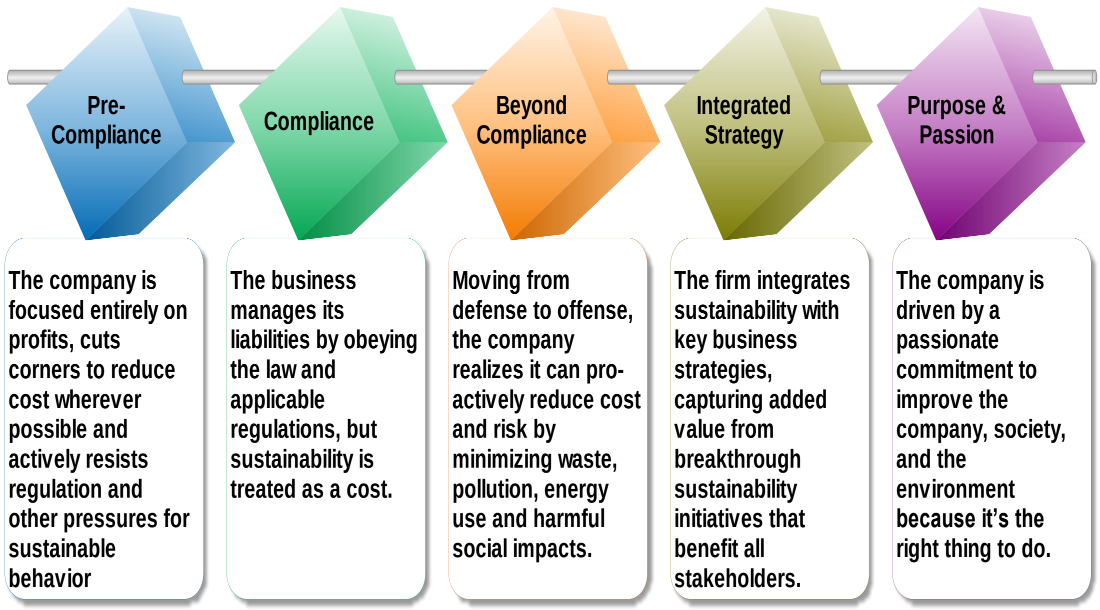


Figure 3.2: Corporate sustainability adoption process (adapted from Willard, 2005).

Corporate sustainability performance measurement and improvement is becoming a game changing trend that affects the competitiveness and even the survival of organisations. Montgomery (2010) states that companies seeking to reach the third stage and beyond should possess a performance assessment system that includes sustainability. It is therefore clear that corporate sustainability performance evaluation is primordial for any type of organisation including contracting companies. The specific drivers for contractors to measure and improve their corporate sustainability performance are explained below.

3.4 Need for sustainability performance evaluation of contractors

In addition to the traditional iron triangle (on time, on budget and as per specifications), project success is currently based on sustainability performance (Alzahrani and Emsley, 2013), and it is widely recognised that project success depends highly on selecting the right contractors (Banki et al., 2009; Ng et al., 2009; Palaneeswaran and Kumaraswamy, 2001; Yaweli et al., 2005). It is thus essential to carefully evaluate contractors' overall organisational performance, particularly their sustainability performance, to satisfy consistent sustainable project success.

Contractors operating in the construction industry face fierce competition that requires continuous performance improvement. Performance measurement and benchmarking are thus necessary to achieve competitive advantage and long-term prosperity (Horta and Camanho, 2014). However, the performance measurement of contractors has been conventionally based on financial indicators only, and ranking systems such as the ENR list of the top construction companies are based exclusively on gross revenues. While this sole criterion of the performance evaluation was valid prior to the start of sustainable construction movement, the new trend now is to consider sustainability performance as the most important competitive advantage (Montgomery, 2010).

A growing body of research supports the importance of holistic sustainability evaluation systems of construction companies (Kumaraswamy and Anvuur, 2008). To respond to this recommendation, different organisations have developed several evaluation systems and guidelines for sustainability performance. Sustainability evaluation systems can help to achieve many benefits including fair judgement of companies' sustainability strategies and initiatives in addition to providing a benchmarking tool for companies to perform self-evaluations and for clients and other stakeholders to compare companies to their peers (Lydenberg, Rogers and Wood, 2010). It is very important to review the existing systems for corporate sustainability performance evaluation systems, assess their suitability for contracting companies and their satisfaction of the evaluation objectives set for this study.

3.5 Existing corporate sustainability performance evaluation systems

Many organisations have launched certification and evaluation systems to assess and acknowledge organisational sustainability performance (Munck et al., 2012). These systems are either applicable to a variety of industries or limited to specific sectors. The following sections outline the main sustainability performance evaluation and guidance systems commonly used by corporate organisations.

3.5.1 Global Reporting Initiative (GRI)

GRI is the best-known reporting framework of corporate sustainability. GRI sustainability reporting guidelines were developed to assist organisations in the voluntary reporting of sustainability performance (Moneva, Archel and Correa, 2006). According to CorporateRegister.com, the number of sustainability and similar reports issued yearly by corporations has grown from 26 in 1992 to over 3,000 in 2008 (Lydenberg et al., 2010). The GRI initiates work on a sector supplement when a quorum of companies in a sector approach the GRI with interest and the ability to fund the development of the guidelines. The GRI has developed sector supplements for a number of industries including the construction and real estate sectors. However, the level of SR in these sectors is still insignificant compared to other industries. A study undertaken by Jones et al. (2010a) showed that only 2.7% of US ENR top contractors publish a corporate sustainability report. In their aim to increase SR in the US, Lydenberg, Rogers and Wood (2010) have suggested a set of sustainability Key Performance Indicators (KPIs) to be used by US corporations in different sectors. Their approach is based on three main principles: simplicity, materiality and transparency. They state that to ensure the availability of a benchmarking to be used by stakeholders and investors, SR should become mandatory across all sectors (Lydenberg, Rogers and Wood, 2010).

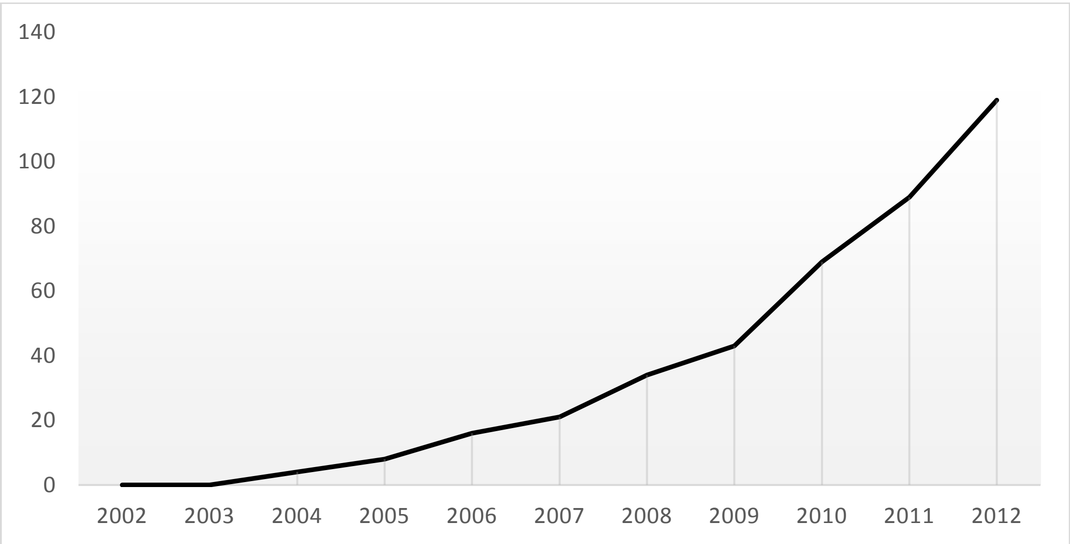


Figure 3.3: SR trend in the construction industry (adapted from GRI, 2014).

While SR is not the sole indicator of sustainability performance of any organisation, it shows whether there is a level of sustainability awareness and an established system of performance measurement within a company. According to the GRI sustainability disclosure database, of 13,908 sustainability reports published between 2002 and 2012, only 3% were published by construction organisations (GRI, 2014), but the number of construction companies publishing their sustainability reports is increasing every year (Figure 3.3).

3.5.2 ISO 26000

ISO 26000:2010 is an international standard that deals with social responsibility. The criteria used in the standard are responsibility, accountability, ethics, and respect for stakeholder interest, law, international behavioural standards and human rights (ISO, 2010). ISO 26000 aims to assist organisations and their stakeholders in addressing social responsibilities and providing practical guidance for SR (Castka and Balzarova, 2008). This standard provides guidance for social responsibility and is not intended for third party certification.

3.5.3 SA8000

SA8000 is a CSR standard that was launched in 2000 by the Council on Economic Priorities Accreditation Agency (CEPAA) (KPMG, 2014). SA8000 is a voluntary accountability standard founded mainly on the International Labour Organization (ILO); it is based on eight human rights and working conditions principles: (1) child labour, (2) forced labour, (3) health and safety, (4) freedom of association and the right to collective bargaining, (5) discrimination, (6) disciplinary practices, (7) working hours and (8) compensation (Ciliberti et al., 2011).

3.5.4 ABC Green Contractor

The Associated Builders and Contractors (ABC) Green Contractor Certification proposes 53 detail criteria including a recycling programme, water and power conservation strategies, sustainable purchasing and sustainable cleaning practices (Lu and Cui, 2012). Contractors have to follow three accreditation steps, comply with all

13 mandatory requirements, meet 12 of the 36 elective items and fulfil all training and education requirements (ABC, 2011). The main focus of this certification programme relates to a sustainable workplace environment both on and off the jobsite (ABC, 2011).

3.5.5 Sustainable Performance Institute (SPI)

The mission of the SPI certification programme is to recognise true leaders in sustainability performance and assist the construction industry 'to move beyond individual success and commit to sustainability at all levels of their organizations from management and operations through project delivery' (SPI, 2012). SPI company certification breaks down its criteria into five categories: strategy, production, support, partnering and outcomes (Highprofile, 2010).

3.5.6 B Corp (Benefit Corporation)

This system certifies organisations for benefiting their workers, the community and the environment. 'To qualify as a B Corp, a firm must have an explicit social or environmental mission, and a legally binding fiduciary responsibility to take into account the interests of workers, the community and the environment as well as its shareholders' (Economist, 2012). To be B Corp certified, companies must undergo an assessment process that examines the impact of companies on their stakeholders followed by assessment reviews conducted by B Lab, the non-profit certification body (Kim *et al.*, 2016).

3.5.7 Dow Jones Sustainability World Index

The Dow Jones Sustainability World Index (DJSI World) was established in September 1999 to track the performance of the world's largest companies that lead the field in terms of corporate sustainability. Regional indexes have emerged, such as the Europe Index, North America Index, Asia Pacific Index and USA index.

The sustainability assessment system used by DJSI was an outcome of a collaboration between the Dow Jones Indices and Sustainability Assessment Models (SAM) to develop Corporate Sustainability Assessment (CSA) methodology to rank sustainability leaders from across all industries based on pre-defined sustainability criteria. No industry is excluded from the indices, and the best performing companies in each industry are assessed and scored with a total sustainability score ranging between 0 and 100. Companies are then ranked against other companies in their industry and only the top 10% from each industry are included in the DJSI World (DJSI, 2012).

Table 3.1: Comparison of existing sustainability performance frameworks

	Year of Launch	Focus	Certification system	Construction Industry specific	Geographic coverage
GRI	2000	TBL	No	Yes	International
ISO26000	2010	Social	No	No	International
SA8000	2000	Social	Yes	No	International
B Corp	2010	TBL	Yes	No	USA
ABC Green Contractor	2009	Environmental	Yes	Yes	USA
SPI	2011	TBL	Yes	Yes	USA
DJSI World	1999	TBL	No	No	International

The aforementioned list shows that a set of different evaluation and reporting systems are already available. Table 3.1shows that GRI and ISO26000 provide reporting and CSR guidance rather than evaluation and assessment systems. Sustainability reports contain excessive amounts of extraneous information which can make analysis and decision-making difficult for investors, regulators, NGOs and consumers. SA800 is a certification system, but it is only based on social performance and more specifically on working conditions and human rights procedures. Despite wide recognition of its increasing role in promoting responsible and transparent businesses, B Corp is still limited to US organisations, and its adoption is slow, especially by construction organisations. Although it addresses construction contractors, ABC Green Contractor is limited to the workplace environment and fails to provide a holistic sustainability assessment approach. SPI focuses on construction organisations and provides a comprehensive change management, measurement and continuous improvement framework. However, SPI's certification process is based on an audit and examination of organisational performance rather than on straightforward evaluation criteria and a scoring system. DSJI is a ranking system that provides a good benchmarking tool for top performers in corporate sustainability, but relevant performance measures need to be simple, quick to measure, visually presentable and easily understood. Ferguson (2009) recommends that the measures themselves should be based on an explicit purpose and have an accurate formula that is both comparable and consistent, that can measure trends, encourages improvement and incorporates target setting. The principle of the sustainability balanced scorecard (Radu, 2012) describes one of the possible ways an organisation can implement sustainable development strategies. The purpose of this study is to build on the above systems and on similar studies in other industries and develop a multi-criteria evaluation system that is specific to contracting companies and realistically applicable to the UAE construction market. Janikowski et al. (2000) argue that using only one assessment criterion cannot be regarded as a correct approach. They also advocate that it is necessary to accept a multi-criteria perspective that takes into account a spectrum of issues regarding a development.

3.6 Proposed sustainability evaluation criteria

The focal concept of sustainability is based on achieving a balance between economic prosperity, environmental protection and social responsibility (i.e. the TBL). Hence, the sustainability evaluation criteria should evolve around these three dimensions. Based on a review of the systems listed above and of several published studies (Alzahrani and Emsley, 2013; Erol, Sencer and Sari, 2011; Lu and Cui, 2012), the sustainability assessment criteria for the conceptual model can be divided into four categories: (1) policy and governance, (2) employees and workplace, (3) procurement and supply chain, and (4) project delivery.

3.6.1 Policy and Governance

There is no universal definition of corporate sustainability. A representative definition is ‘adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining, and enhancing the human and natural resources that will be needed in the future’ (IISD, 1992). In the recent years, corporate organisations have seriously considered disclosing a sustainability policy and indicators as a response to government regulations (Aini and Sayce, 2010) or as a proactive voluntary initiative (Jones et al., 2010). Furthermore, sustainability has to be embedded in an organisation's culture and pursued persistently over long periods, and through continuous learning and policy and institutional change (Connor and Dovers, 2004; Tan, Shen and Yao, 2011; Zhao et al., 2012). SPI (2013) stresses that the success of a sustainable organisation is based on strong leadership, a clear strategy and consistent implementation of policies throughout the organisation. One of the principal targets of any sustainability strategy is to make the Brundtland definition of sustainability operational and to use its mandate as the basis of the company's sustainability policy. Table 3.2 shows a list of related criteria and their corresponding sources in the literature.

Table 3.2: Policy and Governance Criteria

Criteria	Designation	Source
PG1	Statement of environmental stewardship	(Olugu, Wong, & Shaharoun, 2011)
PG2	Statement of social responsibility	(Olugu et al., 2011)
PG3	Anti-corruption and business transparency system	(Holme & Tinto, 2000) (B Corp, 2013)
PG4	ISO 14001	(Azevedo et al., 2012); (Caniato et al. , 2012); (Erol et al., 2011); (Olugu et al., 2011); (Govindan et al., 2013)
PG5	ISO 26000	(Zhao et al., 2012)
PG6	SA 8000	(Zhao et al., 2012)
PG7	Sustainability memberships	(SPI, 2013)
PG8	Community surveys	(B Corp, 2013)
PG9	Community representatives in the Board of Directors	(B Corp, 2013)
PG10	Annual public financial report	(Aini & Sayce, 2010)
PG11	Annual public sustainability report	(Jones et al., 2010)
PG12	Availability of carbon emission tracking system	(Lee & Lam, 2012)

3.6.2 Employees and workplace

Sustainable workplaces are among the most important strategies towards sustainable development (FKC, 2004). According to Jackson and Suomi (2004), sustainable workplace is a broad concept that encompasses a wide range of features such as greenness of the building where employees work, equipment used at work, interaction between employees and interaction with the community and the environment. Cultural change is a prerequisite to successful corporate sustainability (Linnenluecke and Griffiths, 2010). Chou (2014) states that the best way to communicate sustainability policies is by providing education and training to employees. Shifting towards a sustainable workplace is about developing interventions at the building, operation and cultural levels. Table 3.3 presents a list of measurement criteria related to this category.

Table 3.3: Employees and Workplace criteria

Criteria	Designation	Source
EW1	Fraction of facilities using renewable energy	(Erol et al., 2011)
EW2	Buildings employ energy efficiency strategies	(Erol et al., 2011)
EW3	Buildings employ water efficiency strategies	(ABC, 2011)
EW4	Buildings employ indoor environmental quality strategies	(ABC, 2011)
EW5	Availability of waste management scheme	(Olugu et al., 2011)
EW6	Availability of green cleaning scheme	(ABC, 2011)
EW7	Energy efficient office equipment	(ABC, 2011)
EW8	Availability of energy and water monitoring system	(ABC, 2011)
EW9	Transportation minimisation system	(ABC, 2011)
EW10	Environment- friendly transportation system	(ABC, 2011)
EW11	Availability of environmental auditing and reward system	(Olugu et al., 2011)
EW12	Average annual training time	(Erol et al., 2011)
EW13	Annual personnel turnover	(Erol et al., 2011)
EW14	Annual number of applied innovative ideas generated by employees	(Erol et al., 2011)
EW15	Annual number of recordable incidents with respect to harassment and violence/employee	(Erol et al., 2011) (Govindan et al., 2013)
EW16	Annual number of recordable accidents/employee	(Erol et al., 2011) (Govindan et al., 2013)
EW17	Average annual number of recordable employee complaints/employee	(Erol et al., 2011)
EW18	Non-discrimination policy	(Erol et al., 2011) (Govindan et al., 2013)
EW19	Effectiveness of discipline management	(Erol et al., 2011) (Govindan et al., 2013)
EW20	Effectiveness of compensation management	(Erol et al., 2011)
EW21	Effectiveness of Personnel Recruitment and Selection	(Erol et al., 2011)
EW22	Human rights policy and procedures	(Zhao et al., 2012)

3.6.3 Procurement and supply chain

In addition to forging internal sustainable policies and strategies, contracting companies need to be aware of the secondary impacts of their businesses including the environmental damage done during the extraction, manufacturing and transportation of products used in construction activities (Kibert, 2002).

An emerging concept that is increasingly adopted by contractors is known as responsible sourcing or responsible procurement (Glass et al., 2011). This concept can be evidenced through compliance with BES 6001, the framework standard for assessment of responsible sourcing and certification of construction products (BRE, 2009). Sustainable procurement requires a more holistic model to achieve a balanced amalgamation of the three dimensions of sustainable development within the supply chain.

Table 3.4: Procurement and Supply Chain criteria

Criteria	Designation	Source
PS1	Supplier selection based on sustainability practices	(Caniato et al. , 2012) (Youn, Yang, Hong, & Park, 2011)
PS2	Subcontractors selection based on sustainability practices	(Caniato et al. , 2012) (Youn et al., 2011)
PS3	Availability of sustainability evaluation scheme	(Govindan et al., 2013)
PS4	Environmental collaboration with supply chain	(Azevedo et al., 2012); (Caniato et al. , 2012); (Erol et al., 2011) (Olugu et al., 2011) (Tsoulfas & Pappis, 2006)
PS5	Sustainability monitoring of supply chain	(Azevedo et al., 2012) (Caniato et al. , 2012) (Erol et al., 2011)
PS6	Sustainability training of supply chain	(Caniato et al. , 2012); (Youn et al., 2011)
PS7	Percentage decrease in total supply chain cost	(Olugu et al., 2011); (Govindan et al., 2013)
PS8	Responsible sourcing strategy	(ABC, 2011); (Zhao et al., 2012)
PS9	Reverse logistics	(Zhao et al., 2012)

It is agreed that fragmented models of implementing sustainable development principles in the built environment are deficient (Srivastava, 2007; Zhu, Sarkis and Lai, 2013). A collaborative approach to sustainability is required to ensure the achievement of a 'win-win' outcome from the environmental protection and social advancement while gaining competitive advantage and economic benefits all along the supply chain network (Shen et al., 2010). Contractors' sustainability evaluation involves assessing their supply chain selection and management strategies in addition to their procurement strategies. Table 3.4 above presents the criteria under this category.

3.6.4 Project Delivery

The construction industry is a project-based industry in which the projects are considered temporary organisations. Thus, considering sustainability performance at the project and corporate levels is strongly required (Zhao et al., 2012). Consistent sustainable projects delivery can be proved by considering the criteria listed in Table 3.5. Delivery of construction projects constitutes a major part of a contractor's business. Therefore, sustainable contractors must employ consistent and comprehensive sustainability delivery methods to ensure that project sustainability requirements are efficiently and effectively delivered.

Table 3.5: Project Delivery criteria

Criteria	Designation	Source
PD1	Percentage of delivered projects certified by a sustainability accreditation body	(Caniato et al. , 2012) (Youn et al., 2011)
PD2	Percentage of delivered net zero projects	(Caniato et al. , 2012) (Youn et al., 2011)
PD3	Use of life cycle costing tool	(SPI, 2013)
PD4	Use of carbon tracking tool	(SPI, 2013)
PD5	Use of waste estimation and recording tool	(SPI, 2013)
PD6	Environmental Management System	(Qi, Shen, Zeng, & Jorge, 2010)
PD7	Material saving plan	(Qi et al., 2010)
PD8	Site Energy saving plan	(Qi et al., 2010)
PD9	Site Water saving plan	(Qi et al., 2010)
PD10	Site Noise control plan	(Qi et al., 2010)
PD11	Waste abatement plan	(Qi et al., 2010)
PD12	Site Air pollution control plan	(Qi et al., 2010)
PD13	Investment in green products R&D	(Zhao et al., 2012)
PD14	Investment in green construction methods R&D	(Zhao et al., 2012)
PD15	Innovative sustainability delivery beyond requirement	(SPI, 2013)

3.7 Proposed Conceptual Model

The review of literature conducted above has set the first step for the identification of sustainability criteria that can be used to evaluate sustainability performance for construction contractors. The criteria available in existing systems have been reviewed, cross referenced and organised into overarching categories supported with literature. The proposed conceptual model (Figure 3.4) is thus a hierarchical model linking sustainability performance to four domains covering a total of 58 evaluation criteria.

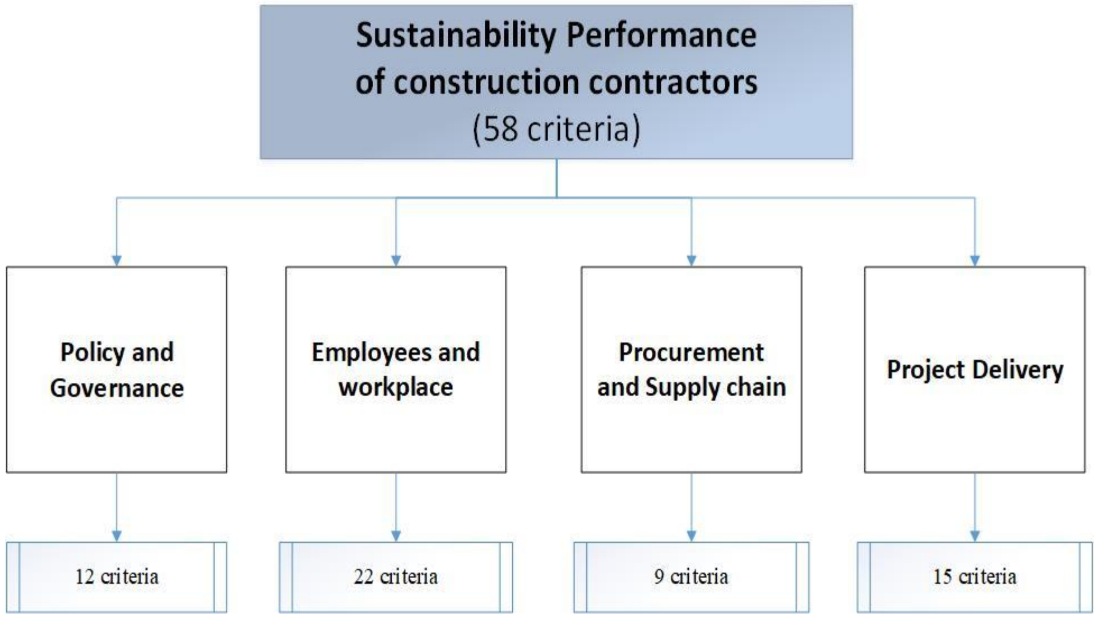


Figure 3.4: Proposed conceptual model

In addition to the coverage of organisational performance categories, the set of criteria should also be considering the three sustainability dimensions (environmental, social and economic). The purpose of the current research is to develop an integrated framework for assessment that is specific for construction contractors and can be easily used by clients for evaluation and equally by contractors as performance evaluation and benchmarking tool. It is thus necessary to test the balanced consideration of sustainability dimensions in the set of identified criteria. It is worth noting that some criteria are not covering only one dimension of TBL but there is usually an integration of two or three dimensions in the same criterion. It is clear from Table 3.6 that the distribution of criteria is not the same for the four categories. This is due to the different focus and purpose of each evaluation category. However, the total set of criteria is almost equally distributed against the three dimensions.

Table 3.6: Criteria distribution by Triple Bottom Line dimensions

Category	Environmental criteria		Social criteria		Economic criteria	
	Number of criteria	Percentage	Number of criteria	Percentage	Number of criteria	Percentage
Policy and Governance	5	33%	7	47%	3	20%
Employees and Workplace	10	30%	13	39%	10	30%
Procurement and Supply chain	8	38%	6	29%	7	33%
Project Delivery	14	52%	4	15%	9	33%
Total	**37**	**39%**	**30**	**31%**	**29**	**30%**

3.8 Summary

Many factors have been reported as the driving forces for companies to go sustainable in an integrated way. The most common drivers are regulations, employees, investors, customers and NGOs/ media. These drivers align with stakeholder theory, which forms the basis of corporate sustainability strategies. The chapter concluded by confirming the necessity for construction contractors to adopt corporate sustainability as a competitive advantage if they aim to survive in such a highly competitive market.

This chapter focuses on the review of existing corporate sustainability rating systems and models that are related to sustainability performance at organisational levels. First the review and evaluation of the existing systems proved the genuine need for a sustainability performance model specifically tailored for construction contractors and for the UAE construction industry. Next, the chapter provides the outcome of extensive review and evaluation criteria used in the reviewed models have been analysed, compared and categorised under four main categories.

The review of literature helped to depict the domain of the new construct prior to conducting research related to the items and criteria to be used in the evaluation model. A review of literature has been conducted to identify the need in industry and gap in literature by evaluating the need for sustainability performance evaluation of construction contractors and reviewing the existing corporate sustainability performance systems. By reviewing the specific needs in contracting business and in the construction industry, the scope and domains of the conceptual framework have been delineated.

The output of this chapter is a rationale for the importance of the new model and the main domains of the proposed model: Policy and Governance, Employees and Workplace, Procurement and Supply Chain and Project Delivery. Once the domain has been thoroughly researched and articulated, a literature review was used to generate the initial list of items (evaluation criteria). Relevant articles have been searched using relevant keywords. The criteria listed in journal articles and the existing corporate sustainability frameworks discussed in the previous section have been segregated and categorised under suitable categories. The output of this chapter is the identification of a set of 58 evaluation criteria categorised into four main domains related to the corporate sustainability performance of construction contractors.

Most of the criteria identified in this literature review are related to the sustainable performance of organisations in other industries. Therefore, there is a need to assess its applicability to construction contractors and to the UAE and to evaluate and validate the proposed structure. This evaluation and validation process will follow a set of steps that are recognised in literature as agreed process for measurement scale development. The philosophical standing and research strategy elements to achieve the aim and objectives of this study are explained and justified in the next chapter.

Chapter 4: Research Methodology

4.1 Introduction

The literature review conducted in previous chapters acts as a need assessment for sustainability evaluation of the UAE construction contractors. Review of similar studies revealed the importance of corporate sustainability concept in the construction industry in general and for contractors in particular. Corporate sustainability performance measurement has also been discussed as a promising tool in differentiating proactive companies and benchmarking companies' performance against peers in the same business area. Finally, a set of existing evaluation systems has been reviewed, and a conceptual framework listing the proposed evaluation criteria was developed.

When undertaking research, it is significantly primordial to select a suitable methodology that can best help achieve the set research objectives and validate the research findings. This chapter provides a review of available research methods, explains the rationale behind the selected research method. The research design and data analysis methods used in this research are also explained and justified. Ethical issues and procedures will also be discussed and addressed at the end of this chapter.

4.2 Research Purpose: Exploratory/Descriptive/Explanatory

Research methodology refers to the research's general approach and is mainly about the logical order adopted to achieve the research objectives. A methodology sets the main path to a target without specifying the steps or methods that will be adopted. A research strategy is a procedural framework between the research's philosophical positioning and the choice of methods to be applied for data collection and analysis. To select the most suitable methodology for research, understanding of types of research is critical. From the application perspective, research can be pure research or applied research. While pure research is about developing and testing theories and hypotheses, applied research involves collection and analysis of information using existing methods and techniques to use them in policy formulation or understanding enhancement.

From objectives perspective, research can be classified as descriptive, correlation, explanatory or exploratory. From the perspective of the mode of inquiry, research can be structured (quantitative) or unstructured (Qualitative) (Kumar (2011). It is strongly recommended that the researcher does not lock himself into becoming either solely a quantitative or a qualitative researcher.

The research approach to be adopted depends on criteria such as flexibility and accuracy. Sellitz and al. (1962) distinguish between two major research purposes: exploratory studies and descriptive studies. The research design involves two primary purposes; conceptualisation of research procedures and ensuring validity and adequacy of those procedures. The decision made about pragmatic paradigm and abductive approach is necessarily impacting the design of research methodology. Methodological implications of paradigm choice cover all the research steps starting from research question through sample selection, data collection tools as well as data analysis (Kivunja & Kuyini, 2017).

4.3 Philosophical and methodological stance

Research is planned according to a question that needs to be answered or a problem that needs to be solved. Grinnell defines research as "a structured inquiry that utilises acceptable scientific methodology to solve problems and creates new knowledge that is generally applicable". (1993: p4). Bulmer (1977: p5) states that "sociological research, is primarily committed to establishing systematic, reliable and valid knowledge about the social world".

Kumar (2011) adds to these requirements the fact that research must have the following characteristics: controlled, rigorous, valid, empirical and critical. It is thus clear that research needs a clear methodology that is clearly structured, explained and justified. As illustrated in Figure 4.1 and as proposed by Jonker and Pennink (2010), selection of research methodology is a decision-making process that can be depicted as a sequence of overlapping decisions. The decisions made for this research in relation to the five elements of the process are explained in subsequent sections.

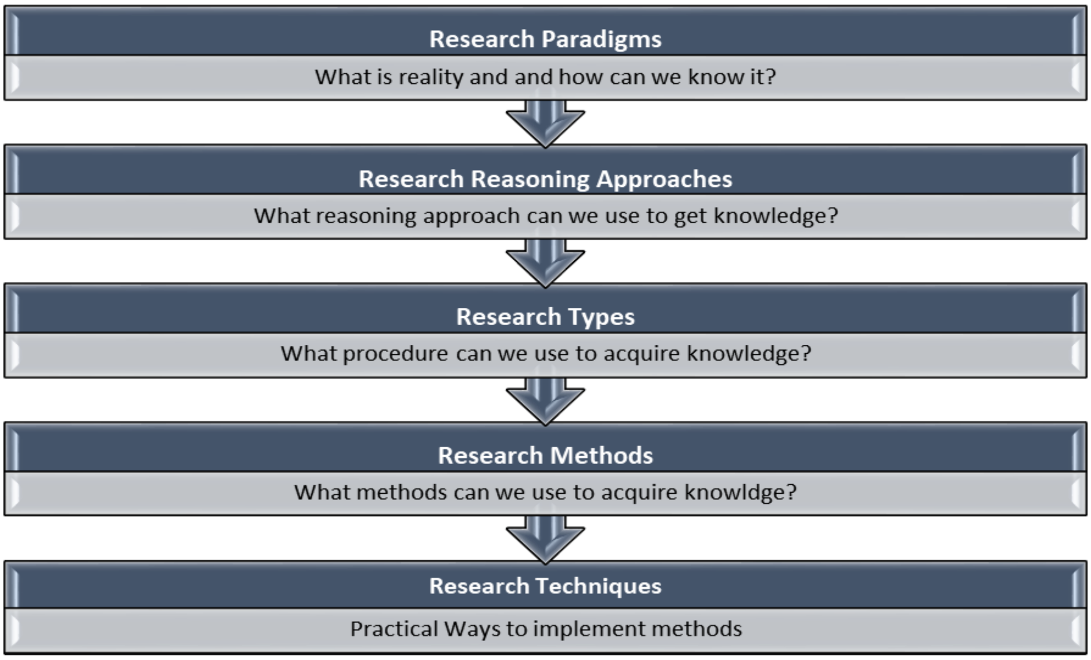


Figure 4.1: Research methods selection process

4.4 Research Paradigm

The term 'paradigm' is associated with the famous philosopher Thomas Kuhn and his book entitled '*The Structure of Scientific Revolutions'* which was a revolution in understanding and recognising different manners of studying reality (Sławecki, 2018). The importance of the existence of research paradigms lies in setting a pre-agreed and pre-tested orientation for researchers without them needing to build their field anew.There are two main paradigms in the field of research: positivism and constructivism, and it is the research purpose that determines the paradigm to be adopted. The research philosophy a researcher adopts reflects the assumptions made about the way he views the world, and it determines the research strategy and methods to be selected (Saunders, Lewis, & Thornhill, 2012). There is no one better research philosophy, but there is a more suitable philosophy for a research question or problem. There are two ways of thinking of research philosophy: ontology and epistemology. The decision about these philosophical positions is based on three main dimensions: nature of reality, acceptable knowledge and the role of values (Saunders et al., 2012) and these dimensions set the researcher position in terms of ontology and epistemology.

4.4.1 Ontology

Ontology is about the nature of reality, and the assumptions researchers make on how the world operates (Schwartz, 2012; Sławecki, 2018; Saunders et al., 2012). In social sciences, ontology is about setting an orientation about the nature of social entities whether they have a reality that is internal or external to the social actors' perceptions and attitudes (Bryman, 2012). There are two positions of ontology: objectivism and subjectivism. In management related research, objectivism emphasises the structural aspects and assumes that management is the same in all organisations and the differences are mainly due to different objective aspects of management as a function (Saunders et al., 2012). Objectivists believe in the fact that social or management phenomena are external facts and are beyond our influence as individuals. Subjectivism stresses the importance of how managers attach their individual way of thinking to the management function. "Subjectivism asserts that social phenomena are created from the perceptions and consequent actions of social actors (Bryman, 2012).

4.4.2 Epistemology

Epistemology is about what constitutes acceptable knowledge. It is agreed that there are two main basic approaches, one is based on knowing through the eyes of the researcher and one based on knowing through the eyes of others (Jonker & Pennink, 2010). The difference between knowing and knowledge is controversial and multifaceted, but the most common classification of epistemological notions boils down to two main concepts: positivism and constructivism.

Positivism/ Post-positivism paradigm

This philosophy emphasises the fact of "working with observable social reality and that the end product of such research can be law-like generalisation similar to those produced by the physical and natural scientists" (Remenyi et al., 1998:32). So from a positivist point of view, social studies should use the methods of natural science to be reliable. According to positivists, knowledge is based on gathering facts; only observable phenomena will provide credible data (Bryman, 2012). Positivism, as a philosophy, believes that science has to be undertaken in a value-free and objective way. Therefore, a positivist researcher is independent of the data observed and collected and relies strongly on highly structured and replicable methodology and quantitative statistical analysis methods. Post-positivism is a slightly less strict variant of positivism; it is based on realism theory and considers that it is impossible to eliminate the effect of the researcher on the study subject. The theory of realism states that there is a reality entirely independent of the mind (Sławecki, 2018). There are two types of realism: direct realism and critical realism. While direct realists believe that our mind and senses portray the world accurately, critical realists think that our senses are only conveying the images of things not the reality of things (Jonker, Jan and Pennink, 2015).

Interpretivism

Interpretivists believe that reality is understood by the people involved. Interpretivists argue that researchers are usually interpreting the ideas an actions of others according to their understanding. They believe that generalisation is of lower value in the business world because business situations are unique and fast changing. This paradigm is valuable to management research, particularly as it postulates that reality is constructed by persons (Fellows and Liu, 2008). For an interpretivist, the reality is a social construct that should be understood from the participants' perspectives and seen through their eyes.

Pragmatism

Pragmatism is based on the idea that concepts are only valid when they support human action. This means that "pragmatism has an interest not only for what 'is', but also for what 'might be. Furthermore, pragmatism gives permission to researchers to use different methods and to adopt various philosophies (Morgan, 1997; Brierley & Ja, 2017; Woka Ihuah & Eaton, 2013). Pragmatists believe that the selection of research methods depends on the subject, and that there is no one best method as there might be many realities that need different approaches to be construed holistically. Onwuegbuzie and Johnson (2006, p. 54) state that "pragmatism includes a healthy dose of pluralism by which we mean that it is not logically contradictory to claim that quantitative and qualitative research are both useful, even if, at times, they appear to be contradictory". It is a middle standing embracing both approaches of positivism and constructivism.

4.4.3 Adopted Research Paradigm

The next step is to decide about ontological and epistemological positions. This decision builds on the research reasoning adopted, and it was guided by the summary of different positions presented in Table 4.1.

Table 4.1: Summary of research philosophical positions

Paradigm	Ontological position	Epistemological position
Positivist	Objectivism: There is a single reality or truth which is apprehensible	Reality can be measured and hence the focus is on reliable and valid tools to obtain that
Constructivist/ Interpretivist	Subjectivism: reality is constructed inter-subjectively by individuals and groups	Reality needs to be interpreted and negotiated through dialogue.
Pragmatism	Inter-subjectivism: Reality is constantly renegotiated, debated, interpreted in light of its usefulness in new situations.	The best method is one that solves problems.

The main aim of this research is to develop a sustainability evaluation model for construction contractors in the UAE. This aim encompasses two main themes in research; scale development, and corporate sustainability that is an organisational management subject. It is agreed that a pure positivist approach is not suitable in organisational management and social studies areas of research (Sławecki, 2018; Hegde, 2015; Bryman, 2012). The main reason put forward is that social concepts and situations are interpreted, understood and perceived by individuals in different ways. Sustainability is no exception to this rationale, as it is a multidimensional concept interpreted in different ways by different individuals and groups (Leal Filho, 2017). However, the development of an evaluation model requires the establishment of invariant constructs that apply across all contracting companies and situations in the UAE. Scale development requires a high level of generalisability and reliability, which is the main strength of positivism. While the research aim is to develop a measurement scale that is considered as 'objective', the research scope itself needs a subjective ontological standing to be understood and translated into factual data that can be further analysed in a value-free objective manner. This is in line with Niglas's recommendation that it is more appropriate for a researcher to adopt a multidimensional philosophy rather than a separate position (2010). Therefore a pragmatism position is more suitable for conducting this research. This paradigm emanates from actions and has to do with what works and what best answers the research questions. Pragmatism, as a research paradigm has the following strengths and benefits:

- Offers an epistemological and logical justification for mixed approaches and methods (Teddlie and Tashakkori, 2009);
- Pragmatism is loose compared to positivism and constructivism, which have a rigorous understanding of reality and acquiring knowledge (Modell, 2010);
- Pragmatic approach rejects the need to choose the two extremes of context-dependent results (constructivism) or universal and generalised results (positivism). Pragmatism promotes the transferability of results from the research context to other situations (Morgan, 1997).

4.5 Research reasoning approach

The first stance to be identified by a researcher is the nature of the link between his research and theory. There are two main types of relationship between research and theory: Deductive and inductive. In deductive theory, the researcher builds on existing data and knowledge about a topic and builds hypotheses that should be tested empirically (Bryman, 2012). On the other hand, inductive type of research involves a process in the opposing direction as the researcher infers the theory from the collected data, and his developed theory will be an addition to the existing body of knowledge in his domain of research. Orton (1997) states that deductive research proceeds from theory to data while the inductive approach proceeds from data to theory. There is a third type of reasoning, which is abductive research, and it is a combination of both approaches. Abductive reasoning aims to address the weaknesses and complexities associated with deductive and inductive approaches. Linking theory to data is the starting point for deciding on the research approach to be adopted. As explained above, there are three main reasoning approaches presented and contrasted in Figure 4.2.

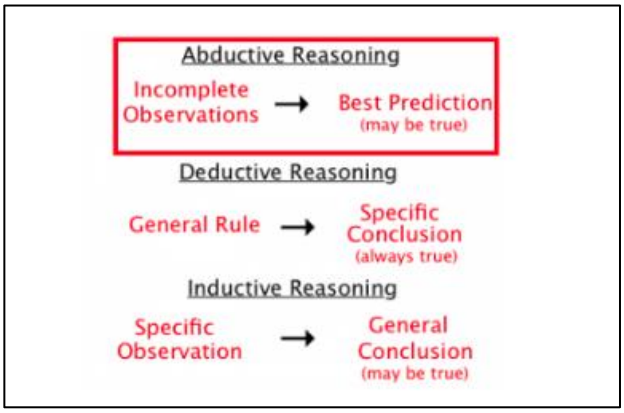


Figure 4.2: Difference between abductive reasoning and alternative approaches (Dudovskiy, 2018)

Considering the aim of this research, which is to develop a sustainability evaluation model for contractors, the literature review revealed that there was no existing evaluation model specifically developed for construction contractors operating in the UAE market. Therefore, purely deductive reasoning is not suitable. On the other hand, the developed model will not be based on observations of sustainable contractors, which makes the inductive reasoning equally unsuitable. Abductive reasoning is more in line with the aim of this study as the objectives require a mix of deductive and inductive approaches to data collection and analysis. A review of existing models will be conducted through literature review, and a theoretical model will be established (deductive), then tested through expert judgement (inductive) and validated through data collection and statistical analysis method (deductive).

4.6 Research methods

Many research methodology authors make a distinction between quantitative research and qualitative research. This distinction is getting more and more controversial and even false in the opinion of some researchers (Bryman, 2012). It is suggested that the distinction goes beyond existence or absence of quantification in the method used. There is a multitude of research methods available in the literature, and each method can be used separately to collect data or methods can be combined to complement each other (Kane, 1977; Frankfort-Nachmias, 1996). The commonly used research methods fall into three broad categories: quantitative, qualitative and mixed method, which is a combination of both approaches. While these methods are mainly founded on the three paradigms explained above, it is essential to understand their meaning and the situations where they can be used.

4.6.1 Qualitative Research

Qualitative research is based on the fact that knowledge about reality can only be obtained through 'the eyes of someone else'. It is common to call this the 'actor approach' ((Jonker & Pennink, 2010). Qualitative studies are suited for the exploratory phases and validation purposes (Blaikie, 2000; Maxwell, 2005). Qualitative research implies using a broad spectrum of data collection approaches including observations, case studies and in-depth interviews. The flow of qualitative research is illustrated in Figure 4.3.

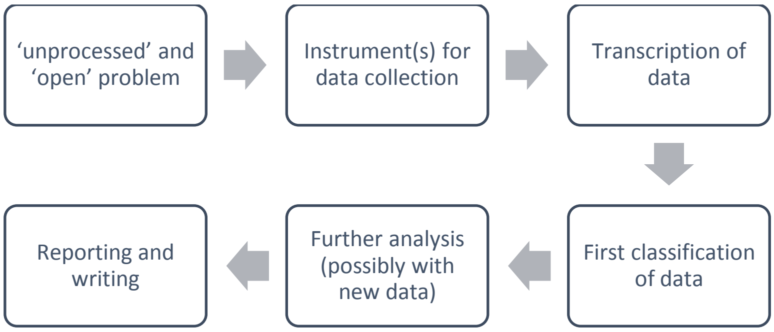


Figure 4.3: The Flow of Qualitative Research (Adapted from Jonker & Pennink, 2010)

4.6.2 Quantitative Research

Quantitative research is based on the belief that knowledge about reality can be obtained through 'the eyes of the researcher'. It is understood to be emphasising measurement and quantification in data collection and analysis.

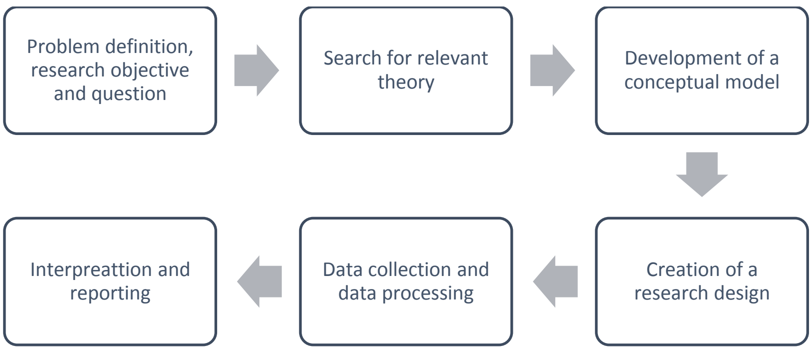


Figure 4.4: The Flow of Quantitative Research (Adapted from Jonker & Pennink, 2010)

In terms of relation to research philosophy and reasoning approach, a quantitative strategy is positivism oriented and deduction based (Bryman, 2012). This type of research operates mainly on the basis on closed and structured data collection approach that is later analysed systematically using statistical methods (Jonker & Pennink, 2010). The typical process used for the quantitative method is illustrated in Figure 4.4.

In summary, there are many differences between quantitative and qualitative approaches to research all emanating from the type of research question (open or closed) and the philosophical stance adopted by the researcher.

Table 4.2: Comparison between Qualitative and Quantitative Research

Point of comparisons	Qualitative Research	Quantitative Research
Alternative labels	Constructivist, naturalistic-ethnographic or interpretative.	Positivist, rationalistic or functionalist.
Scientific explanation	Inductive in nature	Deductive
Data classification	Subjective	Objective
Objective/purpose	To gain understanding of underlying reasons and motivations. To provide insight into the settings of a problem, generating ideas and /or hypothesis for later quantitative research. To uncover prevalent trends in thought and opinion.	To quantify data and generalise results from a sample to the population of interest. To measure the incidence of various views and options in a chosen sample.
Sample	Usually a small number of non-representative cases. Respondents selected to fulfil a given quota or requirement.	Usually a large number of cases representing the population of interest. Randomly selected respondents
Data collection	Participant observation, semi- and unstructured interview, focus groups, conversation and discourse analysis.	Structured interview, self administered questionnaires, experiments, structured observation, content analysis / statistical analysis
Data analysis	Non-statistical	Statistical usually in the form of tabulations. Findings are conclusive and usually descriptive in nature
Outcome	Exploratory and / or investigative. Findings are not conclusive and can not be used to make generalisations.	Used to recommend a final course of action.

(Amaratunga, Baldry, Sarshar, & Newton, 2002)

Table 4.2 lists the main differences between quantitative and qualitative methods in terms of purpose, data collection, data analysis and outcome. It is widely agreed that these two methods both have strengths and weaknesses. This is where the mixed method is recommended as a combination of the two methods. In construction management research, Love et al. (2002) highly recommend this combination for comprehensive, generalizable and reliable research.

4.6.3 Mixed Method

Many researchers who adopt a pragmatic critical realist position believe that there is a fragile line between quantitative and qualitative methods and that the best approach to combine both methods throughout the research process; an approach that is named mixed method. Recognising the fact that both approaches have limitations, researchers decided that biases created by one method can be neutralised by the other. Triangulating data from different sources was the first emerging approach from this mix of methods. According to Creswell (2003), there are three types of mixed method procedures: sequential, concurrent and transformative. These three procedures generate four main types of design that can be adopted by researchers (Figure 4.5).

Design Type	*Timing*	*Mix*	*Weighting/Notation*
Triangulation	Concurrent: QN and QL at the same time	Merge the data during interpretation or analysis	QN + QL
Embedded	Concurrent and sequential	Embed one type of data within a larger design using the other type of data	QN (ql) or QL (qn)
Explanatory	Sequential: QN followed by QL	Connect the data between the two phases.	QN →ql
Exploratory	Sequential: QL followed by QN		QL →qn
QN/qn – *Quantitative* , QL/ql– *Qualitative*			

Figure 4.5- The Creswell Mixed Method Design Types
Creswell & Plano Clark (2007)

The above discussion has provided the background and rationale for the adoption of an exploratory mixed method sequencing qualitative and quantitative research methods. The next subsection discusses the overall research design and tools and techniques used in the study and justifies the reasons for using them.

4.7 Research design

4.7.1 Process for scale development

Scale development is a complex process involving a myriad of data collection and analysis methods (Carpenter, 2018). In order to facilitate this process and reduce improper practices, guidelines have been recommended by researchers to guide the process. Hinkin, Tracey and Enz (1997) propose a seven-step process, while Carpenter (2018) suggests a ten steps guide for scale development and reporting. This research aims to develop a sustainability performance evaluation model for UAE contractors Based on review of literature related to scale development (Bagozzi & Edwards, 1998; Carmines & Zeller, 1979; Churchill, 1979; DeVellis, 2003; Hinkin, 1998; Netemeyer et al., 2003; Nunnally & Bernstein, 1994; Pedhazur & Pedhazur Schmelkin, 1991), this research's model development will follow the process illustrated in Figure 4.6. The process requires a sequence of decisions about the data collection approaches and data analysis methods to be adopted at every stage.

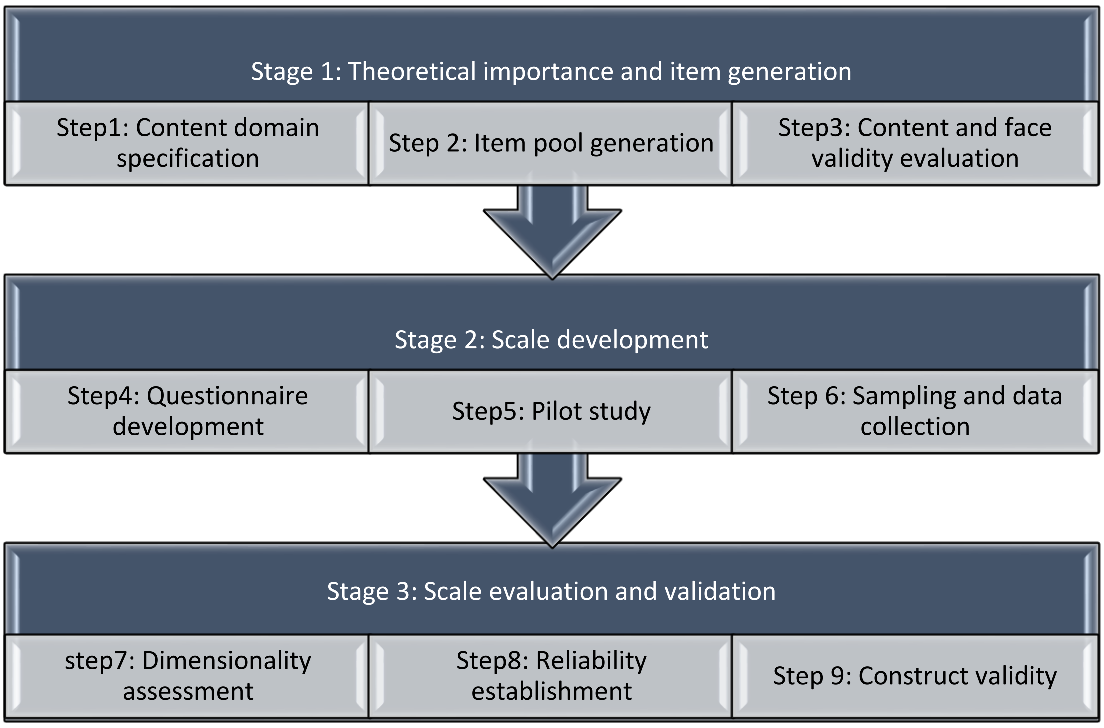


Figure 4.6: Process for scale development
Adapted from (Robertson, 2017; Slavec and Drnovšek, 2012; Hinkin et al., 1997)

4.7.2 *Stage I: Theoretical importance and item generation*

This stage is the underlying foundation of scale development process. This stage aims to set the theoretical basis for the developed construct by specifying the scope, generating a list of items and then validating the scale content. The research methods used for the three constituting steps of this stage are shown in Figure 4.7 below.

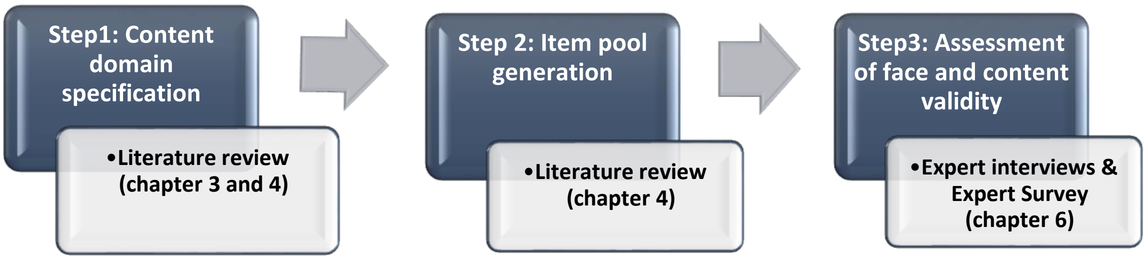


Figure 4.7: Steps for stage I- theoretical importance and item generation

Step 1- Content domain specification- Literature review

This step aims to depict the domain of the new construct, and it is often achieved through an in-depth literature review (Slavec and Drnovšek, 2012). Prior to conducting research related to the items and criteria to be used in the evaluation model, a review of literature has been conducted to identify the need in industry and gap in literature by evaluating the need for sustainability performance evaluation of construction contractors (chapter 3) and reviewing the existing corporate sustainability performance systems (chapter 4). By reviewing the specific needs in contracting business and in the construction industry, the scope and domains of the theoretical framework have been delineated. The output of this step is a rationale for the importance of the new model and the main domains of the proposed model: Policy and Governance, Employees and Workplace, Procurement and Supply Chain and Project Delivery.

Step 2- Item generation- Literature review

Once the domain has been thoroughly researched and articulated, there are two approaches to identifying items: the deductive approach and the inductive approach. The deductive approach assumes that it is sufficient to generate items after a thorough review of the literature, and theoretical fundamentals have been considered. This should only be attempted by researchers who have a good understanding of the phenomena under investigation. The inductive approach is used when there is no or little theory to work from (Robertson, 2017). A literature review was used to generate the initial list of items (evaluation criteria). The same approach has been used by previous studies with the same purpose (Hussain, Khan and Al-Aomar, 2016; Aguezzoul 2014; Waris et al. 2014; Zabihi et al. 2012; Yunus & Yang 2011).

Relevant articles have been searched using keywords such as "corporate sustainability", "sustainability evaluation" and "sustainability assessment". The full text of each article was reviewed, and papers not including corporate sustainability criteria have been excluded. The retained articles included sustainability assessment frameworks developed for different industries such as manufacturing industry (Govindan et al., 2013); fashion industry (Caniato et al., 2012); automobile industry (Olugu, Wong, & Shaharoun, 2011); construction industry and real estate (Zhao et al., 2012; Aini & Sayce, 2010; Jones et al., 2010); grocery industry (Erol et al., 2011) in addition to research papers applied to all industries and businesses (Azevedo et al., 2012; Lee & Lam, 2012; Holme & Tinto, 2000).

The criteria listed in journal articles and the existing corporate sustainability frameworks discussed in chapter 3 have been segregated and categorised under suitable categories. Criteria that are clearly irrelevant to construction contractors have been eliminated and a cross-referencing approach was used to provide sources for each item. The output of this step is the identification of a set of 59 evaluation criteria categorised into four main domains related to the organisational performance of construction contractors. The first performance domain is about policy and governance, which is the starting point of any organisational sustainability change. Contractors have to set clear strategies for their sustainability mission and goals. They have to provide evidence of genuine commitment to sustainability through third-party accreditations, community involvement and sustainability reporting and monitoring. Providing sustainable workplace and responsible people management are the subject of the second domain.

Health and wellbeing, ethics, safety, training and sustainability communication should be at the core of sustainable contractors' facilities management and human resources strategies. The third domain expands beyond the company's boundary. Contractors have to ensure their supply chain partners have the same level of sustainability performance. A responsible procurement strategy should also be in place for consistent sustainability delivery at both strategic and project level. The latter is the focus of the fourth domain that is about consistent delivery of sustainable projects. This requires a good track record in certified projects, established sustainability management plans and tools in addition to a strong innovation approach towards differentiation and continuous improvement. Most of the criteria identified in this literature review are related to the sustainable performance of organisations in other industries. The applicability of these criteria to construction contractors in general and to the UAE market, in particular, have to be tested and validated, which leads to the next step of the process.

Step 3- Assessment of face and content validity

This step is an essential element of the process that precedes any measurement data collection. Content validity is mainly about testing whether the pool of items identified through literature is sufficient and adequately representing the construct (Hinkin, 1995; Hinkin et al., 1997; Carpenter, 2018; Robertson, 2017). Content and face validity assess whether all dimensions and facets of the constructs are included and highlight any missing dimension. It is usually conducted through eliciting opinions of subject matter experts through semi-structured interviews or structured questionnaire survey. In this study, a double layer face and content validation approach have been adopted sequencing semi-structured expert interviews and a structured expert questionnaire survey. This reinforced assessment approach is recommended when the pool of items is developed mainly from literature and not based on existing scales (Robertson, 2017). The approaches used for sampling and data collection for both expert judgement layers are explained below.

Expert interviews

In this step, sustainability experts are subjected to an in-depth qualitative interview to capture their rich and diverse experiences regarding the subject of enquiry

(Bhattacharyya, 2008). Their role is also primordial in judging and validating the list of items identified from the literature review. Interviewing is a data collection method that is commonly used in social sciences and is defined by Burns (1997,p329) as “a verbal interchange often face to face, though the telephone may be used, in which an interviewer tries to elicit information, beliefs or opinions from another person”. The main advantage of interviews is to collect in-depth information and gives the researcher the possibility to supplement the collected data during interviews. The expert interviews conducted sought to examine the sustainability professionals’ views on the need for a sustainability evaluation model for construction contractors and to get their opinions about the identified evaluation domains and items.

The sampling strategy used for interviews is purposive sampling. The goal of this sampling method is “to sample cases/participants in a strategic way so that those sampled are relevant to the research questions that are being posed” (Bryman 2012, p138). A list of 35 potential expert interviewees has been compiled, and invitations with a cover letter explaining the purpose of the interview have been sent. Only nine experts accepted to be interviewed, and three more interviewees have been added to the sample using the snowball sampling method. In total, 12 sustainability experts from corporate, public and academic organisations accepted to take part in the study.

All interviewees have some construction related experience and have current or previous experience in the UAE. Five interviews were conducted via Skype as the interviewees are based outside the UAE. The interviews were semi-structured and lasted between 60 min and 90 min and were recorded following consent from interviewees. The interview schedule (Table 4.3) is structured into three main sections: section 1 is to elicit general information about the interviewees, section 2 aims to understand their perceptions about the anticipated model and the last section aimed to elicit their opinions about the list of categories and any suggested changes. The opinions of experts about the identified criteria have been elicited by sending them the list of criteria before the interview and then asking for any recommended changes or additions during the interviews.

Table 4.3: Expert Interview Schedule

Section	Questions/prompts	Objectives
Introduction and General Information	• Brief about the purpose of the study • Consent to interview • Please provide a brief overview of your background and experience.	Inform interviewees about the purpose of the interview and get their consent for the interview /recording Get detailed information about their profile and expertise
Current situation and need for the proposed model	• Do you think the available green building rating systems are sufficient to achieve holistic sustainability in the construction industry? • Based on your experience, how do you see and evaluate the sustainability performance of contractors in the UAE?	Cross-checking with literature review findings regarding sustainability performance of contractors the need for contractor tailored sustainability performance evaluation model in the UAE
Availability of existing similar contractor evaluation systems	Are you aware of any similar evaluation system specifically designed for construction contractors? If yes, please list them.	Identify any existing scale that has not been captured by literature and could be incorporated as a source of the pool of items
Domains validity assessment	The initial framework developed for this scale is divided into four domains: 1) Policy and governance, 2) Corporate Workplace and Employees, 3) Procurement and supply chain, and 4) Project delivery. Do you think any of these categories is irrelevant to construction contractors? Is there any domain missing in the framework?	Validate the domains of the proposed scale that have been identified from the literature review.
Item pool face and content judgement	The interviewees were provided with the list of items under each domain and asked to comment on whether: • Items measure the intended domain • Wordings is clear and appropriate • Other items are missing	Assurance from the expert judgement that the scale is measuring what it is intended to measure.

Results from expert interviews have been analysed using the method of thematic analysis. The thematic analysis involves the identification of themes and patterns in the interviews' responses. Themes should usually capture and represent a topic or sub-topic that is important for the research. The themes selected for the analysis are the same as section topics included in Table 4.3 above namely: Current situation and need for the proposed model; Availability of existing similar contractor evaluation systems; Domains validity assessment; and Item pool face and content judgement.

Expert Survey

The identified criteria based on literature review and expert interviews input have been integrated into a questionnaire survey to elicit broader perception from sustainability experts in the UAE. A survey is recognised as one of the most cost-effective data collection methods that target a broad population. The postal method of conducting a survey has been increasingly replaced by electronic forms and more frequently web-based surveys as it provides a more efficient and cost-effective method of collecting data from a geographically dispersed population. The questionnaire design was based on the following three main sections:

Section 1- General information

This section aims to collect information about the respondents to conduct sampling analysis at the end of data collection and assess the suitability of the sample in terms level of knowledge, type of organisation and level of experience. Levels of experience help in analysing the sample and finding correlations between the importance levels given to criteria and job positions, type of organisations and ratio of sustainability experience to total years of experience in the construction industry.

Section 2- Level of sustainability expertise

This section aims to measure the levels of awareness about existing building rating systems and corporate sustainability evaluation standards and systems. The purpose of this assessment is to assess the level of expertise of respondents and thus to evaluate the quality of judgements collected through the survey. This section covered two types of expertise: project sustainability rating systems and corporate sustainability systems. The options used for project sustainability rating experience were: 1) accredited with project experience, 2) accredited with no project experience, 3) knowledgeable, 4) aware and 5) not aware.

Section 3- Criteria evaluation

This section is the core section of the questionnaire, and it has been divided into five questions in line with the scale categories identified in the previous steps. For each question, experts were asked to rate the relative importance of each criterion listed in the question according to a five-point Likert scale (1 = not important at all, 2= slightly important, 3 = moderately important, 4 = important, 5 = very important). The objective of these ratings is to assess to which extent experts believe each criterion is important in the evaluation of sustainability performance in the specified domain. This method of using Likert scale for expert feedback is recommended by (Carpenter, 2018) and has been adopted by many scale development studies (KIRSAÇ et al. 2015; Papadas et al. 2017; Hussain, Khan and Al-Aomar, 2016; Zepatou et al. 2016; Waris *et al.*, 2014).

Sampling and analysis

Sampling is an essential and necessary step for any survey. In quantitative research, the purpose of sampling is to be able to draw inferences from the population from which the sample has been selected. De Leeuw (2005, p235) suggests that “when designing a survey, the goal is to optimise data collection procedures and reduce total survey error within the available time and budget. In other words, it is a question of finding the best affordable method”.

The factors affecting the reliability of inferences in quantitative research are sample size and level of variation in the sampling population (Kumar, 2011). In the UAE, there is no available record of sustainability professionals in the construction industry. Therefore, the professional networking website LinkedIn has been used to estimate the number of sustainability professionals in the construction industry. Using specific search keywords and search criteria, a total of 525 sustainability professionals who have current or past experience in the UAE has been found. The same social media website has been used to increase the response rate. Dusek et al. (2015) proved that using

LinkedIn in a quantitative survey has proved to be the right solution for improving response rate and having access to hard to reach population. Considering the estimated population size explained above, the sample size was determined using the formula below from Czaja and Blair (1996):

$$ss = \frac{z^2 \times p(1-p)}{c^2}$$

Where:

ss = sample size
z = standardised variable
p = percentage picking a choice expressed as a decimal
c = confidence interval expressed as a decimal

A confidence level of 95% is commonly assumed in most social studies research (Munn and Drever, 1990; Creative Research Systems, 2003). The value of z corresponding to 95% confidence level is 1.96. Based on the need to find a balance between the level of precision, resources available and usefulness of the findings (Maisel and Persell, 1996), a confidence interval (c) of ±10% was also assumed for this research. We will assume the worst-case percentage picking a choice (p) is 50%.

Based on the formula and assumptions above, the required sample size for the questionnaire survey is 81 sustainability professionals. However, the figure requires a further correction for finite populations. The following formula will be used for correction:

$$New\ ss = \frac{ss}{1 + \frac{ss-1}{pop}}$$

Where pop= total population. The corrected sample size is then 69 sustainability professionals. By assuming a response rate of 30%, the appropriate sample size to be surveyed is 230 sustainability professionals. A total of 250 questionnaires were sent to randomly selected participants for completion. The questionnaire was including a cover letter explaining the purpose of the study (Appendix A) and information about confidentiality and approximate time to complete the survey.

Follow up emails and reminders have been sent twice to improve the response rate. Requests from highly influencing sustainability professionals have also been sought in order to get participants interests in completing the survey. Of the 250 questionnaires sent, 82 responses have been received. This represents a response rate of 33%, which is acceptable and within the normal range (Akintoye, 2000). Data collected from the survey was analysed using a combination of descriptive and inferential statistical analysis.

Descriptive statistics

Descriptive statistics have been used mainly to analyse the two first sections of the questionnaire. These methods involve the calculation of percentages, frequencies and averages. These techniques were used for questions targeting the categories of respondents and their levels of knowledge and experience. The results are then presented in adequate graphical forms and subsequently interpreted to evaluate the sample adequacy in terms of composition and expertise.

Relative index analysis

This technique was selected for this study to analyse the ratings proposed by respondents for different evaluation criteria. This technique has been commonly used to aggregate the scores of variables rated through a survey based on the ordinal scale. The equation below has been used to calculate the rank indices (RIs).

$$RII = \frac{\sum W}{A \times N}$$

Where:

RII is relative importance index;
W is the weight given by respondents to each item and ranges from 1 to 5
A is the highest weight (5 in this case) and;
N is the total number of respondents.

Five important levels are deducted from Relative Index values: High (H) ($0.8 \leq RII \leq 1$), High–Medium (H–M) ($0.6 \leq RII \leq 0.8$), Medium (M) ($0.4 \leq RI \leq 0.6$), Medium–Low (M–L) ($0.2 \leq RI \leq 0.4$), and Low (L) ($0 \leq RI \leq 0.2$). A cut-off value of 0.4 is used and identified relevant criteria as those for which the values are greater than or equal to 0.4.

Kendall Coefficient of Concordance and Chi-square tests

Kendall's coefficient of concordance (W) is a measure of agreement among certain variables in assessing a set of objects. In this study, it is used to determine the degree of agreement among the respondents in their rankings. This coefficient provides a measure of agreement between respondents within a survey on a scale of zero to one, with '0' indicating no agreement and '1' indicating complete agreement or concordance. Using the rankings by each respondent, W was computed using Equation (2) below:

$$S = \sum_{i=1}^{n} (R_i - \overline{R})^2$$

Where S is a sum-of-squares statistic over the row sums of ranks Ri, and R is the mean of the Ri values. Following that, Kendall's W statistic can be obtained from either of the following formulas:

$$W = \frac{12S}{m^2(n^3 - n) - mT}$$

Where n is the number of objects and m is the number of variables.

$$T = \sum_{k=1}^{g} (t_k^3 - t_k),$$

In which t_k is the number of tied ranks in each (k) of g groups of ties. The sum is computed over all groups of ties found in all m variables of the data table. T = 0 when there are no related values. At the end of this stage, an updated list of measurement criteria is identified and will be the basis of the next stage that is focused on scale development and the main survey.

4.7.3 *Stage II: Scale development – Main Survey*

The findings from the previous stage of the scale development process will support the modified conceptual model and pool of criteria that will be assessed through the main survey following the steps in Figure 4.8.

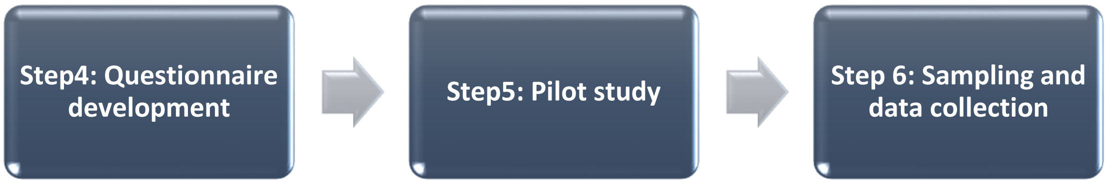


Figure 4.8: Stage 2 – Scale development steps

Step 4: Main Survey Questionnaire development

The identified criteria based on literature review and experts' input have been integrated into a questionnaire survey to elicit broader perception from professionals working in contracting companies as sustainability managers or as corporate decision makers. The questionnaire was divided into two main sections. The first section aims to collect information about the respondents in order to conduct sampling analysis at the end of data collection and assess the suitability of the sample in terms level of knowledge and expertise and size of companies. The second section is the core section of the questionnaire, and it has been divided into five questions. It is vital at this stage to identify the scale to be used and select the most suitable from the available range of scales and response styles. Within organisational management research, Likert-type scales are most commonly used (Hinkin, 1990). These scales use fixed choice response formats and are designed to measure attitudes or opinions (Bowling, 1997; Burns & Grove, 1997). A Likert-type scale assumes that the opinions and attitudes are linear and can be distributed on a continuum from very high agreement to very high disagreement. With the use of ordinal scale, respondents are given a choice of five, seven or nine response options with the neutral point in the middle (Rattray and Jones, 2007). The Likert scale does not assume that intervals between options on the scale are equal, but they can represent a good idea of the relative ordering of the respondent's opinion about an item (Bowling 1997). There is a continuous debate about the high simplistic nature of these scales; however, their use in social studies and management research is highly accepted and recognised.

For this survey, respondents were asked to evaluate their company level of implementation of the identified items as follows: Please indicate the extent to which you perceive that your company is satisfying each of the following criteria using the five-point scale: 1 = Not at all; 2 = To a limited extent; 3 = To a moderate extent; 4 = To a relatively great extent; 5= Fully implemented).

Step 5: Pilot study

Once the items have been selected and written, and a response scale has been attached, they are ready to be pre-tested. While this stage is crucial for any survey, methods used can range from structured interviews to small scale testing survey. For this study expert survey preceded the main survey, the wording of items has been already checked and validated through expert interviews and survey. Therefore, only a limited pilot study was required to assess the scale used by selecting a smaller sample of intended respondents. The pilot study was carried out by selecting companies from the UAE Contractors Association. The purpose was to validate the questionnaire structure, wording clarity, ease of completion and assess the average time required to complete the survey. Five sustainability and environment health and safety managers have completed and provided their feedback. The following questions have been asked to the pilot sample respondents:

- How long did the survey take to complete?
- Were the criteria included in the questions clear? If not, please state which ones need to be reworded.
- Was the questionnaire well structured?
- Any other comments?

No significant changes or concerns have been raised by the pilot study respondents. The average time for completion reported was 10 to 12 min. One change was related to the survey introduction and rationale, and it recommended to make it easier for respondents to understand. One item “personnel turnover reduction” was reported as ambiguous and it was reworded as “Employee retention policy”.

Step 6: Sampling and data collection

Sampling is an essential and necessary step in any survey. In quantitative research, the purpose of sampling is to be able to draw inferences from the population from which the sample has been selected. De Leeuw (2005, p235) suggests that “when designing a survey, the goal is to optimize data collection procedures and reduce total survey error within the available time and budget. In other words, it is a question of finding the best affordable method”. It is agreed that reliability in quantitative research is profoundly affected by the sample size and level of variation in the sampling population (Kumar, 2011).

The objective of this survey is mainly to elicit the levels of satisfaction of the sustainability evaluation criteria by contractors operating in the UAE. Therefore, the large population targeted is composed of general contracting companies in the UAE and the unit of analysis is an individual contracting company. According to literature, there are two main categories of sampling: probability sample and non-probability samples with a different set of sampling methods under each category (Figure 4.9).

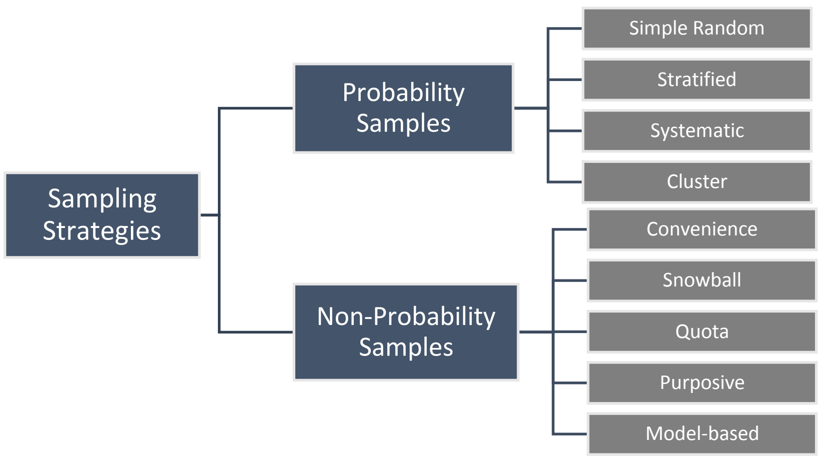


Figure 4.9: Types of sampling methods

Adapted from (Dudovskiy, 2018)

In order to achieve consistent and representative results, a purposive sampling approach was used, and only construction companies, with general contracting as their primary business, were targeted. Purposive sampling is prominent in the field of organisation studies and social research compared to probability sampling such as random, stratified or systematic sampling (Bryman 1989a: 113–14). A list of contractors was collected from different sources mainly the Index UAE website, Yellow Pages and the UAE Contractors' Association' member list.

While there is no agreed formula for calculation of sample size in non-probability sampling approach (Omair, 2014), scale development and factor analysis method recommend some cut-off values for the scale development and analysis to be reliable (Table 4.4). Due to the challenges in having access to the population of general contractors, the least stringent requirement will be used for this study. A minimum sample of 100 and a ratio of five whichever is higher. The proposed sub-scales for this study following expert judgement and scale content validity assessment include a maximum of 13 criteria. This means the minimum sample size is 100 cases (100 > 5 x13). Bryant and Yarnold (1995) state that sample should be at least five times the number of variables and that every analysis should be based on a minimum of 100 observations regardless of the subjects-to-variables ratio" (p. 100).

Table 4.4: Sample size recommendations in factor analysis

Recommendation	Source
Single sample size recommendations	
at least 100	(Gorsuch, 1983) Gorsuch, R. L. 1983. Factor Analysis, 2nd edition. Hillsdale, NJ: Erlbaum Kline, P. 1979. Psychometrics and Psychology. London:Academic Press
at least 200	Guilford, J. P. 1954. Psychometric Methods, 2nd edition. New York: McGraw-Hill.
N to p ratio recommendations (N = sample size , p = number of items included in the analysis)	
a ratio of at least 5	(Gorsuch, 1983)
a ratio of at least 10	(Everitt, BS, 1975)

According to Brown (2006), it is a common practice to split the survey sample in half, one half for EFA and one half for confirming the structure through CFA. This will allow cross-validation and reduce bias in the analysis. Therefore, a total sample size of 200 is required for conduction of EFA and CFA on separate randomly split samples.

In the UAE, the available directory of contractors is through the public yellow pages or the UAE contractors' association. The UAE contractors' association list includes only companies that are member of the association which does not represent the actual population. Therefore, Yellow Pages directory has been used to estimate the number of contractors using "construction contractors" as a search keyword. A total of 580 construction contractors are listed on Yellow pages directory. The sample size required according to the discussion above ranges is a minimum of 200. Assuming a response rate of 30% to 40%, a total of 500 questionnaires were sent to participants in contracting companies for completion.

The questionnaire included a cover letter explaining the purpose of the study and information about confidentiality and approximate time to complete the survey. Follow up emails and reminders have been sent twice to improve the response rate. Requests from highly influencing public authorities and clients have also been sought in order to get participants' interests in completing the survey. Of the 500 questionnaires sent, **228** responses have been received. This represents a response rate of 46% which is acceptable and within the normal range in the construction industry (Akintoye, 2000). The sample is satisfying the requirements for factor analysis and it has been half spilt randomly to be used for EFA/CFA cross validation purpose.

Descriptive analysis has been first used for analysing the questionnaire demographics. These methods involve calculation of percentages, frequencies and averages. These techniques were used for questions targeting the categories of respondents and their levels of knowledge and experience. The results are then presented in adequate graphical forms such as pie charts or bar charts and sometimes as recapitulative tables.

4.8 Stage III: Scale evaluation

Figure 4.10: Scale evaluation steps

4.8.1 Data suitability evaluation

Sample Adequacy. It is agreed that to conduct reliable factor analysis, the sample size needs to be large enough (Hof, 2012). There is a rule of thumb that it is required to have at least 10 to 15 participants per item. There is another method used to test sample adequacy that is the Kaiser-Meyer-Okin test aka as Kaiser test. The KMO "represents the ratio of the squared correlation between variables to the squared partial correlation between variables." (Field, 2009, p. 647).

Evaluation of Data Suitability for EFA- Sample adequacy

As discussed in section 4.7.3, EFA sample should be at least five times the number of variable and the analysis should be based on a minimum of 100 cases regardless of the ratio. However, different studies have revealed that the high level of communality without cross loading in data will affect the adequacy of sample size (Omair 2014; Osborne & Fitzpatrick 2012; MacCallum, Widaman et al. 1999; Fabrigar, Wegener et al. 1999). When communalities are low, large sample size will not be sufficient to ensure accuracy of factor loadings and EFA results. Item communalities that are 0.8 or greater are considered as very good but it very rare to find these high communalities in real data. It is then recommended to have at least low to moderate communalities that have a magnitude in the range of 0.40 to 0.70. Communalities less than 0.40 reflect cross-loading or absence of strong relation to other items. In this case, the item should be eliminated provided this is supported theoretically. Communality values that are higher than 1 are also not acceptable (Watson, 2017).

Another element that affects the suitability of sample size is factor loadings. Although there is no universal agreement on the cut-off value for factor ladings. Tabachnick and Fidell (2013) recommend a minimal value of 0.32 which actually means approximately 10% overlapping variance with the other items in that factor. In addition, Costello and Osborne (2005) stipulate that a factor with less than three items is weak and can mislead the results.

In addition to checking the correlation between sample size, communalities and factor loadings, it is important to further evaluate sample adequacy. To assess sample adequacy, two tests are recommended: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test. A KMO value of 0.60 or greater is used as the condition for good factorability (Tabachnick and Fidell, 2013). Bartlett's test of sphericity gives an estimation of the extent to which the correlation matrix is an identity matrix. In general *p* value less than 0.05 confirms good level of factorability and rejects the null hypothesis that the correlation matrix is equal to identity matrix. If the KMO and Bartlett's test indicate sample adequacy, the researcher can proceed to EFA.

Normality: Further to sample adequacy and data factorability, data normality is also an important aspect to be evaluated as it affects later decisions in both EFA and CFA. In this study, the two most common statistical tests are used to assess normality for all the variables: (a) Kolmogorov-Smirnov and (b) the Shapiro-Wilk test (Hair *et al.*, 2014). The critical value for these tests is 0.05. When using the tests if p value is greater than 0.05, then we can conclude that data are normally distributed.

Factorability. To assess the factorability of the data, Pearson correlations were calculated to determine the intercorrelations for each variable. According to Tabachnick and Fidell (2013), correlation coefficients should exceed .30 in order to justify comprising the data into factors. All variables had at least one correlation coefficient greater than .30 and appear suitable for factor analysis.

4.8.2 Exploratory Factor Analysis

Factor analysis is a common statistical method used to find a small set of unobserved variables (also called latent variables, or factors) which can account for the covariance among a larger set of observed variables (also called manifest variables). There are mainly two types of factor analysis: exploratory (EFA) and confirmatory (CFA). As its name indicates, EFA aims to explore the structure of the constructs while CFA tests hypothetical constructs based on a set of responses (Decoster & Hall, 1998). Both methods are based on the fact that observed measures (responses) are influenced by underlying latent factors. Exploratory factor analysis is often confused for Principal Component Analysis (CPA) although they are two different statistical methods. In this research, EFA was selected over PCA since the main objective is to hypothesise the underlying construct and identifying a number of latent factors based on responses related to observed variables (Figure 4.11). PCA is mainly a reduction technique while EFA is used to explore the structure of a construct (Child, 2006).

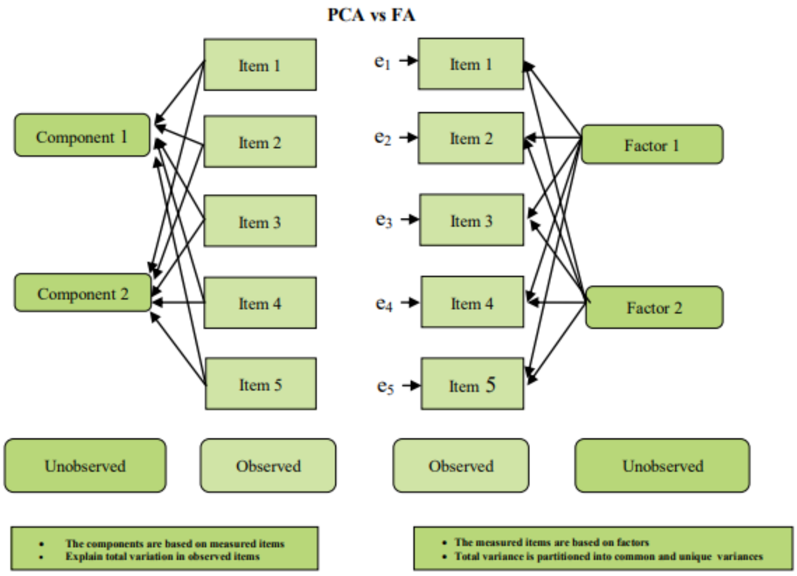


Figure 4.11: PCA and EFA comparison

(Krishnan, 2011)

Data analysis is undertaken by examining covariance among observed measures and measures that show a high correlation are most probably influenced by the same factors. In this research the main categories are confirmed through secondary data and empirical research based on expert interviews. The developed model shows five categories with a set of criteria under each category. EFA will be performed for each category. The main approach and steps for EFA are explained extensively in the next chapter.

EFA is a statistical method that has been used since 1900s for different purposes and mainly for dimension reduction. The method is based on the mathematical model given by the following set of equations:

$$\boldsymbol{x_1 = \lambda_{11} \times f_1 + \lambda_{12} \times f_2 + \cdots + \lambda_{1d} \times f_d + \varepsilon_1}$$

$$\boldsymbol{x_2 = \lambda_{21} \times f_1 + \lambda_{22} \times f_2 + \cdots + \lambda_{2d} \times f_d + \varepsilon_2} \qquad \textbf{(1)}$$

$$\boldsymbol{x_p = \lambda_{p1} \times f_1 + \lambda_{p2} \times f_2 + \cdots + \lambda_{pd} \times f_d + \varepsilon_p}$$

Where x_i(i =1,..., p) are the observed variables; , λ_{ij} (i= 1,..., p and j=1,….,d) are the factor loadings; f_j(j=1,…d) are the unobserved latent common factors; and ε_i (j =1,..d) are the error terms.

The matrix form of model (1) can be described as follows:

$$\mathbf{x} = \boldsymbol{\Lambda} \cdot \mathbf{f} + \mathbf{e} \qquad \textbf{(2)}$$

Where x is the vector of measured variables, Λ is the matrix of factor loadings of all variables on each factor, *f* is the vector of factors, and e is the vector of error terms. In this matrix form, it is assumed that the expected values of all involved variables are equal to zero, error terms are uncorrelated with each other, and the common factors are uncorrelated with the error terms. The covariance matrix can be expressed in the following form:

$$\boldsymbol{S = \Lambda^T . \Lambda + \Psi = \Lambda^T . \Lambda + E\,(e.e^T)} \quad \textbf{(3)}$$

Where Ψ is the diagonal matrix of the variances of error terms. If we also want to present the variance of each variable x_i, we can apply the following expression:

$$\boldsymbol{VAR\,(x_i) = \lambda_{i1}{}^2 + \lambda_{i2}{}^2 + \cdots + \lambda_{id}{}^2 + \sigma_i{}^2 = h_i{}^2 + \sigma_i{}^2} \qquad \textbf{(4)}$$

Where the sum of squared factor loadings λ_{ij} is called the communality h_i^2 of variable xi and represents the common variance (shared with the other variables), while the variance σ_i^2 of the error term e_i and represents the so-called specific variance of the remains. If we want to determine how the measured variables are linked to their underlying factors, we need to estimate the matrix of factor loadings Λ. The calculation of this matrix then also enables the estimation of the communalities. This way, we get the ability to identify the minimum possible number of factors that account for co-variation among the observed variables.

EFA has an exploratory purpose and therefore it is not recommended to specify a rigid process for its implementation (Osborne, Costello and Kellow, 2008). However, Osborne et al. (2008) is proposing that there is a general pattern of performing EFA that researchers can adopt by following five general steps explained below.

Selection of the extraction method

When conducting EFA, there are many decisions to be made in SPSS instead of just using the default options provided by the program. The first decision is related to extraction method. As shown in Table 4.5, different extraction methods have different principles and assumptions. Isabel Izquierdo (2014, p396) state that the selection of extraction method "will depend on the researcher's goal, the fulfilment of the distributional assumptions required by the method, and the researcher's interest in employing goodness-of-fi t indices".

As it is clear from the Table 4.5, the most important assumption to be considered when deciding on the extraction method to be used is data multivariate normality. Fabrigar et al.(1999) state that Maximum Likelihood method, the most used method in factor analysis studies, can produce inaccurate and distorted results when normal distribution assumption is violated. They recommend Principal Axis Factor (PAF) as an alternative in SPSS when normality is not satisfied. For categorical type of data, it is recommended to use WLS or ULS methods (Isabel Izquierdo, 2014). However, Osborne (2007) warns that these latter methods can be sensitive to violation of normality assumption. The selection of the extraction methods for each construct will thus depend on the normality testing results.

Table 4.5: Comparison of EFA extraction methods

Method	Principles	Assumes multivariate normality
Principal axes factor (PAF) extraction	- Identify estimates of communality coefficients - communality estimates are used to replace the diagonal elements of the correlation matrix - Iterations is repeated until communality coefficients stabilize	No
Maximum Likelihood (ML) Extraction	- Seeks to extract factors and parameters that optimally reproduce the population correlation (or covariance) matrix - The parameters chosen are tweaked iteratively in order to maximize the likelihood of reproducing the population correlation matrix- or to minimize the difference between the reproduced and population matrices	This technique is particularly sensitive to quirks in the data, particularly in "small" samples, so if the assumptions of normality are not tenable, this is probably not a good extraction technique
Unweighted Least Squares (ULS) and Generalized Least Squares (GLS) Extraction	- Use variations on the same process of Maximum Likelihood - ULS is said to be more robust to non-normal data - GLS weights variables with higher correlations	No

Selection of the factor retention method

One of the other controversial areas of EFA is related to decision rule for factor retention. Hayton et al (2004) state that factor retention is more important than other decisions about rotation and extraction methods. This importance emanates from the main purpose of EFA that is to adequately represent underlying correlations in order to differentiate major factors from minor ones. Empirical studies about EFA have shown that under-extraction or over-extraction are significant errors that affect scale measurement results (Velicer, Eaton et al. 2000; Hayton, Allen et al. 2004).

The available factor retentions methods are; Cumulative percent of variance extracted, extracted, Kaiser‟s criteria (eigenvalue > 1 rule) (Kaiser 1960), Scree test (Cattell 1966) and Parallel Analysis (Horn 1965). Cumulative percent of variance is known to differ from discipline to discipline and there is lack of consistency on the percentage to be achieved before factors are stopped. MacCallum, Widaman et al. (1999) point out that another issue with this method is related to significant distortion in results when EFA is conducted on variables with low communalities. K1- Kaiser’s method requires that only factors with the eigenvalues greater than one should be retained. This method is the most commonly used in literature mainly because of its ease of use (Gorsuch 1983). The main issue flagged about this approach is that it has been initially proposed for PCA and not for EFA (Gorsuch 1983).

Linn (1968) reported that K1 approach has overestimated the number of factors by 66%. In addition, several studies have stated that K1 approach is one of the least accurate methods for factor retention (Velicer and Jackson 1990; Fabrigar et al.1999; Ledesma and Valero-Mora 2007). The third method that is Cattell’s Scree test is to observe the number of data points above the break and that will be the number of factors to be retained and it is based on the logic that this breaking point distinguishes between major and minor factors (Ledesma and Valero-Mora 2007). Zwick and Velicer (1986) state that while this method is better than the K1 rule, it was still correct only 57% of the time and in most inaccurate cases, the number of factors retained was overestimated (Ledesma and Valero-Mora 2007).

Parallel Analysis (PA) has been proposed by Horn (1965) and it compares the observed eigenvalues extracted from the correlated matrix with those calculated from uncorrelated normal variables. In PA method, the factors will be retained if the actual eigenvalue exceeds random ordered eigenvalue. It has been reported by many researchers that PA is the most accurate method to decide on factor retention (Humphreys and Montanelli 1975; Zwick and Velicer 1986; Glorfeld 1995; Thompson and Daniel 1996; Ledesma and Valero-Mora 2007). In addition, Zwick and Velicer (1986) reported that PA was accurate 92% of the time.

Based on the review of retention methods above, this study will adopt Parallel Analysis as the most appropriate method to decide on the number of factors to retain in EFA. A parallel analysis involves a factor analysis on a random set of data that is of identical dimensions of the measures data. The factors that are extracted from the random data are then compared to the factors extracted from the collected data. Only factors with eigenvalues higher than the random data are retained in the exploratory factor analysis. Since there is no option in SPSS for PA, a syntax file developed by Brian O'Connor (2000) was used.

Selection of the rotation method

As with extraction, there are many choices of rotation method, depending on what software you are using. Each uses slightly different algorithms or methods to achieve the same broad goal- simplification of the factor structure. Rotation methods fall into two broad categories: orthogonal and oblique (referring to the angle maintained between the X and Y axes). Orthogonal rotations produce factors that are uncorrelated (i.e., maintain a 90^o angle between axes); oblique methods allow the factors to correlate (i.e., allow the X and Y axes to assume a different angle than 90^o). The rotation methods available in SPSS are summarised in Table 4.6.

Table 4.6: Rotation methods for EFA

Method	**Principles**
Varimax	Seeks to maximize the variance within a factor (within a column of factor loadings) such that larger loadings are increased and smaller are minimized.
Quatrimax	Tends to focus on rows, maximizing the differences between loadings across factors for a particular variable—increasing high loadings and minimizing small loadings.
Equimax	Considered a compromise between Varimax and Quartimax, in that it seeks to clarify loadings in both directions
Promax	A combination of an initial Varimax rotation to clarify the pattern of loadings, and then a procrustean rotation
Direct Oblimin	Another oblique rotation that can sometimes be problematic but often gives very similar results to Promax

While literature has conventionally advised researchers to use orthogonal rotation method for ease of interpretation, Osborne et al. (2008) stated that this can lead to loss of valuable information if the factors are really correlated which is the case in most social sciences and management studies. The only challenge in using the oblique rotation method is that there are two matrices (pattern and structure) to be interpreted instead of one but these matrices are often parallel to each other and do not make the interpretation difficult. In SPSS, for example, the default extraction is PCA, and the default rotation is Varimax. However, based on the discussion above, the options used for EFA are PAF with Oblimin and PA.

Factorability and multicollinearity assumptions were tested by examining a correlation matrix for each analysis. The factor loadings were interpreted by taking the absolute value of each loading and implementing the criterion suggested by Comrey and Lee (2013). Values greater than .71 are considered excellent, values between .63 and .71 are very good, values between .55 and .63 are good, values between .45 and .55 are fair, and values between .32 and .45 are poor. Tabachnick and Fidell (2013) also recommend that .32 should be the minimum threshold used to identify significant factor loadings. These guidelines can help decide which variables to include for a given factor.

Interpretation and labelling

Examination of the factor matrix involves checking if a variable has more than one significant loading, then we are dealing with cross-loading issue. In this case, other rotation methods may be tested which can eliminate the cross-loadings but if the variable still has significant cross-loadings, then it is a candidate for deletion. Variables can also be deleted if they do not load significantly on any of the latent factors. Communalities have to be checked as well to see the variables meet an acceptable level of explanation. As suggested by (Hair, 2011), the variables are candidates for deletion, if their communalities are less than the value 0.5. Interpretation is the last stage in EFA and involves examination of variables which are attributed to different constructs. Labelling of constructs is considered subjective and based on theory (Pett, Lacky et al. 2003).

Replication or evaluation of robustness

One of the important elements in any research is replicability and testing the ability of other researchers to replicate the same study using the same methods. As mentioned by Osborne et al. (2008), EFA is a slippery technique for which the results and the decisions are unclear, which make replicability more challenging. The reliability test investigates the level of consistency between multiple measurements of a certain variable. The commonly used measure is so-called internal consistency, which means that the "reliable" set of variables will consistently load on the same factor. This can be deduced from the fact that the individual indicators of the scale should all measure the same factor and thus should be highly inter-correlated. The most widely used reliability measure is so-called Cronbach's alpha reliability coefficient, which is usually calculated for each factor. According to Hair (2011), the generally agreed minimum lower level for Cronbach's alpha coefficient is the value 0.70.

4.8.3 Confirmatory Factor Analysis

CFA requires the establishment of a factor model including the criteria and how they are linked to unobserved variables. The model is constructed based on a set of hypotheses and the statistical method of CFA is used to test them. A CFA model is sometimes considered as one of the Structural Equation Modelling (SEM) family of methods. The main distinction between CFA and SEM is that CFA focuses on the relationships between the observed and unobserved variables, whereas a SEM includes causal paths between latent factors (Harrington, 2009).

Many software packages are available to users to conduct confirmatory factor analysis of which the most common are AMOS, LISREL, MPLUS, EQS, SAS CALIS. However, AMOS has been selected for this study, as it is known for its ease of use, particularly getting started with the graphics user interface which is considered easier than syntax commands. The model fit was tested using Chi-square goodness of fit and approximate fit indexes. Harrington (2009) provides a comprehensive step by step process to CFA using AMOS software. This process is summarised in Figure 4.12. CFA will assess the extent to which the measurement model explains the variance in the data.

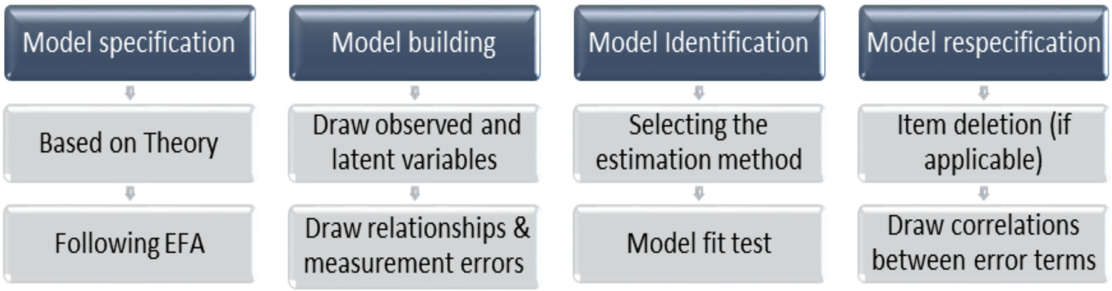


Figure 4.12: CFA process
(Adapted from Harrington, 2009)

Following EFA, CFA is conducted to confirm the factor structures of EFA and verify their compliance with the hypothesised measurement model. Confirmatory Factor Analysis (CFA) is a specific example of structural equation modelling and it is known as the covariance structure. There are two components of SEM: a measurement model linking a set of observed variables to a smaller number of latent variables; and a structural model linking latent variables through cursive and non-recursive relationships. CFA corresponds to the first component. This study has used Amos 24 software to conduct CFA modelling.

Diagram drawing

In Amos, observed variables are represented by a square or rectangle while latent variables are represented by an oval or circle. Direct lines represent relationships that the researcher wants to impose on data to test the theoretical hypotheses while curved lines signifies correlation between latent variables.

Parameter Estimation

The default method of estimation in Amos is Maximum Likelihood (ML). This method involves analysing covariance matrices only and estimate all model parameters using an iterative algorithm. The method of ML assumes multivariate normality and the method becomes weak and biased if this assumption is violated. It was reported that if this assumption is violated, then results may not be reliable. Bias with ML appears in standard errors and chi-square. There could be also underestimation in GFI and overestimation in RMR. Table 4.7 below shows the available estimation methods that are used for SEM parameter estimation.

ML method is often chosen for its popularity in estimating CFA models. Schermelleh-Engel et al. (2003) and Mîndrila (2010) point out that test of overall ˘ model fit for over-identified model is possible with ML. One drawback of ML is the requirement of multinormal distribution assumption, which is often not fulfilled in applied data. If the assumption is violated, then model results may not be reliable. Bias appears in standard errors and chi-square. Goodness-of-fit indices GFI and RMR will also be affected, by underestimation in GFI and overestimation in RMR. As mentioned in Table 4.7, as alternative to ML, there are two methods that are mainly recommended in the case of ordinal data. Though WLS (weighted least square) has been criticized for its poor performance when sample size is small and the model is complicated. As part of the same category, two other methods are proposed and they are unweighted least square (ULS) and diagonally weighted least square (DWLS) (Yang-Wallentin et al., 2010; Brown, 2012).

Table 4.7: Estimation methods for CFA

Estimation method	**Properties**
Maximum likelihood (ML)	Requires at least approximate multivariate normality the normality of all univariate distributions of the variables; the bivariate normality of joint distribution of any pair of the variables.
Generalized least squares (GLS)	Assumption of multivariate normality or no excessive kurtosis. Consistent, asymptotically unbiased, normally distributed, and efficient full in formation estimator.
Unweighted least squares (ULS)	No distributional assumptions about the observed variables. All observed variables must be measured on the same scale.
Asymptotically distribution-free (ADF) methods	Also called the Weighted least squares (WLS). Also involve the forth-order product moments around the mean, besides the second order moments, while using the asymptotic covariance matrix. Strictly require large sample size and due to the inverting of the full-weight matrix computationally very demanding.
Diagonally weighted least squares (DWLS)	It is often used when the significantly non-normal ordinal data and the polychoric correlation between the categorical variables are involved.
Mean- and variance-adjusted WLS (WLSMV)	Specially designed for categorical variables.

The main difference to WLS is in the weight matrix in the fit function. DWLS use a weight matrix which only contains the diagonal elements of the asymptotic covariance matrix, while ULS use the identity matrix as its weight matrix. Forero et al. (2009) suggest that ULS gives more precise estimation (less bias and smaller standard errors) than DWLS. Rigdon and Ferguson Jr (1991) also shows that ULS outperforms DWLS. Besides, Babakus et al. (1987) also recommend that ULS should be used to solve problems when polychoric correlation matrix is used because ULS overcomes the shortage of non-positive definite weight matrix in WLS and reduces inaccurate solutions and tendency of non-convergence. Based on the discussion above, ULS has been adopted for this study as parameter estimation method.

Model Fit Evaluation

In Confirmatory Factor Analysis, there are several assessment criteria for the model fit, known as goodness of fit (GOF) indices, showing the different levels of acceptable fit of proposed models. All the fit indices that can be used as the criteria guidelines for acceptable. According to the literature (Byrne, 1998; Kaplan, 2000; Hair et al., 2010; Kline, 2011), among the fit indices presented in Table 4.8, the following five are central for goodness-of-fit in SEM, as they are adequate for explaining the model validations: the relative Chi-square or $\chi 2$ ratio, root mean square error of approximation (RMSEA), root mean square residual (RMR), comparative fit index (CFI), Goodness of Fit statistics (GFI), normed fit index (NFI), non-normed fit index (NNFI) and incremental fit index (IFI).

Although there are some other fit indices for SEM, researchers are advised to report at least one GOF index in each category namely: absolute fit indices, incremental fit indices and parsimony fit indices (Byrne, 1998). In Amos, when using ULS estimation method, GOF indices are mainly; the relative Chi-square or $\chi 2$ ratio, GFI, RMR, AGFI, NFI and PNFI. These indices will be used to test model fitness and to compare different model options before deciding on the final evaluation model to be proposed. Categories of indices and their acceptable cut off values are summarised in Table 4.8.

Table 4.8: List of CFA model fit indices

Category	Index	Level of Acceptance	Literature
Factor Loading	Standardized Regression Weight	Weight > 0.5	Heir et al (2006)
Absolute Fit	RMSEA GFI RMR	RMSEA < 0.08 GFI > 0.9 RMR < 0.08	Browne and Cudeck (1993) Joreskog and Sorbom (1984)
Incremental Fit	AGFI CFI TLI/NNFI NFI	AGFI > 0.9 CFI > 0.9 TLI > 0.9 NFI > 0.9	Tanaka and Huba (1985) Bentler (1990) Bentler and Bonett (1980) Bollen (1989)
Parsimonious Fit	Chisq /df PNFI	Chisq /df < 5 PNFI > 0.5	Marsh and Hocevar (1985)

Adapted from (Lewis, 2017)

Second Order CFA

In addition to the test of first order CFA models, second order CFA model and bi-factor models are also evaluated. A comparison is then undertaken between the three models to identify the best fitting model. While a first-order model is showing the covariances between the latent factors using a single layer, a second-order measurement model contains two layers of latent constructs and a third order contains three layers. The higher order measurement model is structured in a way that means the higher order factors are theoretically causing the lower order factors, which in turn explains the measured variables (Hair et al., 2010). The use of higher order constructs can be beneficial in testing theoretical hypotheses and refine the scale development. Decision about the use of higher order models is always based on theoretical foundation.

Bi-Factor CFA Model

Another alternative model to second order CFA models is bi-factor model. Bi-factor models are increasingly being applied in different fields of study (Chen, West and Sousa, 2014); Canivez, 2016; Rodriguez, Reise and Haviland, 2016) . This type of model is potentially applicable when there is a possibility of general factor causing all the items in the model and when both general factor (higher order) and sub-factors (first order) are important theoretically and explain the model structure more accurately (Chen, West and Sousa, 2014). Cucina and Kevin (2017) recommend considering using bi-factor models when conducting CFAs as they proved to have better fit than higher order models in the majority of studies they have reviewed.

Chen, West and Sousa (2014) list five advantages of bi-factor model: 1) it is a less restricted model than the second order model; 2) it allows the study of domain specific factors that are independent of a general factor; 3) it permits direct examination of the relationship between the domain specific factors and their associated items without disturbance by the second order factor; 4) it is "useful in testing whether a subset of the domain specific factors predict external variables, over and above the general factor"; and 5) measurement invariance can be tested for both domain specific factors and general factor.

Despite the agreement in literature about the benefits of bi-factor models and it superiority over second order models, it is always recommended to compare both models statistically. In this study, a common method of comparison of nested models will be used. It was developed by Satorra and Saris (1985) and it is based on the difference between chi-square value and difference of degrees of freedom ratio. Rodriguez, Reise, and Haviland (2015a) suggest additional statistical analyses to evaluate the psychometric value of the bifactor model. Theses indices are coefficient omegas (McDonald, 1999; Reise, 2012), Explained Common Variance (Reise, 2012), construct reliability (Hancock & Mueller, 2001), and percent uncontaminated correlations (Reise, 2012) for the model. In order to compute these values, standardized factor loadings are extracted from the model and used as input in the omega software developed by Watkins (2013).

Comparison of competing models

The next step after conducting and comparing first order, second order and bi-factor model CFA subscale models leads towards achieving the study's primary objective of developing a comprehensive sustainability performance model for construction contractors. This section goes on to present the final research model which can encompass all the criteria that should be considered when evaluating sustainability performance of construction contractors. Prior to undertaking factor analysis, it is very important to evaluate the composition and demographics of the sample.

Competing models strategy is used to compare the proposed model with other alternative models in order to verify the superiority of the proposed model (Hair *et al.*, 2014). This approach is usually based on SEM and on the premise that acceptable or good fit of the proposed model does not guarantee that there are no alternative better or equally fitting models. Comparing competing models is conducted through assessment of chi-square (χ^2) difference statistics ($\Delta\chi^2$). The chi-square value from the proposed model (A) is subtracted from the chi-square of less constrained alternative model (B). In addition, the difference in degrees of freedom is calculated and the difference statistics is computed using the following equation:

$$\Delta\chi^2{}_{\Delta df} = \chi^2{}_{df(B)} - \chi^2{}_{df(A)}$$

This chi-square difference is distributed with difference of degrees of freedom and can be checked manually for significance using a χ^2 table. If the χ diff-value is significant, the "larger" model with more freely estimated parameters fits the data better than the "smaller" model in which the parameters in question are fixed.

4.9 Ethical Considerations

Research ethics is an essential element to be considered in conducting a research. In management and social science studies, issues related to anonymity, consent, confidentiality are some of the crucial issues to be addressed by the researcher. In line with Heriot-Watt University Ethical policy, a research ethics form has been signed by the researcher and the supervisor and submitted to the postgraduate committee for their approval and agreement to conduct this research. A consent letter has been signed by interviewees and their personal data was kept anonymous. Anonymity has also been ensured for both surveys. The assurances of absolute anonymity and confidentiality of information were included in the covering letters (Appendix A and Appendix B) sent to the participants in the expert survey and main survey. Respondents have been assured that the aim of data collection is only for research and that anonymity is respected throughout and beyond this study.

4.10 Summary

This chapter has provided a step-by-step explanation of the methodology adopted for this research. The chapter reviewed both philosophical and practical strategies adopted for conducting the study and the scale development objective. In terms of the philosophical considerations, the pragmatism paradigm was adopted as the philosophical stance of this thesis, which then lead to the logical decision of selection of abductive type of research and then to a mixed method approach. For the data collection approach, the chapter explains the adoption of scale development process that is agreed for psychometric measurement models and has been used in many similar studies. Steps involved in the three stages of scale development have been explained including expert judgement, main survey and validation methods. Sampling strategies and analysis methods have been explained and further details of the approaches adopted for factor analysis will be explained in the next two analysis chapters.

Chapter 5: Content Validity- Expert Judgement

5.1 Introduction

Expert judgements are the main step towards content and face validity of the identified performance criteria that was the outcome of literature review. In this study, a double layer face and content validation approach has been adopted sequencing semi-structured expert interviews and structured expert questionnaire survey. This reinforced assessment approach is recommended when the pool of items is developed mainly from literature and not based on existing theoretical model. Following the literature review, face to face and Skype interviews have been conducted with a selected sample of sustainability experts. The interviews aimed to assess the applicability of the identified criteria to the construction industry, to contracting companies and to the UAE market. Subsequently, expert survey has been conducted to elicit broader opinions about the importance and relevance of the proposed performance criteria. This chapter provides findings and analysis of interviews and results of expert survey leading to the final list of validated criteria that will be used in the proposed model.

5.2 Expert Interviews

5.2.1 Approach of expert interviews

The interviews have been conducted face to face for the UAE based interviewees and as Skype call for interviewees outside the UAE. Most of the interviews have been conducted in the period from May to July 2015. Prior to the interviews, interviewees asked to fill a consent form and were provided with details about the purpose of the interview and the anonymity and ethical procedures for the interviews. Each interview lasted from 60 to 90 minutes. The interview schedule (Table 5.1) included six questions that were asked during each interview. The first questions mainly focused on understanding the interviewees' profiles and level of experience and to evaluate the need for contractor sustainability system while the last question aimed at the evaluation of appropriateness of the identified evaluation categories and criteria. The interviews were recorded with the consent of the interviewees for analysis purpose.

Table 5.1: Interview schedule of questions

1. Please provide a brief overview of your background and experience.
2. Do you think the available green building rating systems are sufficient to achieve holistic sustainability in the construction industry
3. Based on your experience, how do you see and evaluate the sustainability performance of contractors in the UAE?
4. Are you aware of any similar evaluation system specifically designed for construction contractors? If yes, please list them.
The initial framework developed for this scale is divided into four domains: 1) Policy and governance, 2) Corporate Workplace and Employees, 3) Procurement and supply chain, and 4) Project delivery. 5. Do you think any of these domains is irrelevant to construction contractors? Is there any domain missing in the framework?
6. Can you evaluate the list of criteria under each domain and comment on their relevance, clarity and applicability to construction contractors in the UAE? Add any criteria you feel necessary to define the related domain.

5.2.2 Experts' profiles

The interviews have been conducted with ten industry experts and two academic researchers. Among the ten construction professionals, three interviewees were from contracting companies, two from client organisations, two from non-profit organisations and three from consulting companies. Table 5.2 summarises the interviewees' profiles. As explained in previous chapter, the sampling strategy used for the interviews is purposive sampling where selection of interviewees is based on their understanding of the topic and expertise in both sustainability and the construction field, in addition to experience in the UAE market.

Table 5.2: Profiles summary of experts

Expert	Type of organisation	Position	Experience (years)		Type of interview
			Total	UAE	
Expert A	Contracting company	CSR director	25	20	Face to face
Expert B	Contracting company	Environment & sustainability team leader	20	5	Skype
Expert C	Contracting company	Sustainability coordinator	12	12	Skype
Expert D	Consulting company	Sustainability manager	15	6	Face to face
Expert E	Consulting company	Senior sustainability consultant	16	10	Face to face
Expert F	Consulting company	Managing Director	16	8	Face to face
Expert G	University	Professor and chair	17	7	Skype
Expert H	Consulting company	Senior Sustainability and CSR professional and visiting lecturer	23	9	Skype
Expert I	Government organisation	Executive Director	20	7	Face to face
Expert J	Government organisation	Head of Sustainability Research and studies	5	5	Face to face
Expert K	NGO	Sustainability consultant	10	10	Face to face
Expert L	NGO	Sustainability Faculty	15	6	Skype

The twelve construction and sustainability professionals come from different background and different type of organisations, covering both the public and private sector as well as academic and industry areas. In addition to insights provided by sustainability professionals working in the industry, the input from academic professionals was very valuable to the study as they are more aware of the research trends in corporate sustainability and value more the scientific and established approach used to develop measurement scales.

5.2.3 Need for the proposed sustainability evaluation system

Stone (1984) indicated that semi- structured interviews could include both structured and open-ended questions. Two questions have been addressed to the interviewees under this part. The purpose of these questions is to test and validate the finding from literature review that there is a need in the industry for a sustainability evaluation of contractors.

The first question asked about the sufficiency of existing sustainability rating systems in promoting sustainable construction throughout the supply chain. Three interviewees believe that the existing rating systems are actually considering the supply chain especially that some supply chain related criteria such as LCA, ISO 14000 are being considered in many of the rating systems. All the other interviewees commented on the fact that green building rating systems are not involving the supply chain enough and they are mainly focusing on some site activities such as waste management, construction environmental management planning and material procurement without any emphasis of sustainability performance of contractors or their supply chain.

The second question asked interviewees about how they see sustainability performance of contractors. Experts A, B and C responded that contractors are performing very well when it comes to implementing sustainability requirements in projects and that most of the time sustainability failure is due to unclear design or inaccurate documentations. Expert A added that the performance level correlates highly with the size of contracting company. On the other hand, experts J and K expressed their dissatisfaction with the sustainability performance of the majority of contractors they have commissioned for their projects.

5.2.4 Availability of existing contractor evaluation systems

Expectedly, nine experts referred to ISO 14000 as an existing system for evaluating contractors' performance. As discussed in literature review, ISO 1400 is very commonly known in the construction industry and it is an important standard to promote sustainability in construction activities, however its focus is mainly environmental management system and project site activities (Riley, Pexton and Drilling, 2003; Lee and Farzipoor Saen, 2012). Expert L added Green Advantage and the Green Roundtable as two good evaluation systems already used in the USA. A review of Green Advantage showed that this is a certification system for construction site personnel including tradespeople, supervisors, engineers and entry level construction workers. Green Roundtable is not an evaluation or certification scheme, it is a non-profit organisation with a mission of mainstreaming green building and construction using the education, technologies and policy. Expert G and D have mentioned the ABC Green Contractor scheme. This scheme has been reviewed in the literature review and as mentioned in section 4.3, its main focus is on sustainable workplace environment which is only one domain of sustainability performance measurement and of the proposed evaluation model in this study. Expert K has also added 'Building Responsibly' but he explained that it is not a certification system but an initiative by a group of companies working together to improve the welfare and work environment in the construction sector. All interviewees agreed that there is no comprehensive system to evaluate sustainability performance of contractors across the three dimensions of sustainability. This agreement in addition to the responses in previous section support strongly the importance of this study.

5.2.5 Judgement of sustainability evaluation dimensions and criteria

The second part of the interview required the experts to evaluate the identified criteria from literature review. Interviewees were asked to identify which items to retain, delete or reword based on the suitability of the items to contracting companies and to the UAE market. Based on their feedback, the second dimension that is corporate facilities and employees' criteria was divided into two distinct dimensions namely: 'corporate workplace facilities' and 'management of employees'. Table 5.3 summarises the changes made to the list of criteria for each of the proposed model dimensions.

Table 5.3: Changes proposed by experts for sustainability evaluation criteria

<table>
<tr><th rowspan="2">Dimension</th><th rowspan="2">Initial number of items</th><th rowspan="2">Items to be eliminated (*)</th><th rowspan="2">Items to be added</th><th rowspan="2">Final number of items</th><th colspan="2">Items with changed wording</th></tr>
<tr><th>Before expert judgement</th><th>After Expert judgement</th></tr>
<tr><td rowspan="7">Policy and Governance</td><td rowspan="7">12</td><td rowspan="7">• Community representatives in the Board of Directors</td><td rowspan="7">• Availability of Corporate Sustainability Department
• Compliance with sustainability laws and regulations</td><td rowspan="7">14</td><td>Statement of environmental stewardship</td><td>Company policy includes a statement of environmental stewardship</td></tr>
<tr><td>Statement of social responsibility</td><td>Company policy includes a statement of social responsibility</td></tr>
<tr><td>ISO 14001</td><td>ISO 14001certification (environmental management)</td></tr>
<tr><td>ISO 26000</td><td>ISO 26000 certification (social responsibility)</td></tr>
<tr><td>SA 8000</td><td>SA 8000 certification (social accountability in the workplace)</td></tr>
<tr><td>Sustainability memberships</td><td>Sustainability memberships (local or international)</td></tr>
<tr><td>Community surveys</td><td>Community support programs</td></tr>
<tr><td>Corporate workplace facilities</td><td rowspan="7">22 (**)</td><td>N/A</td><td>N/A</td><td>10</td><td>Fraction of buildings using renewable energy</td><td>Buildings use renewable energy</td></tr>
<tr><td rowspan="6">Management of employees</td><td rowspan="6">• Availability of environmental auditing and reward system
• Effectiveness of discipline management
• Effectiveness of compensation management</td><td rowspan="6">• Employee active life / wellbeing programs
• Employee sustainability feedback system
• Compliance with labour camp regulations</td><td rowspan="6">14</td><td>Average annual training time</td><td>Sustainability training of employees</td></tr>
<tr><td>Annual personnel turnover</td><td>Employee retention strategy (at corporate level)</td></tr>
<tr><td>Annual number of applied innovative ideas generated by employees</td><td>Employee Sustainability Initiative Award program</td></tr>
<tr><td>Annual number of recordable incidents with respect to harassment and violence</td><td>Anti- harassment and violence policy</td></tr>
<tr><td>Annual number of recordable accidents/employee</td><td>Employee incident/ accident reporting system</td></tr>
<tr><td>Average annual number of recordable employee complaints/employee</td><td>Employee complaints reporting system</td></tr>
</table>

Dimension	Initial number of items	Items to be eliminated (*)	Items to be added	Final number of items	Items with changed wording	
					Before expert judgement	After Expert judgement
Procurement and supply chain	9	N/A	N/A	9	Availability of sustainability evaluation scheme	Availability of a formal sustainability evaluation scheme of suppliers and subcontractors
					Environmental collaboration with supply chain	Sustainability collaboration with supply chain
					Percentage decrease in total supply chain cost	Optimisation plan of total supply chain cost management
					Reverse logistics	Reverse logistics policy and procedures
Project delivery	15	• Percentage of delivered net zero projects • Environmental Management System • Innovative sustainability delivery beyond requirement	• Sustainability manager / engineer appointed on sites	14	Material saving plan and waste abatement plan (combined)	Material saving and waste abatement plan
					Percentage of delivered projects certified by a sustainability accreditation body	Successful delivery of projects certified by a sustainability accreditation body

(*) items have not been deleted at this stage in order to crosscheck with expert survey findings
(**) these two categories have been split up based on expert judgement

5.3 Experts Survey

The identified criteria based on literature review and expert interviews input have been integrated into a questionnaire survey to elicit broader perception from sustainability experts in the UAE. In the UAE, there is no available record of sustainability professionals in the construction industry. Therefore, the professional networking website LinkedIn has been used to estimate the number of sustainability professionals in the construction industry. Using specific search keywords and search criteria, a total of 525 sustainability professionals who have current or past experience in the UAE has been found. A total of 250 questionnaires were sent to randomly selected participants for completion. Follow up emails and reminders have been sent twice to improve the response rate. Requests from highly influencing sustainability professionals have also been sought in order to get participants interests in completing the survey. Of the 250 questionnaires sent, 82 responses have been received.

The survey first sought the background information of respondents and their organisations. Thereafter, respondents were asked to rate the level of importance of the derived criteria based on according to a five-point Likert scale (1 = not important at all, 2= slightly important, 3 = moderately important, 4 = important, 5 = very important). Data collected from the survey was analysed using a combination of descriptive and inferential statistical analysis.

5.3.1 Data screening

The use of web-based survey through Smart-Survey website has assisted in obtaining a good sample for analysis and complete and accurate data. The survey was published for a period of two months and once the data collection was completed, raw data has been retrieved from the website software and then organised and refined in an excel file. Data coding was based on coding each category and related criteria using the initials of words forming that category. Policy and Governance has been coded as (PG) and includes 14 items (PG1 to PG14), Corporate Workplace as CW with 10 items (CW1 to CW10), Management of Employees as ME including 13 items (ME 1 to ME13), Procurement and Supply Chain as PSC with 9 items (PSC1 to PSC9) and Project Delivery as PD with 14 items (PD1 to PD14).

5.3.2 Missing Data

The risk of having missing data is detrimental to factor analysis in particular. However, with the online survey feature, this risk can be easily mitigated. Smart Survey offers the feature of preventing moving to the next page of the survey if questions that have been set as mandatory are unanswered. This solution has gained popularity in dealing with missing data and incomplete survey responses. However, it has been argued that the technique may reduce the response rate. While this can be the case, it is always possible to use response enhancement strategies to mitigate the possible effect of the feature.

5.3.3 Demographics and sample analysis

Evaluating the sample of respondents is an important step in questionnaire analysis. During the survey, background, experience and level of expertise have been sought in the first section of the questionnaire. As the aim of this research is focused on sustainability performance criteria of contractors, it was anticipated to target all sustainability professionals dealing with contractors or working in contracting companies.

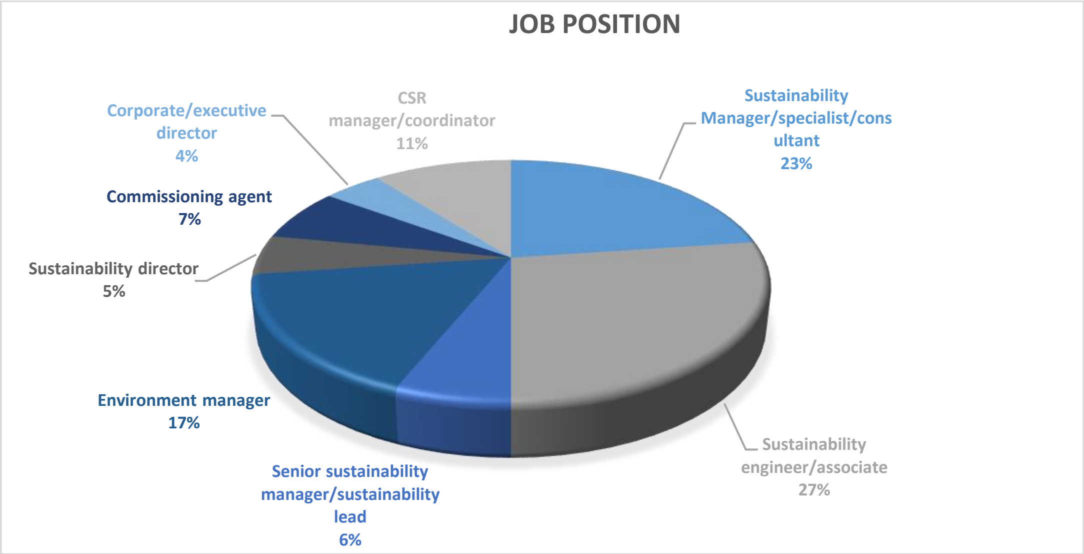


Figure 5.1: Distribution of respondents by job position

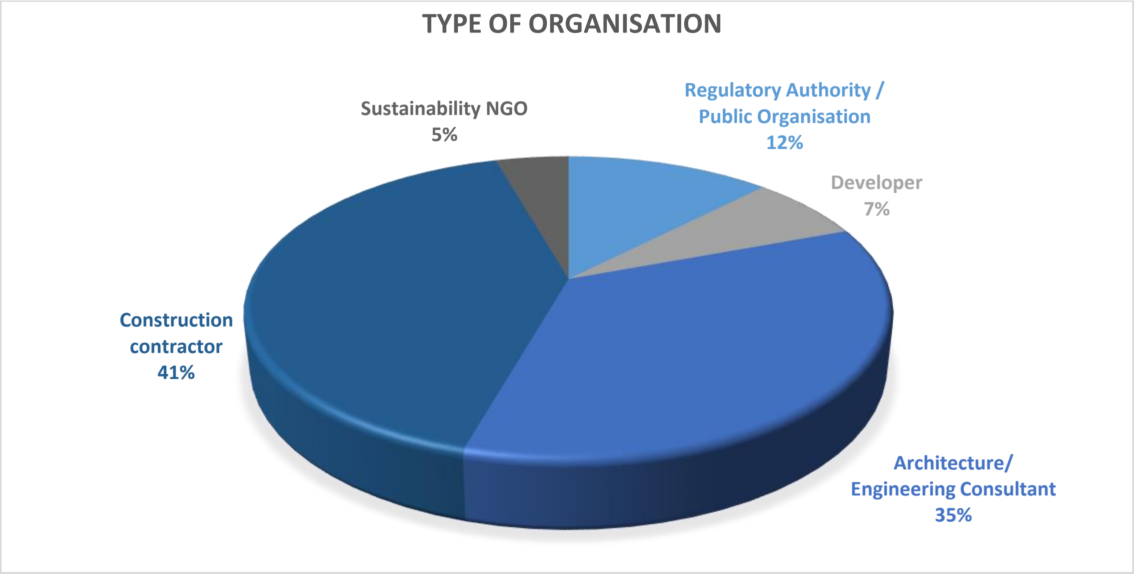


Figure 5.2: Distribution of respondents by type of organisation

The sample composition shows a good combination of sustainability professionals from different types of companies and different management levels within their companies. The majority are from consulting and construction contracting companies while only around 25% of the respondents are from public, private clients (Figure 5.3). In terms of job position, there was also a good sample diversity in terms sustainability focus (environment professionals versus sustainability professionals) and level of seniority as it spans the management hierarchy from sustainability engineers to executive directors.

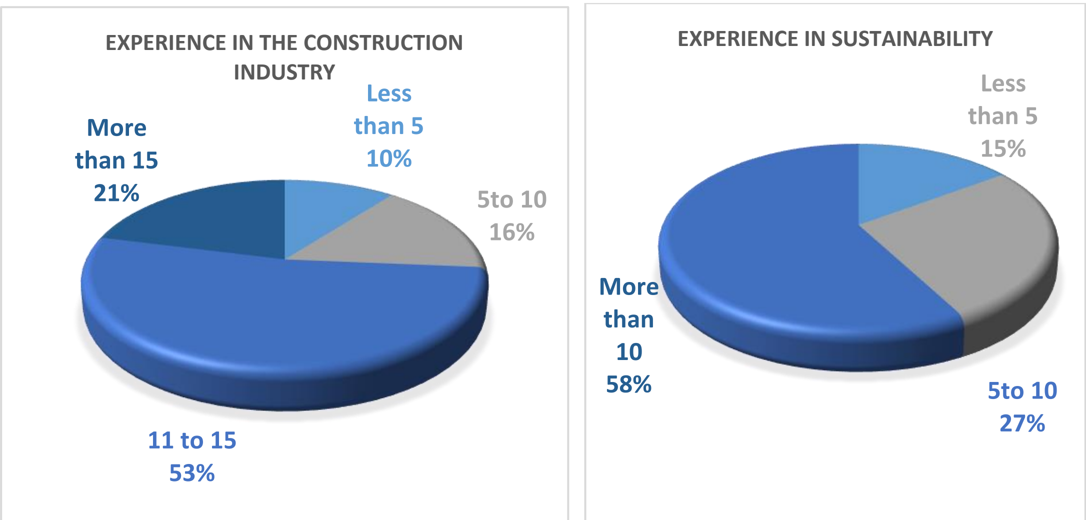


Figure 5.3: Construction and sustainability experience of respondents

Most of the respondents have a long experience in construction industry as almost 75% have over 10 years of experience. More than 58% of the respondents have more than 10 years of experience in different sustainability areas and this is supported by their job positions reflected in the previous question. This proves the level of expertise of the sample and their ability to comment on the suitability of sustainability criteria for construction contractors in the UAE. The next two questions aimed to assess the levels of knowledge of green building rating systems and their level of familiarity with corporate sustainability standards and frameworks. For green building rating systems, respondents were asked to rank their level of expertise according to the scale: (5=Accredited with project experience, 4= Accredited with no project experience, 3= Knowledgeable, 2= Aware, 1= Not aware). For corporate sustainability frameworks, rating should be according to the scale (5= Very familiar, 4= Familiar, 3= Somewhat familiar, 2= Aware, 1= Not aware). The results have been analysed using percentages of levels of expertise for system and calculation of the weighted average as per the equation below.

$$\mathrm{AS}_i = \frac{\sum_{j=1}^{5} X_j N_{ij}}{N}$$

AS_i : the average score of the attribute (i)

Xj: the rank given to the attribute (i)

Nij: the number of respondents who gave the attribute (i) the rank Xj

N: the sample size

Results in Table 5.4 show that LEED and Estidama are the most practised rating systems and the number of experts who are accredited with project experience is the highest among other rating systems whilst CASBEE and HQE have the lowest average level of expertise. This finding is logical as these two systems do not have an international outreach and they are not practised in the UAE.

Table 5.4: Levels of expertise in green building rating and corporate sustainability systems

Green Building Rating Systems	Accredited with project experience	Accredited with no project experience	Knowledge-able	Aware	Not aware	Average Score (out of 5)
LEED	68%	4%	28%	0%	0%	4.4
Estidama	63%	6%	20%	11%	0%	4.2
GSAS	28%	0%	36%	32%	5%	3.1
BREEAM	8%	0%	51%	39%	2%	2.7
GREEN STAR	0%	0%	39%	61%	0%	2.4
CASBEE	0%	0%	8%	45%	47%	1.6
HQE	0%	0%	4%	43%	53%	1.5
Corporate Sustainability System	**Very familiar**	**Familiar**	**Somewhat familiar**	**Aware**	**Not aware**	**Average Score (out of 5)**
GRI	19%	8%	23%	23%	27%	2.7
ISO 26000	8%	26%	4%	34%	31%	2.5
SPI	0%	15%	0%	19%	66%	2.1
B Corp	0%	8%	4%	27%	62%	1.7
ABC Green Contractor	4%	8%	19%	31%	39%	1.6

For corporate sustainability and in confirmation with literature review, GRI has the highest level of popularity and experience among respondents compared to other corporate sustainability frameworks. Familiarity with ISO 26000 was average with more than third of the respondents having a certain level of knowledge about this standard. The lowest levels of awareness are shown for B Corp and ABC Green Contractor. This is in line with the literature review findings regarding the limited geographical coverage of these systems as they are mainly popular and implemented in the US.

The difference in levels of expertise between green building rating systems and corporate sustainability systems is in line with literature review findings about corporate sustainability awareness in the construction industry (Myers, 2005). In general, it can be inferred from the findings above that the survey sample shows a very good level of variety and expertise and it is suitable for second level of expert judgment.

5.3.4 Kendall's W analysis

In order to justify the use of average ratings given by respondents to items under each category, it is important to assess the level of agreement among the group of experts using Kendall coefficient of concordance (W). Each set of questions for the five categories were subjected to a calculation Kendall's W test value using SPSS. The coefficient has a range from 0 to 1; meaning if (W) is close to 0, no agreements among the respondents is indicated and when (w) is close to 1, a strong agreement among the sample members is indicated.

Table 5.5: Kendall's W for evaluation categories

Category	**Num. of items**	**W**	χ^2	**p**
Policy and governance	14	0.56	72.86	< .001
Corporate workplace facilities and operation	10	0.31	57. 47	< .001
Management of employees	15	0.27	24.32	< .001
Procurement and supply chain	9	0.55	69.9	< .001
Project delivery	15	0.75	29.27	< .001

Kendall's W values ranged from .27 among the management of employees questions, which indicated very low agreement, to .755 among the project delivery questions, which indicated high agreement. For each of these sets of items, the chi square value calculated from the test was lower than the critical value of .05, indicating that the null hypothesis, that there is no agreement among the set of items, could be rejected. However, it is worth noting that chi square statistics are highly influenced by sample size, and the sample of 82 may have influenced the resulting chi square statistic toward a significant value. Based on these results, each category was found to have statistically supported concordance, though the level of agreement among the respondents was fairly medium in general. It can be concluded from the results, there is medium to high medium consensus across all categories. The highest Kendall's W value is 0.75. These results support the fact that different sustainability experts have different understanding and importance given to sustainability criteria. The diversity in type of organisations and expertise in corporate sustainability support this concordance test results. Unsurprisingly, the category that has the highest Kendall' W value is project delivery. This in fact reinforces the trend in the industry towards limiting the role of contractors to contract execution and project delivery. Despite some medium levels of agreement among experts, the Kendal's and chi-square test for the five categories prove that the collected data is valid for evaluation and validation of the criteria.

5.3.5 Relative Index Analysis

To identify the top criteria that should be used in each component of the survey, a panel of experts were tasked with indicating a level of importance for each item that would eventually compose the scale. Though this was less important that consistency among the items in each scale, it aided the researcher in making decisions when one or more items of a scale came into question. This was especially important during exploratory factor analysis, where some items required removal due to insufficient loading onto either subscale of a construct. Knowledge of which items were the least dispensable allowed these decisions to be made with consideration for each item's importance.

To test the top criteria for each construct in the survey, a series of relative index analyses were performed. These analyses use data from a panel of experts who have identified importance levels among a series of items, and places them in a ranked order. These rankings are based on the number of rankings in each level of an item's Likert scale, multiplied by the weight of that level of the Likert scale. Thus, this procedure takes into account the number of participants who feel an item is important to its scale as well as the weight they attribute to the item. The relative index also accounts for the number of possible categories in the scale, while the raw average index does not. According to Chinyio (2013), the relative index is typically ordered in level of importance based on the following criteria: 0.8≤RI≤1 (High); 0.6≤RI<0.8 (High–Medium); 0.4≤RI<0.6 (Medium); 0.2≤RI<0.4 (Medium–Low); and 0≤RI<0.2 (Low). The higher the value of RI, more important was the sustainable criteria and vice versa. Relative index was used as a descriptor to assist in decision making about elimination of some items in the next stage of the analysis. At this stage, a cut-off value of 0.4 was used and identified those criteria as at least medium importance.

The first category of items composed the policy and governance scale. None of the items were of low- medium or medium importance. Table 5.6 provides detail for each item's importance from the policy and governance scale.

Table 5.6: Policy and Governance Criteria Ranked

Code	Item	Average index	Relative index	Rank	Importance level
PG9	Availability of Corporate Sustainability Department	4.6	0.92	1	High
PG4	Company policy includes a statement of environmental stewardship	4.2	0.84	2	High
PG3	Company policy includes a statement of social responsibility	4.17	0.83	3	High
PG8	Compliance with sustainability laws and regulations	4.01	0.81	4	High
PG1	ISO 14001 certification (environmental management)	4.0	0.8	5	High
PG13	Sustainability memberships (local or international)	3.94	0.79	6	High–Medium
PG7	SA 8000 certification (social accountability in the workplace)	3.76	0.75	7	High–Medium
PG2	ISO 26000 certification (social responsibility)	3.68	0.74	8	High–Medium
PG10	ISO 26000 (social responsibility)	3.68	0.74	9	High–Medium
PG5	Availability of carbon emission tracking system	3.35	0.67	10	High–Medium
PG6	Community support programs	3.34	0.67	11	High–Medium
PG12	Annual public sustainability report	3.07	0.61	12	High–Medium
PG11	Annual public financial report	2.84	0.57	13	Medium
PG14	Community representatives in the Board of Directors	1.57	0.31	14	Low

'Annual public financial report' item has a medium importance and this low rating compared to other items may be due to the perception of financial report as irrelevant to sustainability performance. This contradicts with the literature review (Lee and

Farzipoor Saen, 2012) and (Giz, 2012) that shows a strong correlation between financial reporting and transparency, and sustainability performance and that financial reports can give evidence of sustainability accounting in organisations. Item 14 related to representation of community in the board of directors received a low ranking that is below the cut-off value. This low level of importance has also been expressed by interviewees as they have recommended to be eliminated, PG14 is therefore removed from the list.

The second category of items composed the corporate workplace facilities scale. None of the items were of low importance, and the majority of items were above 0.5 which means they are at least of high medium importance. The only exception was item 10 and 2, which were just below the high medium ranking, falling into the medium importance category.

Table 5.7: Corporate Workplace Facilities Criteria Ranked

Code	Item	Average index	Relative index	Rank	Importance level
CW5	Buildings employ energy efficiency strategies	4.07	0.81	1	High
CW1	Availability of waste management scheme	3.96	0.79	2	High–Medium
CW7	Buildings employ water efficiency strategies	3.93	0.79	3	High–Medium
CW4	Availability of energy and water monitoring system	3.89	0.78	4	High–Medium
CW8	Buildings employ indoor environmental quality strategies	385	0.77	5	High–Medium
CW3	Energy efficient office equipment	3.75	0.75	6	High–Medium
CW9	Transportation minimisation system	3.30	0.66	7	High–Medium
CW6	Buildings use renewable energy	3.20	0.64	8	High–Medium
CW10	Environment friendly transportation system	2.95	0.59	9	Medium
CW2	Availability of carbon emission tracking system	2.85	0.57	10	Medium

Unsurprisingly, the criteria that have the highest ranking are items covering green building requirements including energy efficiency, water efficiency indoor environmental quality and waste management but they all are above the cut-off value and therefore all items in this scale will be retained. Table 5.7 provides detail for each item's importance from the corporate workplace facilities scale.

The third category of items composed the management of employees scale. Items in this category have received lower levels of rating than the previous categories. Table 5.8 provides detail for each item's importance from the management of employees scale.

Table 5.8: Management of Employees Criteria Ranked

Code	Item	Average index	Relative index	Rank	Importance level
ME13	Compliance with labour camp regulations	3.95	0.79	1	High–Medium
ME1	Sustainability training of employees	3.9	0.78	2	High–Medium
ME10	Employee sustainability feedback system	3.88	0.78	3	High–Medium
ME2	Employee active life / wellbeing programs	3.88	0.78	4	High–Medium
ME7	Employee incident/ accident reporting system	3.85	0.77	5	High–Medium
ME8	Application of innovative ideas generated by employees	3.05	0.70	6	High–Medium
ME11	Employee Sustainability Initiative Award program	3.10	0.62	7	High–Medium
ME3	Non-discrimination policy	2.54	0.51	8	Medium
ME9	Effectiveness of Personnel Recruitment and Selection procedure	2.48	0.50	9	Medium
ME5	Employee complaints reporting system	2.48	0.50	10	Medium
ME4	Employee retention strategy (at corporate level)	2.46	0.49	11	Medium
ME6	Anti- harassment and violence policy	2.41	0.48	12	Medium
ME12	Human rights policy and procedures	2.09	0.42	13	Medium
ME14	Effectiveness of discipline management	1.85	0.37	14	Low
ME15	Effectiveness of compensation procedure	1.23	0.25	15	Low

None of the items were of high importance except item ME13 which has a score tangent to high importance. In general, employee focused programs and criteria had higher ranking than policies and procedures related criteria. This can be explained by the perception that social responsibility is of voluntary nature and should not be based on strict policies. Item ME14 “effectiveness of discipline management” will be eliminated from the list of items as it received a rating below the cut-off value, and this confirms the same explanation above regarding tendency towards voluntary programs rather than discipline and employee compliance procedures.

The fourth category of items composed the procurement and supply chain scale. All the items were of high or high-medium importance. Table 5.9 provides detail for each item’s importance from this scale. None of the items were ranked just below the cut-off which leads us to the retention of all items for factor analysis. This high ranking reflects the focus of sustainability experts in the industry on project level/tactical related criteria that are related to supply chain and procurement.

Table 5.9: Procurement and Supply Chain Criteria Ranked

Code	Item	Average index	Relative index	Rank	Importance level
PSC1	Supplier selection based on sustainability practices	4.23	0.85	1	High
PSC5	Subcontractors selection based on sustainability practices	4.21	0.84	2	High
PSC2	Sustainability collaboration with supply chain	4.16	0.83	3	High
PSC3	Sustainability monitoring of supply chain	4.11	0.82	4	High
PSC6	Sustainability training of supply chain	3.98	0.8	5	High
PSC4	Availability of a formal sustainability evaluation scheme of suppliers and subcontractors	3.96	0.79	6	High–Medium
PSC8	Responsible sourcing strategy	3.74	0.75	7	High–Medium
PSC9	Reverse logistics policy and procedures	3.71	0.74	8	High–Medium
PSC7	Optimisation plan of total supply chain cost management	3.26	0.65	9	High–Medium

The fifth and final category of items composed the project delivery factors scale. Table 5.10 provides detail for each item’s importance from this scale. The rating of items in this category shows a high importance given to site activities related criteria and lower importance given to innovation related items. This can be explained by the fact that construction industry is not R&D and innovation focused. Items 12, 14 and 15 received a low rating from respondents that is below the cut-off value and are eliminated from the list because their elimination has been recommended earlier by interviewees.

Table 5.10: Project Delivery Criteria Ranked

Code	Item	Average index	Relative index	Rank	Importance level
PD1	Sustainability manager / engineer appointed on site	4.65	0.93	1	High
PD3	Use of waste estimation and recording tool	4.62	0.92	2	High
PD2	Material saving and waste abatement plan	4.35	0.87	3	High
PD9	Investment in green construction methods R&D	4.26	0.85	4	High
PD8	Site Water saving plan	4.05	0.81	6	High
PD7	Site Energy saving plan	3.77	0.75	7	High–Medium
PD10	Site Noise control plan	3.59	0.72	8	High–Medium
PD11	Site Air pollution control plan	3.45	0.69	9	High–Medium
PD4	Use of carbon tracking tool	2.89	0.58	10	Medium
PD5	Use of life cycle costing tool	2.67	0.53	11	Medium
PD13	Environmental Management System	1.98	0.4	12	Medium
PD12	Successful delivery of projects certified by a sustainability accreditation body	1.9	0.38	13	Medium–Low
PD14	Investment in green products R&D	1.76	0.35	14	Medium–Low
PD15	Innovative sustainability delivery beyond requirement	1.38	0.28	15	Medium–Low

5.4 Updated list of criteria

Following the expert judgement discussed in this chapter, the list of evaluation criteria was updated after rewording and additions proposed by expert interviews and deletions recommended by interviewees and then further supported through the broader expert survey. Table 5.11 includes the updated list that will be subject to the next stages of the scale development process.

Table 5.11: Updated list of criteria

Sustainability Performance (56 criteria)			
Policy and Governance (13 criteria)		**Management of Employees (13 criteria)**	
PG1	ISO 14001 certification (environmental management)	ME1	Sustainability training of employees
PG2	ISO 26000 (social responsibility)	ME2	Employee active life / wellbeing programs
PG3	Company policy includes a statement of social responsibility	ME3	Non-discrimination policy
PG4	Company policy includes a statement of environmental stewardship	ME4	Employee retention strategy (at corporate level)
PG5	Availability of carbon emission tracking system	ME5	Employee complaints reporting system
PG6	Community support programs	ME6	Anti- harassment and violence policy
PG7	SA 8000 certification (social accountability in the workplace)	ME7	Employee incident/ accident reporting system
PG8	Compliance with sustainability laws and regulations	ME8	Application of innovative ideas generated by employees
PG9	Availability of Corporate Sustainability Department	ME9	Effectiveness of Personnel Recruitment and Selection procedure
PG10	ISO 26000 certification (social responsibility)	ME10	Employee sustainability feedback system
PG11	Annual public financial report	ME11	Employee Sustainability Initiative Award program
PG12	Annual public sustainability report	ME12	Human rights policy and procedures
PG13	Sustainability memberships (local or international)	ME13	Compliance with labour camp regulations
Corporate Workplace Facilities (10 criteria)		**Procurement and Supply Chain (9 criteria)**	
CW1	Availability of waste management scheme	PSC1	Supplier selection based on sustainability practices
CW2	Availability of carbon emission tracking system	PSC2	Sustainability collaboration with supply chain
CW3	Energy efficient office equipment	PSC3	Sustainability monitoring of supply chain
CW4	Availability of energy and water monitoring system	PSC4	Availability of a formal sustainability evaluation scheme of suppliers and subcontractors
CW5	Buildings employ energy efficiency strategies	PSC5	Subcontractors selection based on sustainability practices
CW6	Buildings use renewable energy	PSC6	Sustainability training of supply chain
CW7	Buildings employ water efficiency strategies	PSC7	Optimisation plan of total supply chain cost management
CW8	Buildings employ indoor environmental quality strategies	PSC8	Responsible sourcing strategy
CW9	Transportation minimisation system	PSC9	Reverse logistics policy and procedures
CW10	Environmentally friendly transportation system		
Project Delivery (11 criteria)			
PD1	Sustainability manager / engineer appointed on site		
PD2	Material saving and waste abatement plan		
PD3	Use of waste estimation and recording tool		
PD4	Use of carbon tracking tool		
PD5	Use of life cycle costing tool		
PD7	Site Energy saving plan		
PD8	Site Water saving plan		
PD9	Investment in green construction methods R&D		
PD10	Site Noise control plan		
PD11	Site Air pollution control plan		
PD13	Environmental Management System		

5.5 Summary

This chapter has discussed the development and refinement of the item pool for each sustainability evaluation scale. The most important issue that has been addressed by this chapter was the approach to face and content validation. This study has opted to use the deductive approach where items have been deducted for literature review and existing models in the market. Following the establishment of the initial list of criteria, scale development process requires a validation of the scale content to ensure it measures what is intended to measure. A two-layer content validity method was adopted that involves expert interviews followed by expert survey. The purpose of both methods is to check the accuracy of the model domains and evaluate the relevance of criteria and their wording.

The expert judgements resulted in some alterations of some items wording for clarity and consistency. In addition, one domain 'employees and workplace' has been divided into two domains 'management of employees' and 'corporate workplace facilities. Based on expert interviews. To ensure a robust and valid list of items, this study conducted expert survey analysed through relative index analysis to ensure the items are applicable to contractors and to the UAE construction industry. The content validity of the item pool was testes through 12 interviews with sustainability experts. Interviews resulted in minor modifications to the wording and recommendation to add some items and eliminated others. The recommended items to be added have been included in the expert survey but no items have been eliminated until they are cross checked with the survey results. In the survey, 82 sustainability professionals have responded by providing a ranking of the criteria based on the level of relevance to the related domain. Finally, an updated conceptual model is developed based on the modification resulting from expert judgement. This model will be subject to the next stage of scale development which is factor analysis.

Chapter 6: Model Validation - Factor Analysis

6.1 Introduction

The third stage of the scale development process is focused on model evaluation and validation which involves examination and assessment of validity and reliability of the conceptual model. This chapter covers the steps in this stage for the five subscales and the final overall sustainability evaluation model.

This chapter starts by implementing the approach for exploratory and confirmatory factor analyses explained in chapter 5. The first section of this chapter presents the results and analysis of the main survey through EFA and CFA for the five categories. The second section is focused on examining the proposed overall conceptual model and comparing it against alternative models. The last section summarises and discusses the analysis findings prior to recommending the best model to be adopted for sustainability evaluation of the UAE contractors.

6.2 Demographics and sample analysis

Descriptive statistics aims to analyse the demographic features of the survey sample such as level of education, position, experience, type of contracting company and size of the organisation (Table 6.1). Questionnaire link from smart survey website has been sent to 500 main contractors from the UAE Construction Contractors member list, UAE Index, Yellow Pages and LinkedIn website. From the total of 500 sent to participants for completion, that was including a cover letter explaining the purpose of the study and information about confidentiality and approximate time to complete the survey, only 88 responses have been completed in the first two week. Follow up emails, reminders and support from some developers and clients helped to improve the response rate. Of the 500 questionnaires sent, 228 responses have been received. This represents a response rate of 46%, which is acceptable and within the normal range in construction and sustainability related studies (Akintoye, 2000; Zhu et al. ,2008).

Table 6.1: Sample demographic summary (N= 228)

Description	Freq.	Percentage
Job position		
General Manager/Managing Director	66	28.95%
HSE Director/ Manager	118	51.75%
Sustainability / CSR Manager	44	19.00%
Level of education		
MSc.	78	34.21%
BSc.	122	53.51%
Diploma	28	12.28%
Experience		
Less than 5 Years	18	7.89%
5 to 10 years	84	36.84%
Over 10 years	126	55.26%
Location of the company		
Abu Dhabi	58	25. 44%
Dubai	124	54.39%
Sharjah	24	10.53%
Other Emirates	22	9.64%
Type of organisation		
Local company	134	58.77%
International Company	70	30.70%
Local/International JV	24	10.53%
Company size (No. of FTE)		
Less than 20	6	2.63%
21 -50	30	13.16%
51-100	94	41.23%
Over 100	98	42.98%

From the sample summary in Table 6.1 above, over 80% of respondents have a Bachelor degree and above while only 12% have a diploma level of education. The job position composition follows the requirement specified in the cover letter sent with the survey and all the respondents are from senior management level of their organisations. 29% are corporate executives and managing directors while 52% are in charge of HSE, but only third of this number are sustainability/CSR managers. This is expected as contracting companies are subject to the federal and Emirate health and safety rules, and the majority of medium and large contractors recruit HSE officer or manager (Shibani A, Saidani M and Alhajeri M, 2013) while recruitment of sustainability professionals are not required by law. Only 8% of the respondents have less than five years of experience in the industry, while 55% are at senior level with over 10 years of experience. The breakdown and composition by qualification, experience and job position give evidence of the suitability of the sample for the current study as respondents possess a good level of awareness and knowledge about their company's corporate policies. Over half of the respondents (59%) are from local companies, and expectedly, 75% are located in Dubai and Abu Dhabi, the two largest emirates in the UAE. Three respondents are from small size companies with less than 20 full-time employees, while around 42% are in companies with over 100 FTEs and almost the same percentage of companies employing 51 to 100 employees.

Respondents have not been asked about turnover as it is not information that they would easily have access to. However, it is proved that there is a strong correlation between organizational size and the number of full-time employees in contracting companies (KPMG, 2015). The sample demographics show a good representation in terms of location, size and expertise of respondents. This is important to ensure good quality and reliability of data. The next step after sample adequacy analysis to conduct EFA for the five domains of the model.

6.3 Policy and Governance Scale

6.3.1 Exploratory Factor Analysis

Assessment of the policy and governance construct for evidence of a factor structure began with sample adequacy and assumption testing. To assess sample adequacy, two tests have been used: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test. Using SPSS, these two tests have been conducted, and as it can be seen in Table 6.2, KMO has a significant value of 0.771 and Bartlett's is less than 0.05 which indicates the correlation matrix is not an identity matrix and therefore the sample is adequate for factor analysis.

Table 6.2: Policy and Governance: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.764
Bartlett's Test of Sphericity	**Approx. Chi-Square**	629.921
	df	78
	Sig.	.000

To assess the factorability of the data, Pearson correlations were calculated to determine the inter-correlations for each variable. According to Tabachnick and Fidell (2013), correlation coefficients should exceed .30 in order to justify comprising the data into factors. All variables had at least one correlation coefficient greater than .30 (Table 6.3) and appear suitable for factor analysis. Although variables should be intercorrelated with one another, variables that are too highly correlated can cause problems in EFA.

Multicollinearity was assessed using the Variance Inflation Factor (VIF) and Tolerance tests. Statisticians have proposed that VIF's exceeding ten or Tolerance scores below 0.10 imply extreme multicollinearity (Allison, 1999).

Table 6.3: Policy and Governance: Collinearity test

Model	t	Sig.	Collinearity Statistics		
	B			Tolerance	VIF
Sustainability memberships (local or international)	0.275	2.451	0.016	0.419	2.388
Anti-corruption and business transparency system	0.098	1.136	0.259	0.733	1.364
Company policy includes a statement of social responsibility	0.254	2.049	0.043	0.432	2.314
Annual public sustainability report	-0.057	-0.540	0.591	0.495	2.020
Availability of carbon emission tracking system	-0.078	-0.656	0.513	0.419	2.385
SA 8000 certification (social accountability in the workplace)	0.124	1.388	0.168	0.456	2.192
Community support programs	0.103	0.920	0.360	0.546	1.830
Company policy includes a statement of environmental stewardship	-0.267	-2.590	0.011	0.651	1.537
Annual public financial report	-0.042	-0.411	0.682	0.548	1.824
Compliance with sustainability laws and regulations	-0.055	-0.810	0.420	0.577	1.734
Availability of Corporate Sustainability Department	0.147	1.590	0.115	0.548	1.824
ISO 26000 certification (social responsibility)	0.207	2.160	0.033	0.385	2.599

As shown in Table 6.3, all VIF values for all items are less than 10, and tolerance tests are above 0.10. Therefore, we can conclude that multicollinearity was not detected within the data, and the assumption of collinearity was met.

A core assumption to be tested in factor analysis procedures is normality in the distribution of the data (Tabachnick & Fidell, 2007). Normality assumption is essential for the decision on the factor analysis approach to be adopted. Univariate normality of the data was assessed using two methods: (a) Kolgomorov-Smirnov and (b) the Shapiro-Wilk test (Hair et al., 2010). When using these two tests, probabilities > 0.05 mean the data are normal while probabilities < 0.05 indicate that the data normality is not satisfied. It can be concluded from Table 6.4 below that the normality assumption is violated for all the items.

Table 6.4: Policy and Governance: Normality test

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
ISO 14001 certification (environmental management)	.245	114	.000	.890	114	.000
Sustainability memberships (local or international)	.239	114	.000	.900	114	.000
Anti-corruption and business transparency system	.200	114	.000	.906	114	.000
Company policy includes a statement of social responsibility	.230	114	.000	.875	114	.000
Annual public sustainability report	.274	114	.000	.863	114	.000
Availability of carbon emission tracking system	.220	114	.000	.895	114	.000
SA 8000 certification (social accountability in the workplace)	.199	114	.000	.897	114	.000
Community support programs	.226	114	.000	.854	114	.000
Company policy includes a statement of environmental stewardship	.248	114	.000	.878	114	.000
Annual public financial report	.252	114	.000	.891	114	.000
Compliance with sustainability laws and regulations	.212	114	.000	.883	114	.000
Availability of Corporate Sustainability Department	.234	114	.000	.824	114	.000
ISO 26000 certification (social responsibility)	.178	114	.000	.912	114	.000

Determination of the number of factors is the next step in exploratory factor analysis. As it was explained in section 5.8.2, Parallel Analysis (PA) is the most recommended method for identification of the number of factors**.** The scree plot chart in Figure 6.1 shows the Eigenvalues of the actual data and the Eigenvalues of the simulative data. The number of factors to be considered is where the actual Eigenvalue is smaller than the Eigenvalue for simulative data. In this case. The number of factors proposed by the Eigen method is four factors while the PA method suggests three factors only as the fourth factor has an eigenvalue of simulative data that is greater than the eigenvalue of actual data.

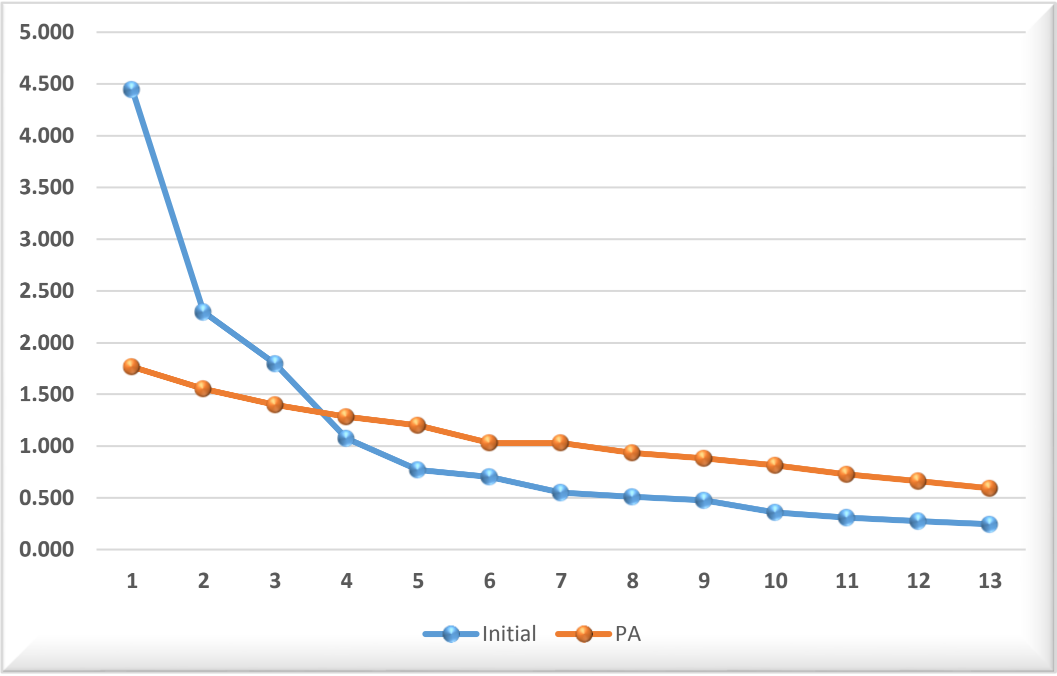


Figure 6.1: Policy and Governance- Scree plot of the actual and simulative data

According to the finding above, EFA was performed in SPSS using the option of restricting the number of factors to three factors rather than four factors suggested by the Kaiser Criterion method. As seen in Table 6.5, the following variables had good loadings for Factor 1: PG13, PG7, PG5, PG6, PG8 and PG9. The following variables had good loadings for Factor 2: PG1, PG2, PG3 and PG4 and PG10, PG11 and PG12 load on factor 3.

Table 6.5: Factor Extraction for Policy and Governance- Pattern Matrix

		Factor loading			Communality
		1	2	3	
PG13	Company policy includes a statement of environmental stewardship	0.641			0.592
PG5	Company policy includes a statement of social responsibility	0.628			0.513
PG6	Anti-corruption and business transparency system	0.579			0.371
PG7	Community support programs	0.550			0.389
PG8	Compliance with sustainability laws and regulations	0.721			0.467
PG9	Availability of Corporate Sustainability Department	0.694			0.674
PG1	ISO 14001 certification (environmental management)		0.696		0.629
PG2	ISO 26000 certification (social responsibility)		0.782		0.472
PG3	SA 8000 certification (social accountability in the workplace)		0.729		0.540
PG4	Sustainability memberships (local or international)		0.795		0.513
PG10	Availability of carbon emission tracking system			0.662	0.438
PG11	Annual public financial report			0.883	0.816
PG12	Annual public sustainability report			0.733	0.535

Note: Factor loadings < .32 are suppressed.

6.3.1.1 Factors labelling

Factor 1 accounted for 29.37% of variance with an eigenvalue of 4.285. Factor 2 accounted for 14.46% of variance with an eigenvalue of 2.260 and Factor 3 accounted for 9.63% with an eigenvalue of 1.73. The three-factor model accounted for 53.46% of total variance in the data. The factor analysis summary is shown in Table 6.6.

Table 6.6: Policy and Governance EFA Summary

Factor	Eigenvalue	% of variance	Cumulative %
Sustainability Strategy and Compliance (SSC)	4.285	29.367	29.367
Sustainability Certification and Membership (SCM)	2.260	14.457	43.824
Sustainability Tracking and Reporting (STR)	1.733	9.632	53.456

Factor 1 is labelled 'Sustainability Strategy and Compliance' (includes five items; accounting for 29.37% of the total variance). The items on this scale include aspects of an underlying strategy that is clearly substantiated in the company policy statements and translated into compliance with sustainability regulation and implementation by a dedicated corporate sustainability department. Factor 2 was labelled 'Sustainability certification and membership' (includes four items; accounting for 14.46% of the total variance). The items loading onto this scale are clustered around the theme of going beyond the self-evaluation and internal strategic goals to cover sustainability third-party certification such as ISO 14001, ISO 26000 and SA8000 in addition to sustainability memberships locally and internationally. Factor 3 is labelled "Sustainability tracking and reporting" (includes three items and accounts for 9.632% of the total variance). The items loading onto this factor are related to carbon tracking, which is very much related to environmental sustainability and financial reporting, which covers economic sustainability aspects and obviously sustainability reporting that is covering all sustainability dimension. This subscale of policy and governance shows clearly that factors leading to performance under this category range from company driven performance such as policies, strategies, compliance and community involvement to stakeholder-driven performance covering certifications and reporting.

6.3.1.2 Cronbach's alpha reliability test

To test the internal consistency of the three factors defined in the policy and governance set of items, a series of Cronbach's alpha tests were conducted. Stemming from the results of the EFA, Factor 1 consisted of the 6 items loaded most strongly onto this factor, including PG 13, 5, 6, 7, 8, and 9. Factor 2 consisted of PG 1, 2, 3, and 4 and the remaining items PG 10, 11, 12 loaded onto Factor 3. These items composed the three subscales of policy and governance and were ready for validation through confirmatory factor analysis.

Table 6.7: Reliability Test for Policy and governance factors

Factor	No. of Items	α
Sustainability Strategy and Compliance (SSC)	6	0.823
Sustainability Certification and Membership (SCM)	4	0.846
Sustainability Tracking and Reporting (STR)	3	0.798

6.3.2 *Confirmatory Factor Analysis*

The PG construct was tested for support of the factor model suggested through the EFA findings. Considering the violation of data normality assumption, Confirmatory Factor Analysis was conducted using Unweighted Least Square (ULS) extraction method. The chi-square test shows a good fit (χ^2/df = 1.21 p < .001). As further evidence, the baseline comparisons, seen in Table 6.8, all indicated that the three-factor model of policy and governance had a good fit, with a GFI of .971, RMR of 0.075 and PNFI of 0.761. These results indicate that the three factors were a reasonable explanation of trends in the data, which indicated that items 3, 4, 1, and 2 were likely to represent latent factor 1, while items 13, 5, 6, 7, 8, and 9 load on factor 2 and items 10, 11 and 12 consistently represented the third latent construct.

Table 6.8: Baseline Comparisons for CFA of Policy and Governance

Model	NFI (> 0.90)	AGFI (> 0.9)	GFI (>0.9)	RMR (<0.08)	PNFI (>0.5)
Default model	0.957	0.956	0.971	0.075	0.761
Saturated model	1.000	-	1.000	.000	.000
Independence model	.000	.000	.319	.512	.000

Furthermore, Figure 6.2 below includes the standardized coefficients from the CFA model, indicating that though the three constructs were correlated, each consisted of items that loaded strongly onto their corresponding factors.

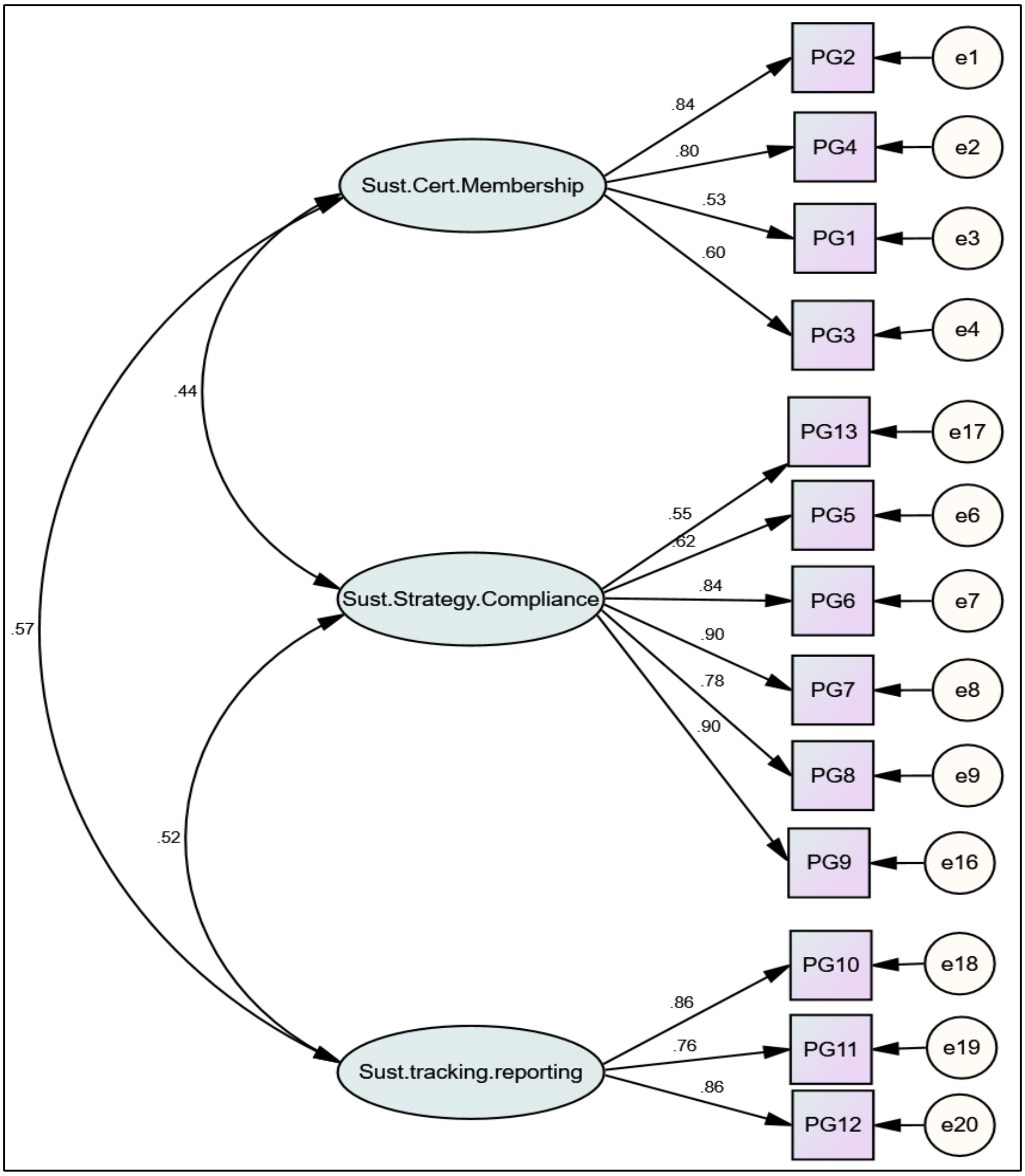


Figure 6.2: Policy and Governance- First Order CFA

In a next step, AMOS was used to test a second-order model (Figure 6.3) specifically to check whether the results of EFA are confirmed by CFA and whether the three detected factors (Sustainability Strategy and Compliance, Sustainability Certification and Membership; and Sustainability Tracking and Reporting) load onto the second-order factor "Policy and Governance". All factor loadings are significant ($p < 0.001$) and indicate strong factor loadings. The results indicate that the three identified factors are relevant to explain the second-order factor measuring performance in policy and governance.

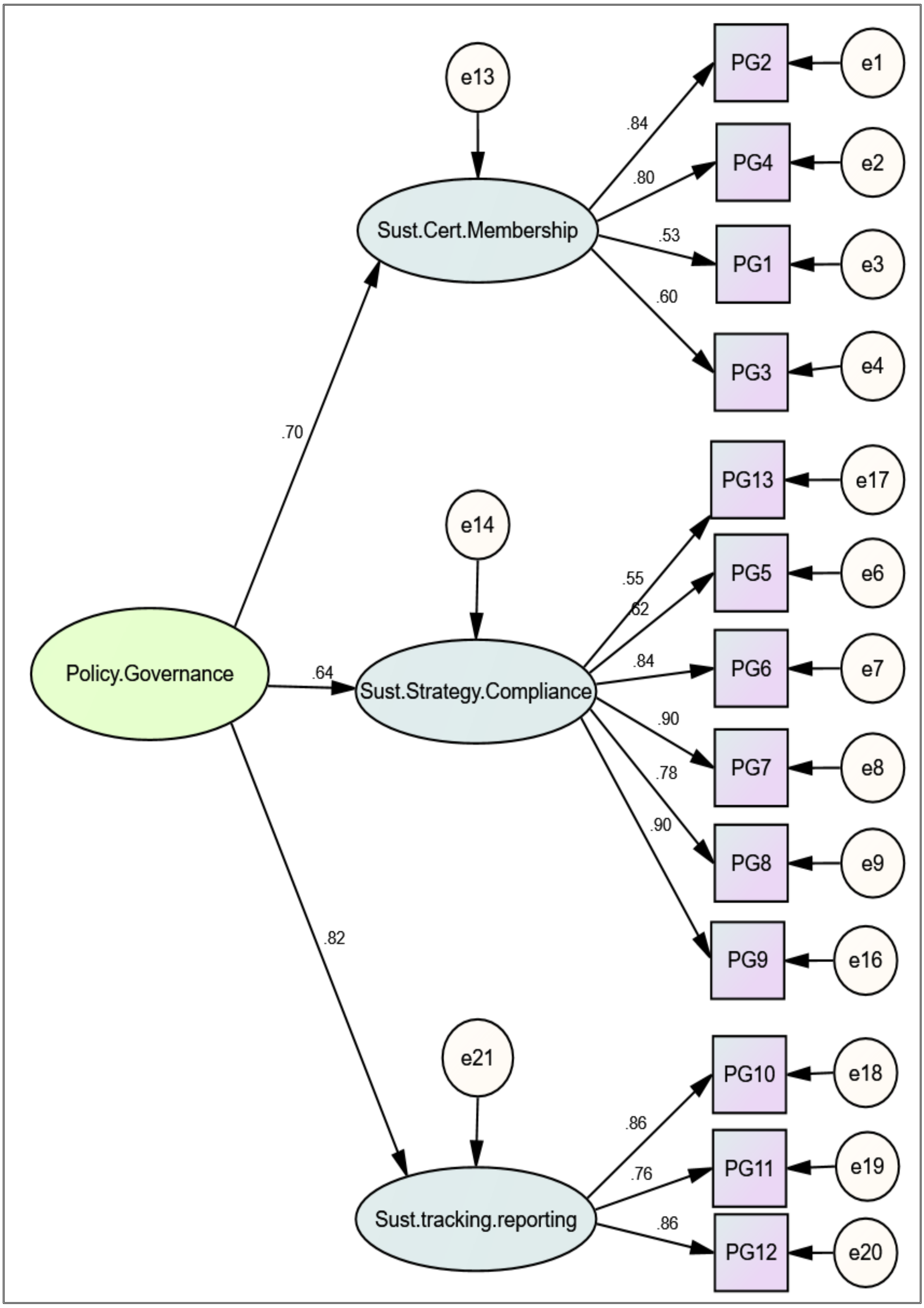


Figure 6.3: Policy and Governance- First Order CFA

The next step in confirmatory factor analysis is to assess the bi-factor model for policy and governance scale. The path diagram used for the bi-factor model with analysis results is presented in Figure 6.4.

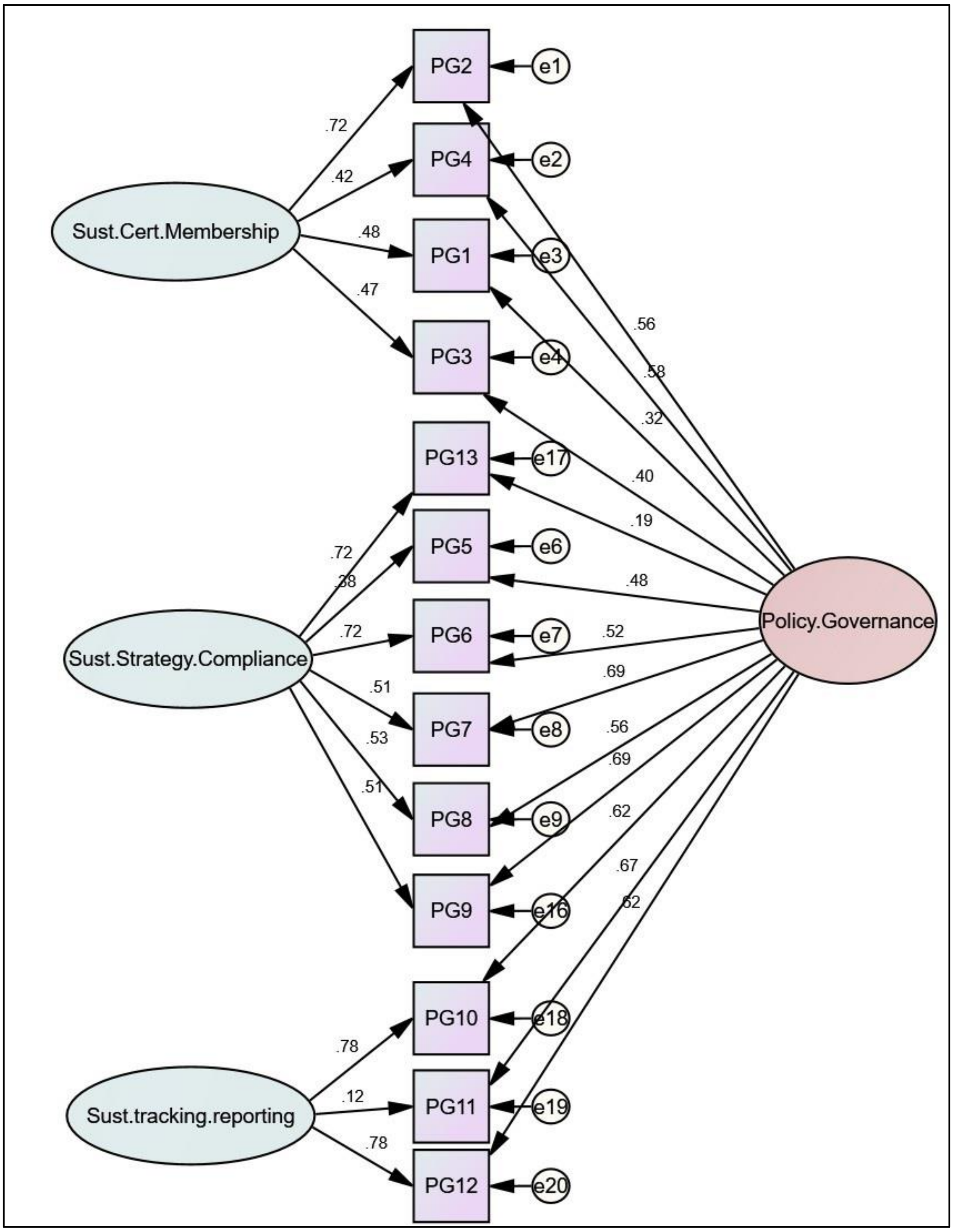


Figure 6.4: Policy and Governance- Bifactor CFA

Following the analysis of the three competing models, a comparison based on their goodness of fitness indices is conducted and summarised in Table 6.9. While Chi-square is not recognised as a reliable index for ordinal data and when ULS is used as an estimation method, Chi-square difference is considered as a reliable comparison index to decide on the best model among different nested alternatives. The chi-square difference between the second-order model and bifactor model is statistically significant at p <0.01 for the difference of df that is equal to 10. This proves that the bi-factor is providing a significant reduction in the chi-square and therefore provides better parsimonious fit of the data.

Table 6.9: Comparative table for Policy and Governance CFA models

Model	**x^2/df**	**AGFI (>0.9)**	**GFI (>0.9)**	**RMR (<0.08)**	**PGFI (>0.5)**
First order model	74.75/62 =1.21	0.957	.971	.085	.661
Second order model	74.75/62 =1.21	0.957	.971	.085	.661
Bi-factor model	47.6/52 = 0.92	0.968	.981	.068	.648

The bi-factor model implies that overall corporate sustainability performance is a general construct that can be measured directly and at the same time can be defined by three dimensions: Sustainability Strategy and Compliance (SSC), Sustainability Certification and Membership (SCM), and Sustainability Tracking and Reporting (STR). The bifactor model can account for both the general Policy and Governance (PG) construct and the three narrower sub-scales using the specific factors. "When multidimensional data are fit to a bifactor model, it is critical for researchers to examine the strength of the resulting general and group factors". The calculations of ancillary bifactor model indices are presented in Table 6.10 below.

Table 6.10: Evaluation indices of Policy and Governance Bi-factor model

	PUC	**ECV**	**ω/ ωS**	**ωH/ ωHS**	**Relative ω**	**H**	**Dimensionality test**
PG (General Factor)	**0.792**	0.474	0.934	0.672	0.719	0.864	PUC < 0.8 ECV < 0.7 Model is multidimensional
SSM		0.138	0.801	0.548	0.559	0.752	
SSC		0.240	0.906	0.588	0.538	0.776	
STR		0.148	0.923	0.501	0.434	0.759	

Reliability test

The reliability factor ω refers to the reliability of scores due to multiple constructs and ωh refers to the reliability of scores due to a single construct. McDonald's ωh (1999) provides a better estimate for the composite score and thus should be used" (p. 228). Reise, Bonifay, and Haviland (2013) suggested that ωh values of .75 or higher would be preferred but values of .50 might be useful in determining whether a composite score provides unique, reliable variance. The Calculation of ω, ωs, ωh and ωhs shows that the variance attributed to the general factor PG is greater than the variance due to group factors SSM, SSC and STR. ωh = 0.672 and ωhs = 0.548; 0.588; 0.501 for SSM, SSC and STR respectively. All these values > 0.5 indicating that all factors (general and subscale) are reliable.

Dimensionality test

Reise et al. (2013) suggest that an instrument can be considered unidimensional if PUC >.80 , and if PUC < .80, then ECV must be > .60 and ωh must be > .70. Quinn (2014) suggests that when ECV of the general factor < 0.7, the model is multidimensional and subscores may have value. Calculation of ECV value for PG general factor gives a value of ECV= 0.474 < 0.70, PUC = 0.792 < 0.8 and ωh = 0.672 < 0.70. According to Quinn (2014) and Reise et al. (2013), these values suggest that the PG scale is multidimentional and that both total score and subscale scores have value and should be considered in reporting sustainability performance under this category.

Replicability test

To estimate the reliability of the underlying factor itself, Hancock and Mueller (2001) advocated use of an index of construct replicability, called H that represents "the proportion of variability in the construct explained by its own indicator variables" (p. 202). Hancock and Mueller (2001) state that to ensure replicability of the construct, we need to meet a standard criterion of H > .70, and by this standard, the general factor is represented. For the policy and governance scale, H = 0.864; 0.752; 0.776; 0.759 for PG, SSM, SSC and STR respectively. All these values are > 0.7 which suggests well-defined latent factors that are more likely to be stable across studies.

6.4 Corporate Workplace Scale

6.4.1 Exploratory Factor Analysis

Following the same process used for Policy and Governance scale, assessment of the Corporate Workplace construct for evidence of a factor structure began with sample adequacy and assumption testing. To assess sample adequacy, two tests have been used: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test. For the ten items related to corporate workplace, KMO has a significant value of 0.806 and Bartlett's test of Sphericity shows a value that is less than 0.05 (which indicates the correlation matrix is not an identity matrix and therefore the sample is adequate for factor analysis.

Table 6.11: Corporate Workplace Facilities: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.806
Bartlett's Test of Sphericity	Approx. Chi-Square	629.921
	df	78
	Sig.	.000

To assess the factorability of the data, Pearson correlations were calculated to determine the intercorrelations for each variable. According to Tabachnick and Fidell (2013), correlation coefficients should exceed .30 in order to justify comprising the data into factors. All variables had at least one correlation coefficient greater than .30 and appear suitable for factor analysis.

Although variables should be intercorrelated with one another, variables that are too highly correlated can cause problems in EFA. Multicollinearity was assessed using Variance Inflation Factor (VIF) and Tolerance tests. Statisticians have proposed that VIF's exceeding ten or Tolerance scores below 0.10 imply extreme multicollinearity (Allison, 1999).

Table 6.12: Corporate Workplace: Collinearity test

Item		t	B	Collinearity Statistics		
				Sig.	Tolerance	VIF
CW5	Buildings employ energy efficiency strategies	0.723	1.817	0.072	0.432	2.32
CW6	Buildings use renewable energy	0.275	2.451	0.016	0.419	2.388
CW7	Buildings employ water efficiency strategies	0.098	1.136	0.259	0.733	1.364
CW8	Buildings employ indoor environmental quality strategies	0.254	2.049	0.043	0.432	2.314
CW1	Availability of waste management scheme	-0.057	-0.540	0.591	0.495	2.020
CW2	Availability of green cleaning scheme	-0.078	-0.656	0.513	0.419	2.385
CW3	Energy efficient office equipment	0.124	1.388	0.168	0.456	2.192
CW4	Availability of energy and water monitoring system	0.103	0.920	0.360	0.546	1.830
CW9	Transportation minimisation system	-0.267	-2.590	0.011	0.651	1.537
CW10	Environment friendly transportation system	-0.042	-0.411	0.682	0.548	1.824

As shown in Table 6.13, all VIF values were less than 10 and tolerance tests are above 0.10. Therefore, we can conclude that multicollinearity was not detected within the data and the assumption of collinearity was met. A core assumption of factor analysis procedures is normality in the distribution of the data (Tabachnick & Fidell, 2007). Normality assumption is important for the decision on factor analysis approach to be adopted. Univariate normality of the data was assessed using two methods: (a) Kolgomorov-Smirnov and (b) the Shapiro-Wilk test (Hair et al., 2010). When using these two tests, probabilities > 0.05 mean the data are normal while probabilities < 0.05 mean the data normality is not satisfied. It can be concluded from Table 6.13 below that the normality assumption is violated for all the items.

Table 6.13: Corporate Workplace - Normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Buildings employ energy efficiency strategies	.245	114	.000	.890	114	.000
Buildings use renewable energy	.239	114	.000	.900	114	.000
Buildings employ water efficiency strategies	.200	114	.000	.906	114	.000
Buildings employ indoor environmental quality strategies	.230	114	.000	.875	114	.000
Availability of waste management scheme	.274	114	.000	.863	114	.000
Availability of green cleaning scheme	.220	114	.000	.895	114	.000
Energy efficient office equipment	.199	114	.000	.897	114	.000
Availability of energy and water monitoring system	.226	114	.000	.854	114	.000
Transportation minimisation system	.248	114	.000	.878	114	.000
Environmental friendly transportation system	.252	114	.000	.891	114	.000

Determination of the number of factors is the next step in exploratory factor analysis. As it was explained in section 5.8.2, Parallel Analysis (PA) is the most recommended method for identification of the number of factors.

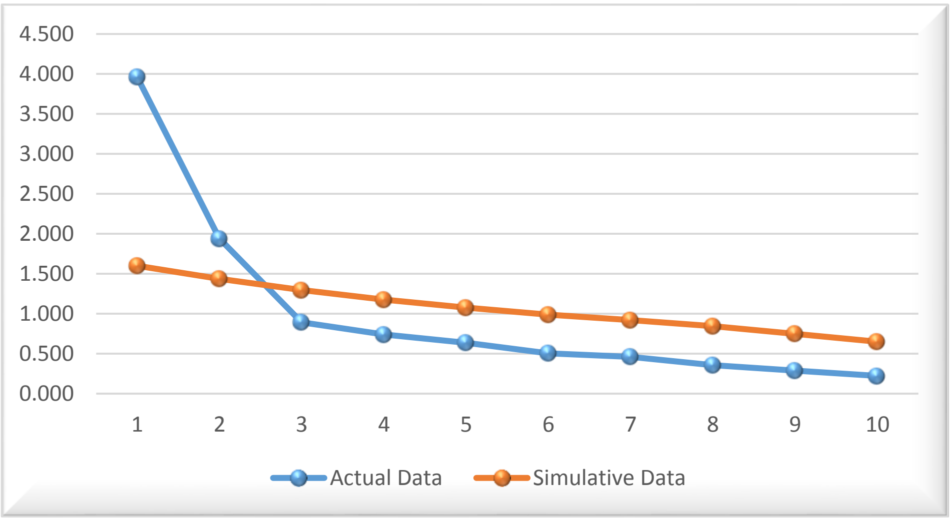


Figure 6.5: Corporate Workplace Facilities- Parallel Analysis Scree Plot

The scree plot chart in Figure 6.5 shows the Eigen values of the actual data and the Eigen values of the simulative data. The number of factors to be considered is where the actual Eigenvalue is smaller than the Eigenvalue for simulative data. In this case. The number of factors proposed by the Eigen method is three factors while PA method suggests only two factors only as the third factor has an eigenvalue of simulative data that is greater than the eigenvalue of actual data. According to the findings above, EFA was performed in SPSS using the option of restricting the number of factors to two factors rather than three factors suggested by the Kaiser Criterion method. As seen in Table 6.14, the following variables had very good loadings for Factor 1: CW1; CW2; CW3; CW4 and CW9 and CW10. The following variables had good loadings for Factor 2: CW5, CW6, CW7 and CW8. However, CW7 has a communality value that is less than 0.30 so it is suppressed from the list of items. CW7 is about use of renewable energy in corporate facilities and it had also a low relative index of 0.39 from the experts' survey. Therefore, removing this item is also supported by experts' opinions. Any loadings that are insignificant (<.32) have been suppressed from the table.

Table 6.14: Factor Extraction for Corporate Workplace Facilities

Variable		**Factor loading**		**Communality**
		1	**2**	
CW1	Availability of waste management scheme	0.640		0.344
CW2	Availability of green cleaning scheme	0.823		0.699
CW3	Energy efficient office equipment	0.753		0.569
CW4	Availability of energy and water monitoring system	0.860		0.459
CW5	Buildings employ energy efficiency strategies		0.622	0.431
CW6	Buildings employ water efficiency strategies		0.805	0.701
CW7	Buildings use renewable energy		0.539	0.283
CW8	Buildings employ indoor environmental quality strategies		0.585	0.714
CW9	Transportation minimisation system	0.598		0.354
CW10	Environmental friendly transportation system	0.573		0.408

Note: Factor loadings < .32 are suppressed.

Factors labelling

Conducting Dimension reduction in SPSS Factor 1 accounted for 35% of variance with an eigenvalue of 3.96. Factor 2 accounted for 14.62 % of variance with an eigenvalue of 1.94. The two-factor model accounted for 35% of total variance in the data. The factor analysis summary is shown in Table 6.15.

Table 6.15: Corporate Workplace Facilities EFA summary

Factor	**Eigenvalue**	**% of variance**	**Cumulative %**
Sustainable Operations	3.959	35.00	35.00
Sustainable Facilities	1.941	14.62	49.62

Factor1 is labelled 'Sustainable Operations' and it includes six items; accounting for 35% of the total variance. The items on this scale include aspects related to energy, waste and water monitoring. This is in addition to cleaning procedures and transportation policies. Sustainable operations is considered an important domain of corporate sustainability in any company and as explained in literature review, workplace facilities cannot be considered sustainable by just complying with sustainable building requirements but operational procedures have a long lasting effect on reducing environmental and social impact of businesses. Factor 2 is labelled "Sustainable Facilities" and includes three items that represent sustainable building requirements namely water efficiency, energy efficiency and indoor environment quality.

Cronbach's alpha reliability test

To test the internal consistency of the two factors defined in the corporate workplace facilities set of items, a series of Cronbach's alpha tests were conducted. The calculation demonstrated excellent overall internal consistency (α = .81) for factor 1 and with strong coefficient alpha (α = .85) for factor 2. Stemming from the results of the EFA, Factor 1 consisted of the 6 items loaded most strongly onto this factor, including CW 1, 2, 3, 4, and 10. Factor 2 consisted of CW 5, 6, 8, 9 and 10. Item 7 was excluded as it had a very low communality value. As with the PG items, these factors were labelled based on the numbering of the CW items on the scale. These items composed the two subscales of corporate workplace facilities and were ready for validation through confirmatory factor analysis.

Table 6.16: Reliability Test for Corporate Workplace Facilities factors

Scale	No. of Items	α
Sustainable Operations	6	0.81
Sustainable Facilities	3	0.85

6.4.2 Confirmatory Factor Analysis

Next, the corporate workplace domain was tested for support of the two-factor model suggested through EFA. Upon first assessment, fit statistics were ideal, and no modifications were necessary. The chi-square test was not significant, suggesting that even with the influence of sample size, the test did not detect a poor fit (χ^2/df = 0.67). Further supporting validity of the two factor model, the baseline comparisons, seen in Table 6.17, all indicated that the two factor model of corporate workplace had a good fit, with a GFI of .982, RMR of 0.59, and an excellent PNFI of 0.696. These results indicate that the two factors were a reasonable explanation of trends in the data, which indicated that items 1, 2, 3, 4, 9 and 10 were likely to represent the same latent construct, while items 5, 6, and 8 consistently represented a second latent construct.

Table 6.17: Baseline Comparisons for CFA of Corporate Workplace Facilities

Model	NFI (> 0.90)	AGFI (> 0.9)	GFI (>0.9)	RMR (<0.08)	PNFI (>0.5)
Default model	.965	.951	.982	.059	0.696
Saturated model	1.000		1.000	.000	.000
Independence model	.000	.000	. 494	.315	.000

Figure 6.6 below includes the standardized coefficients from the CFA model, indicating that though the two constructs were correlated, each consisted of items that loaded strongly onto their corresponding factors. Factor 1 was labelled Sustainable Facilities, while Factor 2 was labelled Sustainable Operations.

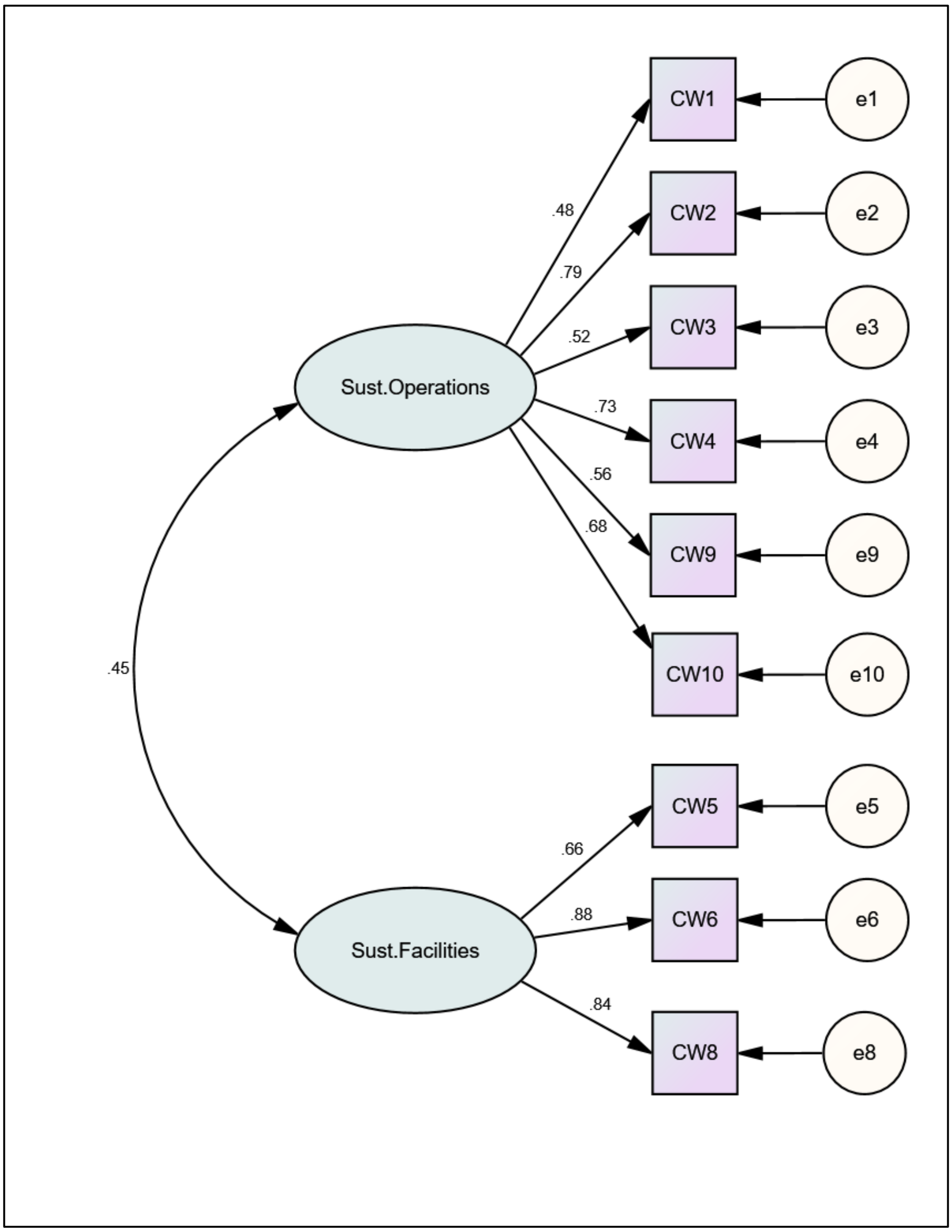


Figure 6.6: Corporate Workplace- First Order CFA

In a next step, AMOS was used to test a second order model (Figure 6.7) specifically to check whether the results of EFA are confirmed by CFA and whether the two detected factors (Sustainability Operations and Sustainable Facilities) load onto the second order factor "Corporate Workplace". All factor loadings are significant ($p < 0.001$) and indicate strong factor loadings. The results indicate that the two identified first order factors are relevant to explain the overall measure of sustainable corporate workplace.

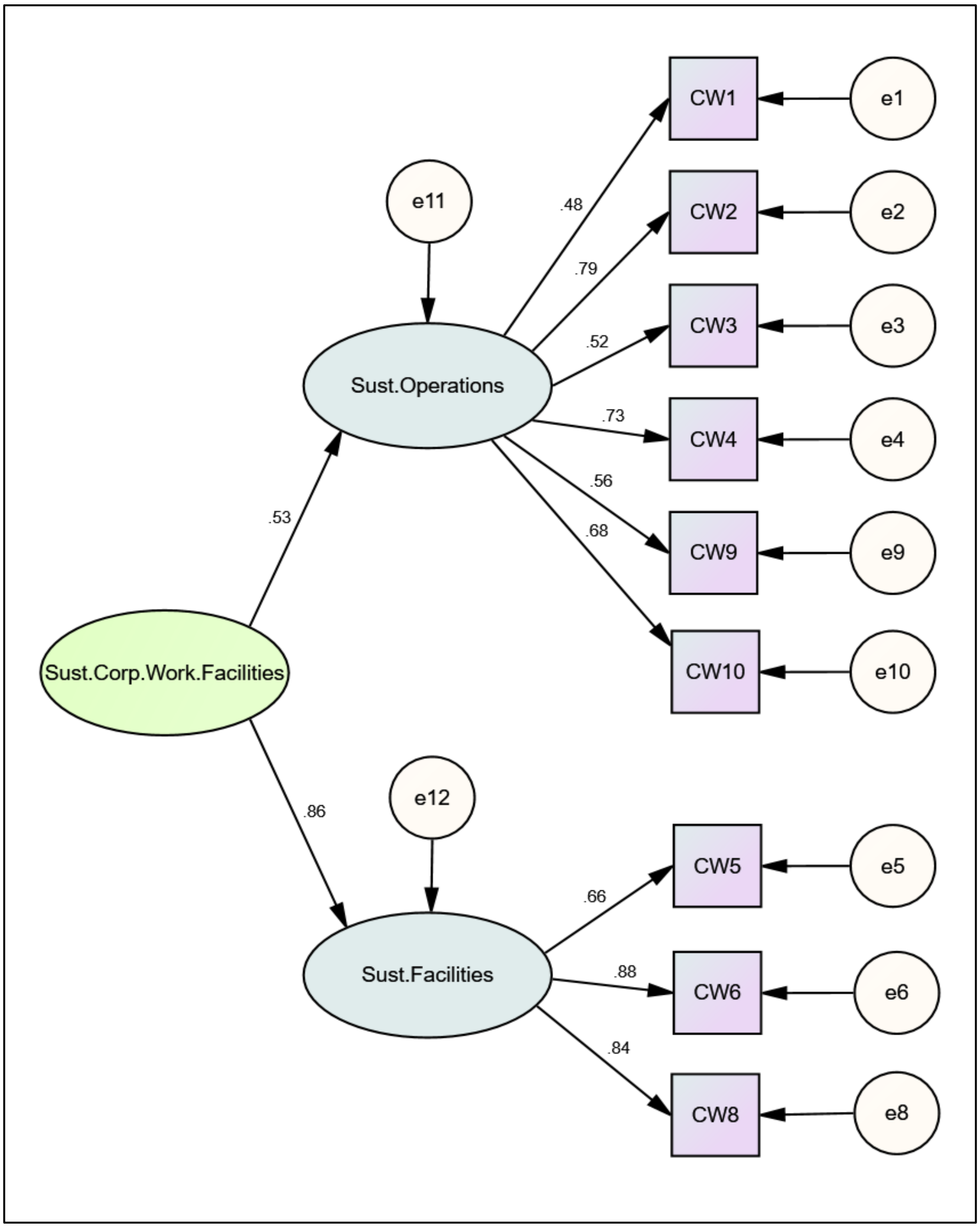


Figure 6.7: Corporate Workplace - Second Order CFA

The next step in confirmatory factor analysis is to assess bi-factor model for corporate workplace scale. The path diagram used for bi-factor model with analysis results are presented in Figure 6.48.

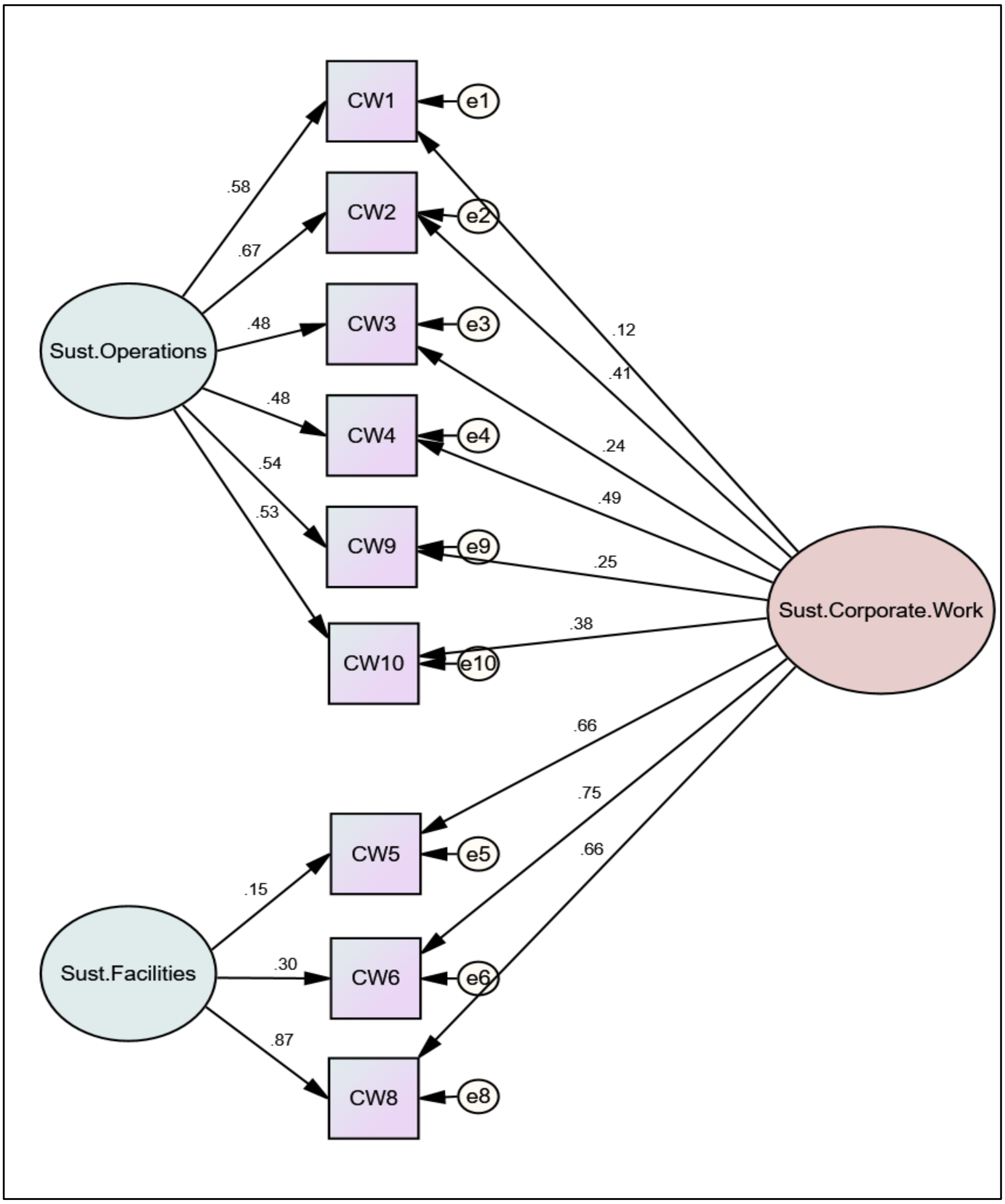


Figure 6.8: Corporate Workplace - Bifactor CFA

Following the analysis of the three competing models, a comparison based on their goodness of fitness indices is conducted and summarised in Table 6.18. While Chi-square is not recognised as a reliable index for ordinal data and when ULS is used as an estimation method, Chi-square difference is considered as an important comparison index to decide on the best model among different alternatives. The chi-square difference between the second order model and bi-factor model is equal to 14.95 which is statistically significant at p <0.05 for the difference of df that is equal to 7. This suggests that the bi-factor is providing significant reduction in the chi-square and therefore provides better parsimonious fit of the data.

Table 6.18: Comparative table for Corporate Workplace Facilities CFA models

Model	**x^2/df**	**AGFI (>0.9)**	**GFI (>0.9)**	**RMR (<0.08)**	**PGFI (>0.5)**
First order model	22.92/34 =0.67	0.972	.983	.061	0.607
Second order model	22.92/32 =0.72	0.972	.983	.061	0.607
Bi-factor model	7.97/25 = 0.32	0.980	. 991	.044	0.450

The bi-factor model implies that overall corporate workplace facilities is a general construct that can be measured directly and at the same time can be defined by two dimensions: Sustainable Facilities (SF) and Sustainable Operations (SO).When multidimensional data are fit to a bifactor model, it is critical for researchers to examine the strength of the resulting general and group factors (Reise et al., 2013). The calculations of ancillary bifactor model indices are presented as proposed by Rodriguez, Reise, and Haviland (2015a) in Table 6.19.

Table 6.19: Evaluation indices of corporate workplace Bi-factor model

	PUC	ECV	ω/ ωS	ωH/ ωHS	H	Dimensionality test
CW (General Factor)	0.51	0.443	0.443	0.871	0.747	PUC < 0.8 ECV < 0.7 Model is multidimensional
SO		0.378	0.723	0.804	0.759	
SF		0.179	0.375	0.895	0.287	

Reliability test

The reliability factor ω refers to the reliability of scores due to multiple constructs and ωh refers to the reliability of scores due to a single construct. McDonald's ωh (1999) provides a better estimate for the composite score and thus should be used" (p. 228). Reise, Bonifay, and Haviland (2013) suggested that ωh values of .75 or higher would be preferred but values of .50 might be useful in determining whether a composite score provides unique, reliable variance. The Calculation of ω, ωs, ωH and ωHs shows that the variance attributed to the general factor CW is slightly greater than the variance due to group factors SO and SF. ωH = 0.871 and ωHs = 0.804; 0.895 for SO and SF respectively. All these values > 0.75 suggesting that all factors (general and subscales) are very reliable.

Dimensionality test

Reise et al. (2013) suggest that an instrument can be considered unidimensional if PUC >.80, and if PUC < .80, then ECV must be > .60 and ωh must be > .70. Quinn (2014) suggests that when ECV of the general factor < 0.7, the model is multidimensional and subscores may have value. Calculation of ECV value for CW general factor gives a value of ECV= 0.474 < 0.60, PUC = 0.51 < 0.8 and ωh = 0.672 < 0.70. According to Quinn (2014) and Reise et al. (2013), these values show that the CW scale is multidimentional and that both total score and subscale scores have value and should be considered in reporting sustainability performance under this category.

Replicability test

To estimate the reliability of the underlying factor itself, Hancock and Mueller (2001) advocated use of an index of construct replicability, called H that represents "the proportion of variability in the construct explained by its own indicator variables" (p. 202). Hancock and Mueller (2001) state that to ensure replicability of the construct, we need to meet a standard criterion of H > .70, and by this standard, the general factor is represented. For the corporate workplace scale, H = 0.747, 0.759, 0.287 for CW, SO, SF respectively. This suggests that CW and SO are well-defined latent factors that are more likely to be stable across studies while SF has a low replicability value and should be re-tested in future studies and also interpreted with caution.

6.5 Management of Employees Scale

6.5.1 Exploratory Factor Analysis

Assessment of the management of employees set of items began with the assessment of sample adequacy, normality, factorability, and absence of multicollinearity. To assess sample adequacy, two tests have been used: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test. For the items related to corporate workplace facilities, KMO for the nine items has a significant value of 0.846 and Bartlett's test of Sphericity shows a value of .000 that is less than 0.05 which indicates the correlation matrix is not an identity matrix and therefore the sample is adequate for factor analysis.

Table 6.20: Management of Employees - KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.846
Bartlett's Test of Sphericity	Approx. Chi-Square	574.508
	df	66
	Sig.	.000

To assess the factorability of the data, Pearson correlations were calculated to determine the intercorrelations for each variable. According to Tabachnick and Fidell (2013), correlation coefficients should exceed .30 in order to justify comprising the data into factors. All variables had at least one correlation coefficient greater than .30 and appear suitable for factor analysis. Although variables should be intercorrelated with one another, variables that are too highly correlated can cause problems in EFA.

Table 6.21: Management of Employees - Collinearity test

Model		t	Sig.	Collinearity Statistics	
				Tolerance	VIF
ME1	Sustainability training of employees	2.912	.004		
ME2	Employee active life / wellbeing programs	3.619	.000	.390	2.564
ME10	Employee sustainability feedback system	.575	.567	.595	1.682
ME11	Employee Sustainability Initiative Award program	1.737	.085	.451	2.219
ME3	Non-discrimination policy	-1.308	.194	.568	1.760
ME5	Employee complaints reporting system	.245	.807	.422	2.372
ME6	Anti- harassment and violence policy	-1.016	.312	.443	2.258
ME7	Employee incident/ accident reporting system	.554	.581	.374	2.676
ME12	Human rights policy and procedures	2.343	.021	.566	1.766
ME4	Employee retention strategy (at corporate level)	-.871	.386	.509	1.966
ME8	Application of innovative ideas generated by employees	.187	.852	.577	1.734
ME9	Effectiveness of Personnel Recruitment and Selection procedure	-.913	.363	.860	1.163

Multicollinearity was assessed using Variance Inflation Factor (VIF) and Tolerance tests. Statisticians have proposed that VIF's exceeding ten or Tolerance scores below 0.10 imply extreme multicollinearity (Allison, 1999). Considering PSC1 as the dependent variable and as shown in Table 6.22, all VIF values were less than 10 and tolerance tests are above 0.10 for all variables. Therefore, we can conclude that multicollinearity was not detected within the data and the assumption of collinearity was met.

Table 6.22: Management of Employees: Normality test

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
ME1	Sustainability training of employees	.218	114	.000	.862	114	.000
ME2	Employee active life / wellbeing programs	.238	114	.000	.856	114	.000
ME10	Employee sustainability feedback system	.187	114	.000	.918	114	.000
ME11	Employee Sustainability Initiative Award program	.259	114	.000	.822	114	.000
ME3	Non-discrimination policy	.226	114	.000	.895	114	.000
ME5	Employee complaints reporting system	.172	114	.000	.924	114	.000
ME6	Anti- harassment and violence policy	.207	114	.000	.906	114	.000
ME7	Employee incident/ accident reporting system	.225	114	.000	.916	114	.000
ME12	Human rights policy and procedures	.249	114	.000	.905	114	.000
ME4	Employee retention strategy (at corporate level)	.233	114	.000	.891	114	.000
ME8	Application of innovative ideas generated by employees	.239	114	.000	.893	114	.000
ME9	Effectiveness of Personnel Recruitment and Selection procedure	.229	114	.000	.899	114	.000

A core assumption of factor analysis procedures is normality in the distribution of the data (Tabachnick & Fidell, 2007). Normality of the data was assessed using two methods: (a) Kolgomorov-Smirnov and (b) the Shapiro-Wilk test (Hair et al., 2010. When using these two tests, probabilities > 0.05 mean the data are normal while probabilities < 0.05 mean the data normality is not satisfied. It can be concluded from Table 6.22 above that normality assumption is not satisfied for all the items.

Determination of the number of factors is the next step in exploratory factor analysis. As it was explained in section 5.8.2. Parallel Analysis (PA) is the most recommended method for identification of the number of factors. The scree plot chart in Figure 6.9 shows the Eigen values of the actual data and the Eigen values of the simulative data. The number of factors to be considered is where the actual Eigen value is smaller than the Eigenvalue for simulative data. The Eigenvalue for the third factor is almost the same for actual and simulative data with a very slight difference. For this reason, the number of factors to be consider for the analysis is three factors.

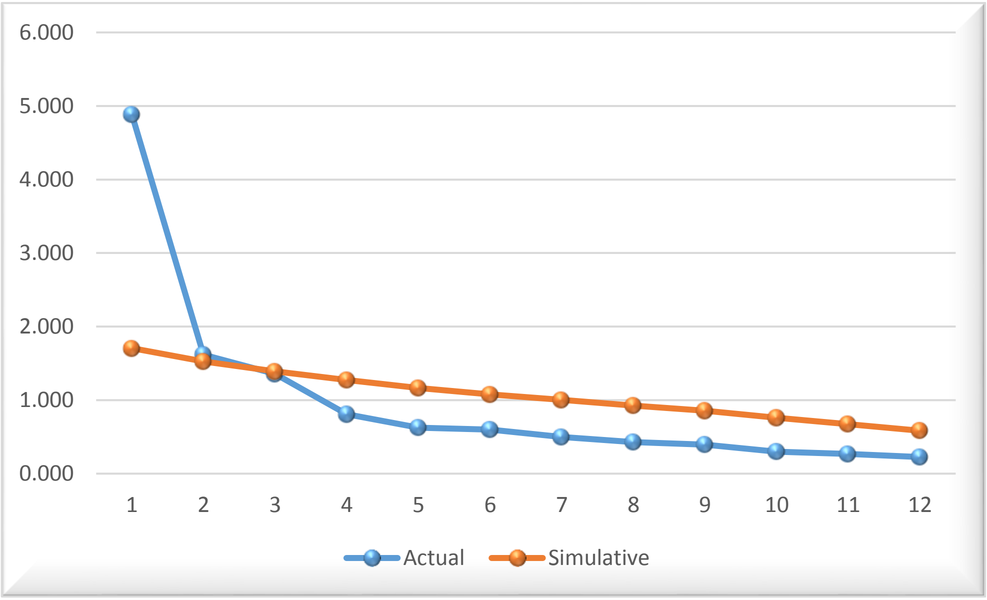


Figure 6.9: Management of Employees- Parallel Analysis Scree Plot

According to the findings above, EFA was performed in SPSS by using the same number of factors suggested by Kaiser Eigen rule. As seen in Table 6.23 below, the following variables had very good loadings for Factor 1: ME1; ME2, ME10, ME11. The following variables had very good loadings on Factor 2: ME5, ME6 and ME7 and ME3. Item ME12 had a very good loading on factor 3 and ME4 and ME8 had acceptable loading on the same factor.

All items have a communality value that is that is above 0.3 except Item ME9 (Human rights policy and procedures) which has a very low communality value of 0.15, thus it is suppressed from the model. This suppression action actually can be supported by the findings from expert survey and by theoretical understanding of this item which is an encompassing criterion that spans all factors and overlaps with items such as ME3, ME5 and ME6. Any loadings that are insignificant (<.32) have been suppressed from the table.

Table 6.23: Factor Extraction for Management of Employees

Variable		**Factor loading**			**Communality**
		1	**2**	**3**	
ME1	Sustainability training of employees	.677			.420
ME2	Application of innovative ideas generated by employees	.989			.845
ME10	Employee sustainability feedback system	.635			.422
ME11	Employee Sustainability Initiative Award program	.743			.589
ME3	Non-discrimination policy		.628		.436
ME5	Employee complaints reporting system		.851		.652
ME6	Anti- harassment and violence policy		.738		.596
ME7	Employee incident/ accident reporting system		.922		.741
ME9	Employee retention procedures			.717	.631
ME4	Compliance with labour camp regulations			.422	.515
ME8	Employee active life / wellbeing programs			.568	.516
ME9	Human rights policy and procedures			.479	.159

Factors labelling

Conduction of dimension reduction analysis in SPSS gives the findings shown in Table 6.24. Factor 1 accounted for 37.305% of variance with an eigenvalue of 4.477, Factor2 accounted for 10.226% of variance with an eigenvalue of 1.227 and Factor3 accounted for 6.822% of total variance and has an eigenvalue of 0.819. The three-factor model accounted for 54.353% of total variance in the data.

Table 6.24: Management of Employees EFA Summary

Factor	Eigenvalue	% of variance	Cumulative %
Factor 1	4.477	37.305	37.305
Factor 2	1.227	10.226	47.531
Factor 3	.819	6.822	54.353

Factor Labelling

Factor 2 is labelled 'Employee Empowerment and Engagement' and it includes four items including aspects related to training and engagement of employees through implementation of their innovative ideas and availability of sustainability award scheme. The second factor is labelled "HR Policies and Procedures" and includes requirements related to HR policies such as anti-harassment and violence, anti-discrimination, employee complaint reporting system and incident/accident reporting system. The third factor is labelled "Employee Wellbeing and Retention" referring to all the criteria that proves investment of the company in improving employees' welfare, happiness and wellbeing. This factor includes compliance with labour camp standards in the UAE in addition to implementing employee active life / wellbeing programs and a clear employee retention procedure.

Cronbach's alpha reliability test

The internal consistency of the three factors was tested through Cronbach's alpha test shown within the results of the EFA. The calculation in Table 6.25 demonstrated excellent overall internal consistency ($\alpha = .742$) for factor 1 and with strong coefficient alpha ($\alpha=0.729$) for factor 2 with a good coefficient alpha ($\alpha = .690$) for factor 3. As explained above, these factors were labelled based on the items loading on them. These items composed the three latent factors of management of employees and were ready for validation through confirmatory factor analysis.

Table 6.25: Reliability Test for Policy and governance factors

Scale	No. of Items	α
Employee Empowerment and Engagement	4	0.742
HR policies and procedures	4	0.729
Employee Wellbeing and Retention	3	0.690

6.5.2 Confirmatory Factor Analysis

Next, the management of employees domain was tested for support of the three-factor model suggested through EFA. Upon first assessment, fit statistics were ideal, and no modifications were necessary. Though the chi square test of fit was significant (χ^2 /df= 0.58, p = .011), indicating a good fit. Further supporting validity of the three-factor model, the baseline comparisons, seen in Table 6.26, all indicated that the three-factor model of Management of Employees had a good fit, with a GFI of .965, RMR of 0.094, and an excellent PNFI of 0.727. These results indicate that the three factors were a reasonable explanation of trends in the data, which indicated that items 1, 2, 10 and 11were likely to represent the same latent construct, items 3, 5, 6, and 7 consistently represented a second latent construct while items 4, 8 and 12 represent the third latent construct.

Table 6.26: Baseline Comparisons for CFA of Management of Employees

Model	**NFI (> 0.90)**	**AGFI (> 0.9)**	**GFI (>0.9)**	**RMR (<0.08)**	**PNFI (>0.5)**
Default model	.941	.924	.965	.084	0.727
Saturated model	1.000		1.000	.000	.000
Independence model	.000	.000	. 405	.386	.000

Figure 6.10 below includes the standardized coefficients from the CFA model, indicating that though the three constructs were correlated, each consisted of items that loaded strongly onto their corresponding factors. Within the Management of Employees domain, Factor 1 was labelled Employee Empowerment and Engagement, while Factor 2 was labelled HR Policies and procedures and Factor 3 is labelled Employee Wellbeing and Retention.

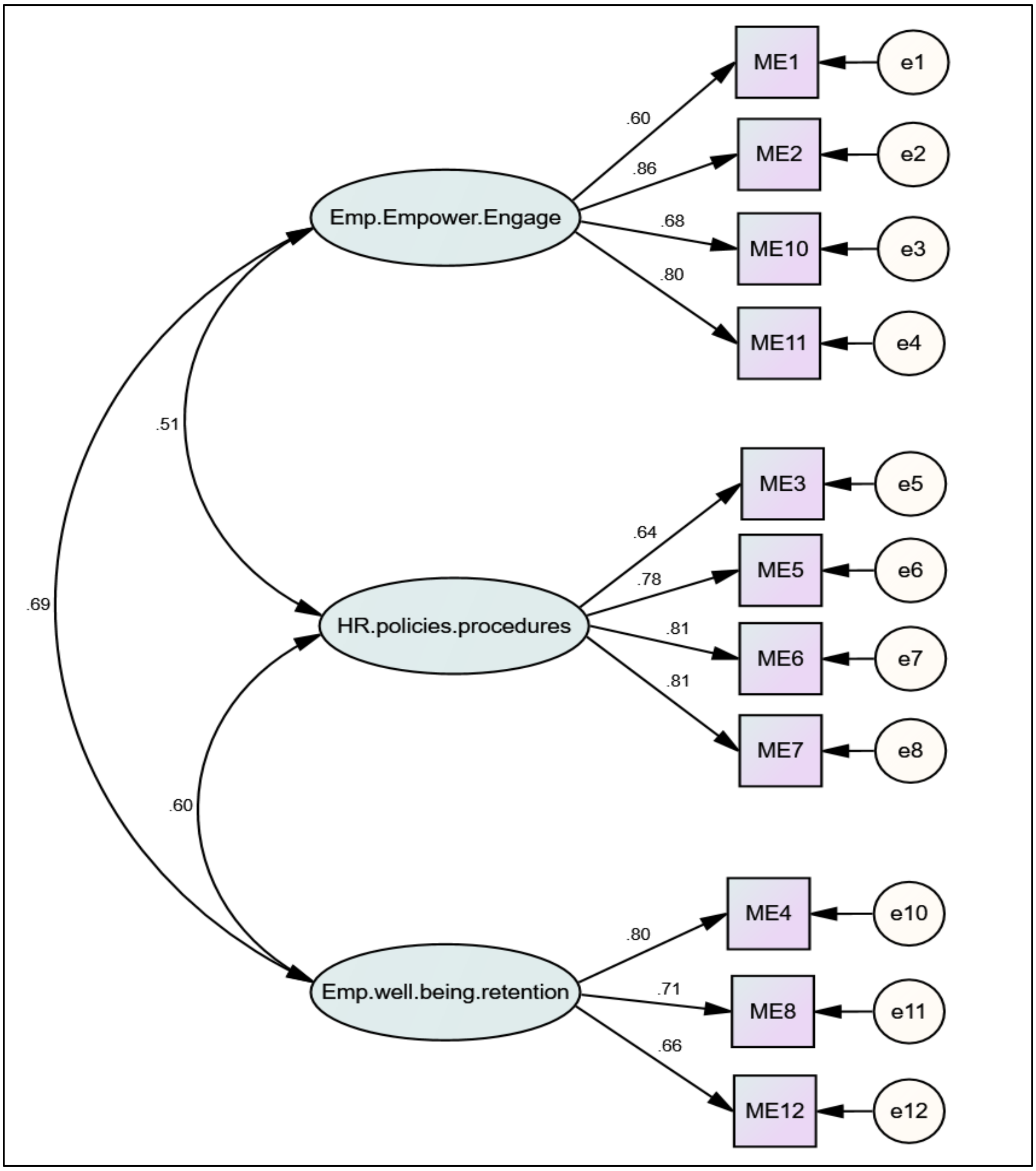


Figure 6.10: Management of Employees- First Order CFA

In a next step, AMOS was used to test a second order model specifically to check whether the results of EFA are confirmed by CFA and whether the three detected factors load onto the second order factor "Management of Employees". All factor loadings are significant ($p < 0.001$) and indicate strong factor loadings (Figure 6.11).

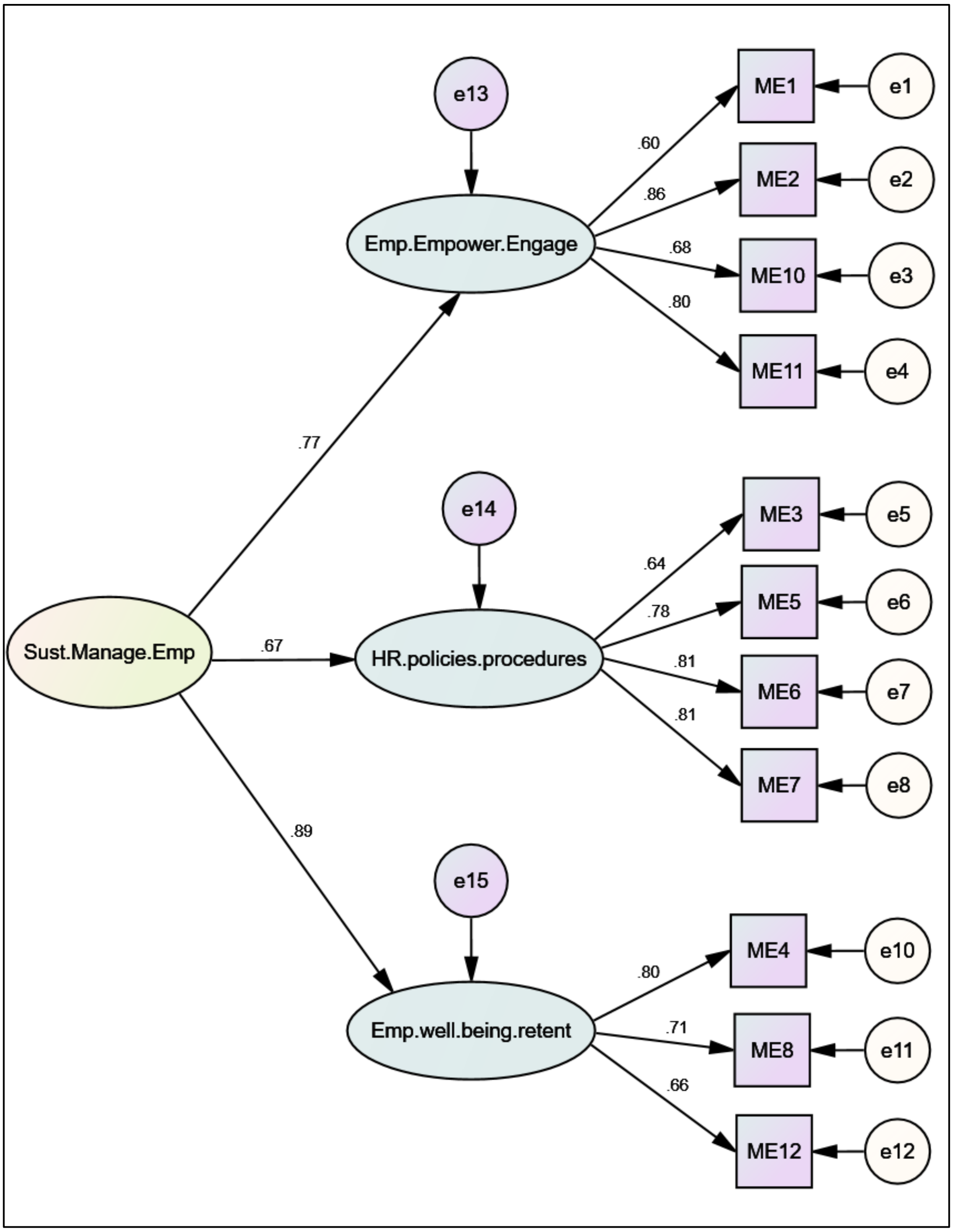


Figure 6.11: Management of Employees- Second Order CFA

The next step in confirmatory factor analysis is to assess bi-factor model for Management of Employees scale. The path diagram used for bi-factor model with analysis results are presented in Figure 6.4.

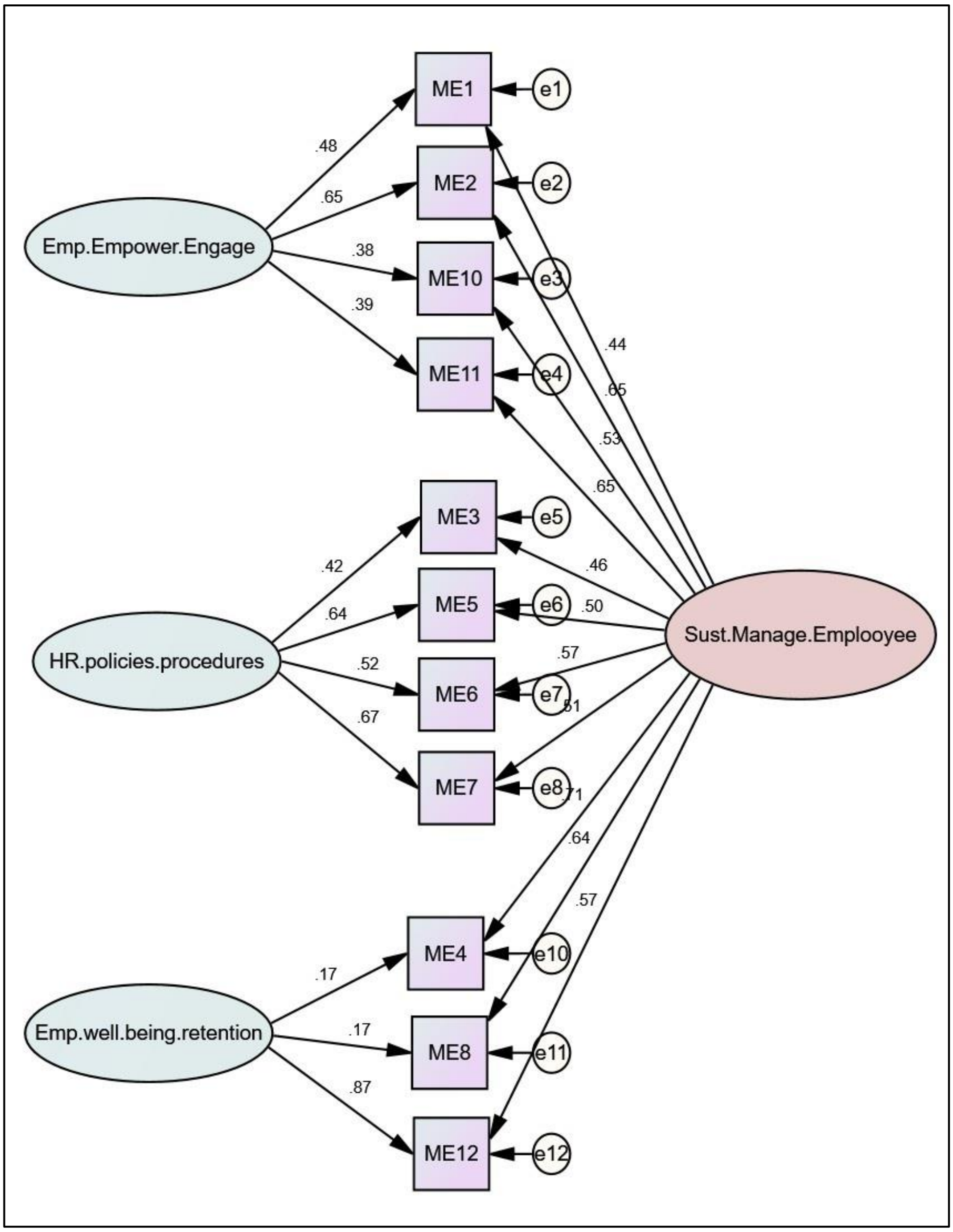


Figure 6.12: Management of Employees Bifactor CFA

The bi-factor model implies that Management of Employees (ME) is a general construct that can be measured directly and at the same time can be defined by three dimensions: Employee Empowerment and Engagement (EEE), HR Policies and Procedures (HRPP) and Employee Wellbeing and Retention (EWR). The bifactor model can account for both the general ME construct and the three narrower sub-scales using the specific factors EEE, HRPP and EWR. Following the analysis of the three competing models, a comparison based on their goodness of fitness indices is conducted and summarised in Table 6.27. While Chi-square is not recognised as a reliable index for ordinal data and when ULS is used as an estimation method, Chi-square difference is considered as an important comparison index to decide on the best model among different alternative nested models. The chi-square difference between the second order model and bifactor model is equal to 58.12 which is statistically significant at p <0.001 for the difference of df that is equal to 18. This proves that the bi-factor is providing significant reduction in the chi-square and therefore provides better fit of the data.

Table 6.27: Comparative table for Management of Employees CFA models

Model	**x^2/df**	**AGFI (>0.9)**	**GFI (>0.9)**	**RMR (<0.08)**	**PGFI (>0.5)**
First order model	23.75/41 =0.58	0.982	0.989	0.056	0.615
Second order model	77. 41/51 = 1.52	0.947	0.965	0.064	0.631
Bi-factor model	19.29/33 = 0.58	0.982	0.991	0.051	0.398

When multidimensional data are fit to a bifactor model, it is critical for researchers to examine the strength of the resulting general and group factors (Reise et al., 2013). The calculations of ancillary bifactor model indices are presented in Table 6.28.

Table 6.28: Evaluation indices of Management of Employees Bi-factor model

<table>
<tr><th></th><th>PUC</th><th>ECV</th><th>ω/ ωS</th><th>ωH/ ωHS</th><th>Relative ω</th><th>H</th><th>Dimensionality test</th></tr>
<tr><td>ME (General Factor)</td><td rowspan="4">0.727</td><td>0.522</td><td>0.939</td><td>0.733</td><td>0.780</td><td>0.868</td><td rowspan="4">PUC < 0.8
ECV < 0.6
Model is multidimensional</td></tr>
<tr><td>EEE</td><td>0.416</td><td>0.815</td><td>0.535</td><td>0.411</td><td>0.830</td></tr>
<tr><td>HRPP</td><td>0.555</td><td>0.946</td><td>0.520</td><td>0.549</td><td>0.808</td></tr>
<tr><td>EWR</td><td>0.421</td><td>0.851</td><td>0.255</td><td>0.300</td><td>0.552</td></tr>
</table>

Reliability test

The reliability factor ω refers to the reliability of scores due to multiple constructs and ωh refers to the reliability of scores due to a single construct. McDonald's ωh (1999) provides a better estimate for the composite score and thus should be used" (p. 228). Reise, Bonifay, and Haviland (2013) suggested that ωh values of .75 or higher would be preferred but values of .50 might be acceptable. Calculations give ωH = 0.733 and ωHs = 0.535; 0.520; 0.255 for EEE, HRPP and EWR respectively. This means that the general factor ME and subscales EEE and HRPP are reliable while subscale EWR is not a reliable construct by itself.

Dimensionality test

Reise et al. (2013) suggest that an instrument can be considered unidimensional if PUC >.80, and if PUC < .80, then ECV must be > .60 and ωh must be > .70. Quinn (2014) suggests that when ECV of the general factor < 0.7, the model is multidimensional and subscores may have value. ECV value for ME general factor gives a value of ECV= 0.522 < 0.70, PUC = 0.727 < 0.8 and ωh = 0.733 < 0.70. According to Quinn (2014) and Reise et al. (2013), these values show that the ME scale is multidimentional and that both total score and subscale scores have value and should be considered in reporting sustainability performance under this category.

Replicability test

To estimate the reliability of the underlying factor itself, Hancock and Mueller (2001) advocated use of an index of construct replicability, called H that represents "the proportion of variability in the construct explained by its own indicator variables" (p. 202). Hancock and Mueller (2001) state that to ensure replicability of the construct, we need to meet a standard criterion of H > .70, and by this standard, the general factor is represented. For the management of employees scale, H = 0.868; 0.830; 0.808; 0.552 for ME, EEE, HRPP and EWR respectively. This suggests that ME, EEE and HRPP are well-defined latent factors that are more likely to be stable across studies while EWR has a low replicability value and should be re-tested in future studies and also interpreted with caution.

6.6 Procurement and Supply Chain Scale

6.6.1 Exploratory Factor Analysis

Assessment of the procurement and supply chain construct for evidence of a factor structure began with sample adequacy and assumption testing. To assess sample adequacy, two tests have been used: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test.

For the ten items related to corporate workplace facilities, KMO has a significant value of 0.821 and Bartlett's test of Sphericity shows a value that is less than 0.05 which indicates the correlation matrix is not an identity matrix and therefore the sample is adequate for factor analysis.

Table 6.29: Procurement and Supply Chain: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.821**
Bartlett's Test of Sphericity	**Approx. Chi-Square**	**371.153**
	df	**36**
	Sig.	**.000**

To assess the factorability of the data, Pearson correlations were calculated to determine the intercorrelations for each variable. According to Tabachnick and Fidell (2013), correlation coefficients should exceed .30 in order to justify comprising the data into factors. All variables had at least one correlation coefficient greater than .30 and appear suitable for factor analysis. Although variables should be intercorrelated with one another, variables that are too highly correlated can cause problems in EFA.

Table 6.30: Procurement and Supply Chain - Collinearity test

Model		**t**	**Sig.**	**Collinearity Statistics**	
				Tolerance	**VIF**
PSC1	Supplier selection based on sustainability practices	2.034	.045		
PSC2	Sustainability collaboration with supply chain	2.582	.011	.542	1.845
PSC3	Sustainability monitoring of supply chain	2.002	.048	.509	1.964
PSC4	Availability of a formal sustainability evaluation scheme of suppliers and subcontractors	-1.154	.251	.666	1.503
PSC5	Subcontractors selection based on sustainability practices	.994	.323	.416	2.404
PSC6	Sustainability training of supply chain	-.305	.761	.649	1.541
PSC7	Total supply chain cost management	2.334	.022	.529	1.890
PSC8	Responsible sourcing strategy	-.218	.828	.606	1.651
PSC9	Reverse logistics policy and procedures	-.011	.991	.552	1.812

Multicollinearity was assessed using Variance Inflation Factor (VIF) and Tolerance tests. Statisticians have proposed that VIF's exceeding ten or Tolerance scores below 0.10 imply extreme multicollinearity (Allison, 1999). Considering PSC1 as the dependent variable and as shown in Table 6.30, all VIF values were less than 10 and tolerance tests are above 0.10 for all variables. Therefore, we can conclude that multicollinearity was not detected within the data and the assumption of collinearity was met. A core assumption of factor analysis procedures is normality in the distribution of the data (Tabachnick & Fidell, 2007). Normality of the data was assessed using two methods: (a) Kolgomorov-Smirnov and (b) the Shapiro-Wilk test (Hair et al., 2010). When using these two tests, probabilities > 0.05 mean the data are normal while probabilities < 0.05 mean the data normality is not satisfied. It can be concluded from Table 6.31 below that the normality assumption is violated for all the items.

Table 6.31: Procurement and supply chain - Normality test

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
PSC1	Supplier selection based on sustainability practices	.226	114	.000	.895	114	.000
PSC5	Subcontractors selection based on sustainability practices	.159	114	.000	.917	114	.000
PSC4	Availability of a formal sustainability evaluation scheme of suppliers and subcontractors	.192	114	.000	.906	114	.000
PSC2	Sustainability collaboration with supply chain	.227	114	.000	.886	114	.000
PSC3	Sustainability monitoring of supply chain	.244	114	.000	.884	114	.000
PSC6	Sustainability training of supply chain	.194	114	.000	.908	114	.000
PSC7	Total supply chain cost management	.257	114	.000	.863	114	.000
PSC8	Responsible sourcing strategy	.234	114	.000	.897	114	.000
PSC9	Reverse logistics policy and procedures	.242	114	.000	.887	114	.000

Determination of the number of factors is the next step in exploratory factor analysis. As it was explained in section 5.8.2, Parallel Analysis (PA) is the most recommended method for identification of the number of factors. The scree plot chart in Figure 6.13 shows the Eigen values of the actual data and the Eigen values of the simulative data. The number of factors to be considered is where the actual Eigen value is smaller than the Eigen value for simulative data. In this case. There is no difference for this set of data in the number of factors proposed by the Eigen method compared to PA method. They both suggest two factors as the third factor has an eigenvalue of simulative data that is greater than the eigenvalue of actual data.

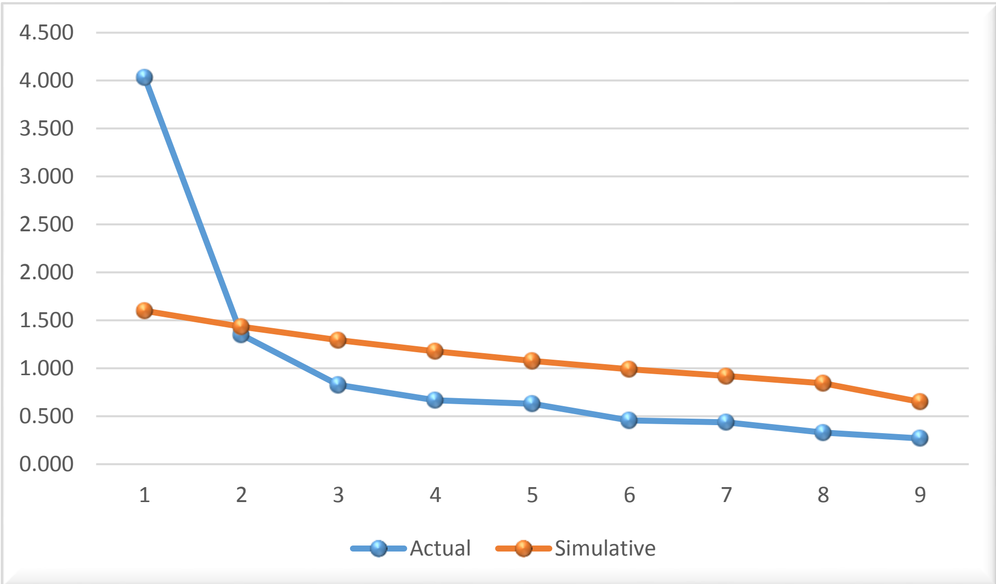


Figure 6.13: Procurement and Supply chain- Parallel Analysis Scree Plot

According to the findings above, EFA was performed in SPSS using the same number of factors suggested by the Kaiser Criterion method. As seen in Table 6.32 below, the following variables had very good loadings for Factor 1: PSC1; PSC4 and PSC5. The following variables had very good loadings for Factor 2: PSC2, PSC3, PSC6 and PSC7 while PSC8 and PSC9 had acceptable loading on Factor 2. All the variables had an acceptable a communality value that is above 0.30 so no item has been suppressed from the list. Any loadings that are insignificant (<.32) have been suppressed from the table.

Table 6.32: Factor Extraction for Procurement and Supply Chain

Variable		Factor loading		Communality
		1	2	
PSC1	Supplier selection based on sustainability practices	.577		0.588
PSC5	Subcontractors selection based on sustainability practices	.791		0.708
PSC4	Availability of a formal sustainability evaluation scheme of suppliers and subcontractors	.823		0.732
PSC2	Sustainability collaboration with supply chain		.663	0.566
PSC3	Sustainability monitoring of supply chain		.809	0.696
PSC6	Sustainability training of supply chain		.632	0.521
PSC7	Optimization of total supply chain cost management		.657	0.610
PSC8	Responsible sourcing strategy		.415	0.429
PSC9	Reverse logistics policy and procedures		.594	0.535

Note: Factor loadings < .32 are suppressed.

Conduction of dimension reduction analysis in SPSS give the findings shown in Table 6.33. Factor 1 accounted for 44.85% of variance with an eigenvalue of 4.04. Factor 2 accounted for 14.99 of variance with an eigenvalue of 1.35. The two-factor model accounted for 49.62% of total variance in the data.

Table 6.33: Procurement and Supply Chain EFA Summary

Factor	Eigenvalue	% of variance	Cumulative %
Factor 1	4.036	44.846	44.846
Factor 2	1.349	14.987	59.834

Factor Labelling

Factor 2 is labelled 'Sustainable Supply Chain Selection' and it includes three items; accounting for 15% of the total variance. The items on this scale include aspects related to selection of suppliers and subcontractors based on sustainability criteria in addition to the availability of a formal sustainability evaluation scheme of suppliers and subcontractors. Sustainable supply chain starts with proper design of the supply chain network and needs formal tools to evaluate the compliance with set sustainability criteria. Factor 2 is labelled 'Sustainable Supply Chain Management' and includes six items that represent sustainability collaboration and empowerment of supply chain through training and monitoring of general sustainability implementation and economic sustainability through proper management of total supply chain cost. This factor includes also possession of responsible sourcing strategy and reverse logistics policy and procedures that will facilitate the implementation of sustainability procurement throughout the supply chain.

Cronbach's alpha reliability test

The internal consistency of the two factors was tested through Cronbach's alpha test shown within the results of the EFA. The calculation in Table 6.34 demonstrated excellent overall internal consistency ($\alpha = .822$) for factor 1 and with strong coefficient alpha ($\alpha = .783$) for factor 2. As explained above, these factors were labelled based on the numbering of the PSC items on the scale. These items composed the two subscales of procurement and supply chain and were ready for validation through confirmatory factor analysis.

Table 6.34: Reliability Test for Policy and governance factors

Scale	No. of Items	α
Sustainable Supply Chain Selection	3	0.783
Sustainable Supply Chain Management	6	0.822

6.6.2 Confirmatory Factor Analysis

The procurement and supply chain domain was then tested for support of the two-factor model, which resulted from the EFA. Model testing indicated that this was a good explanation of the trends from participant responses. The chi-square test was not significant, suggesting that even with the influence of sample size, the test did not detect a poor fit ($\chi^2/df = 0.93$). Further supporting validity of the two factor model, the baseline comparisons, seen in Table 6.35, all indicated that the two factor model of Procurement and Supply Chain had a good fit, with a GFI of .982, RMR of 0.59, and an excellent PNFI of 0.696. These results indicate that the two factors were a reasonable explanation of trends in the data.

Table 6.35: Baseline Comparisons for CFA of Procurement and Supply Chain

Model	NFI (> 0.90)	AGFI (> 0.9)	GFI (>0.9)	RMR (<0.08)	PNFI (>0.5)
Default model	.977	.968	.990	.059	0.571
Saturated model	1.000	-	1.000	.000	
Independence model	.000	.000	.000	.345	.367

Figure 6.14 below includes the standardized coefficients from the CFA model, indicating that though the two constructs were correlated, each consisted of items that loaded strongly onto their corresponding factors. Based on the final structure of the two factors, labels were chosen to be used as domain names in future use of the survey. Factor 1 was labelled Sustainable Supply Chain Selection, while Factor 2 was labelled Sustainable Supply Chain Management.

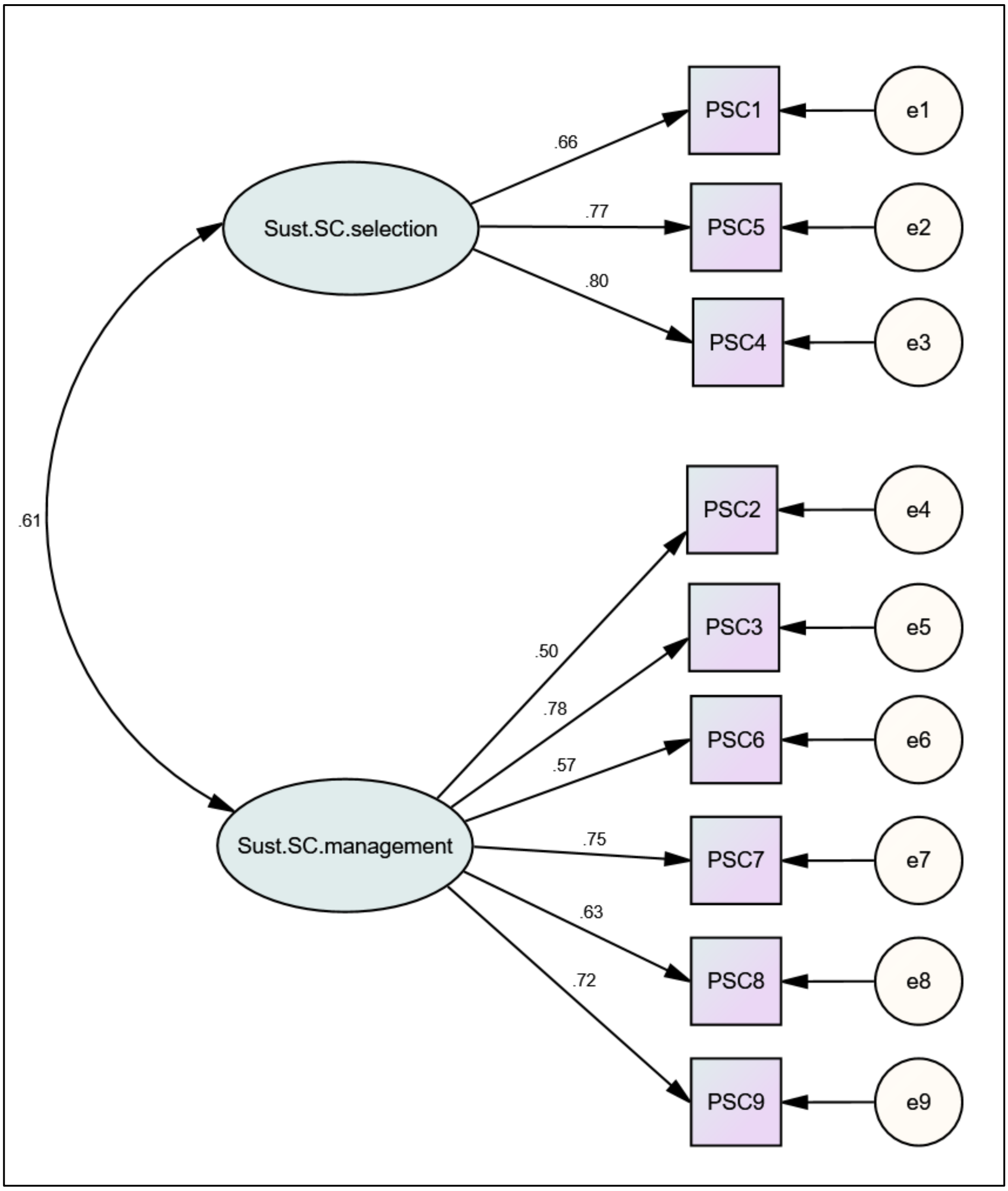


Figure 6.14: Procurement and Supply Chain First Order CFA

In a next step, AMOS was used to test a second order model (Figure 6.15) specifically to check whether the results of EFA are confirmed by CFA and whether the two detected factors "Sustainable Supply Chain Selection" and "Sustainable Supply Chain Management". All factor loadings are significant ($p < 0.001$) and indicate strong factor loadings. The results indicate that the two identified factors are relevant to measure the sustainable supply chain and procurement for contractors.

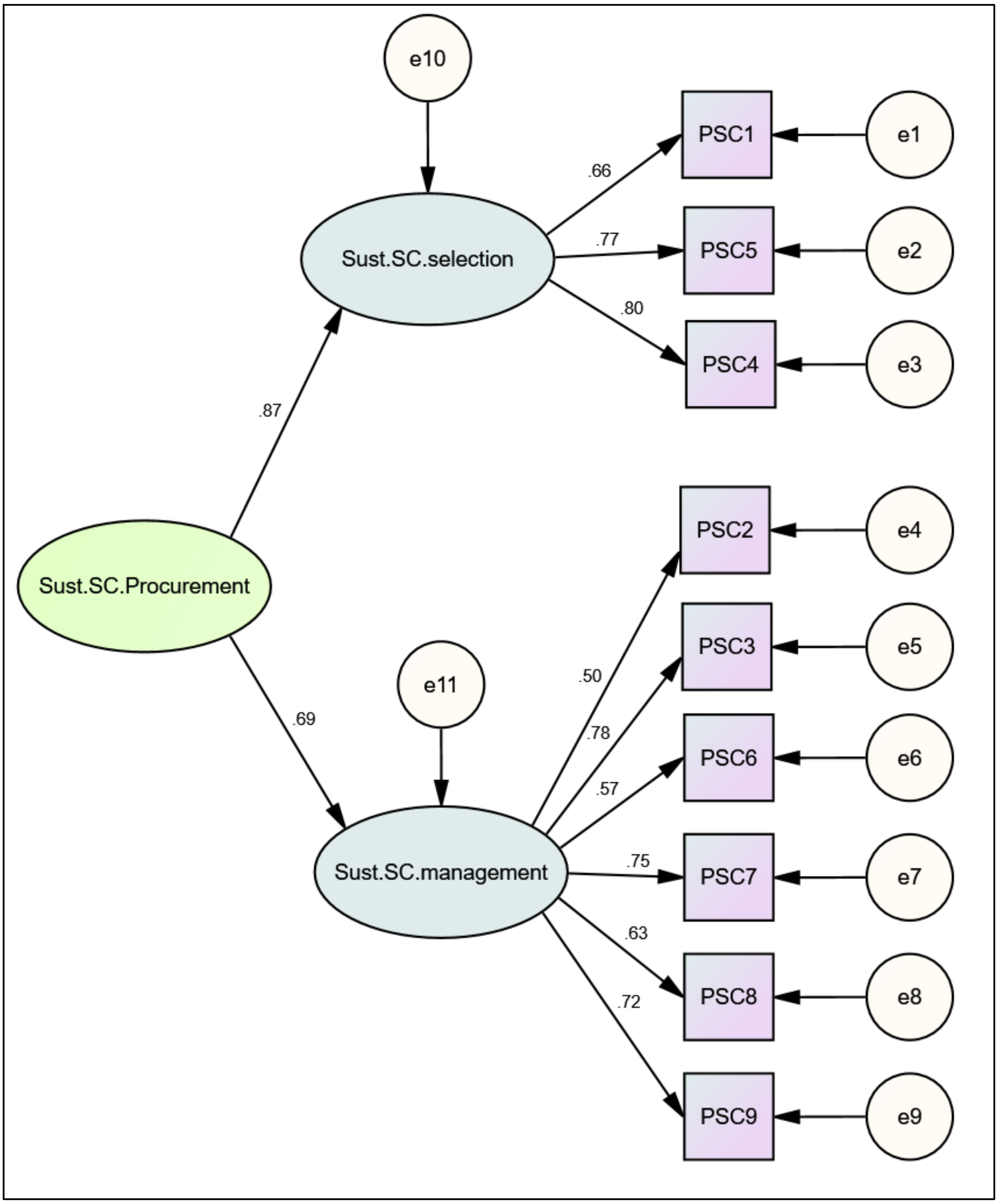


Figure 6.15: Procurement and Supply Chain- Second Order CFA

The next step in confirmatory factor analysis is to assess bi-factor model for policy and governance scale. The path diagram used for bi-factor model with analysis results are presented in Figure 6.16.

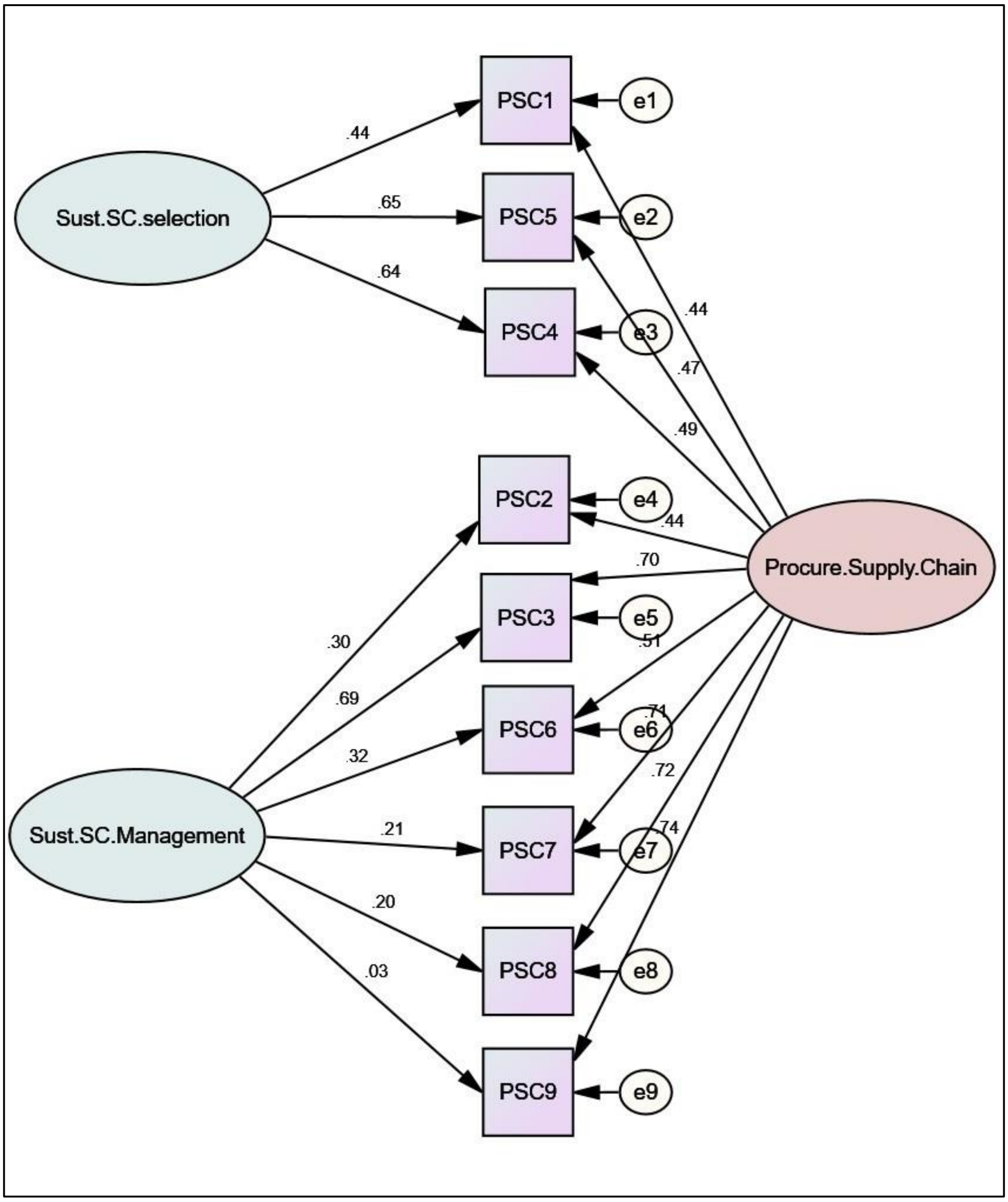


Figure 6.16: Procurement and Supply Chain bifactor CFA

Following the analysis of the three competing models, a comparison based on their goodness of fitness indices is conducted and summarised in Table 6.36. While Chi-square is not recognised as a reliable index for ordinal data and when ULS is used as an estimation method, its difference is considered as an important comparison index to decide on the best model among different alternatives. The chi-square difference between the second order model and bifactor model is equal to 18.76 which is statistically significant at $p < 0.01$ for the difference of df that is equal to 7. This proves that the bi-factor is providing significant reduction in the chi-square and therefore provides better fit of the data.

Table 6.36: Comparative table for Procurement and supply Chain CFA models

Model	x^2/df	AGFI (>0.9)	GFI (>0.9)	RMR (<0.08)	PGFI (>0.5)
First order model	24.06/26 =0.93	0.978	0.987	0.053	0.571
Second order model	24.06/25 =0.96	0.978	0.987	0.053	0.571
Bi-factor model	5.30/18 = 0.29	0.988	0.995	0.032	0.398

The bi-factor model implies that overall Procurement and Supply Chain (PSC) performance is a general construct that can be measured directly and at the same time can be defined by two dimensions: Sustainable Supply chain Selection (SSCS), Sustainable Supply Chain Management (SSCM).

The bifactor model can account for both the general construct and the two narrower sub-scales using the specific factors. "When multidimensional data are fit to a bifactor model, it is critical for researchers to examine the strength of the resulting general and group factors" (Reise et al.,2013). The calculations of ancillary bifactor model indices are presented in Table 6.37.

Table 6.37: Evaluation indices of Procurement and Supply Chain Bi-factor model

	PUC	ECV	ω/ ωS	ωH/ ωHS	Relative ω	H	Dimensionality test
PSC (General Factor)	**0.521**	0.603	0.882	0.736	0.834	0.825	PUC < 0.8 ECV >0.6 and wH>0.7 Model is unidimensional
SSCS		0.267	0.860	0.548	0.637	0.732	
SSCM		0.129	0.821	0.079	0.096	0.469	

Reliability test

McDonald's ωh (1999) provides a better estimate for the composite score and thus should be used" (p. 228). Reise, Bonifay, and Haviland (2013) suggested that ωh values of .75 or higher would be preferred but values of .50 might be useful in determining whether a composite score provides unique, reliable variance. Calculations give ωH =

0.736 and ωHs= 0.548; 0.079 for SSCS and SSCM respectively. This means that the general factor PSC and subscale SSCS are reliable while subscale SSCM is not a reliable construct by itself.

Dimensionality test

Reise et al. (2013) suggest that an instrument can be considered unidimensional if PUC>.80 , and if PUC < .80, then ECV must be > .60 and ωh must be > .70. Quinn (2014) suggests that when ECV of the general factor < 0.7, the model is multidimensional and subscores may have value. Calculation of ECV value for PSC general factor gives a value of ECV= 0.603 > 0.70, PUC = 0.521 < 0.8 and ωh = 0.736 > 0.70. According to Reise et al. (2013), these values show that the PG scale is unidimensional and that only total score and should be considered in reporting sustainability performance under this category.

Replicability test

To estimate the reliability of the underlying factor itself, Hancock and Mueller (2001) advocated use of an index of construct replicability, called H that represents "the proportion of variability in the construct explained by its own indicator variables" (p. 202). Hancock and Mueller (2001) state that to ensure replicability of the construct, we need to meet a standard criterion of H > .70, and by this standard, the general factor is represented. For the PSC scale, H = 0.825 suggesting a well-defined latent factor that is more likely to be stable across studies.

6.7 Project Delivery Scale

6.7.1 Exploratory Factor Analysis

Assessment of the Project Delivery construct for evidence of a factor structure began with sample adequacy and assumption testing. To assess sample adequacy, two tests have been used: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test (Table 6.38). For the 11 items related to project delivery, KMO has a significant value of 0.849 and Bartlett's test of Sphericity shows a value that is less than 0.05 which indicates the correlation matrix is not an identity matrix and therefore the sample is adequate for factor analysis.

Table 6.38: Project Delivery- KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.849
Bartlett's Test of Sphericity	**Approx. Chi-Square**	558.985
	df	55
	Sig.	.000

To assess the factorability of the data, Pearson correlations were calculated to determine the intercorrelations for each variable. Although variables should be intercorrelated with one another, variables that are too highly correlated can cause problems in EFA. Multicollinearity was assessed using Variance Inflation Factor (VIF) and Tolerance tests. Statisticians have proposed that VIF's exceeding ten or Tolerance scores below 0.10 imply extreme multicollinearity (Allison, 1999). As shown in Table 6.39, all VIF values were less than 10 and tolerance tests are above 0.10. Therefore, we can conclude that multicollinearity was not detected within the data and the assumption of collinearity was met.

Table 6.39: Project Delivery Collinearity test

Variables		**t**	**Sig.**	**Collinearity Statistics**	
				Tolerance	**VIF**
PD1	Sustainability manager / engineer appointed on site	2.666	.009		
PD2	Material saving and waste abatement plan	3.780	.000	.397	2.518
PD3	Use of life cycle costing tool	-1.285	.202	.569	1.759
PD4	Use of carbon tracking tool	.342	.733	.426	2.346
PD5	Use of waste estimation and recording tool	-1.115	.267	.447	2.235
PD8	Site Energy saving plan	.580	.563	.595	1.682
PD7	Site Water saving plan	1.728	.087	.451	2.219
PD9	Investment in green construction methods R&D	.644	.521	.377	2.651
PD10	Site Noise control plan	2.218	.029	.584	1.712
PD11	Site Air pollution control plan	-.888	.377	.509	1.965
PD13	Environmental Management System	.014	.989	.598	1.671

A core assumption of factor analysis procedures is normality in the distribution of the data (Tabachnick & Fidell, 2007). Normality of the data was assessed using two methods: (a) Kolgomorov-Smirnov and (b) the Shapiro-Wilk test. When using these two tests, probabilities > 0.05 mean the data are normal while probabilities < 0.05 mean the data normality is not satisfied. It can be concluded from Table 6.40 below that the normality assumption is violated for all the items.

Table 6.40: Project Delivery Normality test

		Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
		Statistic	df	Sig.	Statistic	df	Sig.
PD1	Sustainability manager / engineer appointed on site	.218	114	.000	.862	114	.000
PD2	Material saving and waste abatement plan	.238	114	.000	.856	114	.000
PD3	Use of life cycle costing tool	.187	114	.000	.918	114	.000
PD4	Use of carbon tracking tool	.259	114	.000	.822	114	.000
PD5	Use of waste estimation and recording tool	.226	114	.000	.895	114	.000
PD8	Site Energy saving plan	.172	114	.000	.924	114	.000
PD7	Site Water saving plan	.207	114	.000	.906	114	.000
PD9	Investment in green construction methods R&D	.225	114	.000	.916	114	.000
PD10	Site Noise control plan	.249	114	.000	.905	114	.000
PD11	Site Air pollution control plan	.233	114	.000	.891	114	.000
PD13	Environmental Management System	.239	114	.000	.893	114	.000

Determination of the number of factors is the next step in exploratory factor analysis. As it was explained in EFA approach section, Parallel Analysis (PA) is the most recommended method for identification of the number of factors. The scree plot chart in Figure 6.17 shows the Eigen values of the actual data and the Eigen values of the simulative data. The number of factors to be considered is where the actual Eigen value is smaller than the Eigen value for simulative data. In this case. The number of factors proposed by the Eigen method is three factors while PA method suggests only two factors only as the third factor has an eigenvalue of simulative data that is greater than the eigenvalue of actual data.

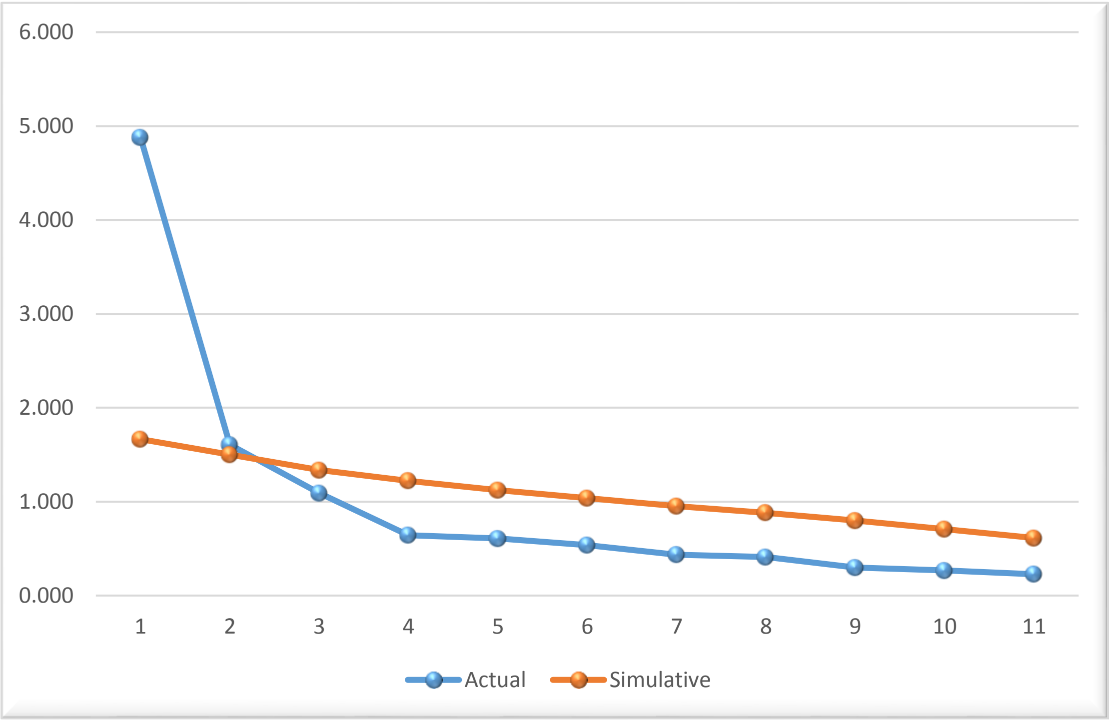


Figure 6.17: Project Delivery- Parallel Analysis Scree Plot

According to the findings above, EFA was performed in SPSS using the option of restricting the number of factors to two factors rather than three factors suggested by the Kaiser Criterion method. As seen in Table 6.41 below, the following variables had very good loadings for Factor 1: PD1 and PD2 while PD7 and PD8 while PD10 and PD11 had fair loadings on the same factor. The following variables had at least good loadings for Factor 2: PD3, PD4, PD5 and PD9. Item PD13 had very weak loading on factor 2 so it will be removed from the next step of factor analysis. Any loadings that are insignificant (<.32) have been suppressed from the table.

Table 6.41: Factor Extraction for Project Delivery

Variable		Factor loading		Communality
		1	2	
PD1	Sustainability manager / engineer appointed on site	.728		.436
PD2	Material saving and waste minimisation plan	.862		.711
PD8	Site Water saving plan	.648		.421
PD7	Site Energy saving plan	.736		.573
PD3	Use of waste estimation and recording tool		.539	.363
PD4	Use of carbon tracking tool		.845	.654
PD5	Use of life cycle costing tool		.708	.581
PD9	Investment in green construction methods R&D		.924	.747
PD10	Site Noise control plan	.485		.333
PD11	Site Air pollution control plan	.515		.447
PD13	Environmental Management System		.358	.336

Conduction of dimension reduction analysis in SPSS give the findings shown in Table 6.42. Factor 1 accounted for 40.081% of variance with an eigenvalue of 4.409. Factor 2 accounted for 10.859% of variance with an eigenvalue of 1.195. The two - factor model accounted for 50.941% of total variance in the data. The factor analysis summary is shown in Table 6.42.

Table 6.42: Project Delivery EFA summary

Factor	Eigenvalue	% of variance	Cumulative %
1	4.409	40.081	40.081
2	1.195	10.859	50.941

Factors labelling

Factor 1 is labelled 'Sustainable Site Management" and it includes six items; accounting for 40% of the total variance. Sustainable site management is crucial for successful delivery of sustainable projects. In addition to complying with sustainability design strategies in project execution, contractors have to have a dedicated sustainability champion on site and to have established plans to reduce environmental impact of construction activities. These plans are covering areas of waste management, noise control, air pollution control, energy and water saving. Factor 2 is labelled 'Sustainability Tools and Innovation' accounting for 10.86%. This factor includes items related to using innovative tools for measuring sustainability performance on site such as life cycle costing tools, carbon tracking tools and waste estimation and recording tools. The fourth item under this factor is related to investment in research and development for green construction methods.

Cronbach's alpha reliability test

To test the internal consistency of the two factors defined in the project delivery set of items, a series of Cronbach's alpha tests were conducted. The calculation in Table 6.43 demonstrated excellent overall internal consistency ($\alpha = .787$) for factor 1 and with strong coefficient alpha ($\alpha = .702$) for factor 2. As explained above, these factors were labelled based on the numbering of the PD items on the scale. These items composed the two subscales of project delivery and were ready for validation through confirmatory factor analysis.

Table 6.43: Reliability Test for Project Delivery factors

Scale	No. of Items	α
Sustainable Site Management	6	0.787
Sustainability Tools and Innovation	4	0.702

6.7.2 Confirmatory Factor Analysis

In the final CFA, the project delivery domain was tested for support of the two-factor model suggested through EFA. Upon first assessment, fit statistics were ideal, and no modifications were necessary. Though the chi square test of fit was significant ($\chi^2/df = 1.09$), indicating a good fit, however this statistic is often ignored based the influence of sample size, which tends to shift this value toward significance (Kline, 2011). Further supporting validity of the two factor model, the baseline comparisons, seen in Table7.44 all indicated that the two factor model of Project Delivery had a good fit, with a GFI of .986, RMR of 0.67, and an excellent PNFI of 0.738. These results indicate that the two factors were a reasonable explanation of trends in the data.

Table 6.44: Baseline Comparisons for CFA of Project Delivery

Model	NFI (> 0.90)	AGFI (> 0.9)	GFI (>0.9)	RMR (<0.08)	PNFI (>0.5)
Default model	.976	.968	.986	.067	0.738
Saturated model	1.000	-	1.000	.000	.000
Independence model	.000	.000	.000	.432	.000

Figure 6.18 below includes the standardized coefficients from the CFA model, indicating that though the two constructs were correlated, each consisted of items that loaded strongly onto their corresponding factors.

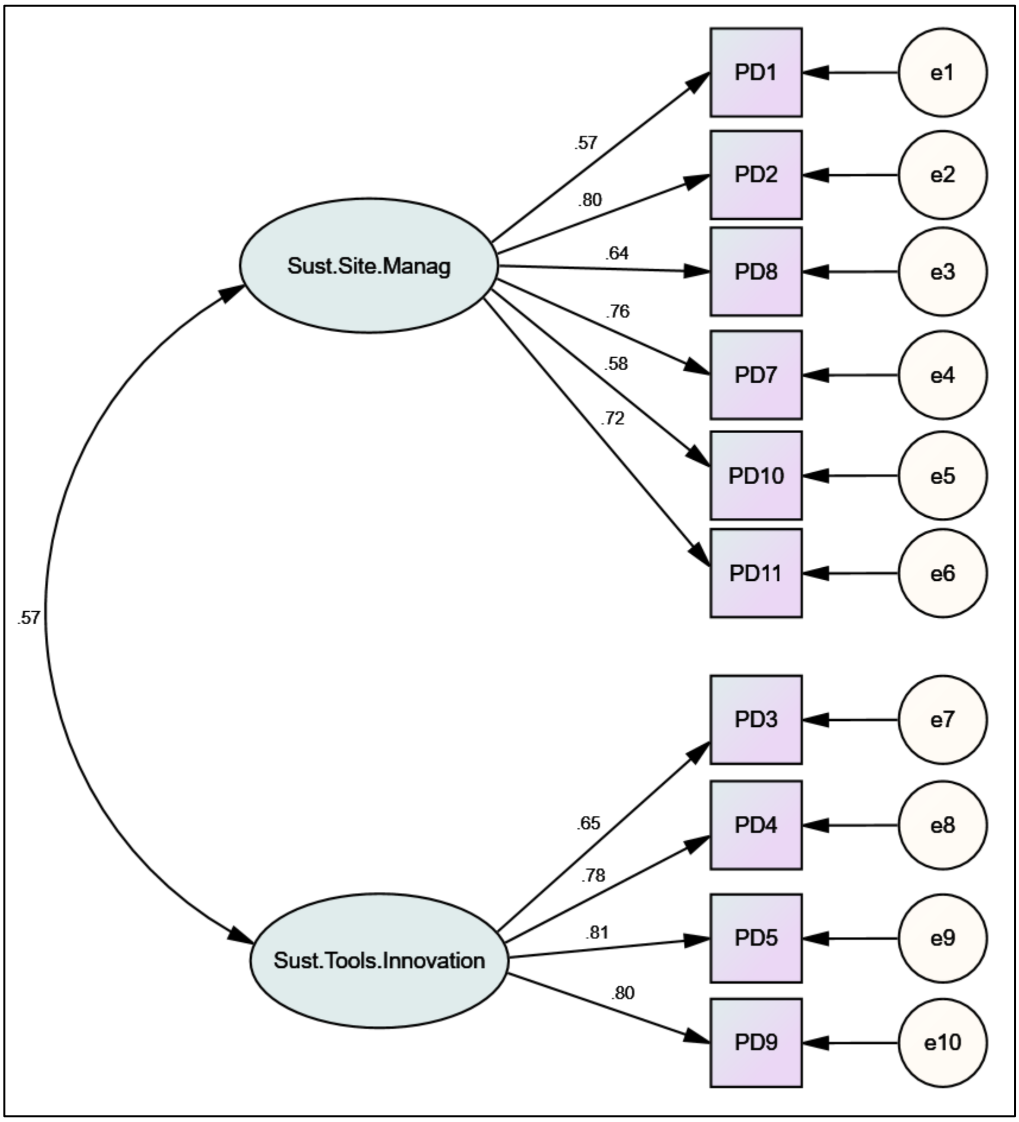


Figure 6.18: Project Delivery - First Order CFA

In a next step, AMOS was used to test a second order model (Figure 6.19) specifically to check whether the results of EFA are confirmed by CFA and whether the two detected factors (Sustainable Site Management and (Sustainability Tools and Innovation). All factor loadings are significant ($p < 0.001$) and indicate strong factor loadings. The results indicate that the two identified factors are relevant to measure the project delivery scale.

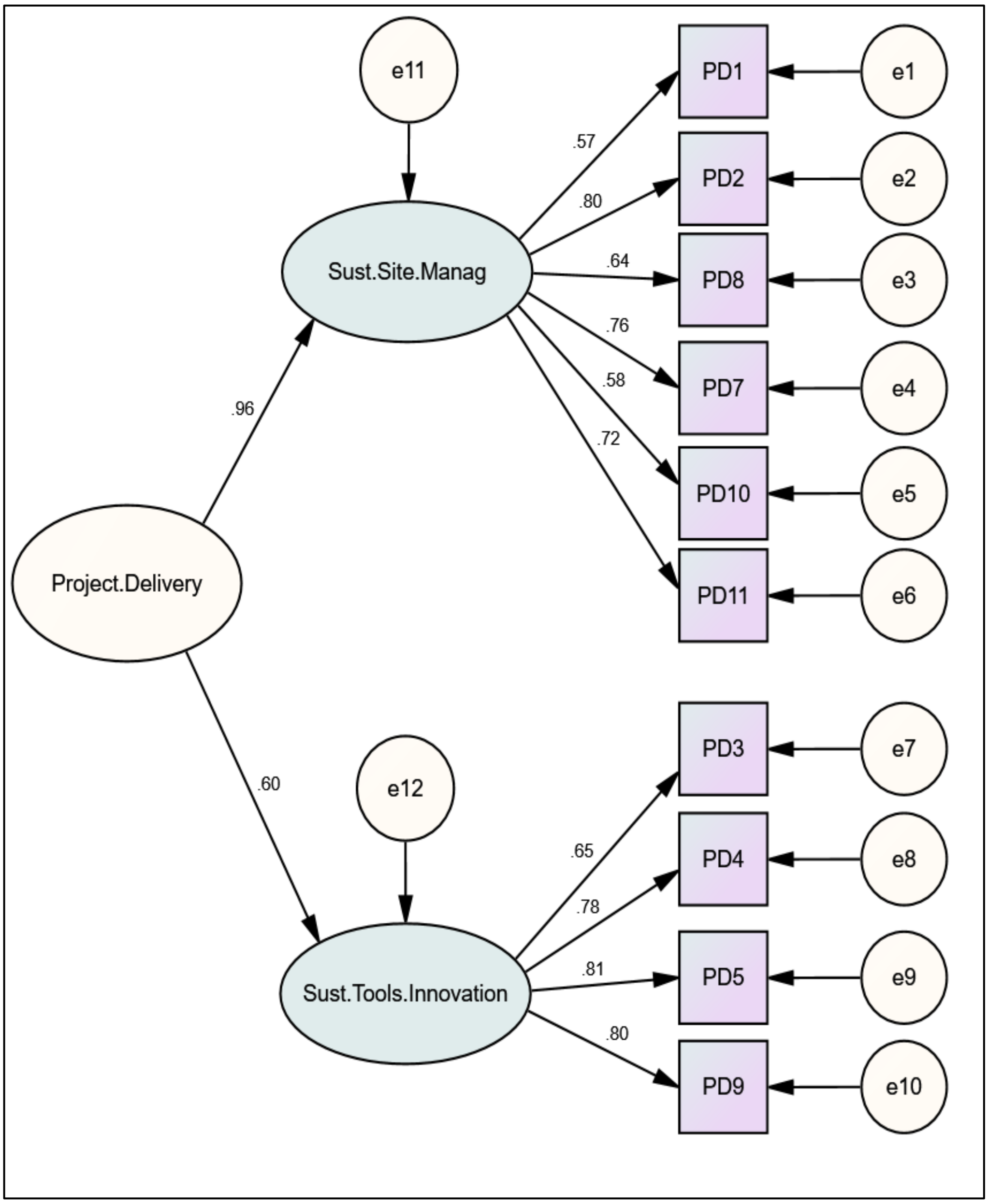


Figure 6.19: Project Delivery - Second Order CFA

The next step in confirmatory factor analysis is to assess bi-factor model for project delivery scale. The path diagram used for bi-factor model with analysis results are presented in Figure 6.20.

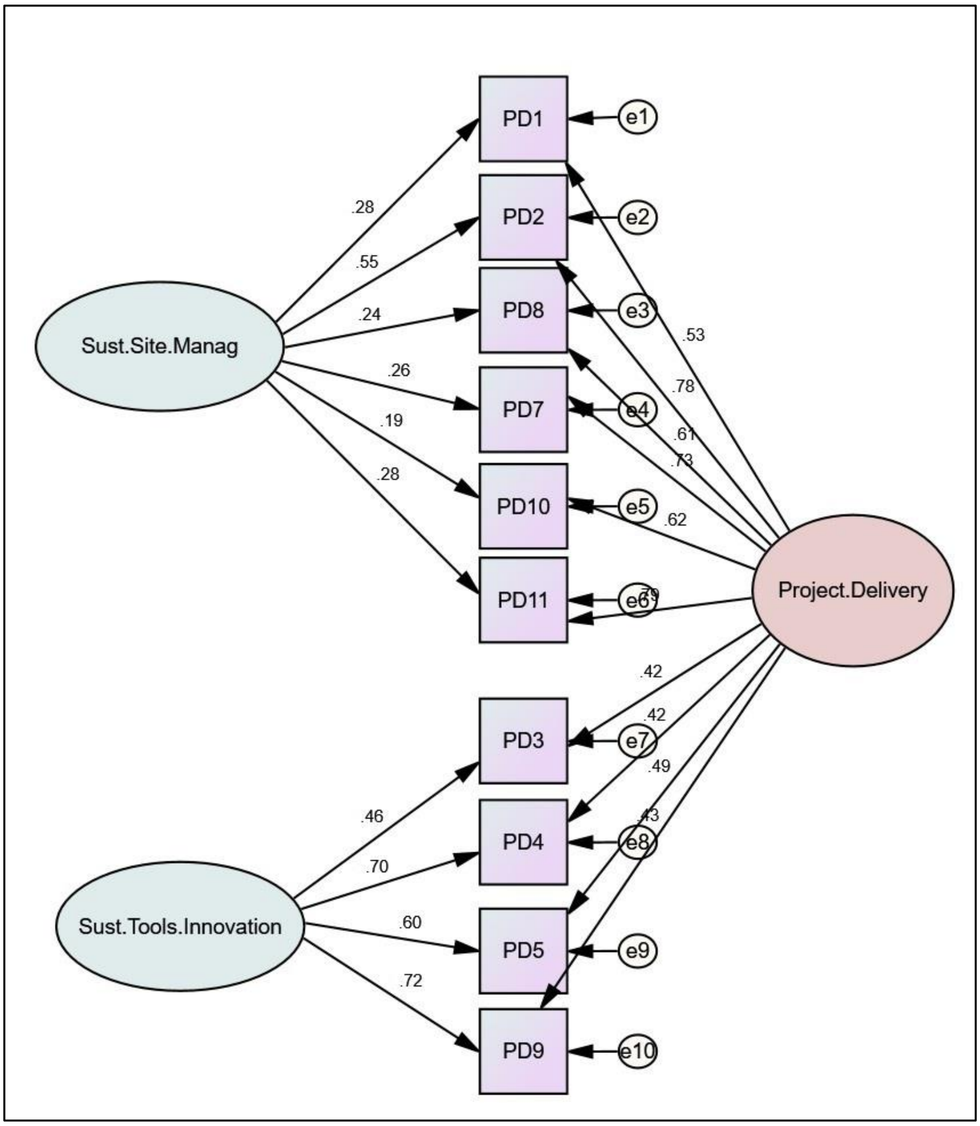


Figure 6.20: Project Delivery - bifactor CFA

Following the analysis of the three competing models, a comparison based on their goodness of fitness indices is conducted and summarised in Table 6.45. While Chi-square is not recognised as a reliable index for ordinal data and when ULS is used as an estimation method, its difference is considered as an important comparison index to decide on the best model among different alternatives. The chi-square difference between the second order model and bifactor model is equal to 16.5 which is statistically significant at p <0.05 for the difference of df that is equal to 8. This proves that the bi-factor is providing significant reduction in the chi-square and therefore provides better fit of the data.

Table 6.45: Comparative table for Project Delivery CFA models

Model	**x^2/df**	**AGFI (>0.9)**	**GFI (>0.9)**	**RMR (<0.08)**	**PGFI (>0.5)**
First order model	27.65/21 =1.09	0.977	.986	.067	0.61
Second order model	27.65/22 = 1.57	0.977	.986	.067	0.61
Bi-factor model	11.15/30 = 0.41	0.984	. 993	.048	.589

The bi-factor model implies that overall Project Delivery (PD) is a general construct that can be measured directly and at the same time can be defined by two dimensions, Sustainable Site Management (SSM), and Sustainability Tools and Innovation (STI). The bifactor model can account for both the general construct and the two narrower sub-scales using the specific factors. When multidimensional data are fit to a bifactor model, it is critical for researchers to examine the strength of the resulting general and group factors" (Reise et al.,2013). The calculations of ancillary bifactor model indices are presented in Table 6.46.

Table 6.46: Evaluation indices of Project Delivery Bi-factor model

	PUC	**ECV**	**ω/ ωS**	**ωH/ ωHS**	**Relative ω**	**H**	**Dimensionality test**
PD (General Factor)	**0.533**	0.500	0.939	0.961	0.636	0.761	PUC < 0.8 ECV < 0.6 Model is multidimensional
SSM		0.432	0.815	0.964	0.415	0.431	
STI		0.618	0.946	0.902	0.552	0.612	

Reliability test

McDonald's ωh (1999) provides a better estimate for the composite score and thus should be used" (p. 228). Reise, Bonifay, and Haviland (2013) suggested that ωh values of .75 or higher would be preferred but values of .50 might be useful in determining whether a composite score provides unique, reliable variance. Calculations give ωH =

0.961 and ωHs= 0.964; 0.946 for SSM and STI respectively. This means that the general factor PD and subscale SSM and STI have high reliability as separate constructs.

Dimensionality test

Reise et al. (2013) suggest that an instrument can be considered unidimensional if PUC>.80, and if PUC < .80, then ECV must be > .60 and ωh must be > .70. Quinn (2014) suggests that when ECV of the general factor < 0.7, the model is multidimensional and subscores may have value. Calculation of ECV value for PG general factor gives a value of ECV= 0.500 < 0.70, PUC = 0.533 < 0.6. According to Quinn (2014) and Reise et al. (2013), these values show that the PD scale is multidimentional and that both total score and subscale scores have value and should be considered in reporting sustainability performance under this category.

Replicability test

To estimate the reliability of the underlying factor itself, Hancock and Mueller (2001) advocated use of an index of construct replicability, called H, that represents "the proportion of variability in the construct explained by its own indicator variables" (p. 202). Hancock and Mueller (2001) state that to ensure replicability of the construct, we need to meet a standard criterion of H > .70, and by this standard, the general factor is represented. For the policy and governance scale, H = 0.761; 0.431; 0.612 for PD, SSM and STI respectively. These values suggest that the general PD factor is replicable while the subscale factors fail the replicability test and should be interpreted with caution. Evaluation of the bi-factor models

6.8 Higher Order Confirmatory Factor Analysis

In previous sections, we have developed the conceptual models for different sustainability performance evaluation domains. The next step after conducting second order CFA subscale models leads towards achieving the study's primary objective of developing a comprehensive sustainability performance model for construction contractors. This section goes on to present the final research model which is capable of encompassing all the criteria that should be considered when evaluating sustainability performance of construction contractors. The method of validating the integrated model is based on the same approach of SEM and more specifically high orders of CFA. The proposed hierarchical model is based on the structure in figure 6.21 below.

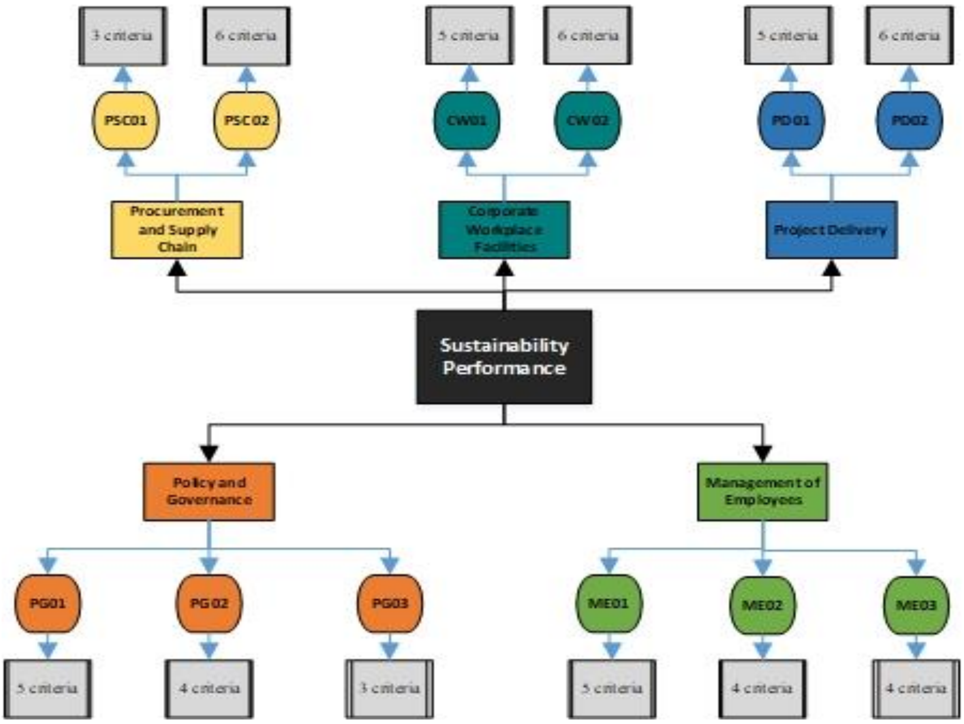


Figure 6.21: Model-A (proposed hierarchical model)

The first model tested above is model A- Third order model (Figure 6.21). This model hypothesises one third order factor, five second order factors and 15 first order factors. Theory about sustainability evaluation and performance measurement supports this hierarchical structure as it assumes sustainability can be measured using one single index using a segregated score based on the hierarchical structure. This assumption has been confirmed and used in many studies (Erol et al. 2011; Boggia & Cortina 2010; Engineering 2013; Akadiri 2011).

This model is based on the second order subscales tested and validated in previous sections. The proposed sustainability evaluation model contains ten domains that are categorised under five subscales. First order and second order models have been validated for the five subscales. It is suggested that higher order CFA models are possible when the latent variables in the first order and second order are highly correlated to one another. A third factor CFA model is possible when the second order factors are highly and significantly correlated to each other and the third order factor(s) may be hypothesized to account for the variation among the second order factors. Third order model is also called hierarchical CFA.

Model fit indices show a poor fit of the higher order model. Although the Chi-square statistic is universally adopted as a model fit index, its significance levels are sensitive to sample size and normal distribution of data. The ratio of chi- square to the degrees of freedom is also considered and it is recommended using ratios less than 5 to indicate reasonable model fit. Therefore, it should be always interpreted with caution in case of small sample size and /or violation of normality assumption. While high CMN can be affected by sample size, GFI is considered a reliable indicator of model fit. GFI ranges from 0 to 1 with higher values indicating better fit (Joreskog and Sorbom 1989).

Table 6.47: Summary of a CFA Proposed Hierarchical Model

Model	**NFI Delta1 (> 0.90)**	**RFI rho1 (>0.9)**	**GFI (>0.9)**	**RMR (<0.08)**	**PNFI (>0.5)**
Default model	.878	.834	.848	.182	0.438
Saturated model	1.000	-	1.000	.000	.000
Independence model	.000	.000	.000	.432	.000

Many researchers interpret GFI of 0.90 or higher as evidence of good fit while GFI scores in the 0.80 to 0.89 range as representing reasonable fit. The next most important index for model fit is RMR which reverts the average difference between the model and sample variance/covariance matrices. Smaller values of RMR are associated with better model fit with scores below 0.05 are indicators of good fit and below 0.08 indicating a good fit (Byrne, 1989).

For second or higher levels, the standard structural coefficient of factors on higher-order constructs are estimates of the validity of the factors. The larger the factor loading or coefficients as compared with their standard errors, the stronger is the evidence that the measured variables or factors represent the underlying constructs (Bollen 1989).

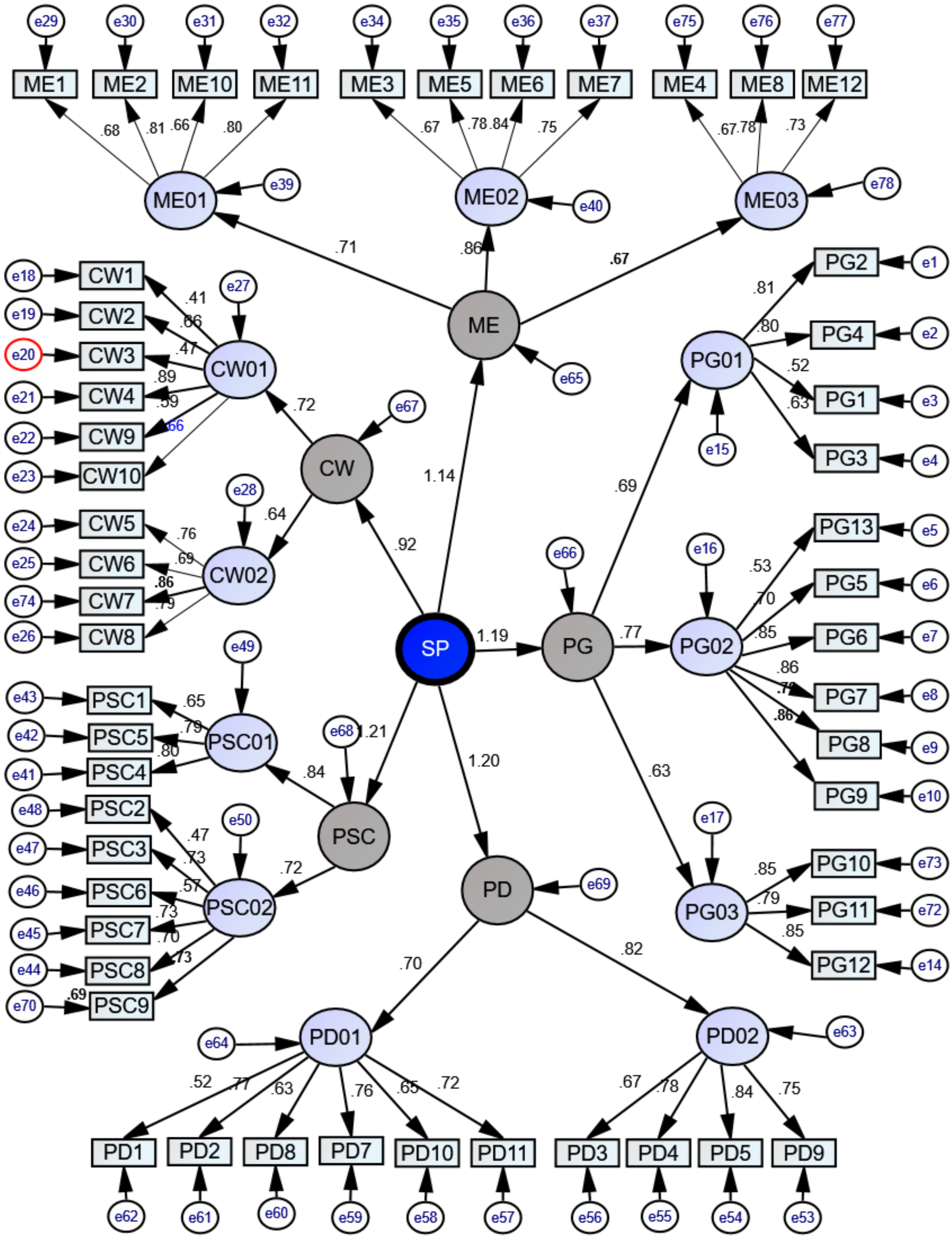


Figure 6.22: Proposed model- third order (Model A)

There is no universally accepted cut-off value for factor loadings. In this research, factor loadings or standard structural coefficients above 0.6 will be considered good measures of their latent construct. Upon first assessment, fit statistics were not very ideal. Though the chi square test of fit was significant (χ^2/df = 5506/21) = 1.317, p = .000), indicating a poor fit, however this statistic is often ignored based the influence of sample size, which tends to shift this value toward significance (Kline, 2011).The baseline comparisons, seen in Table 6.47, show unacceptable fit with values outside the acceptable range (GFI of. 848, RMR of 0.182 and NFI of 0.878).

6.9 Comparison with alternative models

This section will then look at other alternative models based on bifactor models to check their possibility of having better fit to the data since the previous section proved that subscale bifactor models had better fit than the first order models. Model B hypothesises that the five bifactor subscale models are correlated with each other.

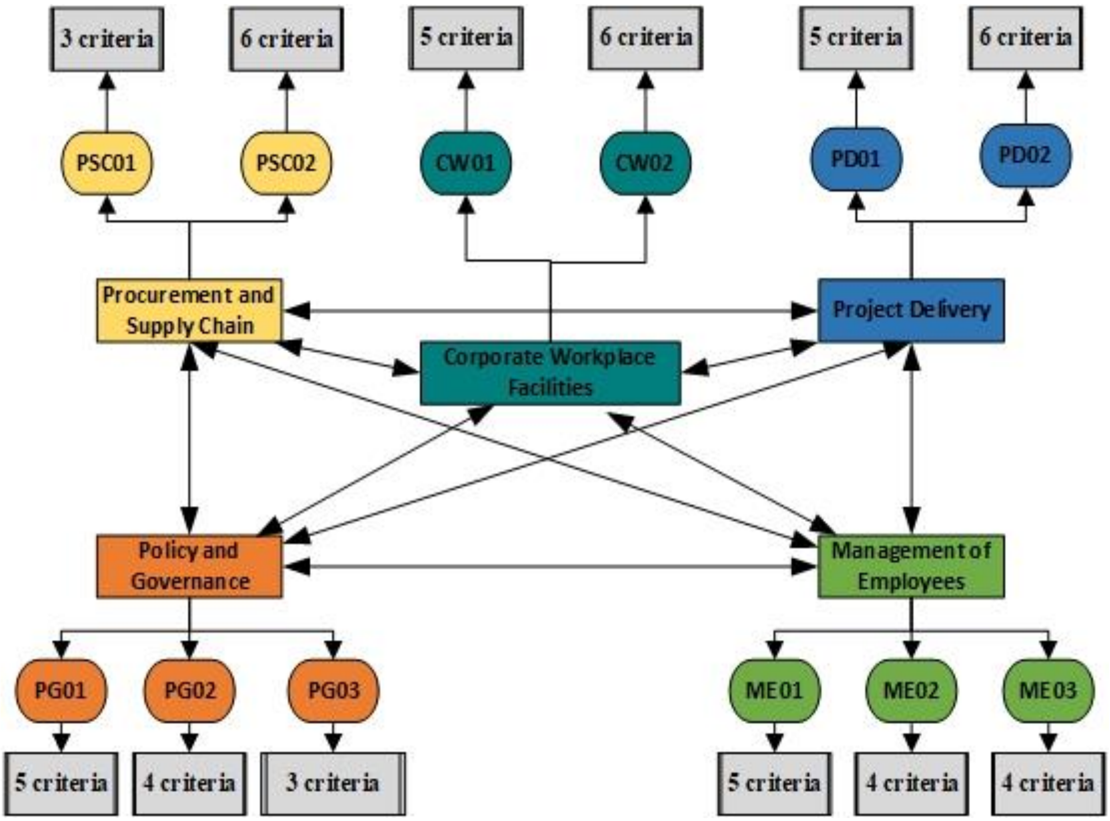


Figure 6.23: Model- B (correlated bi-factor subscales)

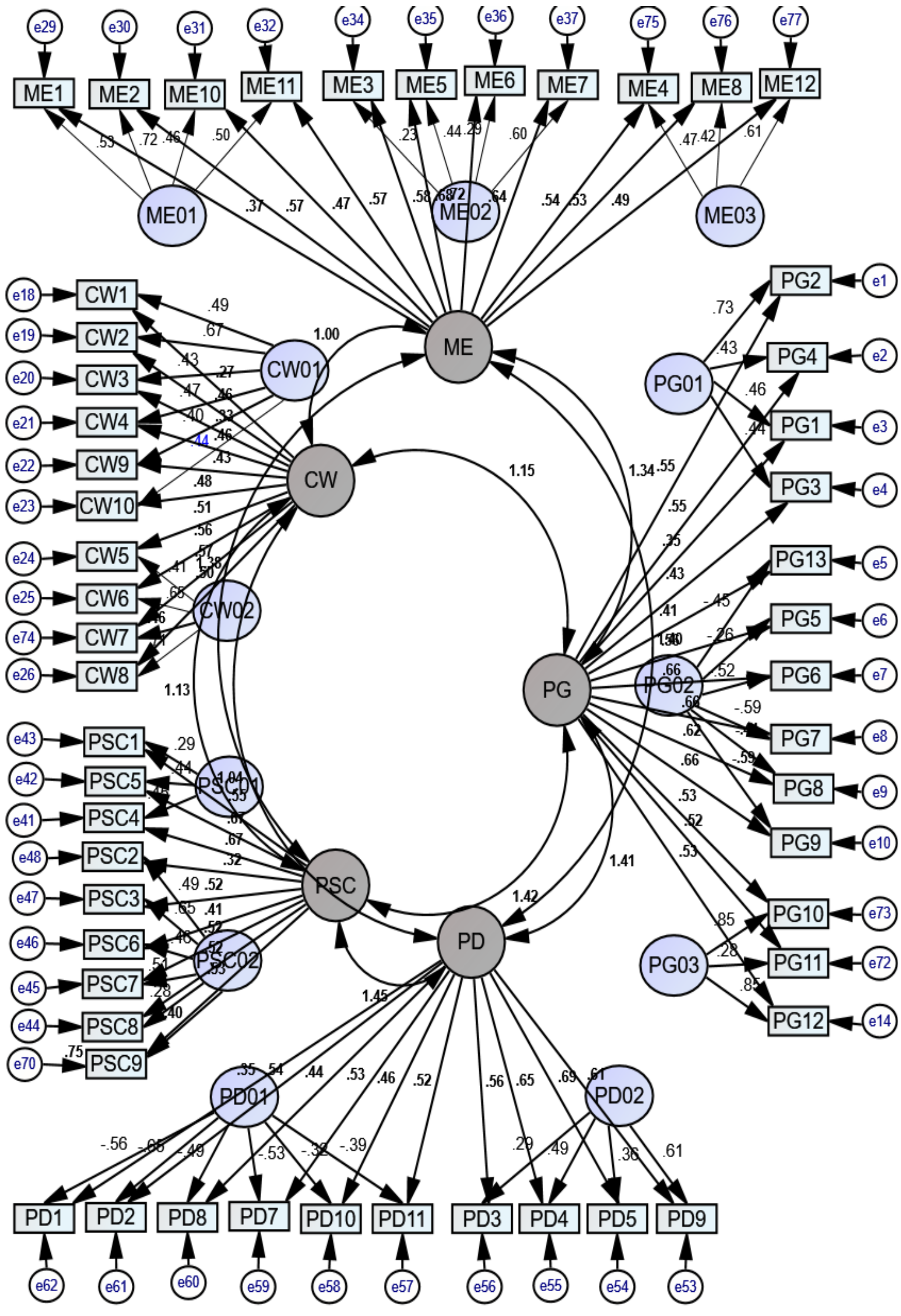


Figure 6.24: Model B (covariance between bi-factor subscales)

Model C is an alternative to model B and it hypothesises one third factor model and five subscale bi-factor models.

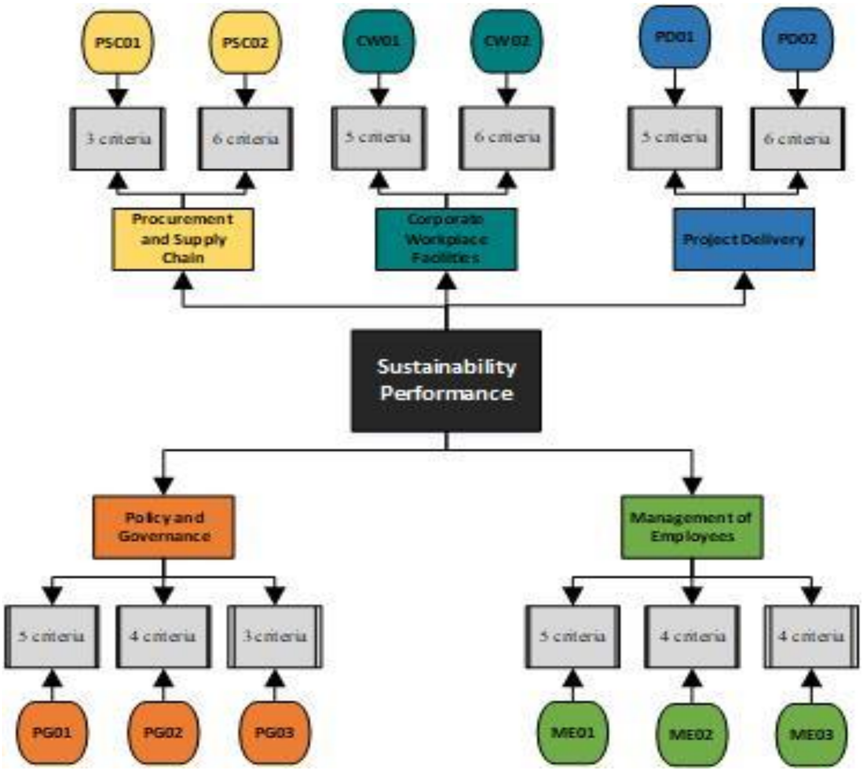


Figure 6.25: Model-C (higher order hierarchy of bi-factor subscales)

Table 6.48: Comparison with alternative models

Model	**X^2/df**	**GFI (>0.9)**	**AGFI (>0.9)**	**PGFI (>0.5)**	**RMR (<0.08)**
Model A -Overall Sustainability Performance scale (third order)	=5501.75/124 **= 44.37**	0.848	0.834	0.776	0.182
Model B- Overall Sustainability Performance scale (bi-factor subscale models with co-variances)	=5265.63/172 **= 30. 61**	0.854	0.835	0.754	0.180
Model B- Overall Sustainability Performance scale (higher order of bi-factor subscale models)	=5278.3/165 **= 31.99**	0.855	0.835	0.756	0.181

The three models listed in the previous section have been evaluated using AMOS. The fit indices are presented in Table 6.48: Comparison with alternative models. It can be seen from the table that all models have poor fit. In terms of comparison, Model B and Model C are considered as having nested structures, therefore, a chi-square difference test was employed for comparing them to determine if one of the structures fits better than the other. The chi-square difference between the two models is 12.67 which is below the threshold of 14.07 for the difference of df that is equal to 7. This proves that we cannot conclude on the superiority of model B over model C.

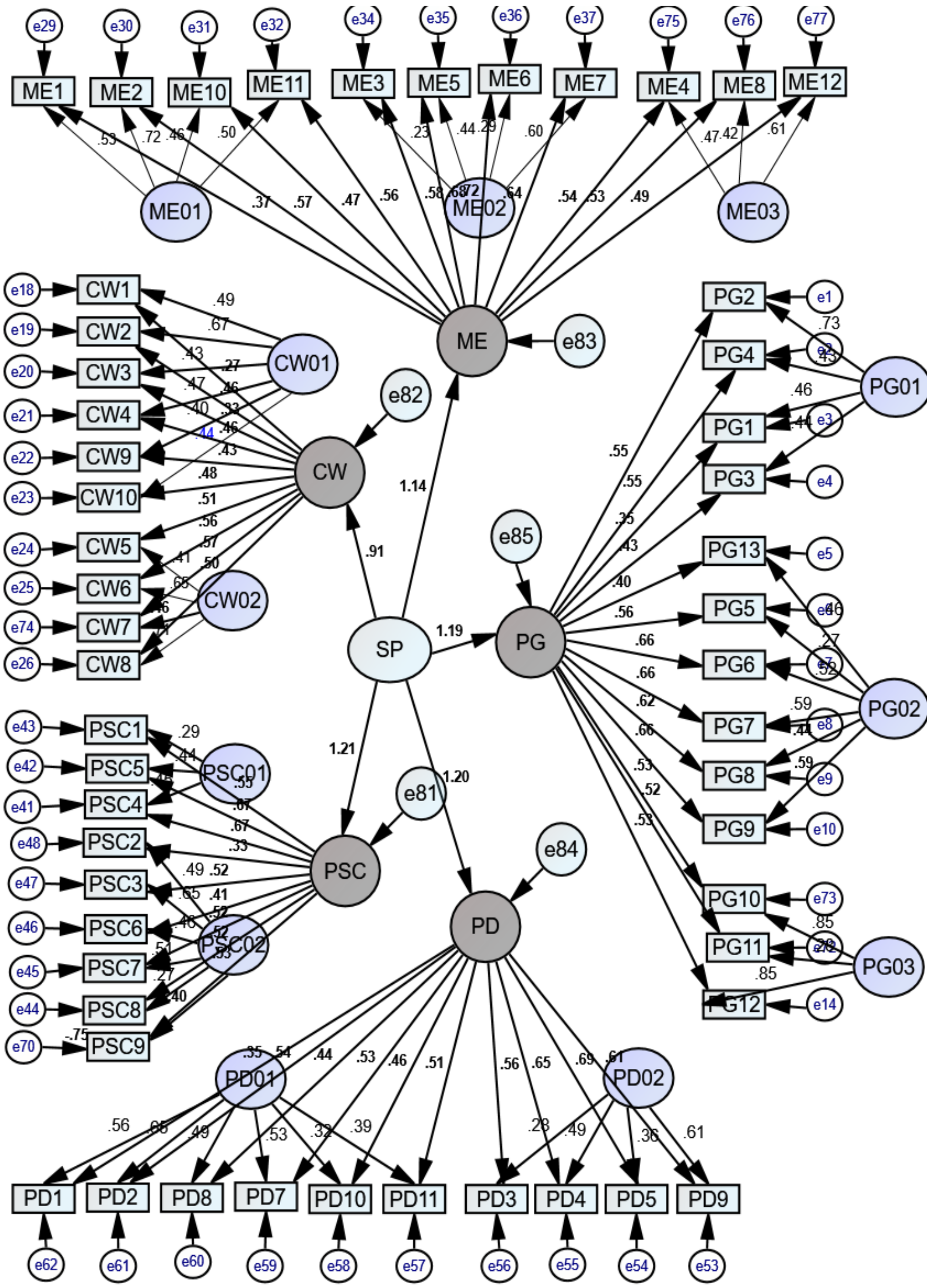


Figure 6.26: Model C (higher order hierarchy of bi-factor subscales)

6.10 Discussion

The analysis conducted in this chapter followed a step by step approach in line with the scale development process. The initial 56 items scale has been divided into five subscales: Policy and Governance, Corporate Workplace, Management of Employees, Procurement and Supply Chain and Project Delivery. First, CFA was conducted for all constructs at the first-order level. Second, CFA was conducted for all subscales at the second-order level to be in line with the theory provided in the previous chapters. First order models and second order models of the subscales have the same fit indices, however only bi-factor models are retained as they fit the data better than first order and second order models for all subscales.

6.10.1 Policy and Governance scale

This performance evaluation scale is based on the fact that sustainability performance of organisations is dependent on strong leadership, clear strategy and a consistent implementation of sustainability policies. Based on the results of the expert survey and interviews, 13 criteria are retained for this scale. EFA has revealed a structure of three latent factors under this scale: Factor 1 (accounting for 29% of total variance) is 'sustainability strategy and compliance' and it includes five items covering aspects of an underlying strategy that is clearly substantiated in the company policy statements and translated into compliance with sustainability regulation and implementation by a dedicated corporate sustainability department. Factor 2 (accounting for 15% of total variance) is 'sustainability certification and membership' and it includes four items clustered around going beyond the self-evaluation and internal strategic goals to cover sustainability third party certification such as ISO 14001, ISO 26000 and SA8000 in addition to sustainability memberships locally and internationally. Factor 3 (accounting for 10% of total variance) is "Sustainability tracking and reporting" and it includes three items that are related to carbon tracking, sustainability and financial reporting. This scale of policy and governance shows clearly that factors leading to performance under this category range from company driven performance such as policies, strategies, compliance and community involvement to stakeholder driven performance covering certifications and reporting. In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the three latent factors are satisfactorily correlated. The highest correlation (r=0.57) is between ‘sustainability certification and membership’ and ‘sustainability tracking and reporting’. This correlation is logical since these two factors reflect organisations focus on stakeholders and external third parties and these two performance factors are related in many organisations (Radu, 2012). Sustainability strategy and compliance has an adequate correlation (r=0.52) with ‘sustainability tracking and reporting’ but lower correlation (r=0. 44) with ‘sustainability certification and membership’. This can be due to the fact that seeking sustainability memberships and certifications is not necessarily an outcome of having an internal sustainability strategy. On the other hand, we can find contractors that are ISO 14001 as it is one of the Estidama credits, but do not necessarily have sustainability strategy and policy. According to Tabachnick and Fidell (2013), when multiple factors are correlated (r >=0.33) in oblique rotations then the latent dimensions are not independent and the correlations between the multiple factors must be considered. The next step in this case is to test the second order model as correlated factors imply a higher order factor to be explicated (Canivez, 2016).

The higher-order model of policy and governance scale has good fitting indices and shows strong loadings on the second order factor of 0.7, 0.64 and 0.82 of ‘sustainability certification and membership’, sustainability strategy and compliance’ and ‘sustainability tracking and reporting’ respectively. The second-order factor influence on observed indicators is fully mediated by the first-order factors (Yung, Thissen, & McLeod, 1999). This means the influence of ‘policy and governance factor’ on the observed variables if fully meditated by the three first order factors. This mediation is highly questionable and should not be considered as a straightforward finding (McDonald, 1999, Gignac, 2008). To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model or as called by McDonald (1999), ‘indirect hierarchical model. The bi-factor model implies that overall corporate sustainability performance is a general construct that can be measured directly and at the same time can be defined by the three dimensions or subscales: sustainability strategy and compliance, sustainability certification and membership, and sustainability tracking and reporting. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that that the bifactor model is statistically significant and fits the data better. This finding is in line with Cucina and Kevin (2017) and Chen, West and Sousa (2014) that bifactor model is superior to second order. It is recommended to examine the strength of the resulting general and group factors when multidimensional data are fit to a bifactor model. Three tests have been conducted for the bifactor model to assess reliability, dimensionality and replicability. Reliability test for the 'Policy and Governance' scale show a high reliability for general factor and subscale factors. This means that each of the three subscales has a unique contribution to the 'Policy and Governance' construct over and above the general factor. The dimensionality test indicates that the PG scale is not a unidimensional construct. This finding means that in measuring and reporting performance under Policy and Governance category, both total score (based on general factor) and subscale scores (based on subscale factors) should be reported. This is important in performance benchmarking and progress tracking because it means that we can find two companies with the same score under Policy and Governance but different scores under 'sustainability certification and membership', sustainability strategy and compliance' and 'sustainability tracking and reporting'. The multidimensionality nature of the construct implies that assessors should look at total score and subscale scores.

6.10.2 Corporate Workplace Scale

This performance evaluation scale is based on the fact that sustainable workplaces are among the most important strategies towards sustainable development (FKC, 2004). Shifting towards a sustainable workplace is about developing and implementing sustainability interventions at the workplace. This category has a contribution to the three dimensions of sustainability: social, through employee wellbeing; environmental, through energy and water saving and waste management; and economic, as a result of building and operation efficiency. The focus here is on corporate workplace not site workplace as in some cases, contractors do not have control over the specifications of site facilities and are often prefabricated and generally temporary in nature.

From literature review, this category was combined with the next one that is related to management of employees, but these two categories have been separated based on expert interviews. Following expert survey and interviews, 10 criteria have been retained for this scale. EFA has revealed a structure of two latent factors under this scale: Factor 1 (accounting for 15% of total variance) is ‘Sustainable Facilities’ and it includes three items that represent sustainable building requirements namely water efficiency, energy efficiency and indoor environment quality. Factor 2 is labelled ‘Sustainable Operation’ and it includes six items; accounting for 35% of the total variance. The items on this factor include aspects related to energy, waste and water monitoring in addition to cleaning procedures and transportation policies.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the two latent factors are satisfactorily correlated (r=0.46). This correlation is logical since companies that take initiative to green their workplace facilities are more likely to complement that with sustainable operation policies, but this is not necessary for all companies. In contracting business and depending on company size, corporate building could be rented not owned by the contracting company. In this case, companies may be able to focus only on sustainable operations and not implement any green retrofitting alterations to their workplace facility. According to Tabachnick and Fidell (2013), when multiple factors are correlated (r >=0.33) in oblique rotations then the latent dimensions are not independent and the correlations between the multiple factors must be considered. The next step in this case is to test the second order model as correlated factors imply a higher order factor to be explicated (Canivez, 2016). The second-order model of corporate workplace scale has good fitting indices and the first order factors “sustainable facilities” and “sustainable operations” have a loading on the second order factor of 0.86 and 0.53 respectively. The second-order factor influence on observed indicators is fully mediated by the first-order factors (Yung, Thissen, & McLeod, 1999). This means the influence of ‘corporate workplace factor’ on the observed variables if fully meditated by the two first order factors. This mediation is highly questionable and should not be considered as a straightforward finding (McDonald, 1999, Gignac, 2008). To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model or as called by McDonald (1999), indirect hierarchical model.

The bi-factor model implies that overall corporate workplace is a general construct that can be measured directly and at the same time can be defined by the two dimensions or subscales: “sustainable facilities” and “sustainable operations”. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better. This finding is in line with Cucina and Kevin (2017) and Chen, West and Sousa (2014) that bifactor model is superior to second order.

It is recommended to examine the strength of the resulting general and group factors when multidimensional data are fit to a bifactor model. Three tests have been conducted for the bifactor model to assess reliability, dimensionality and replicability. Reliability test for the ‘Corporate Workplace’ scale show a high reliability for general factor and subscale factors. This means that each of the three subscales has a unique contribution to the ‘Corporate Workplace’ construct over and above the general factor. The dimensionality test indicates that the CW scale is not a unidimensional construct. This finding means that in measuring and reporting performance under Corporate Workplace category, both total score (based on general factor) and subscale scores (based on subscale factors) should be reported. This is important in performance benchmarking and progress tracking because it means that we can find two companies with the same score under Policy and Governance but different scores under “sustainable facilities” and “sustainable operations”. The multidimensionality nature of the construct implies that assessors should measure and report total score and subscale scores.

6.10.3 Management of Employees Scale

As mentioned above, this category was combined with the previous one based on literature review (Jackson and Suomi ,2004; Linnenluecke and Griffiths, 2010). This performance evaluation scale is focused on the social dimension of sustainability that is critical to successful corporate sustainability. Chou (2014) states that the best way to communicate sustainability policies is by providing education and training to employees. Responsible management of employees can help to change the prevalent negative reputation of the construction industry in this area. Based on literature review and the results of the expert survey and interviews, 13 criteria are retained for this scale. EFA has revealed a structure of three latent factors under this scale: Factor 1 (accounting for 37% of total variance) is ‘Employee Empowerment and Engagement” and it includes four items covering training and engagement of employees through implementation of their innovative ideas and availability of sustainability award schemes. Factor 2 (accounting for 10% of total variance) is “HR Policies and Procedures” and includes requirements related to HR policies such as anti-harassment and violence, anti-discrimination, employee complaint reporting system and incident/accident reporting system. Factor 3 (accounting for 7% of total variance) is “Employee Wellbeing and Retention” referring to all the criteria related to compliance with labour camp standards in the UAE in addition to implementing employee active life / wellbeing programs and a clear employee retention procedure.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the three latent factors are satisfactorily correlated. The highest correlation (r=0.69) is between ‘Employee Wellbeing and Welfare’ and ‘Employee Empowerment and Engagement’. This correlation is logical since these two factors reflect organisations focus on employee’s satisfaction and reflect the company’s respect and valuation of employees. HR policies and procedures factor has lower yet adequate correlation of 0.51, 0.60 with ‘Employee Empowerment and Engagement’ and ‘Employee Wellbeing and Welfare’ respectively. This can be due to the fact that some companies can have strong employee programs without setting HR policies especially if these policies are not driven by local or trade regulations. According to Tabachnick and Fidell (2013), when multiple factors are correlated (r >=0.33) in oblique rotations then the latent dimensions are not independent and the correlations between the multiple factors must be considered. The next step in this case is to test the second order model as correlated factors imply a higher order factor to be explicated (Canivez, 2016).

The higher-order model of ‘management of employees’ scale has good fitting indices and shows strong loadings on the second order factor of 0.77, 0.67 and 0.89 of ‘Employee Empowerment and Engagement’, “HR Policies and Procedures’ and ‘Employee Wellbeing and welfare” respectively. The second-order factor influence on observed indicators is fully mediated by the first-order factors (Yung, Thissen, & McLeod, 1999). This means the influence of ‘management of employees’ on the observed variables if fully meditated by the three first order factors. This mediation is highly questionable and should not be considered as a straightforward finding (McDonald, 1999, Gignac, 2008). To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model or as called by McDonald (1999), ‘indirect hierarchical model. The bi-factor model implies that overall ‘Management of Employees’ is a general construct that can be measured directly and at the same time can be defined by the three dimensions or subscales. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better. This finding is in line with Cucina and Kevin (2017) and Chen, West and Sousa (2014) that bifactor model is superior to second order.

It is recommended to examine the strength of the resulting general and group factors when multidimensional data are fit to a bifactor model. Three tests have been conducted for the bifactor model to assess reliability, dimensionality and replicability. Reliability test for the ‘Management of Employees’ scale show a high reliability for general factor and the two subscale “Employee Empowerment and Engagement” and “HR Policies and Procedures’ while “Employee Wellbeing and Welfare” failed the reliability test and should not be considered as a separate construct as its contribution to the total variance of its related items is mainly explained by the general factor. The dimensionality test indicates that the CW scale is not a unidimensional construct. This finding means that in measuring and reporting performance under Management of Employees category, both total score (based on general factor) and the two subscale scores (EEE and HRPP) should be reported. This is important in performance benchmarking and progress tracking because it means that we can find two companies with the same score under

“Management of Employees” but different scores for the two reliable subscales EEE and HRPP. The multidimensionality nature of the construct implies that assessors should measure and report total score and subscale scores.

6.10.4 Procurement and Supply Chain Scale

Going beyond the company boundaries is the purpose of the procurement and supply chain scale. In addition to forging internal sustainable policies and strategies, contracting companies need to be aware of the secondary impacts of their businesses including the environmental damage done during the extraction, manufacturing and transportation of products used in construction activities (Kibert, 2002). Shifting towards responsible sourcing and solid design of sustainable supply chain are vital to perform under this category. Sustainable supply chain selection involves taking into consideration social, economic and environmental criteria during the design of downstream supply chain network. An established evaluation scheme should be consistently used to inform decisions about suppliers and subcontractors’ selection. In addition, the selected sustainable supply chain needs to be monitored and coordinated effectively. Sustainability coordination and training are to be provided by contractors. Buying responsibly requires a clear strategy for responsible sourcing and procurement of sustainable materials. Adopting waste minimisation strategies such as reverse logistics is also key to sustainable procurement.

From literature review, and following expert survey and interviews, nine criteria have been retained for this scale. EFA has revealed a structure of two latent factors under this scale: ‘Sustainable Supply Chain Selection’ (accounting for 15% of the total variance), and it includes three items covering aspects related to selection of suppliers and subcontractors based on sustainability criteria in addition to the availability of a formal sustainability evaluation scheme of suppliers and subcontractors. Factor 2 is ‘Sustainable Supply Chain Management’, accounting for 45% of total variance. It includes six items that represent sustainability collaboration and empowerment of supply chain and also possession of responsible sourcing strategy and reverse logistics policy and procedures that will facilitate the implementation of sustainable procurement throughout the supply chain.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the two latent factors are strongly correlated (r=0.61). This correlation is logical since sustainable supply chain starts with proper design of the supply chain network and needs formal tools to evaluate the compliance with set sustainability criteria. Selecting the proper supply chain must be followed by proper monitoring and supported with clear policies. On the other hand, successful management of sustainable supply chain depends heavily on the supply chain selection approach adopted. According to Tabachnick and Fidell (2013), when multiple factors are correlated (r >=0.33) in oblique rotations then the latent dimensions are not independent and the correlations between the multiple factors must be considered. The next step in this case is to test the second order model as correlated factors imply a higher order factor to be explicated (Canivez, 2016). The second-order model of ‘Procurement and Supply Chain’ scale has good fitting indices and the first order factors “Sustainable Supply Chain selection” and “Sustainable Supply Chain Management” have strong loadings on the second order factor of 0.87 and 0.69 respectively. The second-order factor influence on observed indicators is fully mediated by the first-order factors (Yung, Thissen, & McLeod, 1999). This means the influence of ‘Procurement and Supply Chain’ factor on the observed variables if fully mediated by the two first order factors. This mediation is highly questionable and should not be considered as a straightforward finding (McDonald, 1999, Gignac, 2008). To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model or as called by McDonald (1999), ‘indirect hierarchical model.

The bi-factor model implies that overall performance in ‘Procurement and Supply Chain’ is a general construct that can be measured directly and at the same time can be defined by the two dimensions or subscales: “Sustainable Supply Chain selection” and “Sustainable Supply Chain Management”. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better. This finding is in line with Cucina and Kevin (2017) and Chen, West and Sousa (2014) that bifactor model is superior to second order.

It is recommended to examine the strength of the resulting general and group factors when multidimensional data are fit to a bifactor model. Three tests have been conducted for the bifactor model to assess reliability, dimensionality and replicability. The dimensionality test indicates that the PSC scale is a unidimensional construct. This finding means that in measuring and reporting performance under PSC category, the total score (based on general factor) is sufficient and is the only score to be interpreted and reported. Reliability test for the 'Procurement and Supply Chain' scale show a high reliability for general factor. The unidimensional nature of the construct implies that assessors should measure and report total score of performance under this category.

6.10.5 Project Delivery Scale

This performance evaluation scale is based on the fact that the construction industry is a project-based industry in which the projects are considered temporary organisations. Delivery of construction projects constitutes a major part of a contractor's business. Therefore, sustainable contractors must employ consistent and comprehensive sustainability delivery methods to ensure that project sustainability requirements are efficiently and effectively delivered.

From literature review and following expert survey and interviews, 11 criteria have been retained for this scale. EFA has revealed a structure of two latent factors under this scale: Factor 1 (accounting for 40% of total variance) is 'Sustainable Site Management' and it includes three items related to having a dedicated sustainability champion on site and establishing plans to reduce environmental impact of construction activities. Factor 2 is 'Sustainability Tools and Innovation' accounting for 11% of total variance, and it includes items related to utilisation of innovative tools for measuring sustainability performance on site such as life cycle costing tools, carbon tracking tools and waste estimation and recording tools.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the two latent factors are adequately correlated (r=0.57). This correlation means that sustainable site management is highly related to the availability of tools and plans that can ensure consistent and efficient management of construction sites. On the other hand, some tools and innovative approaches to sustainability are not prerequisites for sustainable site management. According to Tabachnick and Fidell (2013), when multiple factors are correlated (r >=0.33) in oblique rotations then the latent dimensions are not independent and the correlations between the multiple factors must be considered. The next step in this case is to test the second order model as correlated factors imply a higher order factor to be explicated (Canivez, 2016). The second-order model of 'Project Delivery' scale has good fitting indices and both first order factors have a significant loading on it. "Sustainable Site Management" factor has an excellent loading of 0.96 and this can be due to the fact that all criteria under this category are highly related to site management in a sustainable way in order to mitigate the environmental and social impact of construction activities. "Sustainable Tools and Innovation" has a lower but good loading on the second order factor, which can be explained by the fact that innovation is still limited in construction industry and criteria under this category require high level of investment and proactivity to be implemented. The second-order factor influence on observed indicators is fully mediated by the first-order factors (Yung, Thissen and McLeod, 1999). This means the influence of 'Project Delivery factor' on the observed variables if fully mediated by the two first order factors. This mediation is highly questionable and should not be considered as a straightforward finding (McDonald, 1999, Gignac, 2008). To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model or as called by McDonald (1999), 'indirect hierarchical model. The bi-factor model implies that overall corporate workplace is a general construct that can be measured directly and at the same time can be defined by the two dimensions or subscales. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, the Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better. This finding is in line with Cucina and Kevin (2017) and Chen, West and Sousa (2014) that bifactor model is superior to second order.

It is recommended to examine the strength of the resulting general and group factors when multidimensional data are fit to a bifactor model. Three tests have been conducted for the bifactor model to assess reliability, dimensionality and replicability. Reliability test for the ‘Project Delivery’ scale show a high reliability for general factor and subscale factors. This means that each of the two subscales has a unique contribution to the ‘Project Delivery’ construct over and above the general factor. The dimensionality test indicates that PD scale is a multidimensional construct. This finding means that in measuring and reporting performance under Project Delivery category, both total score (based on general factor) and subscale scores (based on subscale factors) should be reported. This is important in performance benchmarking and progress tracking because it means that we can find two companies with the same score under Project Delivery but different scores under “Sustainable Site Management’” and “sustainable tools and innovation”. The multidimensionality nature of the construct implies that assessors should measure and report total score and subscale scores.

6.10.6 Higher order scales

The next step after conducting CFA for the five domains leads towards achieving the study’s primary objective of testing and validating a comprehensive sustainability performance model for construction contractors. The first model tested is the proposed hierarchical conceptual and it hypothesises one third order factor, five second order factors and 15 first order factors. The second model hypothesises that the five bifactor subscale models are correlated with each other and the third model hypothesises one third factor model explaining five subscale bi-factor models. The level of fit of the three higher order models was inacceptable and this can be due to the sample size compared to the number of variables in the model. From a theoretical perspective, the purpose of having third order model is to show that the five subscales are actually observed factors explained by one main latent factor that is overall sustainability performance. This hypothesis is important for further research that can use the model to develop composite sustainability score for the UAE construction contractors using suitable scoring methods such as regression methods or AHP similarly to other scale development studies (Chang and Chen, 1998; Akadiri, 2011; Zhu, Su and Guo, 2009). However, validation of third order hierarchical model is not necessary and the scales for the five domains can be considered separately.

6.10.7 Final proposed model

As explained above, bifactor models for the five domains of sustainability performance have a good fit and explain the collected data better in comparison to second order models. However, the proposed third order hierarchical model and the two competing higher order models (based on bifactor models) have a poor fit. This suggest that the five domain scales can be considered separately instead of being correlated or explaining a third order construct. CSR and sustainability are multi-dimensional concepts and many studies have attempted to simplify this multifaceted measurement systems into single composite scores. However, Blanchard and Petit (2017) argue that one size does not fit all and that weighting systems used to calculate aggregated score often misinterprets the differences between companies and usually underweight corporate governance issues. In this study, the bi-factor models demonstrated good fit and can be considered as five separate scales measuring sustainability performance of the UAE construction contractors in five domains.

The proposed model will then be composed of five scales. This model is very similar, in principle, to the Balanced Scorecard; a very commonly used performance measurement system (Figure 6.27). Balanced Scorecard is a four perspective framework of indicators aiming at measuring organisational performance in a holistic manner that is beyond financial indicators (Chenga 2011; Yazdani et al. 2012;Warhurst 2002).

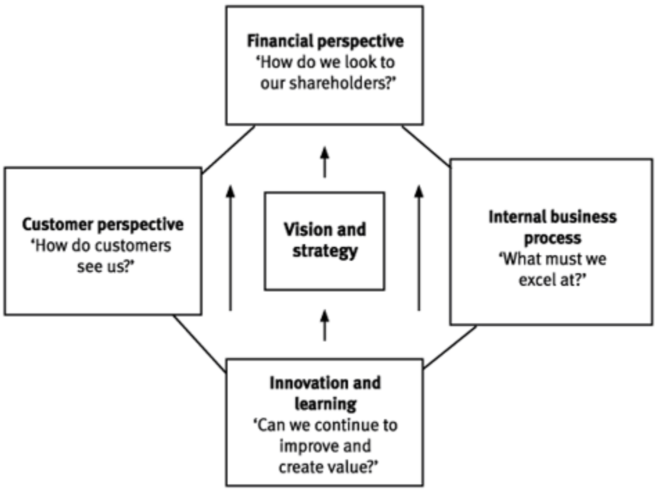


Figure 6.27: The Four Perspectives of Balanced Scorecard
(Kaplan and Norton, 1996)

The causal relationships represented by lines and arrows in the scorecard have been assumed by Kaplan and Norton (1996) and further analysed by other studies such as Nørreklit(2000). Nørreklit (2000) concluded from his evaluation of the foundation for the balance in the balanced scorecard that the causality claimed between perspectives is problematic and not statistically sound. He states that "instead of a cause-and-effect relationship, the relationship between the areas is more likely to be one of interdependence" (Nørreklit 2000, p75). In line with the concept of balanced scorecard that emphasises the fact that strategy and policy is a central element of any performance measurement system, we can propose a model composed of the five validated bi-factor models. While it was not statistically proven that there are causal relationships between different domains of the proposed model, theory strongly supports this aspect of interdependence and overlap between the sustainability performance domains (Kaivo-Oja *et al.*, 2013; Bouslah and Zali, 2015). The proposed evaluation model is illustrated in the Figure 6.28. It is very important to note that the linking connectors between the five perspectives/domains in this proposed model are not supported by the higher order factor analysis. However, the multidimensionality and integrated nature of sustainability assessment in general supports the overlap and interdependence between all the domain scales that constitute the proposed model.

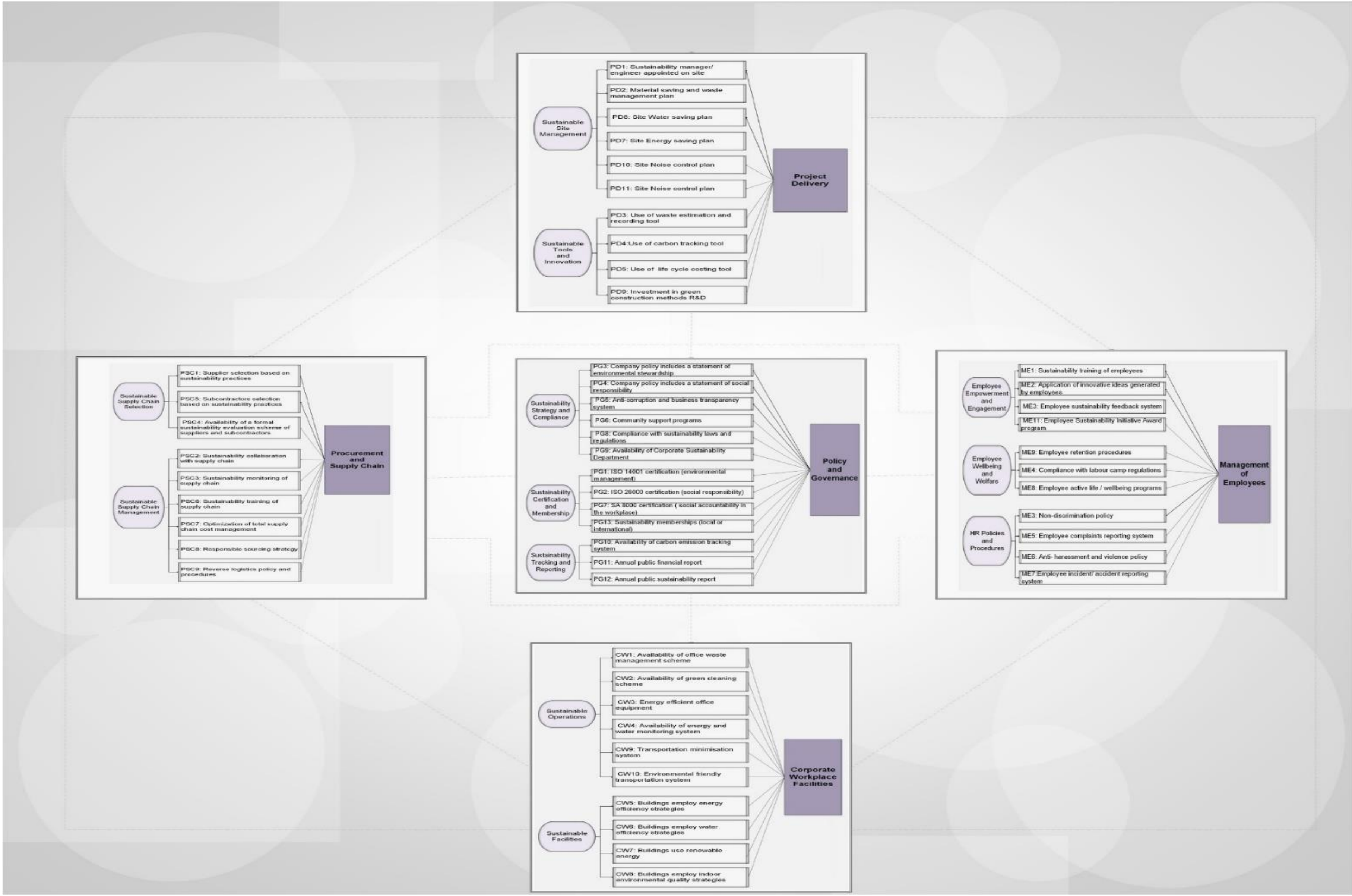


Figure 6.28: Recommended Multidimensional Sustainability Evaluation Model

The proposed model structure is illustrated in Figure 6.28 above showing all the domains, sub-domains and criteria that are proposed by this study to evaluate the sustainability performance of contractors. The findings from further assessment of bifactor models give directions on which scales should be reported and what scales failed the reliability test (Table 6.49). It is worth noting that replicability test is different from reliability test as it only indicates the possibility of using the factor score as independent construct in further SEM studies (Rodriguez, Reise and Haviland, 2016).

Table 6.49: Final bi-factor model scales

	Factors	Dimensionality	Reliability	Replicability
Policy and Governance Scale	Sustainability Certification and Membership (SCM)	Multidimensional	Pass	Pass
	Sustainability Strategy and Compliance (SSC		Pass	Pass
	Sustainability Tracking and Reporting (STR)		Pass	Pass
	General Factor (PG)		Pass	Pass
Corporate Workplace Scale	Sustainable Operations (SO)	Multidimensional	Pass	Pass
	Sustainability Facilities (SF)		Pass	Fail
	General Factor (CW)		Pass	Pass
Management of Employees Scale	Employee Empowerment and Engagement (EEE)	Multidimensional	Pass	Fail
	HR Policies and Procedures (HRPP)		Pass	Pass
	Employee Wellbeing and Retention (EWR)		Fail	Fail
	General Factor (ME)		Pass	Pass
Procurement and Supply chain Scale	Sustainable Supply chain Selection (SSCS)	Unidimensional	Pass	Pass
	Sustainable Supply Chain Management (SSCM)		Fail	Fail
	General Factor (PSC)		Pass	Pass
Project Delivery Scale	Sustainable Site Management (SSM)	Multidimensional	Pass	Fail
	Sustainability Tools and Innovation (STI)		Pass	Fail
	General Factor (PD)		Pass	Pass

To illustrate the implementation of this model to contracting companies, an indicative calculation of factor score can be conducted. Factor score can be calculated as a composite variable that reflects the relative contributions of all variables to the factor. A composite score can be obtained by multiplying each individual score by their respective factor loading scores and then added up all products together to get a weighted average score (Hair *et al.*, 2014).

While this method is considered as a non-refined computing method, it is better than other simplistic cumulative methods that ignore item weighting (Uluman and Doğan, 2016). Refined and robust factor scoring is beyond the scope of this study and this attempt has a mere purpose of clarifying the possible implementation of the proposed measurement model. Calculation of composite scores is helpful because it facilitates reduction of variables. Composite scores, rather than the individual variables, are analysed and interpreted. To illustrate possible implementation of the measurement scales developed in this study, the variable scores are retrieved from the responses (on the Likert scale) of two respondents (representing two randomly selected contractors) in the main contractor survey used in this factor analysis. The scoring of the two contractors are calculated based on weighted sum scores method by taking into consideration the dimensionality and reliability tests of the five scales.

Factors that fail reliability test are flagged as it means that the variance of the items under this factor is largely explained by general factor rather than the subscale factor alone and therefore this subscale should not be reported as separate factor score. The detailed calculation is included in appendix C and the final scores are converted into bar charts (Figure 6.29) to illustrate the comparison between the performances of the two contractors under different reliable factors. An interpretation of the performance charts below show that the assessment should consider total score and subscale scores for the multidimensional constructs. For example, the findings of bi-factor model for policy and governance scale suggests that total performance score and subscale scores must be reported.

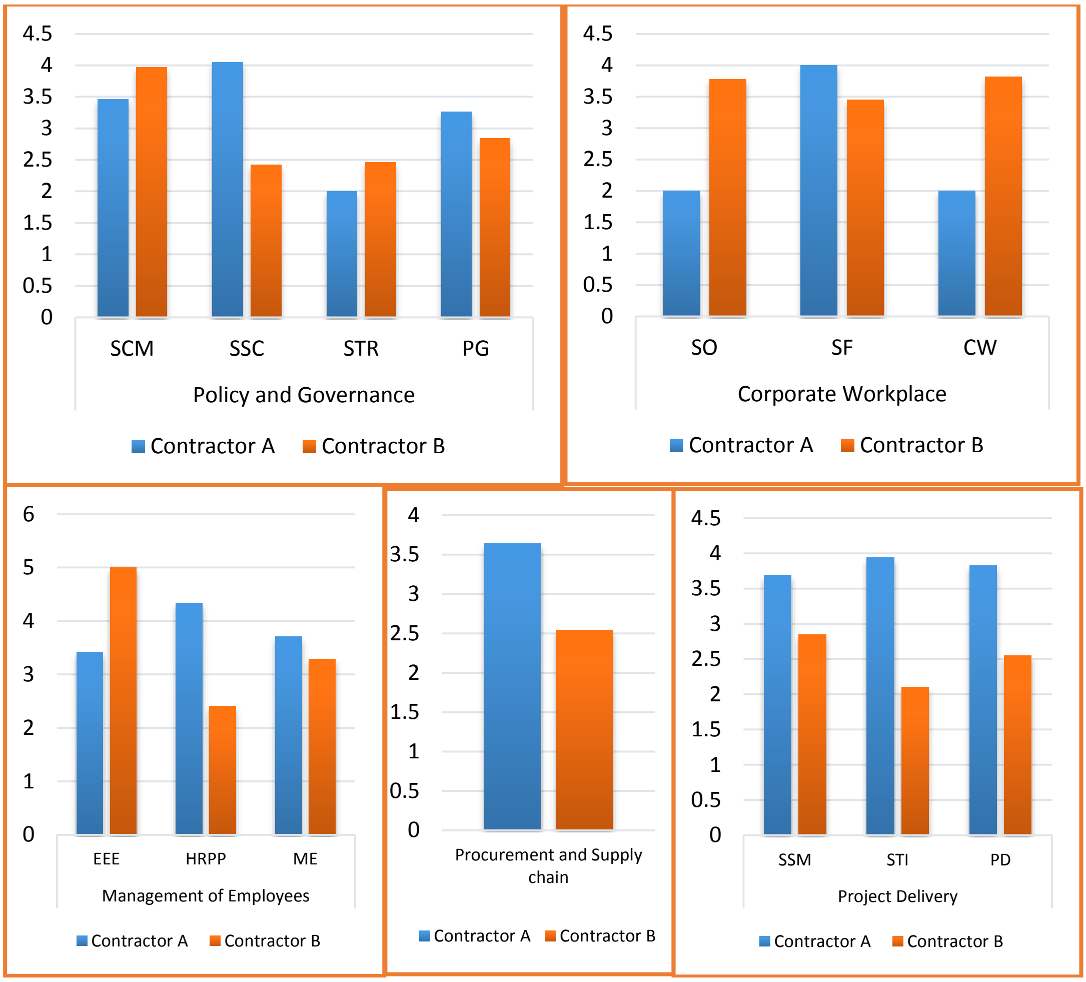


Figure 6.29: Performance charts in the five domains

The chart above shows that contractor A has a higher total score in Policy and Governance. However, we cannot conclude that company A is performing better than company B in policy and governance domain based on total score alone, since its score for subscale SSM and STR is less than the performance score of company B. The best pictorial chart to show the performance under different categories is radar or spider chart. Based on the same data in Appendix C, the comparison between the two companies can be clearly seen in figure 6.30.

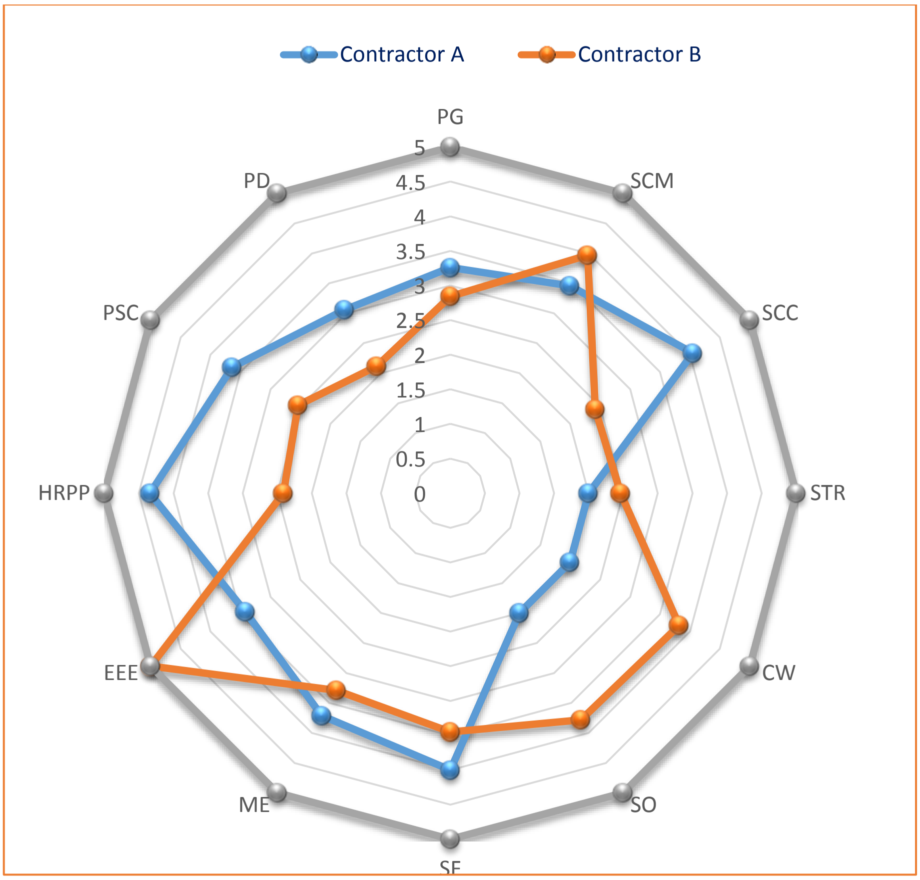


Figure 6.30: Performance Radar Chart

Analysing the radar chart can help companies understand the areas of focus for improvement either by comparing their performance to others or to their performance in previous years. The chart also shows the benefit of having interdependent measurement domains rather than just a total score as the compensation of weak performance in one domain by strong performance in a different domain is often hidden in composite score-performance based.

6.11 Summary

At the beginning of this chapter, the factor analysis was conducted for the five domains following a descriptive analysis of the survey sample. The analysis included data suitability and data factorability assessment. The approach and options for rotation and extraction were based on the explanation provided in sections 5.8.2 and 5.8.3. The structure of the five scales has been explored through EFA and then validated through

CFA in Amos software. For each scale, first order, second order and bi-factor models are tested and validated. While all models have a good fit, bi-factor model has proved to be statistically significant than second order models in the case of the five scales. The next step was to test the proposed higher order level models and two alternative higher order models combining bi-factor models. However, GOF indices of the proposed third order hierarchical model and the two competing higher order models have a poor fit. This suggests that the five domain scales can be considered separately instead of being correlated or explaining a third order construct. The discussion part of this chapter makes an analogy of the five interdependent scales with the balanced scorecard. The proposed model has a similar concept. While the linking connectors between the five scales in the proposed model are not supported by the higher order factor analysis, the multidimensionality and integrated nature of sustainability assessment in general supports the overlap and interdependence between all the domain scales that constitute the proposed model. In the final section of this chapter, implementation of the proposed model was exemplified through a comparison between factor scores for two companies retrieved from the survey. The chapter concludes by explaining the practical implications of the proposed scales and which factors (general and subscales) should be focused upon during performance evaluation, tracking and benchmarking.

Chapter 7: Conclusions

7.1 Introduction

This chapter presents and discusses the main findings from the data analysis results covered in the previous chapter. Integration with literature review findings and empirical data analysis results will be conducted here in a more focused manner. The chapter starts by recalling the research aim and objectives and providing an overview of the theoretical framework for this research. Second section then draws on the findings of the statistical analysis conducted in relation to the sustainability evaluation model of construction contractors in the UAE.

7.2 Research aim and objectives

The overall aim of this research is to develop a multi-criteria evaluation model of the UAE construction contractors based on sustainability performance.

In order to achieve the research aim, the following four key objectives have been set:

1. To review corporate sustainability concept and its implementation in the construction industry.
2. To review the existing corporate sustainability evaluation systems and assess the need for a specific evaluation system for construction contractors.
3. To develop a conceptual model for sustainability evaluation of the UAE construction contractors
4. To empirically assess the validity of the proposed model through factor analysis.

7.3 Achievement of research objectives

This research explored and analysed the sustainability performance criteria that can be used as a basis of an evaluation model for the UAE construction contractors. Prior studies on sustainability performance an existing corporate sustainability system have been reviewed and used as the source of the initial pool of criteria. Table 7.1 below summarises the methodology and main findings of the current study.

Table 7.1: Research Summary

Objectives	**Method**	**Output**	**Related chapters**
Theoretical foundation	Literature review	Need assessment	Chapter 2
Identify scale domains Identify pool of criteria	Literature review	4 domains 58 criteria	Chapter 3
Check applicability and completeness of the selected domains and criteria	Expert interviews	5 domains 6 criteria added 10 criteria reworded	Chapter 5
Cross check relevance of the criteria	Expert survey	5 domains 3 Criteria removed 56 final list of criteria	Chapter 5
Evaluate and validate the measurement scales	Main survey - First order models - Higher order models - Bifactor models	Validated measurement scales and proposed overall model structure of interdependent five bifactor scales.	Chapter 6

Objective 1: Review of corporate sustainability concept and its implementation in the construction industry.

This objective has been achieved through review of literature in chapter two. Chapter 2 laid the ground for the importance of sustainability in the construction industry and the need for projecting global sustainability policies on the corporate level if tangible advancement in sustainable development are to be achieved. The chapter explained how the global sustainability goals and policies are being rolled over to affect and shape sustainability at country level, industry level and company level. Focusing on the UAE, which is the scope of this study, it has been concluded that sustainability movement in the UAE is outstanding in terms of fast introduction and enforcement of regulations which represents a big challenge for the construction industry and construction companies. Review of literature has emphasised the importance of sustainability performance of companies and how it has proved to be strongly correlating with long term financial performance. There are many driving forces for companies to improve their sustainability performance including regulations, employees, customers, investors and non-profit organisations. Companies are increasingly understanding the importance of being proactive in their approach to sustainability should they aim to strive in a highly competitive market. The first part of literature review revealed that the drive towards sustainability in the construction industry is occurring at a very fast pace and it is impacting every level within the construction supply chain. At the contractor level, sustainability starts to affect the contractors' competitiveness and their bidding success rate. Sustainability driven construction requires a genuine move towards full disclosure and accountability throughout the construction supply chain. It is found that sustainability is bringing a positive shift to the existing price paradigm because companies with strong corporate sustainability performance have created a competitive advantage that gives them a valid reason to charge price premiums for their qualifications and capabilities to deliver sustainable projects. However, using this competitive advantage requires a performance measurement system and a continuous improvement strategy. Evaluation of corporate sustainability performance requires a system characterised by clarity, consistency and comprehensiveness acting as a decision aid for clients and as benchmarking tool for contractors. This need is the focus of the second objective of this research.

Objective 2: Review of the existing corporate sustainability evaluation systems and assess the need for a specific evaluation system for construction contractors

This objective has been achieved mainly through literature review in chapter 3 where the importance of corporate sustainability performance measurement has been highlighted and the main corporate sustainability reporting systems have been reviewed. It was clear from this review that a set of different evaluation and reporting systems are already available including GRI, ISO26000, SA8000, B Corp, ABC Green Contractor, SPI, and DJSI World. However, it has been concluded from the evaluation of these systems that they do not satisfy the aim of this study.

The review of the existing systems shows that GRI and ISO26000 provide reporting and CSR guidance rather than evaluation and assessment systems. Sustainability reports contain excessive amounts of extraneous information which can make analysis and decision-making difficult for investors, regulators, NGOs and consumers. SA800 is a certification system, but it is only based on social performance and more specifically on working conditions and human rights procedures. Despite wide recognition of its increasing role in promoting responsible and transparent businesses, B Corp is still limited to US organisations, and its adoption is slow, especially by construction organisations. Although it addresses construction contractors, ABC Green Contractor is limited to the workplace environment and fails to provide a holistic sustainability assessment approach. SPI focuses on construction organisations and provides a comprehensive change management, measurement and continuous improvement framework. However, SPI's certification process is based on an audit and examination of organisational performance rather than on straightforward evaluation criteria and a scoring system. DSJI is a ranking system that provides a good benchmarking tool for top performers in corporate sustainability, but relevant performance measures need to be simple, quick to measure, visually presentable and easily understood. In line with the principles of performance evaluation in general, it is agreed that using only one assessment criterion or using complicated evaluation processes are not found to be a correct approach.

It is found from literature that for a multidimensional concept such as corporate sustainability, it is necessary to accept a multi-criteria perspective that considers a spectrum of issues and performance areas. It is also recommended that the measures themselves should be based on an explicit purpose and should be both comparable and consistent so they can be valid for setting clear targets, measuring trends and comparing performance levels. The review of literature concludes by confirming the need for a multi-criteria evaluation system that is very specific to contracting companies and realistically applicable to the UAE construction market.

Objective 3: Development of a conceptual model for sustainability evaluation of the UAE construction contractors

The purpose of this study is to build on the existing systems and on similar studies in other industries and develop a new evaluation model for the UAE contractors. Based on a review of the existing systems and of several published studies in other industries covering the topic of sustainability evaluation of companies, it was decided to develop the evaluation model as four dimensional model covering these four categories: 1) policy and governance, 2) employees and workplace, 3) procurement and supply chain and 4) project delivery.

Under policy and governance, contractors should have a sustainability statement clearly stated, publicly communicated and covering the triple bottom line; pursue sustainability related certifications and accreditations to prove strong leadership and commitment to sustainability; be considerate to local communities and their social responsibility must go beyond the company boundaries to include communities and wide range of stakeholders; and have a self-inspection system to monitor their sustainability performance. The results of tracking and evaluation processes should be reported and shared with the public in a transparent way and according to international practice.

When it comes to employees and workplace, construction contractors' shifting towards sustainable workplace is about developing interventions at building, operation and cultural levels by: addressing health and well-being of employees through improved building performance strategies in their corporate facilities; considering strategies such as waste management, energy management and sustainable transportation; possess a clear management system of employees at corporate and site levels that includes ethics, safety, sustainability based evaluation and recruitment.

Procurement and supply chain scale involves assessment of contractors' supply chain selection and management strategies in addition to their procurement strategies. This includes selection of supply chain based on sustainability performance followed by proper monitoring and coordination. Sustainable procurement is the operational part of supply chain management and it focuses mainly on responsible sourcing and reverse logistics procedures.

The last category in the theoretical model is related to the type of business construction contractors operate in that is a project-based business. Consistent sustainable projects delivery can be proved by having an established system and reliable tools for life cycle cost analysis, carbon tracking and waste management and possessing established plans to reduce environmental impact of construction activities and ultimately going beyond contractual requirements and proving innovation and investment in new sustainability products or processes.

The proposed conceptual model has a hierarchical structure that includes a total of 58 criteria categorised under the four categories explained above: policy and Governance (12 criteria), employees and workplace (22 criteria), Procurement and supply chain (9 criteria) and project delivery (15 criteria).

To empirically assess the validity of the proposed model through factor analysis

Following the establishment of the initial list of criteria, the scale development process explained in the research methodology requires a validation of the scale content to ensure it measures what is intended to measure. A two-layer content validity method was adopted that involves expert interviews followed by expert survey. The purpose of both methods is to check the accuracy of the model domains and evaluate the relevance of criteria and their wording.

The expert judgements resulted in some alterations of some items wording for clarity and consistency. In addition, one domain ‘employees and workplace’ has been divided into two domains ‘management of employees’ and ‘corporate workplace’. To ensure a robust and valid list of items, this study conducted expert survey analysed through relative index analysis to ensure the items are applicable to contractors and to the UAE construction industry. The updated model based on expert interviews was used in the expert survey, but no items have been eliminated until they were cross checked with the survey results. In the survey, 82 sustainability professionals have responded by providing a ranking of the criteria based on the level of relevance to the related domain. Finally, an updated evaluation model of 56 criteria was proposed based on the modification resulting from expert judgement and it was subject to the next stage of scale development which is factor analysis.

The validated 56 items scale has been divided into five subscales: Policy and Governance, Corporate Workplace, Management of Employees, Procurement and Supply Chain and Project Delivery. First, CFA was conducted for all constructs at the first-order level. Second, CFA was conducted for all subscales at the second-order level followed by bifactor model evaluation. Findings of the factor analysis for the five subscales is explained below.

Policy and Governance Scale: based on the results of the expert survey and interviews, 13 criteria are retained for this scale. EFA has revealed a structure of three latent factors under this scale: 1) Sustainability Strategy and Compliance (SSC): includes five criteria covering aspects of an underlying strategy that is clearly substantiated in the company policy statements and translated into compliance with sustainability regulation and implementation by a dedicated corporate sustainability department; 2) Sustainability Certification and Membership (SCM): includes four criteria clustered around going beyond the self-evaluation and internal strategic goals to cover sustainability third party certification in addition to sustainability memberships locally and internationally; and 3) Sustainability Tracking and Reporting (STR): includes three items that are related to carbon tracking, sustainability and financial reporting.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the three latent factors are satisfactorily correlated. The next step was to test the second order model as correlated factors imply a higher order factor to be explicated. The higher-order model of policy and governance scale has good fitting indices and shows strong loadings of the three factors on the second order factor. This means the influence of 'policy and governance factor' on the observed variables if fully meditated by the three first order factors. To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model.

The bi-factor model implies that overall corporate sustainability performance is a general construct that can be measured directly and at the same time can be defined by the three dimensions or subscales: sustainability strategy and compliance, sustainability certification and membership, and sustainability tracking and reporting. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that that the bifactor model is statistically significant and fits the data better.

Corporate Workplace Scale: This scale has a contribution to the three dimensions of sustainability: social, through employee wellbeing; environmental, through energy and water saving and waste management; and economic, as a result of building and operation efficiency. The focus here is on corporate workplace not site workplace as in some cases, contractors do not have control over the specifications of site facilities and are often prefabricated and generally temporary in nature. From literature review, this category was combined with the next one that is related to management of employees, but these two categories have been separated based on expert interviews. Following expert survey and interviews, 10 criteria have been retained for this scale. EFA has revealed a structure of two latent factors under this scale: 1)Sustainable Facilities (SF): includes three criteria that represent sustainable building requirements namely water efficiency, energy efficiency and indoor environment quality; and 2) Sustainable Operations (SO): it includes six items focusing on aspects related to energy, waste and water monitoring in addition to cleaning procedures and transportation policies.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the two latent factors are satisfactorily correlated which justifies the next step to test the second order model. The second-order model of corporate workplace scale has good fitting indices and the first order factors have a loading on the second order factor of 0.86 and 0.53 respectively. The second-order factor influence on observed indicators is fully mediated by the first-order factors. To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model.

The bi-factor model implies that overall Corporate Workplace is a general construct that can be measured directly and at the same time can be defined by the two dimensions or subscales: “sustainable facilities” and “sustainable operations”. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better.

Management of Employees Scale: This performance evaluation scale is focused on the social dimension of sustainability that is critical to successful corporate sustainability. Based on literature review and the results of the expert survey and interviews, 13 criteria are retained for this scale. EFA has revealed a structure of three latent factors under this scale: 1) Employee Empowerment and Engagement (EEE) which includes four items covering training and engagement of employees through implementation of their innovative ideas and availability of sustainability award schemes; 2) HR Policies and Procedures (HRPP) including requirements related to HR policies such as anti-harassment and violence, anti-discrimination, employee complaint reporting system and incident/accident reporting system; and 3) Employee Wellbeing and Welfare referring to all the criteria related to compliance with labour camp standards in the UAE in addition to implementing employee active life / wellbeing programs and a clear employee retention procedure.

CFA was then conducted to test and validate EFA findings. First order model revealed that the three latent factors are satisfactorily correlated. The next step in this case is to test the second order model as correlated factors imply a higher order factor to be explicated. The higher-order model of ‘management of employees’ scale has good fitting indices and shows strong loadings of first order factors on the second order factor. The second-order factor influence on observed indicators is fully mediated by the first-order factors. To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model.

The bi-factor model implies that overall ‘Management of Employees’ is a general construct that can be measured directly and at the same time can be defined by the three dimensions or subscales. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better.

Procurement and Supply Chain Scale: Going beyond the company boundaries is the purpose of the procurement and supply chain scale. From literature review, and following expert survey and interviews, nine criteria have been retained for this scale. EFA has revealed a structure of two latent factors: Sustainable Supply Chain Selection (SSCS) which includes three items covering aspects related to selection of suppliers and subcontractors based on sustainability criteria in addition to the availability of a formal sustainability evaluation scheme of suppliers and subcontractors; and 2) Sustainable Supply Chain Management (SSCM) including six criteria covering sustainability collaboration and empowerment of supply chain and also possession of responsible sourcing strategy and reverse logistics policy and procedures to facilitate the implementation of sustainable procurement throughout the supply chain.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the two latent factors are strongly correlated. The next step in this case is to test the second order model as correlated factors imply a higher order factor. The second-order model has good fitting indices and the first order factors have strong loadings on the second order factor. The second-order factor influence on observed indicators is fully mediated by the first-order factor. To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model.

The bi-factor model implies that overall performance in ‘Procurement and Supply Chain’ is a general construct that can be measured directly and at the same time can be defined by the two dimensions or subscales: “Sustainable Supply Chain selection” and “Sustainable Supply Chain Management”. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, The Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better.

Project Delivery Scale: this performance evaluation scale is based on the fact that the construction industry is a project-based industry in which the projects are considered temporary organisations. Delivery of construction projects constitutes a major part of a contractor’s business. Therefore, sustainable contractors must employ consistent and comprehensive sustainability delivery methods to ensure that project sustainability requirements are efficiently and effectively delivered. From literature review and following expert survey and interviews, 11 criteria have been retained for this scale. EFA has revealed a structure of two latent factors under this scale: 1) Sustainable Site Management (SSM) including three items related to having a dedicated sustainability champion on site and establishing plans to reduce environmental impact of construction activities; and 2) Sustainability Tools and Innovation including items related to use of innovative tools for measuring sustainability performance on site such as life cycle costing tools, carbon tracking tools and waste estimation and recording tools.

In a next step, CFA was conducted to test and validate EFA findings. First order model revealed that the two latent factors are adequately correlated. The next step in this case is to test the second order model as correlated factors imply a higher order factor to be explicated (Canivez, 2016). The second-order model of ‘Project Delivery’ scale has good fitting indices and both first order factors have a significant loading on it. This means the influence of ‘Project Delivery factor’ on the observed variables if fully mediated by the two first order factors. To evaluate the validity of this mediation further, the next step of CFA was conducted, which is bifactor model.

The bi-factor model implies that overall project delivery is a general construct that can be measured directly and at the same time can be defined by the two dimensions or subscales. The results indicate that the first-order model, second-order model, and bifactor model fit the data well. However, the Chi-square difference test indicated that the bifactor model is statistically significant and fits the data better.

Proposed model

The next step after conducting CFA for the five domains leads towards achieving the study's primary objective of testing and validating a comprehensive sustainability performance model for construction contractors. The first model tested is the proposed hierarchical conceptual model and it hypothesises one third order factor, five second order factors and 15 first order factors. The second model hypothesises that the five bifactor subscale models are correlated with each other and the third model hypothesises one third factor model explaining five subscale bi-factor models. The level of fitness of the three higher order models was inacceptable and this can be due to the sample size compared to the number of variables in the model.

The proposed model will then be composed of five scales. This model is very similar, in principle, to the Balanced Scorecard; a very commonly used organisational performance measurement system. The linking connectors between the five subscales in the proposed model have not been supported by the higher order factor analysis. However, the multidimensionality and integrated nature of sustainability assessment in general supports the overlap and interrelationships between all the subscales that constitute the proposed model. The findings from further assessment of bifactor models give directions on which scales are reliable and should be reported, and what scales failed the replicability test and should be retested as they are not currently suitable to feed into SEM structures as standalone constructs.

7.4 Value of the study

For construction contractor to properly measure and benchmark their sustainability performance, they have to identify what should be measured and what are the criteria valued by clients and which would benefit the whole industry towards the main goal of being sustainable. Nevertheless, there has been insufficient research to identify the performance criteria to be adopted for evaluation of construction contractors. There is a significant agreement in academia and industry about the importance of measuring sustainability performance but there is little clarity on the basis of this measurement. It is nearly impossible for clients to assess contractors' sustainability performance or for contractors to prove their proactive approaches towards sustainability. Due to these necessities and limitations in the existing literature, this research intended to develop scales for the evaluation of sustainability performance of construction contractors with focus on the UAE as geographical scope of the study. The present study will make a significant academic and practical contribution to the fields of corporate sustainability and sustainable construction as it will build on existing corporate sustainability systems and best practices to develop a holistic sustainability evaluation system specifically tailored to contractors and to the UAE construction market.

The contributions of this study are as follows. First, this study focuses on sustainability performance of construction contractors, an area that has been overlooked in sustainable construction research. Despite the fact that sustainable construction objectives have been increasingly considered globally and, in the UAE, the main focus has always been on design and less frequently on construction activities. This study addresses the importance of corporate sustainability performance in construction companies in general and contracting companies in particular. In terms of scale development area of research, this study provides a clearly explained process with all the options adopted for the analysis to facilitate replicability and contribute towards shifting from the default extraction, rotation and estimation methods that have been widely used in the literature without proper rationale. The study of different levels of CFA models and of the bifactor models represent a good contribution to the fields of corporate sustainability and scale development.

In practice, the developed model can be adopted by the following stakeholders for different purposes:

- Local authorities can use the model as the basis for a sustainability classification system of contractors. Classification of contractors has always been based on financial and technical qualifications. This model can help assign sustainability scores to contracting companies and classify them accordingly.

- It could also be used by clients as a supporting decision-making tool during tender prequalification stage and as part of designing their sustainable supply chain. Clients usually develop their tender evaluation and pre-qualification criteria based on their project success factors. If this model is developed into a classification system by local authorities, clients will have a reliable and easy ranking to guarantee the sustainability performance of their bidding contractors. They will be able to set a threshold for the required rank that will allow only contractors at that rank to bid for their sustainable projects. The models can also be used directly by client as a tool towards designing their sustainable supply chain. Clients can use the model scales and criteria to evaluate contractors and select the most suitable contractor to form part of their sustainable supply chain or to be accepted on their list of certified pre-qualified contractors.

- The evaluation model can also help contractors track and benchmark their performance and provide clear evidence of their sustainability commitment and competitive advantage in corporate responsibility. Contractors can use the model to track their performance over a period of time, to benchmark their performance against best and average market performance in different categories. This would help them identify their areas of strength and weakness and decide on the correction measures towards enhancing their competitive advantage in corporate sustainability performance.

7.5 Limitations of the study

The study results need to be interpreted carefully in consideration of the following limitations. First, massive samples from construction contractors in the UAE were difficult to collect due to limited response and time constraints. Although a reliable face and content validity has been undertaken through two layers, both expert samples were limited and could have been broader. Sample size for factor analysis was within the required limit for subscales, however, it was very small for the evaluation of higher order models with larger number of variables. Moreover, the scale developed in this study covered mainly medium and large size contractors and may not be suitable for small enterprises. The main limitation of this study is the uncertainty of model validation created by small samples. AMOS software also presents some limitation when Unweighted Least Square (ULS) method is used as not all indices as provided as output and the factor scores are not imputed when this method is used.

7.6 Recommendations for further studies

The aforementioned limitations provide opportunities for further research areas and approaches. In addition, the findings from this current research provides avenues for further research directions. This study focuses on construction contractors in the UAE. Future research may verify the validity of the proposed model in other geographical areas and for other construction companies such as consultancies and developers. With respect to triple bottom line, the proposed scale is covering five categories that include criteria related to the three dimensions of sustainable development: social, economic and environmental. While a simple categorization of criteria has been confirmed in 3.7, further research can focus on empirical test of triple bottom line coverage in a balanced way. Moreover, another research direction would be to investigate the link of sustainability performance to financial performance of contracting companies. This kind of study can be conducted using SEM similarly to previous similar studies conducted for other industries and other research fields and assessing the links between different performance areas and practices (Jiang *et al.*, 2018; Deng and Pierskalla, 2018; Zhu, Sarkis and Lai, 2013).

While not the focus of this study, a development of sustainability performance composite score can be undertaken in future studies using multivariate analysis methods such as AHP method and eliciting experts' opinions in relation to relative importance of evaluation criteria. While composite score is not necessary for measuring sustainability performance, it makes benchmarking and progress evaluation easier. Local authorities can use composite scores to classify contractors into different classes based on their sustainability performance. This classification can be used in line with the existing classification system of contractors and integrated with the prequalification method used by clients to select the most suitable contractors for their projects. As explained in study limitations, higher order models showed a poor fit but the accuracy of this finding is significantly affected by the sample size. Further study with larger sample can be conducted to evaluate the higher order nested model option discussed in this study. The main aim of this research is to develop an evaluation model based on sustainability performance of the UAE contractors. A set of criteria has been identified and validated. Future research can focus on the next level by developing a measurement system and setting indicators for each criterion that companies and assessors can utilise to collect the right measurement data to justify performance scores and to facilitate benchmarking and continuous improvement.

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APPENDICES

Appendix A: Expert survey questionnaire

Sustainability evaluation criteria for contractors in the UAE construction industry

Dear Respondent,

This survey is part of a PhD research that I am conducting with Heriot Watt University, School of Energy, Geoscience, Infrastructure and Society. The purpose of this research is to develop a multi-criteria evaluation model of the UAE construction contractors based on their sustainability performance. This model can be adopted by local authorities and would be used by clients as a supporting decision making tool during prequalification stage and as part of designing their sustainable supply chain.The evaluation model can also help contractors track their performance and provide clear evidence of their sustainability commitment and competitive advantage in corporate responsibility.

One of the primary, but very important steps of this study is to identify the evaluation criteria to be used in the model. Following a review of existing systems and criteria used in other industries, a set of criteria has been identified. In this survey you are mainly asked to rank the listed criteria in terms of how important they are to evaluate contractor sustainability performance in the UAE.

Please be assured that this is a strictly confidential survey. No individual response or firm will be identified in the research and only aggregate results will be reported.

I will be happy to send you a copy of the study summary report if you desire. There is a checkbox on the survey form to indicate your preference. I hope you will take few minutes to complete this survey. As a sustainability professional, your answers and opinions are essential to the accuracy and completion of this study.
For any queries about the questionnaire or about your participation in this study, please feel free to contact:

Karima Hamani

PhD student

Heriot Watt University

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What category best describes your organisation?

☐	Regulatory Authority
☐	Developer
☐	Architecture/ Engineering Consultant
☐	Construction contractor
☐	Sustainability NGO
☐	Other (please specify):

Please provide the following information about your experience. *

Current position	
Number of years of experience in sustainability field	
Number of years of experience in the construction industry	

Please rate your level of expertise in the following rating systems. *

	Accredited with project experience	Accredited with no project experience	Knowledgeable	Aware	Not aware
BREEAM	☐	☐	☐	☐	☐
CASBEE	☐	☐	☐	☐	☐
Estidama	☐	☐	☐	☐	☐
GREEN STAR	☐	☐	☐	☐	☐
GSAS	☐	☐	☐	☐	☐
HQE	☐	☐	☐	☐	☐
LEED	☐	☐	☐	☐	☐

How familiar are you with the following corporate sustainability frameworks?

	Very familiar	Familiar	Somewhat familiar	Slightly familiar	Not at all familiar
GRI (GLOBAL REPORTING INITIATIVE)	☐	☐	☐	☐	☐
ISO 26000:2010	☐	☐	☐	☐	☐
B Corp (BENEFIT CORPORATION)	☐	☐	☐	☐	☐
ABC Green Contractor	☐	☐	☐	☐	☐
SPI (SUSTAINABLE PERFORMANCE INSTITUTE)	☐	☐	☐	☐	☐

3. Evaluation criteria

Follwing a review of the existing evaluation systems in literature and practice, a set of 60 sustainability evaluation criteria covering the tripple bottom line has been identified. These criteria are further divided into 5 categories: 1) policy and governance, 2) workplace facilities 3) management of employees, 4) procurement and supply chain and 5) project delivery.

Please rate the criteria below under each category in term of their importance in sustainability evaluation of construction contractors in the UAE.

Category 1: Policy and Governance

	Very important	Important	Moderately Important	Slightly important	Not important at all
Company policy includes a statement of environmental stewardship	☐	☐	☐	☐	☐
Company policy includes a statement of social responsibility	☐	☐	☐	☐	☐
Anti-corruption and bribery policy	☐	☐	☐	☐	☐
ISO 14001 certification (environmental management)	☐	☐	☐	☐	☐
ISO 26000 certification (social responsibility)	☐	☐	☐	☐	☐
SA 8000 certification (social accountability in the workplace)	☐	☐	☐	☐	☐
Sustainability memberships (local or international)	☐	☐	☐	☐	☐
Availability of Corporate Sustainability Department	☐	☐	☐	☐	☐
Compliance with sustainability laws and regulations	☐	☐	☐	☐	☐
Community support programs	☐	☐	☐	☐	☐
Community representatives in the Board of Directors	☐	☐	☐	☐	☐
Annual public financial report	☐	☐	☐	☐	☐
Annual public sustainability report	☐	☐	☐	☐	☐
Availability of company's carbon emission tracking system	☐	☐	☐	☐	☐

Category 2: Corporate workplace facilities

	Very important	Important	Moderately Important	Slightly important	Not important at all
Buildings employ energy efficiency strategies	☐	☐	☐	☐	☐
Buildings use renewable energy	☐	☐	☐	☐	☐
Buildings employ water efficiency strategies	☐	☐	☐	☐	☐
Buildings employ indoor environmental quality strategies	☐	☐	☐	☐	☐
Availability of waste management scheme in workplace	☐	☐	☐	☐	☐
Availability of green cleaning scheme in workplace	☐	☐	☐	☐	☐
Energy efficient office equipment	☐	☐	☐	☐	☐
Availability of energy and water monitoring system	☐	☐	☐	☐	☐
Transportation minimisation system	☐	☐	☐	☐	☐
Environment friendly transportation system	☐	☐	☐	☐	☐

Category 3: Management of employees

	Very important	Important	Moderately Important	Slightly important	Not important at all
Average annual training time	☐	☐	☐	☐	☐
Annual employee retention rate (at corporate level)	☐	☐	☐	☐	☐
Annual number of applied innovative ideas generated by employees	☐	☐	☐	☐	☐
Employee Sustainability Initiative of the Year Award	☐	☐	☐	☐	☐
Employee sustainability feedback system	☐	☐	☐	☐	☐
Employee active life / well being programs	☐	☐	☐	☐	☐
Annual number of recordable incidents with respect to harassment and violence/employee	☐	☐	☐	☐	☐
Annual number of recordable accidents/employee	☐	☐	☐	☐	☐
Average annual number of recordable employee complaints/employee	☐	☐	☐	☐	☐
Non-discrimination policy	☐	☐	☐	☐	☐
Effectiveness of Personnel Recruitment and Selection procedure	☐	☐	☐	☐	☐
Available and effective discipline management procedure	☐	☐	☐	☐	☐
Effectiveness of compensation management	☐	☐	☐	☐	☐
Human rights policy and procedures	☐	☐	☐	☐	☐

Category 4: Procurement and supply chain

	Very important	Important	Moderately Important	Slightly important	Not important at all
Supplier selection based on sustainability practices	☐	☐	☐	☐	☐
Subcontractors selection based on sustainability practices	☐	☐	☐	☐	☐
Availability of a formal sustainability evaluation scheme of suppliers and subcontractors	☐	☐	☐	☐	☐
Sustainability collaboration with supply chain	☐	☐	☐	☐	☐
Sustainability monitoring of supply chain	☐	☐	☐	☐	☐
Sustainability training of supply chain	☐	☐	☐	☐	☐
Percentage decrease in total supply chain cost	☐	☐	☐	☐	☐
Responsible sourcing strategy	☐	☐	☐	☐	☐
Reverse logistics policy and procedures	☐	☐	☐	☐	☐

Category 5: Project delivery

	Very important	Important	Moderately Important	Slightly important	Not important at all
Percentage of delivered projects certified by a sustainability accreditation body	☐	☐	☐	☐	☐
Sustainability manager / engineer appointed on site	☐	☐	☐	☐	☐
Use of life cycle costing tool	☐	☐	☐	☐	☐
Use of carbon tracking tool	☐	☐	☐	☐	☐
Use of waste estimation and recording tool	☐	☐	☐	☐	☐
Environmental Management System	☐	☐	☐	☐	☐
Material saving plan	☐	☐	☐	☐	☐
Site Energy saving plan	☐	☐	☐	☐	☐
Site Water saving plan	☐	☐	☐	☐	☐
Site Noise control plan	☐	☐	☐	☐	☐
Waste abatement plan	☐	☐	☐	☐	☐
Site transportation minimisation plan	☐	☐	☐	☐	☐
Site Air pollution control plan	☐	☐	☐	☐	☐
Investment in green products R&D	☐	☐	☐	☐	☐
Investment in green construction methods R&D	☐	☐	☐	☐	☐
Innovative sustainability delivery beyond requirements	☐	☐	☐	☐	☐

Appendix B: Main survey questionnaire

Sustainability evaluation of contractors in the UAE construction industry

Dear Respondent,

This survey is part of a PhD research that I am conducting with Heriot Watt University, School of Energy, Geoscience, Infrastructure and Society. The purpose of this research is to develop a multi-criteria evaluation model of the UAE construction contractors based on their sustainability performance. This model can be adopted by local authorities and would be used by clients as a supporting decision making tool during prequalification stage and as part of designing their sustainable supply chain.The evaluation model can also help contractors track their performance and provide clear evidence of their sustainability commitment and competitive advantage in corporate responsibility.

In this survey you are mainly asked to evaluate the level of statisfaction of the identified criteria by your organisation. Please be assured that this is a strictly confidential survey. No individual response or firm will be identified in the research and only aggregate results will be reported.

I hope you will take few minutes to complete this survey. As a sustainability professional, your answers are essential to the accuracy and completion of this study.

For any queries about the questionnaire or about your participation in this study, please feel free to contact:

Karima Hamani

PhD student

Heriot Watt University

kh175@ hw.ac.uk

What category best describes your organisation?

☐	Local company
☐	International company
☐	Local/international JV

What is your company size ?

☐	Less than 20
☐	21 -50
☐	51-100

Where is your company's HQ located in the UAE?

☐	Abu Dhabi
☐	Dubai
☐	Sharjah
☐	Other Emirates

Please provide the following information about your experience.

Current position	
Number of years of experience	

What is your level of education?

MSc.	
BSc.	
Diploma	

Evaluation criteria

Please indicate the extent to which you perceive that your company is satisfying each of the following criteria.

Category 1: Policy and Governance

	Fully implemented	To a relatively great extent	To a moderate extent	To a limited extent	Not at all
ISO 14001 certification (environmental management)	☐	☐	☐	☐	☐
ISO 26000 certification (social responsibility)	☐	☐	☐	☐	☐
Company policy includes a statement of social responsibility	☐	☐	☐	☐	☐
Company policy includes a statement of environmental stewardship	☐	☐	☐	☐	☐
Availability of carbon emission tracking system	☐	☐	☐	☐	☐
Community support programs	☐	☐	☐	☐	☐
SA 8000 certification (social accountability in the workplace)	☐	☐	☐	☐	☐
Compliance with sustainability laws and regulations	☐	☐	☐	☐	☐
Availability of Corporate Sustainability Department	☐	☐	☐	☐	☐
ISO 26000 certification (social responsibility)	☐	☐	☐	☐	☐
Annual public financial report	☐	☐	☐	☐	☐
Annual public sustainability report	☐	☐	☐	☐	☐
Sustainability memberships (local or international)	☐	☐	☐	☐	☐

Category 2: Corporate workplace facilities

	Fully implemented	To a relatively great extent	To a moderate extent	To a limited extent	Not at all
Availability of waste management scheme	☐	☐	☐	☐	☐
Availability of carbon emission tracking system	☐	☐	☐	☐	☐
Energy efficient office equipment	☐	☐	☐	☐	☐
Availability of energy and water monitoring system	☐	☐	☐	☐	☐
Buildings employ energy efficiency strategies	☐	☐	☐	☐	☐
Buildings use renewable energy	☐	☐	☐	☐	☐
Buildings employ water efficiency strategies	☐	☐	☐	☐	☐
Buildings employ indoor environmental quality strategies	☐	☐	☐	☐	☐
Transportation minimisation system	☐	☐	☐	☐	☐
Environmental friendly transportation system	☐	☐	☐	☐	☐

Category 3: Management of employees

	Fully implemented	To a relatively great extent	To a moderate extent	To a limited extent	Not at all
Sustainability training of employees	☐	☐	☐	☐	☐
Employee active life / wellbeing programs	☐	☐	☐	☐	☐
Non-discrimination policy	☐	☐	☐	☐	☐
Employee retention strategy (at corporate level)	☐	☐	☐	☐	☐
Employee complaints reporting system	☐	☐	☐	☐	☐
Anti- harassment and violence policy	☐	☐	☐	☐	☐
Employee incident/ accident reporting system	☐	☐	☐	☐	☐
Application of innovative ideas generated by employees	☐	☐	☐	☐	☐
Effectiveness of Personnel Recruitment and Selection procedure	☐	☐	☐	☐	☐
Employee sustainability feedback system	☐	☐	☐	☐	☐
Employee Sustainability Initiative Award program	☐	☐	☐	☐	☐
Human rights policy and procedures	☐	☐	☐	☐	☐
Compliance with labour camp regulations	☐	☐	☐	☐	☐

Category 4: Procurement and supply chain

	Fully implemented	To a relatively great extent	To a moderate extent	To a limited extent	Not at all
Supplier selection based on sustainability practices	☐	☐	☐	☐	☐
Sustainability collaboration with supply chain	☐	☐	☐	☐	☐
Sustainability monitoring of supply chain	☐	☐	☐	☐	☐
Availability of a formal sustainability evaluation scheme of suppliers and subcontractors	☐	☐	☐	☐	☐
Subcontractors selection based on sustainability practices	☐	☐	☐	☐	☐
Sustainability training of supply chain	☐	☐	☐	☐	☐
Optimisation plan of total supply chain cost management	☐	☐	☐	☐	☐
Responsible sourcing strategy	☐	☐	☐	☐	☐
Reverse logistics policy and procedures	☐	☐	☐	☐	☐

Category 5: Project delivery

	Fully implemented	To a relatively great extent	To a moderate extent	To a limited extent	Not at all
Sustainability manager / engineer appointed on site	☐	☐	☐	☐	☐
Material saving and waste abatement plan	☐	☐	☐	☐	☐
Use of waste estimation and recording tool	☐	☐	☐	☐	☐
Use of carbon tracking tool	☐	☐	☐	☐	☐
Use of life cycle costing tool	☐	☐	☐	☐	☐
Site Energy saving plan	☐	☐	☐	☐	☐
Site Water saving plan	☐	☐	☐	☐	☐
Investment in green construction methods R&D	☐	☐	☐	☐	☐
Site Noise control plan	☐	☐	☐	☐	☐
Site Air pollution control plan	☐	☐	☐	☐	☐
Environmental Management System	☐	☐	☐	☐	☐
Sustainability manager / engineer appointed on site	☐	☐	☐	☐	☐
Material saving and waste abatement plan	☐	☐	☐	☐	☐
Use of waste estimation and recording tool	☐	☐	☐	☐	☐
Use of carbon tracking tool	☐	☐	☐	☐	☐
Use of life cycle costing tool	☐	☐	☐	☐	☐

Appendix C: Performance scoring calculation

		Items	item score A	item score B	SSM	SSC	STR	PG (g)	Subscale score A	Subscale score B	Total score A	Total score B
Policy and Governance	Sustainability Certification and Membership (SCM)	PG1	3	2	0.72			0.56	**3.46**	**3.97**	**3.26**	**2.84**
		PG2	3	5	0.42			0.58				
		PG3	4	5	0.48			0.32				
		PG4	4	5	0.47			0.40				
	Sustainability Strategy and Compliance (SSC)	PG13	5	3		0.38		0.19	**4.05**	**2.42**		
		PG5	4	2		0.72		0.48				
		PG6	5	3		0.52		0.52				
		PG7	3	2		0.53		0.69				
		PG8	5	3		0.52		0.56				
		PG9	3	2		0.72		0.69				
	Sustainability Tracking and Reporting (STR)	PG10	2	3			0.78	0.63	**2**	**2.46**		
		PG11	2	2			0.12	0.67				
		PG12	2	2			0.78	0.63				
		Items	**item score** A	B	**SSM**	**SSC**	**STR**	**PG** (g)	**Subscale score** A	B	**Total score** A	B
Corporate Workplace	Sustainable Operations (SO)	CW1	2	3	0.58			0.12	**2**	**3.78**	**2**	**3.82**
		CW2	4	3	0.67			0.41				
		CW3	3	4	0.48			0.24				
		CW4	2	4	0.48			0.49				
		CW9	3	4	0.54			0.25	**4**	**3.45**		
		CW10	2	5	0.53			0.38				
	Sustainability Facilities (SF) (**)	CW5	4	3		0.15		0.66				
		CW6	4	5		0.30		0.75				
		CW8	4	3		0.87		0.66				

		Items	item score A	item score B	SSM	SSC	STR	PG (g)	Subscale score A	Subscale score B	Total score A	Total score B
Management of Employees	Employee Empowerment and Engagement (EEE)	ME1	3	5	0.45			0.41	**3.42**	**5**	**3.71**	**3.29**
		ME2	3	5	0.62			0.62				
		ME10	4	5	0.40			0.56				
		ME11	4	5	0.37			0.61				
	HR Policies and Procedures (HRPP)	ME3	4	3		0.42		0.46	**4.34**	**2.41**		
		ME5	5	2		0.82		0.65				
		ME6	3	3		0.66		0.72				
		ME7	5	2		0.73		0.55				
	Employee Wellbeing and Retention (EWR) (*)	ME4	3	2			0.18	0.73	**3.13**	**2.73**		
		ME8	4	2			0.16	0.58				
		ME12	3	3			0.91	0.60				
		Items	**item score A**	**item score B**	**SSM**	**SSC**	**STR**	**PG (g)**	**Subscale score A**	**Subscale score B**	**Total score A**	**Total score B**
Procurement and Supply Chain	Sustainable Supply chain Selection (SSCS) (*)	PSC1	4	3	0.44			0.44	**4.00**	**2.63**	**3.64**	**2.54**
		PSC5	5	2	0.65			0.47				
		PSC4	3	3	0.64			0.49				
	Sustainable Suuply Chain Management (SSCM) (*)	PSC2	3	2		0.32		0.44	**3.48**	**2.99**		
		PSC3	3	4		0.69		0.70				
		PSC6	4	3		0.32		0.51				
		PSC7	4	2		0.21		0.71				
		PSC8	3	2		0.20		0.72				
		PSC9	4	2		0.30		0.74				
		Items	**item score A**	**item score B**	**SSM**	**SSC**	**STR**	**PG (g)**	**Subscale score A**	**Subscale score B**	**Total score A**	**Total score B**
Project Delivery	Sustainable Site Management (SSM) (**)	PD1	3	2	0.28			0.53	**3.69**	**2.85**	**3.83**	**2.55**
		PD2	3	4	0.55			0.78				
		PD8	4	3	0.24			0.61				
		PD7	4	2	0.26			0.73				
		PD10	4	3	0.19			0.62	**3.94**	**2.1**		
		PD11	5	2	0.28			0.79				
	Sustainability Tools and Innovation (STI) (**)	PD3	3	3		0.24		0.42				
		PD4	5	2		0.70		0.42				
		PD5	3	2		0.60		0.49				
		PD9	4	2		0.72		0.43				

(*) Subscale failed reliability test

(**) Subscale failed replicability test