Improving Project Collaboration to Minimise the Energy Performance Gap in Residential Construction.

Case study of Kurdistan

By

Hazhar Mohammed Ameen Faris

The thesis is submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy of the University of Portsmouth

January 2020

School of Civil Engineering and Surveying

University of Portsmouth

United Kingdom

Abstract

Residential buildings consume a significant amount of energy. Researchers have indicated that deficiencies during project delivery stages are some of the reasons for a gap between the designed and actual performance of buildings in terms of energy consumption. Competing relationships and fragmentation in the construction industry are highlighted as principal causes for this underperformance. Collaboration has been demonstrated as a solution to these challenges in the construction industry. However, collaborative environments are still far from effective in developing countries with a lack of research and information available for such countries. This research is undertaken on the residential sector in the Kurdistan region of Iraq. Despite that the residential sector is a significant contributor to the economic growth of the region, those projects are not performing as expected regarding energy consumption. Researchers have pointed to lack of collaboration as a primary reason for high energy consumption in the residential sector.

To investigate and explore these challenges, this research uses a systematic enquiry, utilising quantitative and qualitative methods. This thesis aims to explore these challenges, by reviewing literature and investigating construction practices to better quantify those factors that underlie collaboration. A comprehensive review of the literature was conducted to identify the most critical factors. Then, a questionnaire was used to survey the opinions of practitioners, analysed through Exploratory Factor Analysis. Six factors were identified: project vision, participant behaviour, communication, relationship definition, contractual agreements and systematic process. The factors were used to develop a framework that aims at improving

collaboration in the Kurdistan region in order to minimise the energy performance gap. The framework was validated using interviews with construction experts. The developed framework explains the process of delivering collaboration in the form of a set of tasks distributed over a project's lifecycle. These tasks must be accomplished to ensure collaboration between practitioners throughout the project lifecycle. Since there was an absence of studies that investigate improving collaboration in the residential sector in the Kurdistan region, this research significantly contributes to the scarce literature on construction projects in the region. Additionally, the study has a practical contribution by providing a framework that could be implemented to enhance collaboration and minimise the gap between the designed and actual performance of residential buildings in the Kurdistan region, and other countries at a similar stage of development.

Table of Contents

List of Tables

List of Figures

Abbreviations

AIA	American Institute of Architects
BIM	Building Information Modelling
EFA	Exploratory Factor Analysis
GDP	Gross Domestic Product
IPD	Integrated Project Delivery
IEA	International Energy Agency
KCU	Kurdistan Contractors Union
KMO	Kaiser-Meyer-Olkin
KRG	Kurdistan Regional Government
MOCAH	Ministry of Construction and Housing
PCA	Principal Component Analysis
PFA	Principal Factor Analysis
PM	Project Management
TCM	Traditional Construction Management
UNEP	United Nations Environment Programme

Declaration

Whilst registered as a candidate for the above degree, I have not been registered for any other research award. The results and conclusions embodied in this thesis are the work of the named candidate and have not been submitted for any other academic award.

Hazhar Mohammed Ameen Faris

Acknowledgements

Many individuals and organisations have contributed directly or indirectly to achieving this research, and I am very grateful to all of them.

I would like to express my sincere appreciation to my first supervisor, Professor Mark Gaterell, for his excellent supervision, advice and valuable feedback during this PhD journey. It would not be possible to complete this research without his invaluable guidance. I would like to express my deepest gratitude and thanks to my second supervisor, Dr David Hutchinson, who provided me with support and recommendations when I needed the most.

I am grateful to everyone who participated in surveys of this project with their helpful opinions. I appreciate the role of all personnel at the School of Civil Engineering and Surveying at the University of Portsmouth. Thanks to everyone that I learned from; at different stages of my academic career.

I would like to express my deepest appreciation to my family; my parents, my brothers and my sisters for their unconditional support and love for me throughout this journey and in my life generally.

List of Publications

- Faris, H., Gaterell, M., & Hutchinson, D. (2019). Investigating underlying factors of collaboration for construction projects in emerging economies using exploratory factor analysis*. International Journal of Construction Management*, 1-13. doi: 10.1080/15623599.2019.1635758.

- Faris, H., Gaterell, M. & Hutchinson, D., (2020) Improving collaboration in construction projects in developing countries: The case of Kurdistan region of Iraq. *The 10th International Conference on Engineering, Project, and Production Management. Berlin*.

1 Chapter One: Introduction

1.1 Introduction

This chapter aims to establish the need for the study and clearly outline the intentions of the research. It commences by explaining the research background. Then, based on that background, the research gap and the need for this study are demonstrated. The research aim and objectives are outlined. The methodology used to achieve those objectives is also briefly illustrated. The final section presents the structure of the thesis.

1.2 Research background

Globally, buildings consume a significant amount of energy. The International Energy Agency (IEA, 2010), reported that buildings account for 40% of total energy consumption. From this consumption, residential buildings contribute a considerable amount and are expected to consume more in the coming years due to an increase in population (Pérez-Lombard, Ortiz, & Pout, 2008). In addition, there is often a gap between the designed and actual energy performance of buildings, with actual energy used being higher than predicted at design stage (Guerra-Santin, Christopher Tweed, & Gabriela Zapata-Lancaster, 2014; Tuohy & Murphy, 2014). Therefore, reducing energy consumption is an essential requirement for the construction industry.

Researchers have explored the reasons for the difference between designed and actual energy consumption in buildings (Motawa & Carter, 2013; Schade, Olofsson, & Schreyer, 2011; van Dronkelaar, Dowson, Spataru, & Mumovic, 2016). Those studies have pointed

to various technical, organisational and management issues as reasons for the performance gap. A critical reason for the performance gap in buildings is found to be: *lack of collaboration* (de Wilde, 2014; UNEP SBCI, 2009).

Several issues related to collaboration are identified as reasons for the performance gap. For example, a lack of collaboration between construction teams and design teams has been referred to as one of the primary causes for the performance gap by de Wilde (2014). Ineffective communication between project stakeholders was highlighted as a cause for the underperformance in the housing sector (Zero Carbon Hub, 2014). For Motawa and Carter (2013), most of the reasons for the underperformance of projects and for having energy-related issues are in the design and preconstruction stages. This study explained that construction stakeholders are not sharing information effectively during project delivery stages. This fragmentation has resulted in a lack of information available for designers regarding energy consumption in building projects. According to White, Dec, Troy, and Thornton (2008), it is the lack of collaboration between stakeholders involved at the design phase, such as engineers and architects, that make buildings consume more energy than expected. Fedoruk, Cole, Robinson, and Cayuela (2015) investigated the phenomenon of anticipated versus achieved energy consumption in buildings and explained that the primary impediments are the way projects phases are specified, contacted and implemented. The study revealed that project delivery methods have resulted in a lack of communication, information sharing and interaction between involved project members.

The construction industry is commonly known to be fragmented and to have adversarial relationships between stakeholders (Arditi & Gunaydin, 1998). Many researchers have

explained that there is a clear lack of collaboration between construction industry stakeholders, such as clients, contractors and designers (Grilo, Zutshi, Jardim-Goncalves, & Steiger-Garcao, 2013; Hughes, Williams, & Ren, 2012; Liu, van Nederveen, & Hertogh, 2017). This lack of collaboration has resulted in severe deficiencies and produced a considerable performance gap in construction projects (Morrell, 2015). Therefore, research has insisted that the construction industry needs to improve collaboration and to adopt new ways of working to remain competitive and meet the expectations of increasingly demanding clients (Cao et al., 2015; Shelbourn, Bouchlaghem, Anumba, & Carrillo, 2007).

This observation is also apparent in the Kurdistan region of Iraq, hereinafter referred to as the Kurdistan region, where the construction process is highly uncommunicative, with a significant lack of collaboration between stakeholders. This lack of interaction between participants has resulted in many shortcomings in construction projects such as deviations in construction and design (Zebari & Ibrahim, 2016). Faris (2015) found that lack of collaboration is a major reason for construction projects not delivering expected outcomes. This lack of collaborative working has caused many issues regarding the performance of construction industry products. For example, building projects have been found to consume a significant amount of energy and to have a substantial gap in performance (Mustafa, 2017). Zebari and Ibrahim (2016) indicated that there is a lack of collaboration in the construction projects in the Kurdistan region, which has resulted in the underperformance of the housing sector. Additionally, many shortcomings in the residential sector are due to a lack of regulations on performing construction practices during project delivery stages (Shawkat, Al-Din, & Kuzović, 2018).

Therefore, investigating the collaboration is necessary to reduce the energy consumption of residential buildings. Construction practitioners in the Kurdistan region need to raise their level of awareness of collaborative methods. The necessity for these improvements increases, if the importance of the residential sector for the area is considered. The housing sector is the main contributor to economic developments of the region (Soderberg & Phillips, 2015). Residential projects are a primary contributor to the GDP (gross domestic product), the total value of all goods and services produced in a year, of the Kurdistan region and provide many job opportunities (Abramzon et al., 2016). In the last two decades, the construction sector has grown rapidly, with many international companies starting to work in the region (Neamat & Yitmen, 2017). The study explained that the need for housing units is a primary reason for investing in the construction sector. Therefore the most common type of construction project are large residential complexes. The housing sector is likely to expand further and remain as a principal contributor to financial developments of the Kurdistan region (BMI Research, 2014).

Although the literature on residential projects in the Kurdistan region is limited, it is evident that the sector is a primary contributor to economic growth and developments. Despite this importance, the sector is facing many difficulties and projects are not meeting expected performance. Residential projects are consuming a considerable amount of energy. Therefore, it is necessary to investigate the reasons for these issues and increase the performance of the residential sector in the region.

1.3 Research gap and need for the study

Several researchers have indicated that lack of collaboration during the project delivery stages is a principal reason for energy consumption such as White et al. (2008), Motawa and Carter (2013), de Wilde (2014) and (Fedoruk et al., 2015). In addition, there is an extensive literature on factors of collaboration. Many researchers have explored the factors required to improve collaborative practices in the construction industry (Bidabadi, Hosseinalipour, Hamidizadeh, Mohebifar, & Dorostkar, 2015; Black, Akintoye, & Fitzgerald, 2000; Lu & Yan, 2007; Meng, 2013; Nursin & Latief, 2018; Shelbourn et al., 2007). However, there is still a lack of research about collaboration factors that affect the energy performance of buildings. Accordingly, there is a need to determine the collaborative factors that could particularly have an impact on removing the gap between designed and as-built performance in building projects.

Additionally, despite a considerable amount of literature on factors of collaboration, there are still gaps in research on how to deliver such factors and at what stage of the project lifecycle those factors need to be delivered. There is a lack of clear frameworks that identify the required tasks leading to enhanced collaboration factors, especially in developing countries.

In the context of the Kurdistan region, the literature is minimal on the construction industry in general, and collaborative practices in particular. Researchers have explained that the construction sector is fragmented, and a considerable lack of collaboration exists between practitioners in the Kurdistan region (Shawkat et al., 2018; Zebari & Ibrahim, 2016). This lack of collaborative approaches has caused many issues in the

construction industry, including a big performance gap in terms of energy consumption (Mustafa, 2017; Neamat & Yitmen, 2017). Nevertheless, there is an absence of studies that investigate improving collaboration in the Kurdistan region. Additionally, no studies were found that investigate minimising energy consumption in the residential sector in the Kurdistan region.

Therefore, there is a huge gap of research towards the effects of collaboration on construction projects and how to enhance that collaboration in the Kurdistan region. Consequently, it is essential to determine effective ways to strengthen those practices in order to have a higher-performing housing sector. This research intends to fill those gaps in the literature and to identify a set of factors needed for improving collaboration in the housing sector of the Kurdistan region. The primary aim is to develop a collaborative framework to enhance collaborative working between construction practitioners and to minimise the gap between the expected and achieved performance of residential projects.

It is also expected that the study will make a significant practical contribution to residential building projects in the Kurdistan region by developing a framework that could be applied to both public and private construction sectors. Considering the importance of the housing sector in the Kurdistan region, this study has the potential to contribute to more sustainable development in the region. As Ofori (2015) stated: Researchers have a duty to contribute to improving the construction industry in developing countries, thereby helping millions of people overcome poor socio-economic situations.

1.4 Research questions

The main research question is: how can collaboration be improved to minimise the gap between the designed and actual performance of residential buildings in terms of energy consumption in the Kurdistan region?

The research sub-questions are as follows:

1. What are the reasons for the gap between the designed and actual performance of residential buildings regarding energy consumption?
2. What are the effects of collaboration on the performance gap in the construction industry?
3. What are the states of collaborative working in the residential building projects in the Kurdistan region?
4. What are the factors that can improve collaborative working in the construction industry?
5. What are the factors that can improve collaboration in the residential sector in the Kurdistan region?
6. How can collaboration be implemented throughout project delivery stages?

1.5 Aim and objectives

The primary aim of this study is to develop a framework for improving collaboration in order to minimise the performance gap. A framework to explain how to implement collaboration throughout project delivery stages in the Kurdistan region. To achieve this aim, a set of objectives is set:

1. To explore the performance gap in residential building projects and causes of the performance gap, then demonstrate it in the context of the Kurdistan region.
2. To investigate the effects of collaboration in minimising the performance gap in residential building projects.
3. To identify the potential factors that improve collaboration and verify such factors in the context of Kurdistan residential projects.
4. To determine the level of importance of factors of collaboration for residential projects in Kurdistan.
5. To identify the final critical factors from factor analysis.
6. To develop and validate a framework to improve collaboration in residential projects in Kurdistan.

1.6 Scope of the study

This study focuses on residential construction projects in the Kurdistan region. The research aims to cover both private and public sectors of residential projects across the region. To do so, minimising energy performance gap by improving collaborative practices is investigated across the area. Also, research is discussed with stakeholders involved in both sectors of housing in various locations in order to cover the topic in the context of the region as much as possible. Therefore, the outcomes of the research can be applied in both public and private housing sectors in the Kurdistan region.

1.7 Methodology

The methodology of this research is designed based on a pragmatism philosophy. Pragmatism suggests using mixed methods for answering research questions. In this research, both quantitative and qualitative methods are adopted to answer the research problem. The study uses a combination of literature review, questionnaires and interviews.

The research starts with an in-depth review of the literature investigating the issue of energy consumption in buildings. The reasons for building underperformance and the high energy consumption are studied, and how this consumption can be minimised. Lack of collaboration in construction projects is identified as a principal reason for this underperformance. Then, the collaboration phenomenon is investigated, and the impacts of the lack of collaboration on construction industry products are explained.

Later, the means of developing collaborative environments in the sector were investigated using a comprehensive review of the literature. The most closely-related articles for improving collaboration in the construction sector are reviewed, and the most frequently mentioned factors are determined. These identified factors are from the global literature about the construction industry and have the potential to be critical in the residential sector in the Kurdistan region. Therefore, those identified factors from the review of the literature are considered as *potential factors* of collaboration, in this thesis.

Those factors were used to develop a questionnaire survey that aimed at determining *local* factors of collaboration. The questionnaire survey represented the quantitative

phase of the research methodology and consisted of two parts. The first part was designed to collect some background information about respondees. The second part, which is the main section, consisted of 23 questions asking respondees to rate the importance of different variables. The variables that are required for improving collaboration in order to minimise the performance gap in the housing sector. The survey is used in the housing sector in Kurdistan region to collect the perceptions of the construction practitioners regarding factors of collaboration. The industry-wide questionnaire is distributed using hard and soft copies delivered to construction project members. Participants included professionals from different organisations such as client representatives, project managers, design team members, contractors and subcontractors. The process of data collection resulted in 227 surveys to be included for final data analysis.

Regarding the data analysis techniques adopted for analysing the questionnaire data, descriptive statistics are used to understand the nature of the data better. Then, Exploratory Factor Analysis (EFA) is used to analyse the opinion of respondents about improving collaboration. Factors analysis is adopted to determine the underlying dimensions between the variables, and to group related variables under similar clusters. The EFA test was undertaken using IBM SPSS Statistics 24. The process of factor analysis resulted in identifying 6 factors as final factors of collaboration in the context of the Kurdistan region. Then, those factors are used to develop a collaborative framework for the residential sector in the region in order to minimise the performance gap.

Later, to validate the framework, a qualitative approach was used by interviewing construction industry experts. The feasibility and applicability of such means in the

Kurdistan region were discussed with the interviewees. The interview data are analysed using NVivo 12 software package. The framework is revised, and the final recommendation and conclusion were emerged based on the results of all phases.

1.8 Structure of the thesis

This thesis consists of seven chapters, which are introduced below briefly

Chapter 1: Introduction

This chapter outlines the research background and the context of the study. The research gap is addressed, and the need for the study to fill this gap is explained. Then, the research methodology and thesis structure are briefly illustrated.

Chapter 2: Performance gap and lack of collaboration

In this chapter, a review of the literature is presented about the difference between the designed and actual performance in residential projects. The reasons for that gap are explored, and the contribution of collaboration to minimise the performance gap is highlighted. Later, the states of collaborative working in the construction industry are observed with an explanation of the benefits of collaboration in the sector. Then, this chapter presents an in-depth review of the literature to determine a set of factors required to develop collaboration. The final section explains those factors in detail.

Chapter 3: Residential construction projects in the Kurdistan Region of Iraq

This chapter is a review of the literature about construction projects in developing countries and particularly the Kurdistan region. The focus is on residential building projects in the Kurdistan region. The role of these projects and the significant

contribution of housing projects to developments in the area are demonstrated. Finally, the chapter presents barriers and difficulties that the housing sector needs to overcome to increase its performance

Chapter 4: Research Methodology

This chapter illustrates the methodology adopted in this study. The research design, which is based on a pragmatism philosophy, is outlined. The chapter discusses various options available at each stage of research design and justifies adopted choices. The use of quantitative and qualitative data to achieve research objectives is also explained.

Chapter 5: Data collection and analysis

The process of the data collection and data analysis are presented in this chapter. The procedure of developing the survey questionnaire, which is the primary data collection technique, is explained. Then, using that questionnaire for surveying opinions of practitioners in the housing sector of the Kurdistan region is demonstrated. Later, data analysis is presented, in which factor analysis is used as the main technique. The purpose of factor analysis is to determine a set of local factors of collaboration for the residential sector in the Kurdistan region. Finally, those factors identified from factor analysis are described in detail.

Chapter 6: Framework development

This chapter presents the final framework of the research. The process of the framework development from results of factor analysis is elucidated. The framework distributes factors of collaboration over the project lifecycle. Additionally, those factors are presented in the form of a set of conditions. For providing each factor, those conditions

should be met. Interviews are used to validate the framework and get opinions of construction practitioners on the framework. Later, the outcomes of interviews and opinions of experts are discussed.

Chapter 7: Discussion and conclusions

In this chapter, a general discussion of the study results is presented. Research limitations and contribution to knowledge are outlined. Research recommendations and recommendations for the housing industry in the Kurdistan regions are also demonstrated.

1.9 Chapter summary

The aim of this chapter was to introduce the research. The research background was illustrated briefly, followed by the gaps in the literature and the need for this research. Then, the aim and objectives were presented to cover this need. Later, the methodology to achieve research objectives was explained.

2 Chapter Two: Performance gap and lack of collaboration

2.1 Introduction

This chapter aims to explore the gap between the actual and expected performance of residential buildings regarding energy consumption. It presents an analysis of literature regarding the reasons for this performance gap. The role of collaboration in reducing the energy consumption of housing projects is illustrated. Despite the recognised importance of collaboration, promoting collaboration in the construction industry is a challenge. This chapter presents an in-depth review of the literature to identify a set of potential factors that can develop collaborative environments in the construction sector.

2.2 The performance gap in the construction industry

Buildings account for more than 40 % of global energy consumption, and one-third of greenhouse gas emissions (IEA, 2010; Yuce & Rezgui, 2017). The contribution of buildings to energy use is enormous, in both developed and developing countries (UNEP SBCI, 2009). While buildings consume a significant amount of energy anyway, it is compounded by the gap between the designed and actual performance of buildings. Many researchers have indicated that in terms of energy consumption buildings are not performing as expected. Those studies have shown that the actual energy consumed in

building projects is significantly more than the amount estimated at design stage (Austin & Charlson, 2013; Tuohy & Murphy, 2014; van Dronkelaar et al., 2016).

In this research, the difference between design calculations and actual usage of energy is referred to as the *performance gap*. Robinson, Foxon, and Taylor (2016) stated that the performance gap is the barrier facing the building industry to reduce energy consumption in its projects. The performance gap in construction projects exists globally, and buildings are consuming more energy than expected at the design stage (Guerra-Santin et al., 2014). The gap is found to vary a lot across projects, although researchers varies significantly with any quantitative estimation of the energy consumption of buildings during the design and use stages. For example, van Dronkelaar et al. (2016) stated that the energy gap had been found to deviate by +34% based on 62 case study buildings. Another study argued that the actual energy consumed by a building could be 250% of the expected consumption (de Wilde, 2014).

An enormous amount of energy consumed by buildings is associated with residential buildings, due to the increase in population and the process of urbanisation. For instance, Pérez-Lombard et al. (2008) anticipated that, in 2030, 67% of global building energy consumption would be attributed to the residential building sector due to increase in population. Buildings have been identified as a primary consumer of energy in various areas. For example, Griffiths (2017) noted that in the Middle Eastern countries, buildings are currently playing a principal role in energy consumption. Additionally, energy use is increasing in countries in that area. Pérez-Lombard et al. (2008) explained that according to current business trends, building energy consumption by nations with emerging economies such as those in the Middle East will

continue to increase. Similarly, UNEP SBCI (2009) expected that the energy consumption of buildings in developing countries would surpass use in developed in the coming years. Therefore, reducing energy consumption in such countries is crucial for building projects.

Energy use in the Middle East has actually increased rapidly in recent years, and governments need to take actions and limit the irregular use of resources (Dar-Mousa & Makhamreh, 2019). The authors pointed to residential buildings as the main consumers of the energy in Middle Eastern countries. The reason for that is the growth in population and continuous expansion of the cities, which is anticipated to continue. Therefore, the region urgently needs to reduce energy use in housing sectors.

Buildings consume energy at different stages of their lifecycle such as manufacturing of materials, construction, operation and demolition. See Figure 2.1 below:

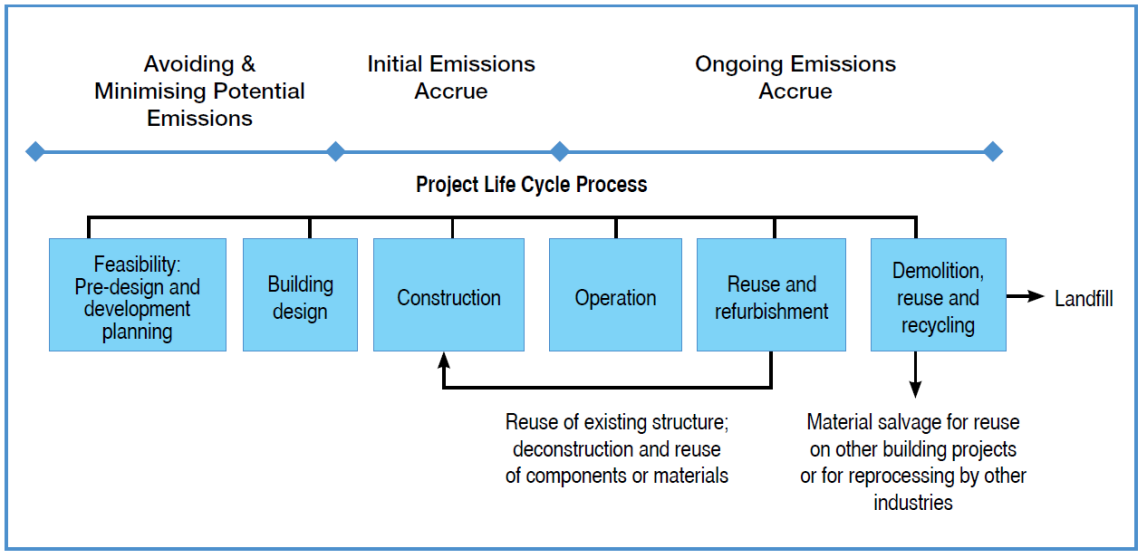


Figure 2-1 Energy use at various stages of building lifecycle (UNEP SBCI, 2009)

The energy consumed by a building can be divided into operational energy and embodied energy. Operational energy is the energy used by occupants during the lifespan of a building. Embodied energy is the energy used for manufacturing of materials, construction, transportation and maintenance. Commonly embodied energy is believed to account for a small part of total energy consumption, 10-20% according to (UNEP SBCI, 2009). Although, Chastas, Theodosiou, and Bikas (2016) explained that in recent times, the share of embodied energy has increased to 26%-57% in low energy buildings and to 74%-100% in nearly zero-energy buildings. Similarly, Thormark (2002) illustrated that in the lifespan of 50 years, embodied energy accounts for 40% of total life cycle energy of residential buildings.

However, in addition to the contribution to the embodied energy, the methods and materials during project delivery stages have a considerable impact on the operational energy (Heravi & Qaemi, 2014; Thormark, 2002; Winther & Hestnes, 1999). These studies show that improving the design and construction process could considerably reduce energy consumed at the operational stage. Heravi and Qaemi (2014), for example, insisted that the only way to construct energy-efficient buildings is to adopt more advanced measures in the design and construction stages. The study explained that the impact of those phases lasts the whole project lifecycle.

Therefore, the construction sector needs to improve the project delivery process in order to minimise the performance gap. Stakeholders in the sectors have aimed to decrease energy consumption and to increase the performance of the buildings. Thormark (2002) explained that a primary target for the construction sector is to produce buildings that consume the least energy. van Dronkelaar et al. (2016) agreed

that building energy modelling has become a part of the design process. However, the study explained that there is still a significant gap in the performance of building projects about the use of energy. Similarly, Guerra-Santin et al. (2014) discussed that modern buildings are performing better than old buildings but yet not meeting the predicted performance.

The building construction sector is going through the process of rapid change. In recent years, many policies and initiatives have been developed to improve the whole-life performance of buildings (Tuohy & Murphy, 2014). However, buildings are still consuming a significant amount of energy, especially in the residential sector. Therefore, the literature insists on the need to decrease this consumption and to remove the gap between the designed and actual performance of buildings regarding energy consumption (Directive, 2010; Foucquier, Robert, Suard, Stéphan, & Jay, 2013; Mustafa, 2017; Schade et al., 2011; UNEP SBCI, 2009).

2.3 Critical analysis and reasons for the performance gap

The performance gap in the construction industry exists for several different reasons. It is necessary to understand the reasons for this performance gap in order to close it. Researchers have referred to many issues as reasons for the performance gap. van Dronkelaar et al. (2016), for example, pointed to specification uncertainty in modelling, design complexity, changes in design, lack of feedback, poor operational practices, and occupant behaviour. Additional causes were indicated such as inaccuracy in design calculations, construction that alters the design intentions, poor commissioning and use of buildings (Austin & Charlson, 2013).

According to Schade et al. (2011), construction organisations are strictly focused on investment cost, and this approach does not help in improving the whole-life performance regarding energy consumption. Reducing the energy consumed over the whole-life of a building requires construction projects to use high-quality materials and adopt modern practices (Motawa & Carter, 2013). These improvements in project delivery stages may raise the upfront costs. However, increasing the investment cost does not mean that the building will cost more when considering the lifecycle costs of a project. In many cases, a small increase in initial cost could reduce a significant amount of lifecycle costs. For example, Motawa and Carter (2013) argued that a minor increase in investment cost of 2% could deliver lifecycle savings of up to 20% of the total construction cost, and this is around ten times the initial investment cost. Therefore, more attention needs to be paid to project delivery stages for having buildings that perform better in use. Similarly, White et al. (2008) explained that collaboration between stakeholders in project delivery stages to reduce energy consumption in buildings could result in many cost savings. Azhar, Carlton, Olsen, and Ahmad (2011) agreed that early design and preconstruction phases are critical in the building lifecycle, and decisions in these stages have a significant impact on the performance of the buildings. Hence, construction stakeholders need to focus on project delivery stages to minimise the energy consumed in the sector.

The United Nations Environment Programme (UNEP SBCI, 2009) referred to the fragmentation of the building sector as one of the main reasons for the performance gap. Many stakeholders are involved at different stages of the building lifecycle with a lack of collaboration between them. For example, decisions at the assessment and

design stages have a considerable effect on energy consumption. However, in many cases, the design does not account for whole-life performance (UNEP SBCI, 2009). de Wilde (2014) pointed to a lack of collaborative working between the design team, client and contractors as the primary reason for the energy performance gap. The author explained that, firstly, at the design stage, there is a lack of attention to buildability, the sequence of construction tasks and simplicity. Secondly, the construction process is also not implemented according to the design specifications. For instance, in many cases, design details are left for unskilled contractors to understand. This fragmentation results in poor decisions being made about the energy performance of buildings regarding energy consumption.

Similar reasons were found in a review of a significant number of published papers and investigations of current housing developments by the Zero Carbon Hub (2014). The report identified some key reasons for the performance gap and explained that there is a lack of skills and knowledge about energy consumption between practitioners in the housing industry. There is also a considerable number of issues related to communication problems at various stages of working. Also, Motawa and Carter (2013) described a lack of effective sharing of information between stakeholders as the primary contributor to expanding the performance gap.

Several other studies have insisted that the lack of collaboration between the design and the construction stages has resulted in many issues regarding the performance gap. Robinson et al. (2016), for instance, explained that incorrect assumptions at the design stage are the main reasons for the performance gap. The author explained that, in the design stage, there is a lack of information on occupant behaviour, material

understanding and construction process. According to Chan, Chan, et al. (2004), it is a lack of involvement of contractors in traditional ways of project delivery that has caused these problems at the design stages such as lack of practical information on construction tasks.

Additionally, Fedoruk et al. (2015) indicated that lack of adequate communication and system integration between stakeholders at different stages of the building life cycle is a significant reason for the performance gap. Therefore, there is an ultimate need for better engagement among all parties. In a case study based research Guerra-Santin et al. (2014) concluded that the difference between the design and as-built stems from targets being unrealistically set and these may be the result of a poor connection and lack of communication between the design and construction teams. In many cases, related stakeholders are involved too late to influence decisions and to collaborate with the design team (White et al., 2008). The authors emphasised that this lack of collaboration is the primary reason for deficiencies in buildings envelopes and systems of heating and cooling.

Further studies have demonstrated that fragmentation and a lack of collaboration results in poor performance. For instance, Baiden, Price, and Dainty (2006) explained that fragmented approaches to project delivery had caused a lack of trust between different parties and the emergence of a 'blame culture'. The authors added that in the current culture of the industry, people focus on reducing their level of exposure to poor performance instead of working collaboratively to raise that performance. Ahmad, Svalestuen, Andersen, and Torp (2016) argued that the fragmentation that exists in the construction industry makes it difficult to imitate the processes found in other sectors,

such as the manufacturing industry. This lack of collaboration has also resulted in a lack of feedback to designers on construction and operation stages. Menezes, Cripps, Bouchlaghem, and Buswell (2012) demonstrated that lack of feedback to designers has resulted in a lack of information available in the design phase. Consequently, designs lack the required accuracy about energy consumption and projects are not performing as expected.

Zero Carbon Hub (2014) investigated the housing sector to identify critical issues causing underperformance of projects. The problems determined included the communication of design intent through work stages, insufficient design information provided for construction stage, lack of designer availability on-site and a lack of clarity of construction teams' responsibilities regarding energy performance. These issues show that collaboration in residential building projects needs to be investigated in order to be improved. Similarly, in the Middle East, Heravi and Qaemi (2014) explained that underperformance of the residential buildings regarding energy consumption is an outcome of insufficiencies at design and construction stages. The authors added that for improving the performance of projects, the design process needs to be enhanced and construction should implement design intent. It is essential to minimise energy use in the housing sector for the countries in the Middle East because energy consumption is significant in those buildings (Dar-Mousa & Makhamreh, 2019).

Therefore, to reduce the performance gap in the residential construction sector, there is an urgency for the engagement of all related parties. There is an ultimate need for improving collaboration in the construction sector to overcome performance issues in

projects (Arditi & Gunaydin, 1998; Fedoruk et al., 2015; Guerra-Santin et al., 2014; Kożuch, 2009).

Researchers have posited several issues as causes of the performance gap. Determining such causes is essential if we want to overcome them. Table 2.1 presents the principal causes associated with the four stages of project delivery. In addition, these causes might occur at various stages of project delivery, and can be related to a wide range of tasks. Also, the stakeholders responsible for different tasks during the stages of project delivery change from one stage to another. Therefore, identifying reasons for the performance gap in construction projects is not straightforward. To clarify Table 2.1 categorises those causes based on the stage of project delivery which might occur, such as in preparation, design, preconstruction, and construction. Identifying which stage causes the performance gap to occur can help involved stakeholders to focus on related tasks in order to prevent such issues from developing. Consequently, it can also help minimise the gap between the design and the actual performance of houses.

Table 2-1 Causes of the performance gap at different project delivery stages

Project delivery phase	Causes of the performance gap
Preparation	Senior management and planning teams are not aware of the impact early decisions can have on the performance gap and energy usage in finished houses (Schade et al., 2011). Preparation teams do not utilise the knowledge and skills of designers regarding the energy performance of the house prior to the design stage (Zero Carbon Hub, 2014).
Design	Lack of communication regarding detailed design between design team members, especially when different designers are involved in both concept design and detailed design (Koutsikouri, Austin, & Dainty, 2008).

	Lack of buildability of designs due to a lack of knowledge among design teams regarding site work and restrictions on contactor involvement (Chan, Chan, et al., 2004). Lack of integration between fabric design and services during the design stage, resulting in the inadequate installation of building elements (White et al., 2008). Deficiencies in calculating heat loss in thermal bridging and inadequate instructions for installing insulations (Motawa & Carter, 2013). Limited availability of tools and standards for performing accurate energy modelling and early evaluation of performance (van Dronkelaar et al., 2016). Design teams providing insufficient information to the procurement team regarding energy performance assumptions in detailed design (Baiden et al., 2006). Inadequate design information provided to construction teams with regard to the installation of building fabric, resulting in poor decisions being made by contractors on site (Zero Carbon Hub, 2014). A lack of feedback provided to the design team on construction practices and occupant behaviour (Menezes et al., 2012)
Pre-construction	Lack of understanding of design details and design assumptions among stakeholders involved in the preconstruction stage (Robinson et al., 2016) Procurement team failing to consider knowledge of energy performance in the contractor selection process and labour employment. This results in a lack of available skills on-site regarding energy consumption (Eriksson & Westerberg, 2011). Procurement teams not focusing on and informing construction teams of the conditions required to deliver energy-efficient buildings (Baiden et al., 2006).

	Procurement team changing material and products to control costs during the bid awarding stage without considering performance criteria (Zero Carbon Hub, 2014). Contractual documents lacking sufficient details of energy performance requirements (Fedoruk et al., 2015).
Construction	Lack of skills and knowledge about energy-related issues in the construction team (Zebari & Ibrahim, 2016). Incorrect construction and positioning of building fabric elements such as windows, doors, and cavity walls, resulting in reduced performance (Guerra-Santin et al., 2014). Product substitution by contractors to reduce costs without informing the design team (Austin & Charlson, 2013). Lack of available designers on construction sites. This means contractors and subcontractors have to make decisions on the complicated details of designs (Zero Carbon Hub, 2014). Design details on insulations, cavity walls, ducts are inaccessible to most construction team members (Heravi & Qaemi, 2014). Roles and responsibilities of construction team members are unclear (Bresnen & Marshall, 2000a). Insufficient testing of building fabric and partitions before delivery to customers. This results in incorrect assumptions about the as-built performance of houses (Zero Carbon Hub, 2014).

2.4 Introduction to collaboration

In the world of complex designs, large businesses and big organisations, the need for collaboration increases every day (Shen et al., 2010). Collaboration can be the key mechanism to deliver efficient, practical, and productive teams, which lead to the achievement of better results (Chiocchio, Forgues, Paradis, & Iordanova, 2011; Kożuch & Sienkiewicz-Małyjurek, 2016). A fundamental ingredient to success for any community is the ability to coordinate itself to achieve common goals and communicate; in other words, to collaborate (Patel, Pettitt, & Wilson, 2012).

There are various beliefs on the origins of collaboration. Randrup, Druckenmiller, and Briggs (2016) argued that the idea of collaboration originates from the first humans that decided to work together to make their life better. Collaboration's teleological perspective is dependent on some beliefs. For instance, Randrup et al. (2016) described that people can achieve better values through joint effort than working separately, considering tangible and intangible outcomes. Nevertheless, Vermeulen, Parker, and Penders (2013) believed that in the life sciences, a brief and cohesive narrative on collaboration is still absent.

In the literature, many factors are used to describe collaboration such as; mutual goals, commitment, joint effort, trust and social relations. Based on the availability of those factors, the level of collaboration may change from an individual to another within the same organisation, or between different organisations. One group may work fully collaboratively while in another one, members may only spend some hours working toward the mutual target (Öberg, 2016). Randrup et al. (2016) added that collaborative

working cannot be explained through physical actions alone. The study described that an activity could be considered as collaboration in a case but not always, because the same activity may not serve the common goal if repeated or performed under a different situation. To achieve effective collaboration, members need to make continuous and intense efforts to coordinate their methods of engagement and activities (Bidabadi, Hosseinalipour, Hamidizadeh, & Mohebifar, 2016).

Furthermore, collaboration has been defined differently by different authors. Wood and Gray (1991), for example, used different definitions for collaboration such as *''constructive management of differences''* and *''a process of joint decision making among stakeholders about their future''*. Roschelle and Teasley (1995) identified collaboration as a mutual engagement of members in coordinated activity to solve a problem. According to Randrup et al. (2016) collaboration can be defined as "*joint effort toward a group goal*".

This thesis concerns collaboration within the context of the construction sector. An in-depth review of the literature is used to investigate the status of collaborative practices in the industry. Additionally, a survey of opinions of construction practitioners is used to identify factors of collaboration. The final factors required to improve collaborative practices are explained in section 5.7.7. Based on outcomes of all phases, this research defines collaboration as ''*A systematic process, in which relationships and communication lines are clearly defined between project members, and those project participants behave according to a shared vision and adoption of the right terms of contracts.''*

According to Vermeulen et al. (2013), in modern working and business environments, collaborative practices could be improved using advanced technologies and enhanced communication strategies. To date, improvements in collaboration have increased production capacity of many companies in different sectors and provided those organisations with better results (Turiera & Cros, 2013; Vachon & Klassen, 2008). Despite the fact that collaboration is proven to be an effective way of working, there is still a considerable lack of collaboration in construction projects (Meng, 2012). The construction sector still lags behind other industries in terms of collaborative practices between its stakeholders (Ahmad et al., 2016).

2.5 Collaboration in the construction industry

In the construction industry, many organisations work together to deliver the products required by clients. To accomplish this, they need to collaborate and to depend on each other (Liu et al., 2017). This complexity has caused many issues and a significant gap in performance in construction projects. The big gap in the performance of the construction industry, in any other industry, would be considered as a scandal; construction stakeholders need to take serious actions to solve this problem (Morrell, 2015). The author called for enhancing collaboration to increase the performance of projects and explained that construction institutions could be more effective if they present a shared understanding. It is necessary to have a shared vision to deal with some critical issues in construction projects, such as the gap between the design intent and actual performance of buildings.

There are different perspectives on collaboration in the construction industry, depending on who is representing a given project. Directing the process by different personnel can give different points of view to members (Hughes et al., 2012). Globally, the construction industry is more fragmented than other sectors, such as the manufacturing sector, and has more difficulties in terms of relationships and collaboration (Phua, 2006). Many researchers have explained that the construction industry has an absolute need for developing collaboration between stakeholders such as clients, contractors and designers. Kożuch (2009), for example, emphasised that managing relationships between different parties in collaborative ways could move construction organisations toward achieving their goals and delivering better projects. In contrast, continued use of traditional means of project delivery, which lack collaboration, could result in serious quality defects in construction projects (Bidabadi et al., 2015).

In construction projects practising collaboration, to some extent, depends on the procurement route chosen for the project. Project delivery systems define relationships between parties and responsibilities of those parties. The construction industry has passed through three main delivery systems: traditional construction management (TCM), the project management (PM) model and partnering (Xue, Shen, & Ren, 2010). The TCM approach is a competition between independent parties to win competitive bids and project responsibilities are based on strict contractual clauses. In this traditional approach, there is no shared vision between parties and each organisation defends their own interest. The TCM delivery system has resulted in many difficulties such as delays, cost overruns, win-lose culture and adversarial relations (Chan, Chan, et al., 2004). To

overcome the issues of TCM, PM has been used. PM models try to control cost, time and quality in a project-based system to achieve client needs; however, this approach also has faced many difficulties (Shen & Wu, 2005).

After an investigation to solve the problem of fragmentation and underperformance in the UK construction industry (Latham, 1994), partnering was used as a solution instead of traditional methods of project delivery. Partnering delivered better results than traditional approaches to project management. However, relationships in partnering still need to be improved to overcome the underperformance of construction industry projects (Meng, 2012).

These different procurement routes have a varying impact on relationships between stakeholders involved at different stages of projects. Design-Bid-Build (DBB) or traditional contacting is by far the most widely used method across the world (Oyegoke, Dickinson, Khalfan, McDermott, & Rowlinson, 2009). In DBB, the organisations undertaking design and construction works differ and the professionals involved in these two important phases are not connected. This method of project delivery encourages fragmentation and limits the opportunities for collaboration between involved parties (Eriksson & Westerberg, 2011). For example, there is a strict restriction on the involvement of contractors and subcontractors in the design stage, which has resulted in the underperformance of construction teams and, consequently, the underperformance of buildings. Another widespread route in the construction industry is Design and Build (DB) (Oyegoke et al., 2009). In DB, the opportunity for collaboration between practitioners is greater than DBB as a single entity is responsible for design and the construction phases. Information flow between related personnel can be more

effective in the DB route, which helps reduce the loss of data and facilitates better communication of the design across all project lifecycle stages. However, although DB is a more integrated approach than traditional contracting, the construction industry still faces many issues in projects using DB. For example, Azhar, Kang, and Ahmad (2014) explained that since in DB a single organisation undertakes design and construction, there is a clear lack of cross checks on design documents and construction practices. Consequently, many problems in DB projects remain undisclosed, which affects the quality of finished houses. Furthermore, although contractors are involved in the design stage, they are not independent, which may affect their decisions. Consequently this might result in deficiencies in the quality of projects.

To overcome fragmentation issues and improve collaboration, the American Institute of Architects (AIA National, 2007) introduced the Integrated Project Delivery (IPD) approach. The AIA described the IPD as a project delivery method which is based on a collaborative alliance of stakeholders. Key project stakeholders such as the client, the lead designer and the contactor, enter into a single contract and agree to share risks and rewards. These stakeholders agree on mutual goals and on the budget required to deliver such goals. The contract identifies the responsibilities of each party, and indicates that the successful delivery of the project is a shared responsibility. Through its collaborative alliance, IPD tries to maximise the expertise and efficiency of teams in terms of optimising the results.

According to the AIA, to achieve successful collaboration under IPD all participants should embrace the following principles: 1) mutual respect and trust; 2) mutual benefits and rewards; 3) collaborative innovation and decision making; 4.) early goal definition;

5) early involvement of key participants; 6) open communication; 7) intensified planning; 8) appropriate technology; and 9) organisational leadership.

IPD is an attempt to realise project objectives by enhancing cost, time, and quality factors, which depends on effective communication and integration between project stakeholders (Kahvandi, Saghatforoush, Alinezhad, & Noghli, 2017). The authors explained that IPD delivers better results than tradition project delivery methods; however, the implementation of IPD is still in its infancy. To adopt this approach in the construction industry, a wide range of factors need to be considered, including organisational culture and the financial status of the industry. Azhar et al. (2014) agreed that, despite the potential benefits of IPD, implementing this approach in the construction industry depends on numerous legal, organisational, and technological factors. For example, in many countries, procurement laws mandate that contractors need to be selected based on the lowest bid, which means that designs are completed prior to the bid awarding stage, and contractors bid for the finished designs. Consequently, there is no chance of contractor input during the design stages. IPD has also been criticised for requiring a large initial cost for managing the design process due to the input of various parties and owner involvement; funding which maight not be available in the case of small projects (Azhar et al., 2014). Spending a great deal of money on design facilities also means that IPD is more suitable for repetitive projects, where developed designs can be re-used and improved, rather than for one-time unique projects. Therefore, before adopting IPD or any other collaborative approach, a wide range of factors needs to be addressed.

In many cases the implementation of IPD has been linked to the adoption of BIM (Building Information Modelling) and they have been evaluated together; in IPD studies, BIM is considered a must-have tool when adopting IPD (Kahvandi et al., 2017). Recently, BIM has emerged as the most common method for undertaking the design, construction and maintenance of buildings. BIM has been described as a set of processes and technologies that tries to represent project data in a digital format through project lifecycle phases (Bryde, Broquetas, & Volm, 2013).

A combination of IPD and BIM is strongly regarded to be an innovative solution to the problem of a lack of collaboration in the construction sector. However, their marriage has not delivered the expected results. Therefore, to realise the full potential of this combination, the construction industry needs to be revolutionised and adapt to a new culture (Rowlinson, 2017). In order to implement IPD, the construction industry needs political and business will to change the procurement laws, which in many cases, are against the principles of IPD. The industry needs to overcome the organisational inertia which besets construction companies and governments, and consequently creates an environment of mistrust between stakeholders. Since construction practitioners are used to traditional ways of delivering projects, at this stage, exemplar institutions can lead the way and help the industry to adapt to the IPD and BIM methods (Rowlinson, 2017). These institutions need to combine expertise in terms of collaborative ways of project delivery with a high level of technological capacity, to facilitate the adoption of a new culture in the construction industry. However, finding or establishing these kinds of organisations in the construction industry is a challenge, especially in developing

countries, considering the lack of skills and technology that these countries struggle with (Elkhalifa, 2016).

Implementing Building Information Modelling (BIM) to solve the problem of the fragmentation of projects has gained increasing attention from researchers in recent years. In fact, much of the work undertaken in construction projects in terms of collaboration has focused on technological solutions (Shelbourn et al., 2007). Motawa and Carter (2013) suggest that the performance gap could be reduced by using BIM technology as a collaborative tool for transferring information throughout different stages of the building lifecycle. However, even the implementation of BIM depends on other parameters, such as business strategy, management of external relations, collaborative business process, and organisational characteristics, as referred to by Grilo et al. (2013). Tulenheimo (2015) agreed that adopting BIM in construction projects presents multiple challenges and depends primarily on factors such as social aspects, company organisation, and communication between parties.

Despite the evident importance of technology in construction projects, the industry can not overcome the performance issue only by using advanced technologies and ignoring other essential factors such as the organisational, people and cultural issues (Grilo et al., 2013; Shelbourn et al., 2007).

Performance problems, delays and cost overruns are still hampering the construction industry; industry members need to search for new ways to solve these issues in project delivery stages (Cao et al., 2015). Shelbourn et al. (2007) insisted that the construction industry needs to improve collaboration and to adopt new ways of working to remain competitive. The research explained that clients' demands are increasing continuously

in the construction sector, and only through developing collaboration this demand could be supplied. Since in modern construction, it is impractical for a construction company to deliver a large project without dealing with other companies in the market. Therefore, it is important to improve relationships between those organisations and stakeholders in the construction industry. Snow (2015) explained that organisation systems should be changed from strict hierarchies to more open and shared places between stakeholders. Collaborative management of construction projects should be accomplished via direct relations between members and parties rather than firm contract-guided regulations.

According to Liu et al. (2017), the conventional ways of working have been affected by some changes in construction projects, and the trend is towards developed relationships between parties. The authors added that the construction industry could no longer ignore the effects of the behaviour of participants and engagement between parties on the efficiency of teams. Subsequently, the performance of these teams directly determines the quality of the products.

To overcome this issues, a focus on “softer” issues, organisations’ individuals and business process is necessary, particularly in the case of developing countries where projects face many additional problems related to social, cultural and political situations (Elkhalifa, 2016). Construction projects are still missing fundamental elements for establishing collaborative working environments.

Accordingly, in order to improve collaboration, a broader range of factors needs to be considered as a means of overcoming project issues. This is because developing collaboration and implementing new ways of working faces many barriers, and teams might fail to adopt such approaches (Patel et al., 2012).

2.6 Benefits of collaboration in the construction industry

Researchers have agreed that collaboration is important for improving construction practices and that it has many benefits for the industry (Kożuch & Sienkiewicz-Małyjurek, 2016; Meng, 2013; Shelbourn et al., 2007). Collaboration has external and internal benefits in the construction industry (Hughes et al., 2012). Externally, firms need to collaborate to overcome strong competition within the market and to deal with pressure from governments. Internally, collaboration is necessary for stability, economic efficiency, a higher level of satisfaction and meeting clients' needs.

According to Black et al. (2000), the main benefit of collaborative working is fewer adversarial relationships between parties. Moreover, reducing the conflicts in construction through collaboration can improve supply chain relationships. Adversarial relationships in traditional routes are the cause of many issues that still exist in the construction industry such as delays and underperformance of projects (Akintan & Morledge, 2013). Improving relationships and moving away from a win-lose culture could result in significant improvements in performance in the construction industry, whether this is a financial performance for construction companies or asset performance for clients.

Collaborative working is vital to achieving long-term business objectives and continuous improvements (Eriksson, 2010). Continuous improvement could ensure future work and long-term relationships between parties. These relationships between construction industry firms are crucial to gaining economic benefits. Vaaland (2004) explained the role of collaboration in resolving different views between parties that can produce well-

developed business relationships, which leads to reduced loss of productivity and minimised costs. Ultimately, economic targets become possible when effective relationships are maintained among industry stakeholders.

Clearly, combining the resources and expertise of stakeholders could lead to increasing the efficiency of teams and delivering higher quality products. The involvement of suppliers and subcontractors at the right time in projects brings practical knowledge to the teams and helps prime contractors and clients to control performance issues (Bemelmans, Voordijk, & Vos, 2012). Fragmentation and the involvement of a large number of stakeholders such as designers, clients, contractors and subcontractors in the construction industry have caused low-levels of customer satisfaction. Morrell (2015) insisted that collaboration between different parties will resolve performance issues and lead to a higher level of customer satisfaction. Delivering end-users' needs is one of the main aims of project teams to ensure the success of their organisations in construction markets. Akintoye, McIntosh, and Fitzgerald (2000) emphasised that improved customer services and cost objectives are the main benefits of collaborative working processes.

Despite improving project processes and team culture, another significant benefit of collaborative approaches is schedule reduction and improved time scales (Bresnen & Marshall, 2000a). One of the main problems with construction projects is delays; keeping up with schedules is always a difficult task. Many issues in construction projects such as deficiencies in control mechanisms and delays are considered as the result of a lack of teamwork in traditional approaches (Koraltan & Dikbas, 2002). Construction

teams could overcome this issue and deliver projects to a planned timetable by using an effective collaboration process and the experience of all teams.

Construction parties have lower exposure to risks when collaboration is developed between teams. In collaborative working practices, risk and rewards are shared; if a party is at risk of losing their rewards, then all parties may be at risk based on principles of gain-pain sharing (Yeung, Chan, & Chan, 2007). This approach encourages parties to cooperate with other parties at risk and reduce the overall 'pain' to a minimum.

Furthermore, Rahman, Endut, Faisol, and Paydar (2014) emphasised the role of improved teamwork and open communication to simplify the construction process. Design complexity is a common issue within construction projects that can be solved by producing a collaborative environment between the design and construction teams. This collaboration will increase the awareness of construction teams toward design details and will also increase the buildability of the design. For example, the involvement of contractors in the design phase facilitates the process and can increase constructability as well as maximising value engineering (Bresnen & Marshall, 2000c). Despite its benefits, delivering effective collaboration in the construction industry is still a challenge. Therefore, this research reviews the literature to identify the most critical factors needed to deliver effective collaboration.

2.7 Factors to deliver effective collaboration

To ensure successful collaboration in construction projects, a range of factors need to be considered and addressed (Azhar et al., 2014). For this purpose, many researchers have explored the elements of collaboration. Kożuch and Sienkiewicz-Małyjurek (2016),

for example, classified factors to deliver successful collaboration into five groups namely: factors of external environments, factors related to people characteristics, factors related to organisation characteristics, instruments of inter-organisational collaboration and relational factors. Similarly, Patel et al. (2012) investigated the factors influencing collaborative working, and presented a framework of the main factors which are listed under; context, teams, individuals, support, tasks, interaction processes, and overarching factors. Collaboration is a non-adversarial organisation-based environment, where through correct relations, and early involvement of key members, everyone understands their roles and responsibilities and respects others (Hughes et al., 2012). The study explained that several techniques, such as regular meetings, open dialogue, risk sharing and early warning system, can be used as a means for managing relationships.

A further study by Cheng, Li, and Love (2000) classified critical success factors for partnering in construction under two categories of subjective factors and objective factors. The most crucial factors mentioned were mutual trust, adequate resources, management support, effective communication and conflict resolution. Moreover, Azhar et al. (2014) argued that factors affecting collaboration could be distributed to some groups such as organisational, technological and legal factors. The American Institute of Architects (AIA National, 2007) indicated several elements for delivering collaboration under the Integrated Project Delivery (IPD) approach. According to AIA National (2007) guide for achieving successful collaboration, all participants should embrace the following principals; 1) mutual respect and trust. 2) Mutual benefits and reward. 3) Collaborative innovation and decision making. 4.) Early goal definition. 5)

Early involvement of key participants. 6) Open communication. 7) Intensified planning. 8) Appropriate technology. 9) Organisational leadership.

Clarke (2012) explained that one of the main factors influencing project performance and organisational commitment is leadership style and senior management support. Effective leadership can prevent many issues in projects and encourage developing relationships between involved parties. Leaders in the construction industry should focus on satisfaction and motivation of team members rather than targeting finishing tasks only (Clarke, 2012). Additionally, in order to improve project performance, parties need to share resources, hold regular meetings and assess the performance of the project (Cheng et al., 2000). An owner's choice of project delivery systems on building projects could also define supply chain relationships subsequently directly affecting project processes and project performance (Mesa, Molenaar, & Alarcón, 2016).

Furthermore, researchers have also suggested some practical working ways to improve collaboration within projects. For instance, clarifying roles and responsibilities of team members and assigning the right people to perform tasks can be used as factors to deliver the required level of collaboration, as described by Kożuch and Sienkiewicz-Małyjurek (2016). Arditi and Gunaydin (1998) explained that combining available resources for the project produces more effective problem-solving situations. Also, it has been argued that managing task dependencies and establishing clear roles are essential in improving group coordination and teamwork planning (Antoni, 2005; Cataldo, Wagstrom, Herbsleb, & Carley, 2006).

Many other researchers have studied collaborative approaches to working and have mentioned different factors to improve those practices. For example, both Meng (2012)

and Akintoye et al. (2000) have identified 10 factors for improving collaborative relationships in the construction industry, but their lists have only three similar factors (mutual objectives, trust and communication). There are also different opinions on determining critical factors. Some factors were considered the most important by some authors and have been given the least importance or not even mentioned by others. For instance, commitment and trust were identified as the most important factors by Wu, Greenwood, and Steel (2008), but commitment was given less importance by Dikmen, Birgonul, Ozorhon, and Eren (2008a) when ranked 6th out of 13, and the factor was not even in the 10-item list determined by Meng (2012). Therefore, disagreement exists among researchers about factors of collaboration. In this thesis, a systematic process has been used to identify and rank the potential factors of collaboration from past literature, explained below.

2.8 Collaboration factors selection process

A considerable amount of literature exists on the factors to deliver collaboration and ensuring better relationships within construction projects. In this research, a comprehensive review has been undertaken to identify critical success factors of collaboration in the construction projects. The process of identifying factors of collaboration, partnering and alliancing from the previous literature has been used by other researchers (Chan, Chan, & Ho, 2003; Nyström, 2005; Yeung et al., 2007). In this thesis, the most relevant literature from 2000 to 2019 has been reviewed. To identify a sample of papers for the review, the first step was to search for keywords in titles and abstracts of the articles. As the past literature has used different words to describe

collaborative relationships, such as partnering, strategic partnering, alliancing, teamwork, collaboration and so on. Similarly, studies describing factors of collaboration have used different terms such as critical factors, attributes, attitudes, components and so on. In this research, a combination of words from both aspects of collaboration and factors has been used to identify related studies. Then, related articles were scanned qualitatively to identify most-closely related studies. Similar approaches were also used by Kożuch and Sienkiewicz-Małyjurek (2016) and Wu et al. (2008) in collaboration research. This process resulted in 35 articles being considered for this research which are listed in Table 2.2. Later, the most commonly mentioned factors in the articles were identified. The final factors identified from the literature are shown in Table 2.3 with their definition outlined below.

Table 2-2 Reviewed papers to identify factors of collaboration

Ref. no	Author(s)	Year	Ref. no	Authors	Year	Ref. no	Author(s)	Year
1	Akintoye et al.	2000	13	Lu and Yan	2007	25	Patel et al.	2012
2	Black et al.	2000	14	Shelbourn et al.	2007	26	Akintan and Morledge	2013
3	Bresnen	2000	15	Yeung et al.	2007	27	Meng	2013
4	Bresnen	2000b	16	Dikmen et al.	2008	28	Rahman et al.	2014
5	Cheng et al.	2000	17	Erdogan et al.	2008	29	Azhar et al.	2014
6	Bayramoglu	2001	18	Koutsikouri et al.	2008	30	Gassel et al.	2014
7	Cheng and Li	2001	19	Wu et al.	2008	31	Bidabadi et al.	2015
8	Cheng and Li	2002	20	Eriksson	2010	32	Bidabadi et al.	2016
9	Koraltan and Dikbas	2002	21	Xue et al.	2010	33	Kozuch and Sienkiewicz-Małyjurek	2016
10	Chan et al.	2004	22	Bemelmans et al.	2012	34	Koolwijk et al.	2018
11	Vaaland	2004	23	Hughes et al.	2012	35	Nursin et al.	2018
12	Nystrom	2005	24	Meng	2012			

Table 2-3 Factor of collaboration and resources mentioned

Rank	Factors of Collaboration	Frequency	No. of resource mentioned the factor
1	Trust	31	[1 - 2 - 3 - 4 -5 - 6 -7 - 8 - 9 - 10 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 21 - 22 - 23 - 24 - 25 - 26 - 27 - 28 - 29 - 31 - 33 - 34 - 35]
2	Communication	26	[2 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 14 - 15 - 16 - 18 - 19 - 21 - 22 - 23 - 24 - 25 - 27- 28 - 30 - 31 - 32 - 33 - 34 - 35]
3	Conflict resolution	21	[5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 15 - 16 - 17 - 19 - 21 - 23 - 24 - 25 - 27 - 28 - 29 - 35]
3	Mutual goals	20	[1 - 4 - 5 - 9 - 10 - 12 - 13 - 14 - 15 - 18 - 19 - 21 - 22 - 23 - 24 - 25 - 27 - 28 - 29 - 33]
5	Top management support	20	[1 - 2 - 5 - 7 - 8 - 10 - 12 - 13 - 15 - 16 - 20 - 19 - 21 - 22 - 25 - 28 - 29 - 31 - 32 - 34]
6	Commitment	19	[1 - 2 - 3 - 5 - 7 - 8 - 10 - 13 - 14 - 15 - 16 - 19 - 22 - 25 - 28 - 31 - 32 - 33 - 34]
6	Gain-pain sharing	18	[1 - 2 - 3 - 6 - 9 - 13 - 14 - 15 - 19 - 20 - 21 - 22 - 23 - 24 - 27 - 28 - 29 - 34]
8	Culture	16	[1 - 2 - 4 - 5 - 9 - 13 - 14 - 16 - 18 - 21 - 22 - 25 - 29 - 31 - 33 - 35]
9	Resource sharing	14	[5- 7 - 8 - 10 - 12 - 13 - 14 - 15 - 17 - 19 - 25 - 26 - 28 - 33]
10	Early involvement of key participants	14	[4 - 5 - 6 - 10 - 12 - 14 - 15 - 20 - 21 - 23 - 25 - 29 - 31 - 34]
11	Clear roles	13	[2 - 4 - 10 - 14 - 16 - 18 - 23 - 25 - 27 - 28 - 31 - 32 - 33]

2.8.1 Trust

For collaboration to be effective, parties need to build trust (Meng, 2013). This is because if the level of trust is low, parties tend to act against each other and it is not possible to work collaboratively. Construction organisations need to improve the level of trust between their practitioners by using new ways of working (Wu et al., 2008). It is very important in construction projects that stakeholders take time out from routine activities to increase the level of social interaction in order to build mutual trust and respect (Shelbourn et al., 2007). These personal interactions are necessary to find new ways of working and move away from hard contractually-guided relations. Construction managers should notice that building trust between individuals is essential to building trust between organisations. Yeung et al. (2007) agreed that trust is based on previous experience either directly, with people concerned, or indirectly, by anticipated or projected experiences. Therefore, trust is an emotional and human situation that is necessary for every team to achieve successful business relationships. Mutual trust is necessary at all stages of working, thus parties need to continuously make efforts to improve the level of trust. Actually, gaining higher levels of trust after working together in a project reveals the level of success of collaborative relationships between involved parties (Cheng & Li, 2002). Consequently, continuous work could be ensured between parties that leads to future developments and achieving organisational goals.

2.8.2 Communication

A lack of open communication is the main reason for failures in construction projects, hence, it is essential to have well-established communication lines to avoid performance

issues and cost overruns (Meng, 2012). Black et al. (2000) argued that good communication is the most important factor for construction sites considering a large number of problems that occur as a result of poor communication between client, contractor and consultants. Many issues are the result of poor communication skills among project participants. Construction organisations need effective communication skills to exchange visions and ideas, which may reduce misunderstandings and produce effective working environments (Cheng et al., 2000). Clear communication channels create formal and informal ways to exchange information, increase shared awareness and obtain a shared benefit (Patel et al., 2012). Therefore, to attain a steady process, project teams need to enable organised communication lines between all involved parties.

It is noticeable that the importance of communication has increased in construction projects with the implementation of new ways of working and using complex designs. For instance, Koutsikouri et al. (2008) insisted that rich communication is crucial in design stages to provide shared understanding and simplify complicated design details. The research added that communication underpins all other factors needed for collaborative working, and it is the major contributor to success. Design and construction teams need to have clear communication channels to increase shared awareness and avoid technical issues on construction sites. Moreover, van Gassel, Láscaris-Comneno, and Maas (2014) explained that it is fundamental to enable effective communication lines to gain efficient processes of collaboration, and that regular meetings could be used as a means to gain efficient communication (van Gassel et al., 2014).

2.8.3 Mutual goals

Establishing mutual goals is a major contributor to the success of construction projects and is regarded as a prerequisite of success for any collaborative approach (Bresnen & Marshall, 2000a). Construction teams need to agree on mutual goals at the highest levels of management and transfer those goals to the lower levels to ensure all involved parties work toward a common target. Akintoye et al. (2000) described mutual interest as a key factor to provide a collaborative environment between different levels of working chains in construction teams. It is not possible for construction parties to work collaboratively and gain benefits without setting common targets. All parties are required to attain common goals and consider each other's interests in order to achieve business profits (Kożuch & Sienkiewicz-Małyjurek, 2016).

2.8.4 Conflict resolution

A proper conflict resolution system is crucial for a collaboration to survive between construction parties. In conflictual events, resolving tense relationships is important to avoid a total breakdown of the interaction and work termination between stakeholders (Vaaland, 2004). Vaaland (2004) argued that solving conflicts between parties with different perceptions can be used as a means to enhance collaborative relationships. Since conflicted parties need to explain reasons for a different view, this may find the underlying causes of the conflict and prevent it from happening again. Construction practitioners need to solve disputes at the lowest level possible before rapid escalation to legal authorities (Bayramoglu, 2001). If a conflict reaches a point that requires a court to solve it, it may cause all parties to lose time and incur a cost. Disputes are present in

all construction projects depending on size, duration and complexity of contracts. However, Xue et al. (2010) indicated that a proper strategy of conflict resolution provides stability and prevents many issues related to adversarial relationships in traditional contracting approaches.

2.8.5 Top management support

Top management support is essential to develop relationships and increase confidence between parties because it supplies adequate resources, finance, information and time (Cheng & Li, 2001). Top management is required to lead and arrange activities in construction projects and ensure that processes are working effectively. The first step to producing collaboration in construction projects should come from top management through expressing support and commitment to goals (Bidabadi et al., 2015). Similarly, Nyström (2005) identified top management support as the main prerequisite for developing a collaborative approach in the construction industry. Therefore, in order to achieve targets set for parties working at different levels in construction projects, top management needs to show full support. Support from management is essential to develop and maintain relationships at a high level and to avoid disputes (Dikmen, Birgonul, Ozorhon, & Eren, 2008b). Lack of support from management could result in the growth of small issues that become big obstacles to proceeding the process.

2.8.6 Commitment

A core item required for the success of collaboration is commitment by the involved parties; commitment and motivation are required to reinforce relationships in construction projects (Bresnen & Marshall, 2000b). As the construction industry

struggles with adversarial relationships, practitioners need a commitment to common goals to help them adopt collaborative approaches (Bidabadi et al., 2016). It has been illustrated that parties need to show a long-term commitment to common visions in order to attain stability within projects and to achieve project goals. Committed stakeholders prefer long-term achievement to a small immediate benefit which reduces the possibility of rising disputes from different tasks. Bemelmans et al. (2012) discussed that success of collaboration in construction projects is highly influenced by the commitment of parties in providing shared resources and working toward common objectives. Setting common goals, even if it is an early stage of the project, does not benefit businesses if parties are not fully committed.

2.8.7 Gain-pain sharing

Another crucial factor for a collaboration to succeed is a gain-pain sharing system between parties. A large number of obstacles on construction projects stem from unfair risk sharing in old-fashioned contractual clauses (Koraltan & Dikbas, 2002). The construction industry needs to find effective ways to share risks and rewards between its parties in order to be able to improve adversarial relationships. Implementation and adoption of new ways of working depend on parties' obligations to share the profits of target achievements and simultaneously to bear the risks of missing that goal (Azhar et al., 2014). It can be argued that the absence of a proper means of gain-pain sharing is responsible for restraining resources and information, which results in a lack of collaboration and performance issues. The importance of risk sharing increases in the case of larger projects. As explained by Lu and Yan (2007), in complex projects with a

high degree of uncertainty it is essential to share risks and rewards in a systematic way to gain effective collaboration.

2.8.8 Culture

Project and organisational management trends are moving toward more decentralised, flexible and collaborative organisations. However, the success of this step toward collaboration is associated with understanding the crucial role of cultural changes within this process (Black et al., 2000).

Organisational characteristics such as regulations, organisational structure, leadership and organisational culture have a strong influence on the efficacy of collaboration within the organisations (Kożuch & Sienkiewicz-Małyjurek, 2016). Culture is a very influential factor on collaboration in every organization; it could indicate methods of communication and engagement of the members in projects. Bemelmans et al. (2012) argued that in order to build a collaborative workplace, leaders need to explain collaboration as a culture or the way the organisation works for the members of the project. Traditional methods of project delivery have produced an adversarial culture in construction projects that does not encourage collaborative working (Baiden et al., 2006). Therefore, it is the culture of the construction industry that needs to be changed in order to increase the performance of construction products.

2.8.9 Resource sharing

Sharing resources creates an atmosphere of collaboration that is more harmonious and effective, and parties need to increase the level of resource sharing to avoid deficiencies in the performance of projects (Akintan & Morledge, 2013). Resource sharing increases

trust and respect between parties and helps to produce collaborative environments. Sharing resources increases the willingness to work collaboratively and facilitates the development of relationships in an efficient way (Rahman et al., 2014). It is important for construction projects to share resources in a proper way to avoid deficiencies in resources for different tasks. Management teams need to use resources in an appropriate way to avoid any failure in the implementation of collaboration (Erdogan, Anumba, Bouchlaghem, & Nielsen, 2008).

2.8.10 Early involvement of key participants

In many cases, the early involvement of some key participants such as contractors, subcontractors and suppliers is restricted under old contract approaches. The lack of involvement of key participants such as contractors has resulted in a lack of practical experience in design stages; consequently, this leads to deficiencies in the buildability of designs. Eriksson (2010) explained that it is crucial to involve contractors and subcontractors as early as possible to negotiate directly with the design team to avoid performance issues. Chan, Chan, et al. (2004) agreed that despite the involvement of contractors, major subcontractors need to be brought in as well at an early stage of projects so that parties will develop collaborative relationships at the start. The early involvement of participants increases the level of understanding, thus reducing disputes and improving team performance. Collaborative teams need to be built on the early involvement of key members so as to move away from a conservative construction culture and improve the performance of industry products (Hughes et al., 2012).

2.8.11 Clear Roles

For a collaboration to be successful, roles need to be clearly defined and individual responsibilities need to be coordinated toward achieving the project target (Patel et al., 2012). The complexity that exists in construction projects makes it difficult to clarify the responsibilities of each individual that is involved in a task. However, Black et al. (2000) indicated that a clear understanding of responsibilities is required if collaborative working is to succeed, and that this requires the effort of all project stakeholders. It is important for construction teams to understand that each individual has a different role and should be respected by others. Besides clarifying roles, construction teams need to have some flexibility in roles because many issues that arise in traditional ways of contracting are due to a high level of specialisation in role definition, which has resulted in a lack of support between team members. A significant step toward effective collaboration in construction projects is to eliminate duplication in responsibilities and increase flexibility in the roles of members (Bresnen & Marshall, 2000a).

2.9 Chapter summary

This chapter presented the outcomes of the literature review about the performance gap in the construction industry and the reasons for that gap. Previous literature has indicated that the lack of collaboration is a primary reason for the performance gap in residential building projects. Then, the state of collaboration practices in the construction industry was explored. The literature emphasised that fragmentation of the industry is an inevitable challenge that construction practitioners need to overcome. Therefore, a comprehensive review of the literature was undertaken to identify critical

factors for delivering collaboration. The process resulted in determining 11 factors as necessary for improving collaborative environments. The factors are identified from global literature and are have the potential to be critical in the context of the Kurdistan region. These potential factors will be used to develop a survey questionnaire that aims to identify local factors of collaboration in the context of the Kurdistan region, explained in chapter 5. The next chapter will introduce the Kurdistan region and explain in detail the case of residential projects in that context.

3 Chapter Three: Residential construction projects in the Kurdistan Region of Iraq

3.1 Introduction

This chapter explores construction practices in developing countries in general, with a particular focus on the Kurdistan region. It gives a brief description of the Kurdistan region and explores the construction sector in the region with a specific focus on residential projects. The final section presents the challenges and barriers that the industry needs to overcome to improve construction quality.

3.2 Introduction to the Kurdistan Region of Iraq

The Kurdistan region, is a mountainous area in the Middle East, a federal region located in the north of Iraq. The Kurdistan region has a distinct local government, the Kurdistan Regional Government (KRG), the region comprises a total area of 40,643km². The Kurdistan region shares borders with Turkey to the north, Iran at the east and Syria to the west and rest of Iraq to south, (Figure 3.1). The region is the southern part of Kurdish-populated areas that are spread over those four mentioned countries. Historically, the region had various periods with different levels of political instability and economic crises. However, after the Iraq war in 2003, the northern region of Iraq experienced a considerable degree of stability and safety. Unlike other parts of Iraq, the Kurdistan region remained peaceful for most parts of the last decade (Lababedi & Choufany, 2013). The relative stability in the region has resulted in considerable

economic growth. The capacity of the local government has developed significantly, and the region is attracting foreign investors. Many global companies are undertaking projects in the region, especially in the construction sector. Additionally, the region is an oil-rich area, Lababedi and Choufany (2013) explained that by having 45 billion barrels of oil and gas reserves, the Kurdistan region is in the top ten oil reserves in the world. Exporting oil has contributed massively to the development and growth of the region.

Figure 3-1 The map of the Kurdistan region

Erbil, the capital city of the Kurdistan region, is the glaring example of developments in the region. Erbil was chosen as the tourism capital of the Middle East for 2014 (Akram, Ismail, & Franco, 2016). According to the International Council on Monuments and Sites (ICOMOS), Erbil is also believed to be the oldest continuously inhabited city in the world dating back some 6000 years (Akram et al., 2016). The business-friendly attitude of the

region and openness to the West are expected to cause more economic evolution in the region (Barnard, 2013).

However, Barnard (2013) added that the Kurdistan region still faces many problems, politically and socially. To reach the full potential of the region a proper set of economic, political and security policies must be established by the authorities in the region. The nature of the Kurdistan region, especially with an adequate supply of water from rivers, encourages agriculture and means that historically the Kurdish population has relied on small agricultural projects. However, both tourism and the oil sector have increased in the region recently. Yet, the housing sector is the largest industry of the region and the principal contributor to economic development (World Bank, 2015). Furthermore, the Kurdistan region hosts around 2 million refugees and internally displaced people (IDPs) from Syria and Iraq (Soderberg & Phillips, 2015). This increase in population is significant for a region with a population of around 7 million and has caused considerable stress and challenges in all sectors of business, including construction.

3.3 Construction projects in developing countries

The construction industry is fundamental to an advanced economy; it provides the infrastructure and builds an environment that enables a population to flourish socially, culturally and economically (Bennett, 2007; Winch, 2010). The contribution of construction is increased in the case of developing countries. Lopes, Ruddock, and Ribeiro (2002) investigated the role of construction in developing countries and argued that there is a significant relationship between the amount of construction going on and economic growth for countries still at developing stage. Despite the fact that the

contribution of construction decreases in developed economies (Lopes et al., 2002), it remains a significant contributor to economic growth.

In developing countries, the construction industry has a linear correlation with Gross Domestic Product (GDP), where around half of the investments in those countries is in construction (Giang & Pheng, 2011). Although the volume and contribution of construction vary from one country to another, the industry remains vital across developing countries (Ofori, 2007). The sector even contributes to developments in other areas such as agriculture and tourism by providing much-needed infrastructure (World Bank, 2015). Therefore, the construction industry contributes significantly to both financial improvements of developing countries and the general living standards of their population. This crucial role of the construction industry is well recognised, and construction projects are a priority in many governments' planning.

A review of 40 years of literature by Giang and Pheng (2011) on the contribution of the construction industry to economic growth in developing countries explained that there is a consensus on the existence of a positive relationship between the share of construction in total GDP and GDP per capita. Nevertheless, the authors insisted that it is essential for construction projects to spend the invested money appropriately and consider to fill the needs of people with high-quality products. Since irregular investments in construction, like any other industry, might result in a waste of national resources and harm the economy of countries.

In the Middle East, the construction industry and oil sector are the biggest influencers on the economy of most of the countries, including Iraq and its Kurdish region (Soderberg & Phillips, 2015). A large amount of money is invested in construction

projects, in which housing projects grab the most prominent portion (Sweis, Sweis, Hammad, & Shboul, 2008). Governments rely on international firms for big projects, but there is optimism for local firms to increase their capacity as well. The construction sector in the Middle East is expanding with anticipations for more developments in the region in coming years, around US$1 trillion is expected to be spent on construction projects by 2030 (Rached, Hraoui, Karam, & Hamzeh, 2014). The authors explained that despite many obstacles such as rigid contractual terms and lack of collaboration hindering the construction process, the construction industry remains a primary contributor to developments of the region, alongside the oil sector. AECOM (2015) explained the vital role of the construction sector in the development of the Middle East region, and despite uncertainty over the geopolitical situation and instability of oil prices affecting the region, prospects in the construction industry are positive as a maturing sector with long-term infrastructure spending. In their later handbook on the construction industry in the Middle East, AECOM (2016) explained that construction maintains its importance across the countries in the region. Growth of the construction industry in the area has resulted in increasing interest of stakeholders to improve the construction process and adopt state of the art practices.

3.4 Construction projects in Kurdistan region

The Kurdish region in the North of Iraq has seen a considerable level of security and safety for several years, working environment and government regulations are significantly different to the rest of Iraq and supportive of investments (Bekr, 2015). The situation is encouraging investment, especially in construction projects, due to relative

stability and need for construction industry products. The regional government depends on the construction industry to equip the region with the required infrastructure and contribute to economic developments. Therefore, construction projects have an additional role in restoring the nation's internal built environment, replacing housing, securing essential resources such as water, power and sewage. At the same time, creating the necessary foundation such as transport systems for inter-regional connections and international connectivity, facilitating much-needed international investment (RTI International, 2008). The construction industry has responded to the needs of the region and provided many high profile buildings, infrastructure projects and large residential complexes. Blossoming of the sector reached peak speed after the Iraqi war in 2003 when the region developed economically, and opportunities of investment increased (Neamat & Yitmen, 2017). The authors described that since then, an immense number of international companies have moved to commence working in the Kurdish construction sector. Besides that, many local companies have established or expanded their capacities to be able to compete in the market.

The KRG allocates a high proportion of its budget to the ministry of construction and housing, and with a significant foreign investment in the private sector, construction projects are widespread in the region. The construction sector has grown rapidly in the last decade, as a result of active cooperation between the KRG and foreign companies (Jabary & Hira, 2013). For example, trade between the KRG and Turkey in 2014 was $12 billion that was Turkey's second-largest overseas market after Germany (Soderberg & Phillips, 2015). BMI Research (2014) compared the economic contributions of energy and construction sectors in the Kurdistan region. It reported that the construction

industry is expected to outperform the energy and oil sector with the year on year growth averaging 8%.

Shatz, Constant, Luoto, Smith, and Abramzon (2014) analysed the economic situation and labour market of the Kurdistan region and identified construction as the sector that helps the government the most by providing a substantial number of jobs. The research described that the industry is likely to grow, and more employment opportunities will be granted for skilled and unskilled personnel. The principal part of these developments in the construction sector is in residential projects. However, despite the crucial role of building construction projects in the Kurdistan region, there is a significant lack of standards and regulations for these projects (Shawkat et al., 2018). Consequently, there are many construction projects that are delivered to customers but never meet the required demands. Especially the housing sector, which is the most requested type of construction, encounters difficulties in delivering housing units to the expected quality. Therefore, Neamat and Yitmen (2017) explained that construction industry stakeholders, managers and engineers should collaborate to establish and understand innovative processes for delivering construction projects. The KRG needs to take serious actions for improving project delivery processes and increasing the performance of construction outcomes. The performance of the industry products can only be enhanced by improving the construction process and adopting strengthened practices.

3.5 Residential building projects in Kurdistan region

In most of the countries in the Middle East, residential projects dominate the construction sector and hold a massive amount of investments (Sweis et al., 2008). The

Kurdistan region is no exception; the most common form of construction in the region is residential building projects. Housing is a basic human need, and all governments must ensure that their citizens have decent houses. However, in most developing countries, the housing sector has shortfalls in delivering high demands for residential units (Ofori, 2015). The KRG seeks to cooperate with foreign companies to facilitate the building process and encourages them to invest in the housing sector through many procedures. For instance, under the Kurdistan investment law 2006 for housing projects, foreigners are allowed to own land, something which is not permitted in the areas administrated by the Iraqi central government (Ministry of Planning, 2013). The report added that, despite these attempts, housing developments are still struggling to meet the high demand for housing units in the region.

There are several reasons for investment in residential projects in the region. Soderberg and Phillips (2015) explained that economic growth has resulted in a rapid increase in population and a consequent rise in the need for housing projects. Additionally, due to the Syrian civil war and the Iraqi conflicts, many people have chosen to move to the relatively safe Kurdistan. Although it can be argued that immigration is a temporary settlement and does not affect demand for housing, the case is more complicated in the Kurdistan region. The region is surrounded by the Kurdish population in the neighbouring countries, due to the historical distribution of Kurds in that area. Therefore, a significant proportion of immigrants from those neighbouring countries to the region are Kurds. This means that they share the same culture and the same language with the population of the Kurdistan region. The shared culture between the Kurdish nation increases the interest of immigrants to stay in the region. Also, the KRG

does not impose strict regulations to return immigrants to their land at the earliest possible opportunity. Hence World Bank (2015) expected that a significant number of these people would make their lives in the region, and the Kurdistan region will need new residential buildings. The situation is actually happening; many of those immigrants are planning to stay and have already opened businesses in the region (Yassen, 2019).

Since the 1990s, the KRG has developed plans for building a large number of housing units and reconstruct towns and cities. During those years, the housing sector was led by different international organisations such as the UN housing agency, Habitat (Natali, 2007). This process helped the KRG to standardise the housing sector comparatively and create thousands of jobs for skilled and unskilled workers. The speed of expanding the housing sector started to increase rapidly after the Iraqi War in 2003, which resulted in a change of constitutions in Iraq. The Ministry of Construction & Housing (2017) of the KRG described the program of constructing housing units in four phases. The data are available from 1992, which is the year the KRG was founded.

The first phase, 1992 – 1998

This stage mostly involved rehabilitation of towns and repairing already existing buildings. The KRG, with the support of international organisations, tried to provide basic housing needs for people. Around 39,000 units housing were constructed and repaired during those years, which at that time was a significant step forward.

The second phase, 1998 – 2005

During this period the housing sector was supervised by the housing agency of the UN, Habitat. The organisation cooperated for several years with the Ministry of Construction

and Housing, and according to the data available, 19,789 housing units were constructed.

The third phase, 2005 – 2011

This period is known as after the Iraqi war. The KRG took complete control over the housing sector. The KRG distributed the responsibilities of housing projects into public and private sectors. From then on, the Ministry of Construction and Housing has been responsible for public projects, while the Kurdistan Board of Investment is in charge of private projects (see Figure 3.2). During this period, the focus started to be on constructing high-quality buildings rather than quantity, around 9,151 housing units were built.

The fourth phase, 2011 – present

The process of urbanisation has grown and led to a significant increase in the population of cities. Therefore, the government is trying to use the land productively and produce massive numbers of housing units through high-rise buildings. Currently, most of the projects are large residential complexes in cities. There are many projects under construction according to the Ministry of Construction & Housing (2017) the details of public and private projects are as below.

In the public sector:

- The total number of residential projects under construction: 64 projects and 8,392 units (6,892 units are apartments in high-rise buildings + 1500 units are in projects including both apartments and single houses)

- The total number of finished building projects but yet to be handed over to users (commissioning): 1,044 units.

In the private sector:

- There are 175 residential building projects in the region (Investment Board, 2017)

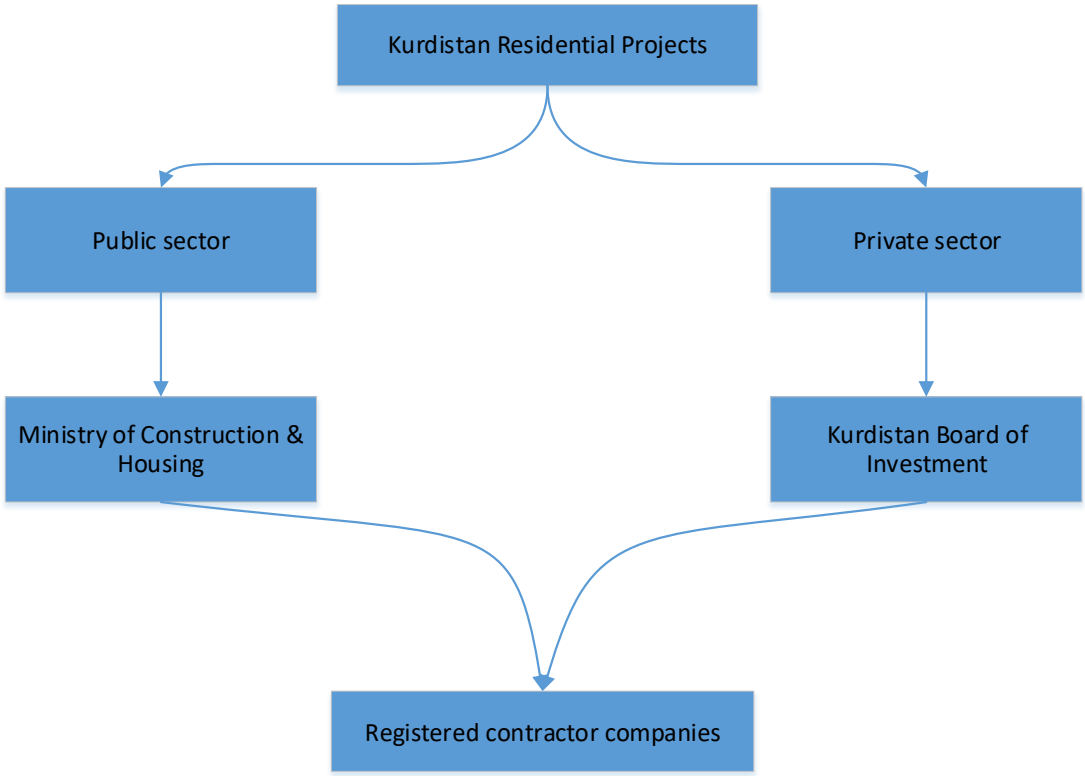


Figure 3-2 Residential building projects distribution in the Kurdistan region.

The housing sector in the region has become a competitive market for local and foreign companies. Besides the local workforce, thousands of workers from neighbouring countries, especially Turkey and Iran, are working in the housing projects in the Kurdistan region (Natali, 2007). Then after the civil war, Syrians started to target working in the region as well. The KRG supports this growth by allocating a high percentage of its

budget - 37% - to residential projects and reconstruction (World Bank, 2015), as illustrated in Figure 3.3 below:

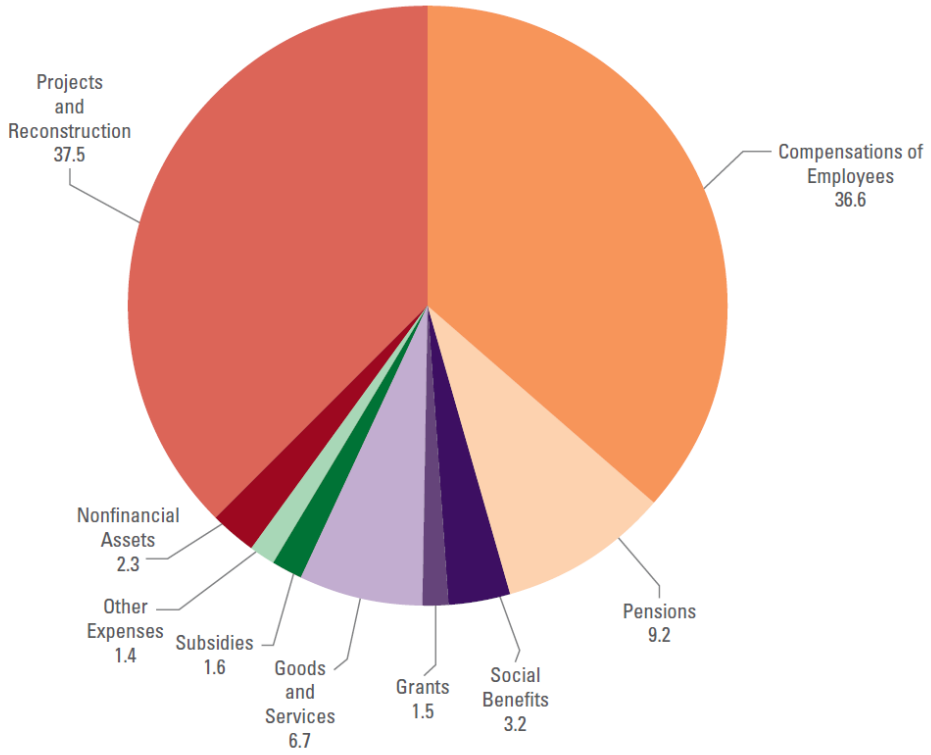


Figure 3-3 The KRG's budget distribution per sectors (World Bank, 2015).

Additionally, in the private sector, the Department of Information and Studies in the KRG valued total investment that in the region at $46 billion (Investment Board, 2017), of which housing projects alone account for a substantial amount as shown in Figure 3.4:

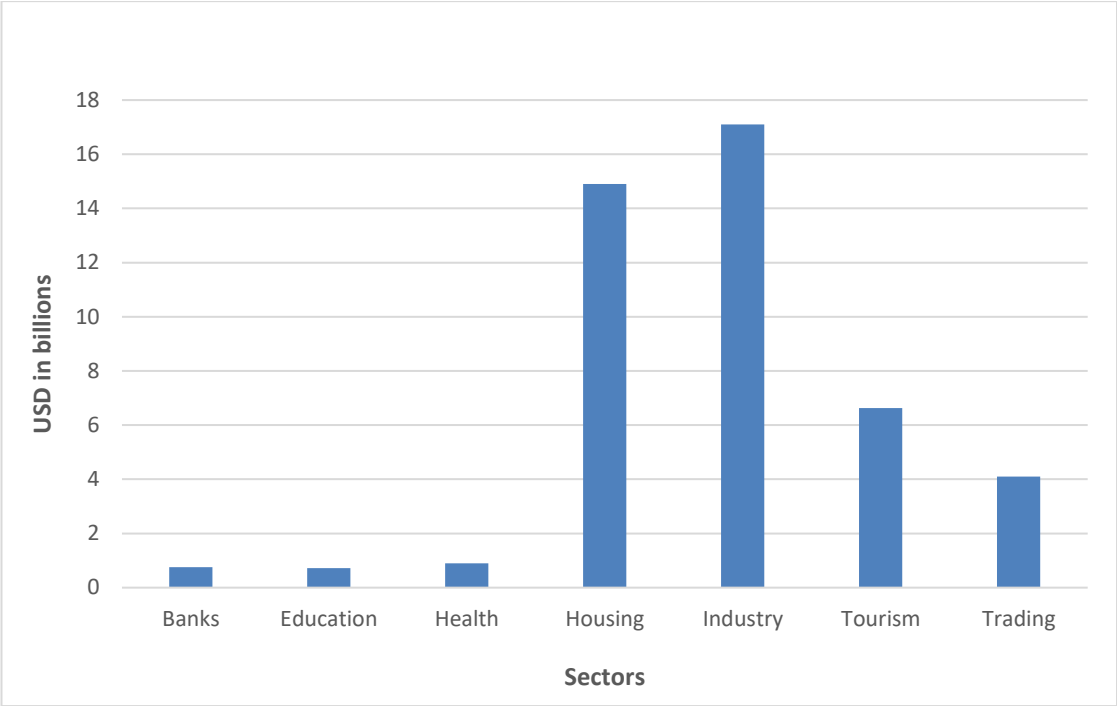


Figure 3-4 Distribution of capital by sector in Kurdistan region (Investment Board, 2017).

Around 37% of the Regional Government's budget and $14.8 billion from private investment makes housing Kurdistan's largest sector. Clearly, residential construction in the Kurdistan region forms a significant part of the economy of the region due to its considerable size and persistent impact on other areas (Soderberg & Phillips, 2015). In the Kurdistan region, the building construction industry acts as a significant contributor to job prospects and in building the Gross Domestic Product (GDP) of the region. Supported by the private sector, residential construction is the fastest growing sector in the Kurdistan region, upon which a major part of the economy of the country depends (Invest in Group, 2016). The officials of the new cabinet of the KRG, which commenced work in 2019, insisted that investment in the residential sector will continue. There are strategies to expand the sector more and build massive projects to high-quality

standards. Since the demand for housing units keeps rising, it is necessary to develop the industry to be able to appropriately satisfy this need.

There is evident economic importance of residential projects in the Kurdistan region. In contrast, the environment has been affected negatively, and pollution has increased within the cities by building large numbers of buildings in a short period. Especially in terms of energy consumption, the housing sector is responsible for consuming a large amount of energy and most of the buildings are not performing as expected (Amin & Al-Din, 2019). The gap between design and in-use energy consumption is a common issue in those projects in the Kurdish region. Mustafa (2017) explained that there is little understanding or knowledge about energy consumption in building projects. Teams involved in construction projects lack knowledge regarding the energy gap and its causes, and this lack of knowledge has resulted in a significant performance gap in buildings. The study used a post-occupancy evaluation survey to investigate the building performance in the Kurdistan region. The results showed that 78% of experts rated building performance as between very poor and moderate. Also, users' satisfaction was very low as 83% of occupants ranged between very dissatisfied to moderately satisfied (Figure 3.5).

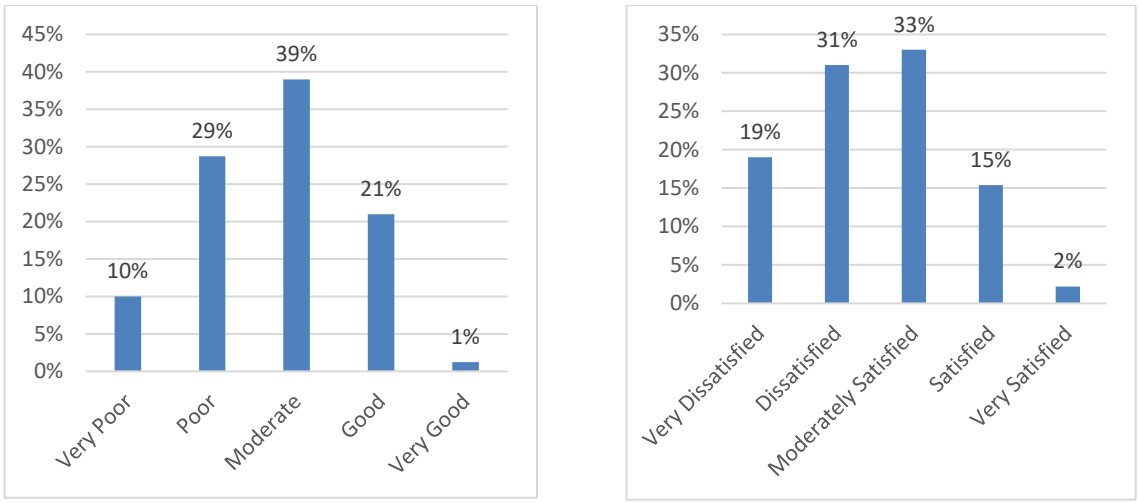


Figure 3-5 Building performance in Kurdistan based adopted from Mustafa (2017).

Therefore, there is an immediate need for improving the quality of residential construction and increasing the performance of housing units. To do so, construction stakeholders need to raise the level of awareness towards the energy performance gap and identify its reasons. Zebari and Ibrahim (2016) indicated that residential projects in the Kurdistan region have many problems in design and construction toward energy consumption. The authors argued that most of the housing projects have insufficient insulation, ventilation, water heating systems, air conditioning and thermal comfort. The Ministry of Planning of the government is working with the construction sector to develop satisfactory solutions to improve energy efficiency in residential buildings (Ministry of Planning, 2013). Poor building performance is the result of many problems in the construction process which are considered in the next section.

3.6 Challenges facing residential building projects

Construction projects are perceived as a risky sector due to the involvement of various contracting parties such as clients, contractors, subcontractors and designers (Halawa,

Abdelalim, & Elrashed, 2013). The barriers facing construction projects exist globally. However, Ofori (2000) explained that many issues have only been discussed in the context of industrialised countries, and it has been considered that these matters do not, as yet, concern developing countries. There is a lack of proper research on construction projects in developing countries (Elkhalifa, 2016). This is a result of a lower level of economic growth and a lack of support for research in these countries (Ofori, 2007). Additional problems confront construction projects in developing countries compared to those found in developed counties. These include social, cultural, organisational, economic and process-related obstacles (Elkhalifa, 2016; Haron, Soh, Ana, & Harun, 2017; Ofori, 2000). Several challenges of the construction industry in developing countries were recognised by the authors in the past years, but there is little done to overcome those obstacles. For example, Edmonds (1979) has called for clarifying regulations and providing guidance for the industry practitioners to undertake the construction process in a systematic way so that industry will be able to provide the basis for sustainable growth. However, these obstacles still exist in the construction industry.

After a review of literature on construction projects in developing countries, Ofori (2015) stated that the construction industry needs to be rescued and empowered to be able to help in the ongoing development of nations. Construction projects need to build capability and resilience to face future changes that have started to confront the industry. In the Middle East, construction projects are going through a process of change and development; many companies from different countries work in that industry (Gerges et al., 2017). This process of change has resulted in many issues in the

management of construction projects and in providing projects with a consistent process. Griffiths (2017) added that the continuing drop in oil prices that started in 2014 has had a negative influence on the economy of countries dependant on exporting oil, indicating that this situation requires them to focus on the more efficient use of energy. A large amount of energy is consumed by the residential sector in the Middle East. Governments have started to plan to reduce this consumption in the residential sector by delivering housing units that consume less energy. However, residential projects are still facing many issues in most of the countries in the Middle East and are not meeting expectations of end-users. Sweis et al. (2008) investigated the residential sector in Jordan and explained that poor planning, incompetent technical personnel, and financial issues are the main problems in the sector.

Similarly, building construction projects in the Kurdistan region face many difficulties such as socio-political, environmental, communication and the need for skilled professionals (RTI International, 2008). For example, Faris (2015) found that a lack of collaboration and the fragmentation of the industry are among the main reasons for projects not performing as expected and for construction delays in this region. The main issues causing projects to underperform included ineffective communication, lack of contractor involvement, the lack of available design information, inadequate planning and weakness of supply chains. Similar issues were found by Bekr (2015) while surveying opinions of the construction practitioners in Iraq. The main factors that hinder the process were determined to be security issues, awarding contracts on the lowest-bid basis, change orders, lack of skilled personnel and several problems related to lack of communication.

In the Kurdistan region, the lack of contactor involvement at the design stage has resulted in a considerable lack of practical experience between design team members. This lack of expertise on construction site tasks causes errors and discrepancies in design documents. Consequently, it creates difficulties for contractors and construction teams to understand detailed plans. Often intricate design details are left for contractors to understand. Since most of the contactor teams lack technical skills (Bekr, 2015), imprecise decisions are undertaken, and projects fail to meet expected performance. According to Rached et al. (2014), the lack of early involvement of contractors and subcontractors are among the main barriers facing the implementation of collaborative approaches across the Middle Eastern countries. The study explained that it is essential to improve collaboration in these countries to increase the performance of construction teams. However, this process of change will face some barriers, such as resistance to change and cultural issues. The culture of the construction industry is fragmented, and companies are used to traditional systems. Therefore, it is not easy for the management of those organisations to accept change

In addition, the construction sector in the Kurdistan region is growing for many reasons, such as the growth in foreign investment in the region as illustrated by the World Bank (2015). The report explained that this progress had increased the number of different stakeholders in building projects. Barnard (2013) expected more developments and progress in the Kurdistan region. Consequently, the need for improving relationships and collaboration between the parties involved in the project lifecycle is increasing. Ofori (2007) explained that growth and globalisation are inevitable phenomena in the construction industry of developing countries; therefore, local firms need to learn,

collaborate and compete with international firms already working in their countries in order to contribute to economic growth effectively. To achieve this, industry practitioners should be provided with proper guidance on competent and modern working methods.

Shawkat et al. (2018) determined several barriers to achieve sustainable and energy-efficient buildings in the Kurdistan region. The authors stated that there is a lack of building construction specification, deficiencies in the construction process, unawareness toward energy consumption, and a considerable shortage of skilled professionals. Other barriers were identified as cost, socio-cultural, technical and management factors. Issa and Al Abbar (2015) explained that those obstacles that face sustainable construction and energy-efficient buildings are similar across the Middle East region. The study emphasised the need to increase the level of awareness towards construction practices to solve those issues. From the results of a survey in the Kurdistan region, Neamat and Yitmen (2017) described that many construction firms fail to deliver projects with required quality due to lack of technology, unskilled staff and adopting traditional ways of project delivery. The researchers illustrated the necessity for improving collaboration between construction practitioners and implementing effective strategies for the construction process.

The construction process of residential buildings in the Kurdistan region is highly uncommunicative, and involved stakeholders are not collaborating, this lack of interaction between participants has resulted in many issues toward energy consumption of buildings (Zebari & Ibrahim, 2016). For example, in many cases, contactor does tasks without any collaboration with participants involved in related jobs

or without considering the design requirements. The study also explained that unskilled workers and lack of knowledge are the reasons for the insufficient construction process (Zebari & Ibrahim, 2016). Shatz et al. (2014) agreed that the lack of skilled personnel is a significant barrier that results in inadequate construction practices and the inability of staff to work in collaborative environments. The authors called on the authorities of the Kurdistan region to educate construction practitioners so that construction products will meet customer demands.

The limited literature on residential building projects in the Kurdistan region shows the existence of a lack of collaboration between involved participants which has resulted in the inadequate construction process in the housing sector. This shortage of collaboration in project lifecycle has caused a considerable gap that exists between the actual and designed energy consumption of buildings. Therefore, there is a crucial need for improving collaboration within residential projects in the Kurdistan region. Providing a solution to improve these practices in the Kurdistan region can also help other emerging economies and Middle Eastern countries to implement proportionate methods. Kurdistan shares many characteristics with these countries, making the region a suitably representative case study for emerging economies. First, Kurdistan is at a similar stage of economic development (Soderberg & Phillips, 2015). Second, like many other countries, the housing sector is making an important contribution to economic development in the region (Abramzon et al., 2016). Third, construction practices are similar across emerging economies and face similar challenges (Elkhalifa, 2016). Fourth, Middle Eastern nations share an extremely similar culture; consequently there is a similar culture within the construction industry (Gerges et al., 2017). These similarities

suggest that this study can represent the construction industry beyond the borders of the Kurdistan region.

3.7 Chapter summary

This chapter explored construction projects in developing countries and the Kurdistan region. The focus was on residential building projects in the Kurdistan region. The role and importance of these projects were outlined. It was recognised that residential projects are regarded as the leading sector in the region. Then, the chapter demonstrated the challenges facing these projects. The limited literature on Kurdish construction insisted on an apparent lack of collaboration that has resulted in the performance gap in residential construction projects.

4 Chapter Four: Research Methodology

4.1 Introduction

Research Methodology refers to a set of principles and processes that are applied to investigate a scientific question (Fellows & Liu, 2015). Adopting an effective methodology is essential in any kind of research in order to answer a scientific enquiry successfully. There are different approaches to research design. Saunders, Lewis, Thornhill, and Wilson (2009) explained the research process in the form of research 'onion' consisting of layers. See Figure 4.1 below. The main purpose of the research onion is to systematically consider steps of research design and approaches that can be applied to achieve research outcomes. In this study, research onion classification from Saunders, Lewis, and Thornhill (2015) is used in order to design the research methodology. The following sections present the methodological ways adopted to investigate the research problem.

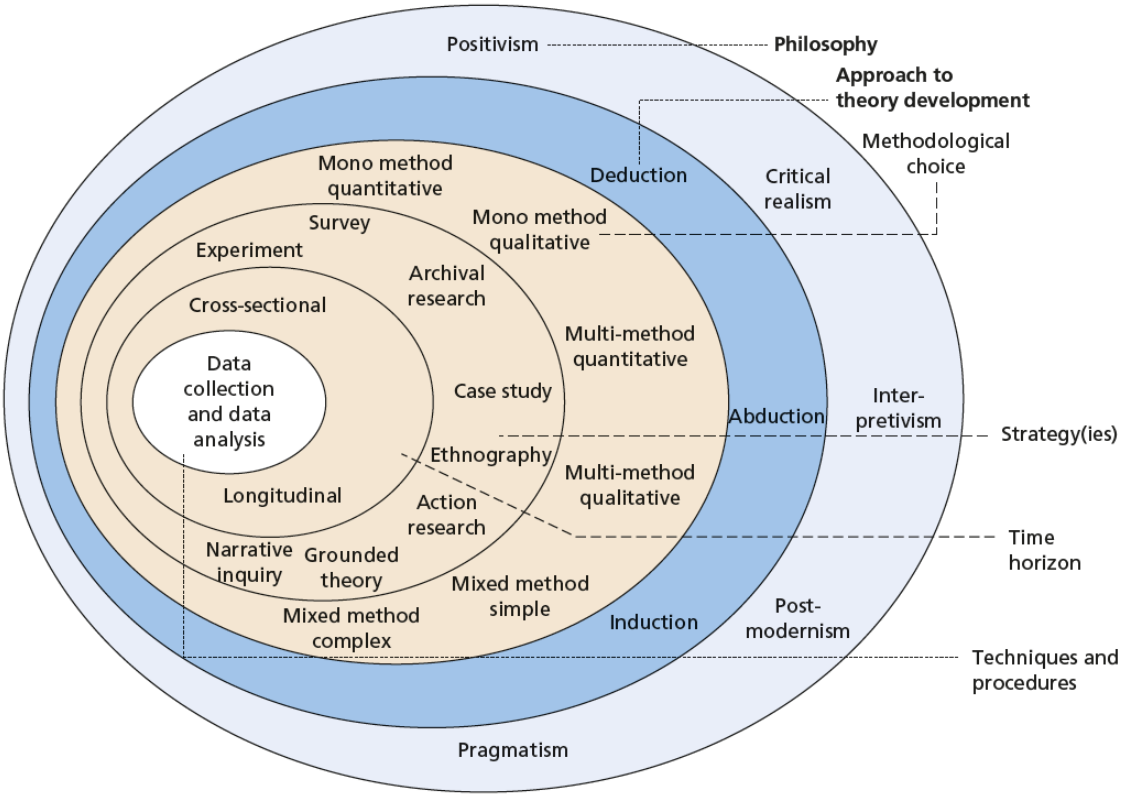


Figure 4-1 The research onion adopted from Saunders et al. (2015).

4.2 Research philosophy

The term 'research philosophy' indicates development and the nature of knowledge. Research starts with a set of philosophical assumptions that inquirers make about a way to undertake the study (Creswell & Poth, 2017). Research philosophy is a system of assumptions and beliefs that identify a researcher's view to the world (Saunders, Lewis, Thornhill, et al., 2009). It indicates the researcher's view on the relationship between knowledge and the process that developed that knowledge. These assumptions include assumptions about reality (ontology), about human knowledge (epistemology), and about the impact of the researcher's values on the research (axiology) as explained by Burrell and Morgan (1979). Assumptions about philosophy underpin strategies and

techniques adopted in examining the research problem. According to Saunders et al. (2015), there are five main philosophies: positivism, critical realism, interpretivism, postmodernism and pragmatism.

4.2.1 Positivism

Positivist epistemologies stand on a range of traditional approaches that resemble natural science. Burrell and Morgan (1979) used positivist to describe epistemologies that try to explain and predict what is happening in social life by seeking causal relationships and regularities between its components. This approach has some elements such as reductionistic, cause and effect, deterministic and previous hypotheses (Creswell & Poth, 2017). Positivism is concerned with facts instead of impressions in which the researcher claims to be value-free. Usually, positivism works with observable social realities and the outcome of the research can be used as a law-like generalisation similar to natural scientists (Saunders, Lewis, Thornhill, et al., 2009).

4.2.2 Critical realism

Critical realism is a branch of epistemology that assumes reality exists independent of our mind. In this interpretation, realism is against idealism which suggests only the mind and its contents exist (Saunders, Lewis, Thornhill, et al., 2009). Critical realism is similar to positivism in that it suggests a scientific approach for knowledge development. Saunders, Lewis, Thornhill, et al. (2009) explained another type of realism which is direct realism; direct realism asserts that human experiences portray the world precisely. While, critical realism describes that human experiences are sensations and images of the world, not the real world itself, not the actual things. A critical realist will point out

that senses deceive the way people perceive the world, and the knowledge about life comes from social conditions and cannot be separated. Direct realist responds by arguing that illusions and senses stem from insufficient information about real things.

4.2.3 Interpretivism

This philosophical position emphasises the researcher's interpretation of specific phenomena (Fellows & Liu, 2015). Interpretivism insists on the difference between human beings rather than objects in conducting research. For an interpretive approach, values, concepts and theoretical beliefs of the researcher are fundamental and shape their understanding of the social world. Interpretivism disagrees with positivism and argues that the richness of the different insights into the world will be lost if such complexity is down to a set of law-like generalisations (Saunders, Lewis, Thornhill, et al., 2009). The challenge for research under this philosophy is to enter the world of research subjects and understand the world from their perspective.

4.2.4 Postmodernism

Postmodernism seeks to question common ways of thinking and gives power to marginalised preceptions by attributing more importance to the role of language (Saunders et al., 2015). A postmodernism researcher tries to expose power relations; it is like a deconstruction of those beliefs to form new views that have been excluded previously. Postmodernists are involved in deconstruction of the data, to seek to investigate data in a way to uncover hidden messages and to interpret such data in ways that have not been considered before (Denscombe, 2014).

4.2.5 Pragmatism

Adopting one philosophical position in research has been criticised as unrealistic, in many cases, research falls into a position that identifying the adopted paradigm is not obvious. Pragmatism is the philosophy in which the researcher believes that choosing between paradigms is not realistic in practice (Saunders, Lewis, Thornhill, et al., 2009). A pragmatist argues that the research question is the most essential determinant of the ontology, epistemology and axiology a researcher adopts. Morgan (2007) explained that the great advantage of pragmatism in social science studies is that it emphasises the relation between an epistemological view about the nature of knowledge and technical concerns used in developing that knowledge. Pragmatism allows the researcher to see the world from different points of view and create a practical approach to undertake the research. Pragmatism philosophy focuses on making a difference to organisational practices as explained by Saunders, Lewis, Thornhill, et al. (2009).

4.2.6 Adopted research philosophy

Considering the debate among researchers about philosophical stances, in this research, pragmatism has been used as a philosophical position. This study explores the factors and enablers of collaboration in order to improve building performance. Later, the research aims at measuring the importance of such factors in the context of Kurdistan construction. It can be noted that both contextualisation and generalisation are required to solve the research problem. Interpretivism is linked with the exploration of phenomena, and that is the case in this research when the effects of collaboration and factors of collaboration are explored. However, identifying the importance of such

factors requires measurements and that are associated with positivism. This means adopting either interpretivism or positivism is not enough for answering the research query. Saunders, Lewis, Thornhill, et al. (2009) stated that if a research problem does not indicate that one particular method should be adopted, this confirms the pragmatist point of view. The importance of pragmatism for social science researchers is combining different qualitative and quantitative methods to answer the research question (Morgan, 2007). For the pragmatist, research begins with a problem and aims at solving that problem for future practices. In this philosophy, the most crucial determinant of the research design are research questions. Hence, pragmatism is used in this research.

4.3 Research approaches

The second layer of the research onion is allocated to research approaches. After deciding on the philosophical position of the research the second step is to understand and choose a suitable approach to undertake that research. In Figure 3.1, it can be seen that there are three main research approaches: *induction*, *deduction and abduction*. Deduction is connected to the positivism philosophy and induction approach is more suited to interpretivism (Saunders, Lewis, Thornhill, et al., 2009). While abduction combines both to find a practical way to investigate the research problem. Saunders, Lewis, Thornhill, et al. (2009) have explained these approaches as below:

4.3.1 Deduction approach

Deduction is the development of a theory depending on a rigorous test. It is the dominant approach in natural science, in which laws form the basis for explanation and for anticipating phenomena. Deduction possesses a range of characteristics. Firstly, it

searches for a causal relationship among variables; it develops a hypothesis to determine those relations. Secondly, deduction uses a highly structured methodology with quantitative data to answer the proposed hypothesis. The third main aspect is generalisation, thus, in order to be able to generalise findings a sufficiently large sample should be used.

4.3.2 Induction approach

Induction is developed to deal with social science problems, to understand human interpretation of the social world. Inductive researchers criticise the rigid and highly structured methodologies of deduction as not permitting an alternative way for understanding things going on. The inductive approach is usually concerned with one context that events are happening in and uses smaller samples than deduction. Frequently, studies under this approach use qualitative data in order to establish various perceptions about phenomena.

4.3.3 Abduction approach:

Abduction moves backwards and forwards between induction and deduction, it is used commonly under the pragmatism philosophy (Morgan, 2007). In the abductive approach, the researcher may start by exploring a phenomenon, by identifying themes and patterns related to that phenomenon. Later, the gathered information might be used to develop a conceptual framework or building theory. These theories will be tested using new data or already existing data. This process is similar to what many management researchers actually do (Saunders et al., 2015).

4.3.4 Adopted research approach

This research aims to investigate the relationship between residential building performance and collaboration in construction projects. Therefore, an abductive approach has been adopted to achieve this aim and to solve a real world problem. The reason for this choice was the need to use different approaches in this research. Induction was adopted in the first stages of gathering literature to develop a theory about the effects of collaboration on project performance. Then, deduction was used in testing the developed theory by gathering quantitative data. A questionnaire survey was used to evaluate the importance of factors for such collaboration. Actually, in real life investigations is almost impossible to stick to either theory-driven deduction or a data-driven induction, therefore, the most practical way is to use an abductive approach (Morgan, 2007). The abduction approach starts by converting data into theories and then assesses these theories by action. Furthermore, Saunders et al. (2015) explained that a topic that has a wealth of information about it in one context but far less in another context may lend itself to an abductive approach and requires adjustment of the existing information. Hence, abduction was the approach used in this research.

4.4 Methodological choice

Methodological choices are core items in the complicated process of research design; they connect early stages of research design as such as philosophical assumptions to later stages such as data collection, data analysis and interpretation of the outcomes (Creswell & Tashakkori, 2007). A methodological choice stands for researcher's way of using qualitative and quantitative approaches. A researcher may use one of those

methods (mono-method) or use more than one (multiple methods) method in the research.

4.4.1 Quantitative (mono-method)

Commonly used under the positivism paradigm, quantitative methods tend to gather factual data in order to yield quantified results. Quantitative approaches are generally linked to numerical methods of data collection such as questionnaires and statistical analysis that generate numbers (Saunders, Lewis, Thornhill, et al., 2009). Quantitative approaches are developed based on previous research which has built theories and principles to decide on the type of data required for a specific study (Fellows & Liu, 2015). The authors added that before collecting data practically in a quantitative study, it is essential to carefully decide what types of data are needed, and how such data should be collected and analysed. In the case of underestimating these considerations, a researcher is expected to face many difficulties in undertaking the work. Bernard (2017) emphasised that it is important for the researcher to understand and distinguish between quantitative and qualitative methods for data collection and data analysis in order to answer certain types of questions.

4.4.2 Qualitative (mono-method)

In contrast to quantitative methods, qualitative approaches are widely used to refer to non-numerical ways of data collection and data analysis. Qualitative research tends to be used under interpretivism, in which researcher values, beliefs and understandings are significant contributors to the research process. In natural science usually things happen with precise regularity, deemed laws; in social science, there are no such laws.

However, this does not mean that social life is irregular and chaotic but rather is associated with regular concepts and phenomena (Berg, 2001). Thus, to investigate this complexity of real-life research should understand the beliefs and ideas of people involved. Denscombe (2014) summarised distinctions between quantitative and qualitative approaches as shown in Table 3.1 below:

Table 4-1 A comparison between quantitative and qualitative approaches

Quantitative approaches	Qualitative approaches
Numbers are used as units in analysis	Words or visual graphs are used as the unit of analysis
Researcher is detached from the study	Researcher values and beliefs have a significant impact on the data collection and analysis
It is associated with large-scale samples	It is associated with small-scale samples
Quantitative study leans toward analysing specific variables	Leans toward a holistic perspective
Data analysis is separated from data collection	Data collection and data analysis can be parallel

4.4.3 Multi methods

Saunders, Lewis, Thornhill, et al. (2009) described a multi-method as using more than one data collection or data analysis technique, but it is restricted to either qualitative or quantitative choices. For example, a researcher may decide to collect data using a questionnaire and structured observations, then, analyse those data using a quantitative procedure. Similarly, a multi-method qualitative study might be undertaken by using more than one qualitative research approach. Therefore, under such

circumstances, multi-method users do not mix quantitative and qualitative techniques. Those combinations of either qualitative or quantitative methods are adapted to answer distinct research questions (Bryman, 2006).

4.4.4 Mixed methods

Mixed methods refer to a type of research design in which the researcher uses both quantitative and qualitative approaches, either in a parallel way or in a sequential way (Saunders, Lewis, Thornhill, et al., 2009). Mixed methods are becoming a norm in social science studies because they provide researchers with more practical ways to deal with complex real life situations (Bernard, 2017). Creswell and Tashakkori (2007) investigated different perspectives on mixed methods and explained that mixed methods focus on outcomes of both quantitative and qualitative data to integrate research aspects such as worldviews, questions, techniques and conclusions. Excessively metaphysical methods have faced difficulties in answering social science questions. Therefore, mixed methods offer a practical solution to deal with the complexity of real life, such methods are generally used under the pragmatism philosophy (Morgan, 2007). Creswell (2014) described three basic types of mixed method designs, outlined below:

Convergent parallel mixed methods design:

The researcher collects both qualitative and quantitative data in a parallel way. Then, two types of data will be analysed separately to see whether results confirm or disconfirm each other.

Explanatory sequential mixed methods design:

This is a two-phase research approach, in which the researcher starts with collecting quantitative data and analysing it; then, uses results from the first phase to design the second phase, qualitative stage. The initial idea is to have qualitative data to support quantitative data results. For example, interviews might be undertaken to explain the results of a quantitative questionnaire carried out at an earlier stage.

Exploratory sequential mixed methods design:

The researcher begins by exploring qualitative data and analysing it, then, uses the outcomes to design the quantitative phase. The second phase (quantitative phase) is built on the outcomes of the first phase (qualitative phase). For instance, the researcher might undertake a qualitative phase in order to develop an instrument. Later, that instrument is used by a sample of the population for quantitative assessment. In many cases, an adequate measurement instrument may not be available to measure a concept within the sample the researcher wants to study. Therefore, this design might have three phases: exploratory, instrument development, and administering the instrument to the population.

4.4.5 Adopted methodological choice

In line with other researchers who have agreed that mixed methods are the most adequate choice for answering research questions in social sciences (Bernard, 2017; Bryman, 2006; Morgan, 2007), an *exploratory sequential mixed methods design* is adopted to achieve the research aim in this thesis as outlined by Creswell (2014). The most practical way to solve the research problem was found to be utilising both

qualitative and quantitative data. Since, it was necessary to start by investigating how other authors have thought about the subject (Berg, 2001), a qualitative method was applied to explore the past literature about construction collaboration. The data were used to develop a questionnaire in which, during the pilot study stage, perceptions of practitioners were used to enhance the instrument. Later, the outcomes of the qualitative phase were used to design the quantitative phase. Quantitative methods were used as described and recommended by Denscombe (2014). A questionnaire survey was used for measuring the importance of some factors that contribute to a collaboration process. A five-point Likert scale was used to gather the perception of practitioners.

4.5 Research strategies

The fourth layer of research onion by Saunders et al. (2015) represents eight strategies that a researcher might choose from to undertake a study. This choice of strategies should be in line with answering the research question, research objectives, time available and researcher's philosophical assumptions.

4.5.1 Experiment

Experiments are empirical strategies aimed to investigate the properties of specific variables or to identify relationships between those variables (Denscombe, 2014). The term experiment tends to be linked with research in laboratories which is focused on precise measurements using sophisticated equipment. A typical experiment might test a relationship between two variables to see whether changes in an independent variable affect the dependent variable or not. A more complex experiment will look at the size

of the change and importance of that change for the independent variable. This type of methodology is considered as the bedrock of physical sciences, however, it has been practised in social sciences as well (Denscombe, 2014).

4.5.2 Survey

Surveys are an effective strategy commonly described under deductive approach of theory development. Surveys are frequently used in management research in both exploratory and descriptive studies. Those studies that aim at collecting numerical and quantitative data, which can be analysed using descriptive or inferential statistics (Saunders, Lewis, Thornhill, et al., 2009). A survey might gather attitudes, opinions or characteristics of a population numerically by investigating a sample of that population. Survey types vary from highly structured questionnaires to open interviews. Surveys are efficient in collecting reasonable samples in a speedy and economical way. Since it is extremely rare to have a full population considered for a survey; researchers use the results of surveys to draw generalisations from the sample to the population (Fellows & Liu, 2015). However, Creswell (2014) explained to make such generalisations, the researcher needs to consider some factors in the survey design stage such as sample size, a timeline of the study, type of data to be collected, reliability and validity of the scale and data analysis techniques. Besides those factors, every designed instrument should be pilot tested to ensure it will succeed. Brace (2018) insisted on undertaking pilot studies with respondents of eligibility criteria to identify any problems in survey instruments such as time required to answer or language used in writing. At a minimum, informal interviews with colleagues can help in clarifying a survey instrument problems.

4.5.3 Archival research

Archival research uses past records and documents as the source of data. Common resources of archival material include government reports, industrial documents, personal photo collections or diaries, school records, medical records, tax rolls, reports of court cases and land-holding records (Bernard, 2017). The advantage of archival research is that it is truly objective, of course, the original data might have been collected subjectively, but the current stage remains non-reactive as people cannot change past behaviour.

4.5.4 Case study

A case study strategy is used by researchers to study a complex phenomenon within a specific context (Baxter & Jack, 2008), where an investigator wants to cover contextual conditions that are relevant to the phenomenon. Although, in many cases, boundaries between context and the phenomenon are not clear. This approach usually focuses on answering ‘’ how’’ and ‘’why’’ questions. Conventional wisdom is against generalising case-dependent results in social sciences, however, to understand a complex issue in detail, an in-depth case study research is necessary (Flyvbjerg, 2006). There are two main designs in case study research, *single-case* and *multiple-case* designs as explained by Tellis (1997). While using the multiple-case strategy, the researcher must make sure that the approach follows a replication, not sampling logic. If there is only one suitable case, then the researcher is limited to single-case design. In the case study strategy, the analysts may need to collect different types of data to ensure that there is enough

evidence to support a comprehensive investigation. It is an ethical need to use triangulation of data to confirm that the approach is valid (Tellis, 1997).

4.5.5 Ethnography

Ethnography is an approach rooted from anthropology that studies races and cultures of a group. The researcher becomes part of the study and observes subjective behaviours of the group researched (Fellows & Liu, 2015). This type of research may identify cultural items such as beliefs and value structures. The aim of the investigation is to reconstruct a holistic approach of the phenomenon studied and to do a precise presentation of people lifeways (LeCompte & Goetz, 1982). In ethnographic research, determining the effects of the researcher's presence on the outcomes is extremely challenging, thus, the researcher is a part of the phenomenon. LeCompte and Goetz (1982) described the difference between ethnography and experimental research; in which the earlier tends to avoid any prior assumptions or relationships between variables. In contrast, experimental research is adapted to confirm hypothesised relationships between variables. In a sense, ethnography aims at finding a theory to explain the data, while, experiments are oriented to find data that matches theories.

4.5.6 Action research

This research strategy was developed by Lewin (1946) to improve group relationships in social sciences. It focuses on an action that aims to change organisational practices. According to Saunders, Lewis, Thornhill, et al. (2009), action research has been used in different ways by management researchers but it has four common themes. Firstly, it is a research in action, for example, implications of a change to solve an organisational

issue with those who experience the problem directly. Secondly, practitioners are involved directly in the study, therefore, the researcher is a part of the organisation under investigation. Thirdly, it is an iterative process, actions are taken and evaluated in order to identify further steps of the study. Finally, actions research results should be transferable and applicable to other contexts rather than just the studied organisation.

4.5.7 Grounded theory

Grounded theory consists of a set of inductive strategies of data collection and data analysis intended to establish a theory (Charmaz & Belgrave, 2007). This means that data collection starts before building any theoretical framework. The theory will be developed from the data collected and analysed. The research process explicitly unites with theory development. In addition, the rigid boundaries between data collection and data analysis are blurred. It is a continuous interplay between data collection and data analysis; subsequently, theory evolves during the actual research (Strauss & Corbin, 1994).

4.5.8 Narrative inquiry

Narrative inquiry is qualitative research based on a story. Usually, a story can be told in various ways such as a book, interviews, visual images or dramas. Denscombe (2014) indicated for a story to be treated as a narrative inquiry it should have certain characteristics. Those properties include: the story must have a purpose such as moral message. It needs to link the past to the future and to explain developments happened over time. Finally, it must have human participation in the events told.

4.5.9 Adopted research strategies

After studying different research strategies, a *survey* was adopted in this research. A survey instrument was used to collect the perceptions of construction practitioners about collaboration process. The survey aimed to investigate the importance of factors contributing to improving collaborative environments. Surveys have been found effective in collecting reasonable samples in similar research about construction management by different researchers (Black et al., 2000; Hughes et al., 2012; Meng, 2013).

4.6 Time horizon

Another layer of the research onion is time horizon. It indicates whether the research has been undertaken at a particular time or over long periods. Fellows and Liu (2015) explained that if the research is to be carried out at one point in time is called cross-sectional study. While, if the research is undertaken at multiple, commonly pre-defined, time points it is a longitudinal study. Time horizon is an independent item from research strategies or choice of methods. It depends on the research questions and the time available for the research process (Saunders, Lewis, Thornhill, et al., 2009).

4.6.1 Adopted time horizon

Considering the research question and the time available for the research, this study adopted a cross-sectional time horizon. The data were collected at a particular point in time. The study used a survey to collect data commencing from April 2018 to October

2018. Surveys are a common choice used in cross-sectional studies to describe a phenomenon at a given period of time (Saunders, Lewis, Thornhill, et al., 2009).

4.7 Techniques and procedures

The core of research onion is dedicated to techniques and procedures of the study. Techniques and procedures refer to methods used to collect and analyse the data. Thus, the main techniques and procedures include data collection methods such as questionnaires, observations and interviews, and both statistical (quantitative) and non-statistical (qualitative) data analysis methods (Saunders, Lewis, Thornhill, et al., 2009).

4.7.1 Questionnaires

Questionnaires are the most common technique to collect data in survey strategies, in which the respondent is asked to answer a range of predetermined questions (Saunders, Lewis, Thornhill, et al., 2009). A questionnaire is a means of communication between the researcher and the subject of the study as explained by Brace (2018). The investigator articulates questions and seeks an answer to those questions. The subject's answers are transmitted back to the researcher. Therefore, it also can be described as a method of communication between two people that may never meet physically. This conversation is the heart in survey strategies; all the other items such as hiring participants, preparatory work, and analysing techniques are in service of that communication (Krosnick, 2018). The researcher needs to make sure that the questions asked can obtain precise required answers. There are two main types of questions asked in questionnaires open and closed questions (Fellows & Liu, 2015). Open questions are those that give respondent full freedom in answering whatever they think. Open

questions are usually easy to ask but difficult to answer and analyse. While, closed questions are those that have a set number of responses defined by the investigator. Although the choice of the questions and type of design depends on the type of study and the targeted population, some general recommendations should be considered in all cases (Lietz, 2010). These general guides include clarity of questions, general questions to precede specific ones, use of numerical scales and matching verbal labels, and Likert-type of answers are preferred.

4.7.2 Observation

It is a distinct technique that does not depend on what respondents say, do or think. It is more direct than that, it depends on eye witness evidence from researcher by attending in a real-life situation (Denscombe, 2014). In this method, the observer or the investigator records field notes of the attitude and behaviours of participants at the research site (Creswell, 2014). That is the main difference between observation and some other methods such as interviews and questionnaires which rely on the information given by the respondent. The role of the qualitative observer may vary from non-participant to a fully participating observer. According to Denscombe (2014), data collection using this method might face challenges that may have different levels of effect on the process based on the power of recall and commitment of the researcher. The main difficulty is human memory cannot remember everything precisely as it is experienced. Additionally, perception of different observers to the same event may vary based on emotions, physical state and past experience.

4.7.3 Interviews

Like any other method use of interviews should be consistent with research strategy and research questions. Qualitative interviewing is a common way of collecting in-depth data among researchers (Bryman, 2006). Interviews might be highly structured using a predefined set of questions, or completely unstructured and open conversations. Level of formality of interviews can be categorised into three types: structured interviews, semi-structured interviews and unstructured or in-depth interviews (Saunders, Lewis, Thornhill, et al., 2009). Selecting one of the types should depend on a theoretical base to ensure adequate data are collected (Fellows & Liu, 2015). These choices directly affect the responses obtained and subsequent interpretation of the outcomes

4.7.4 Adopted techniques and procedures

In line with pragmatism as philosophy and mixed methods as the methodological choice, this study has used different data collection and analysis techniques. *Questionnaire* was adopted as the main technique of the data collection. Self-administrated questionnaires were distributed over construction practitioners to get their perception about factors contributing to improving collaboration.

The purpose of the questionnaire was to survey a representative sample from a population of practitioners in both public and private housing sectors in the region. According to the Kurdistan Contactors Union, 3000 companies work in these sectors. Questionnaires are a proven and effective means of data collection, especially in survey studies (Brace, 2018; Denscombe, 2014).

Using a questionnaire was also a practical way to collect data from practitioners working in different locations within the region. It was distributed to construction professionals in all three governorates of the Kurdistan region: Erbil, Duhok, and Sulaymaniyah. Regarding the administration of the survey, the questionnaire was distributed in both hard (paper version) and soft copies (Google forms). The primary method involved physically delivering hard copies of the questionnaire to practitioners. This was for practical reasons as most construction practitioners in the Kurdistan region do not have access to the internet or have limited internet services (Soderberg & Phillips, 2015). Additionally, the construction industry continues to use traditional methods and practitioners are therefore more used to dealing with paper-based work than online material. Thus, relying solely on an online version would not have provided a representative sample of the housing sector.

These reasons therefore justified using a traditional questionnaire in preference to other methods of data collection, such as the Delphi method where data are collected through several rounds of contacting participants. Okoli and Pawlowski (2004) explained that, in a Delphi study, the researcher conducts the first survey by contacting a panel of experts and then analyses the data. Another survey is then designed and administered and the respondents are asked to revise their responses based on the feedback from the first survey. This process is reiterated unitil a satisfactory level of agreement is reached between respondents. However, because the participants of this survey were based in a different country with limited access to the internet, it was not possible to gather a suitable panel for Delphi, nor was it practical to visit the Kurdistan region several times due to constraints of cost and time.

Using a traditional questionnaire was found to be effective in this study. It resulted in a sample of 227 participants representing a response rate of 30.2%. Details of the sample collection are presented in section 5.4.3. Other researchers have used questionnaires in similar studies in the construction industry. For example, Black et al. (2000) followed a similar process and used a Likert-scale questionnaire to determine the elements of partnering in the UK construction industry. Similarly, Akintoye et al. (2000) found that a traditional questionnaire is an appropriate method for surveying the opinions of construction practitioners regarding supply chain collaboration. Therefore, questionnaires have been proven to be an effective tool when it comes to gathering reliable data in the construction industry.

The questionnaire itself was written in the English language and was not translated into Kurdish. This is because English is practically the second language in the region and all university courses related to engineering and construction are delivered in English; thus, construction practitioners have an appropriate mastery of the English language (RTI International, 2008). The questionnaire was also refined for language purposes in two rounds of pilot studies, the first trial in the UK and the main pilot studies in the Kurdistan region (explained in section 5.3). Although it can be argued that English is not the Kurdish population's first language, and that the use of a secondary language may have affected the outcomes of the survey, none of the participants raised any concern or issues relating to language during their interaction with the researcher. Also, participants did not appear to have any difficulty in understanding the questions, nor showed any reason for the researcher to question their ability in terms of dealing with

the English language. Therefore, using English was found to be an appropriate choice for the purpose of this survey.

Regarding data analysis, the results of the literature review were analysed and presented in chapter 2. Then, pilot studies were analysed qualitatively to refine and improve the questionnaire instrument. As for analysing data from the final questionnaire, both descriptive analysis (see section 5.5) and factor analysis (see section 5.7) were used.

4.8 Overall research design

As can be seen in Figure 3.2 below, this research consists of four main phases: qualitative phase, quantitative phase, data analysis and framework development. The final recommendations and conclusion were drawn based on the outcomes of all four phases. In the qualitative phase, an in-depth review of past literature was undertaken to identify the effects of collaboration on residential projects performance regarding energy consumption. Additionally, factors underlying collaboration effectiveness in the construction industry were determined from the global literature. Details of this process were presented in chapter 2. Later, identified factors were used to establish a questionnaire instrument. Pilot studies in the form of the interview-administrated questionnaire aimed at refining and preparing the instrument for the quantitative phase. In the second phase (quantitative), the questionnaire instrument was distributed over construction practitioners in the residential building sector of the Kurdistan region. The purpose was to gather practitioners' perceptions regarding critical factors that underpin collaborative environments in Kurdistan residential projects. The third phase

(data analysis) used descriptive statistics to understand the nature of the data, also to explain the background and profile of respondents. Furthermore, factor analysis was used to investigate factors that are essential to improve the collaboration process. A set of local factors was identified to be crucial for improving collaboration. The factor analysis process resulted in determining six final factors for delivering collaboration, this part is presented in chapter 5. Then, the fourth and final stage, which is framework development, used factors identified from the factor analysis to develop a framework. The framework was validated using interviews with experts in the construction industry and aimed at improving collaboration and minimising the gap between the designed and actual performance of residential building projects. Details of the fourth phase are shown in chapter 6

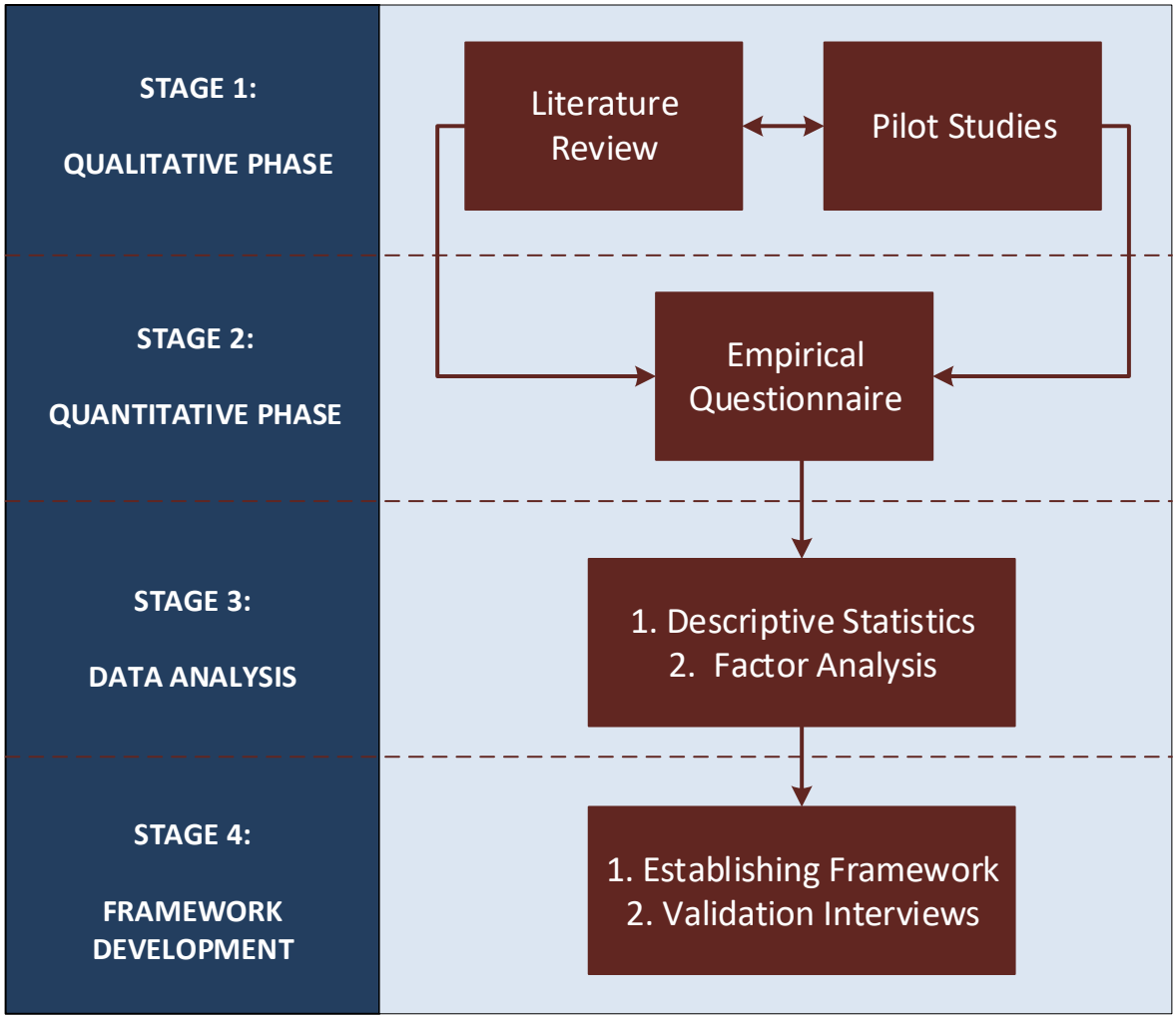


Figure 4-2 Research framework of this study

4.9 Ethical consideration

This research was undertaken according to the ethical requirements of the University of Portsmouth. In the beginning, the consent of responsible organisations was taken such as the Ministry of Construction and Housing, Kurdistan Contractors Union and Kurdistan Engineering Syndicate. Later the participants were approached according to local and the university guides. All the participants were informed that the participation is completely voluntary and they may withdraw in any stage of the study. All the data

collected were anonymised and no personal data were collected from participants. The ethics form of this study can be found in Appendix A.

4.10 Chapter summary

This chapter presented the methodological choices of the study. For designing an appropriate methodology, research onion by Saunders et al. (2015) was analysed. Research choices for each layer were justified. The research is based on pragmatism philosophy and the adapted approach for theory development is an abduction. Subsequently, mixed methods were used to answer research questions. The next chapter presents the data collection and data analysis processes.

5 Chapter Five: Data Collection and Analysis

5.1 Introduction

This chapter describes the process of data collection and data analysis. It starts by explaining the development of the questionnaire survey, as the means of data collection. The 11 potential factors of collaboration identified from the past literature, explained in chapter 2, are used in developing the instrument. A pilot study used to refine the questionnaire is outlined, followed by a section describing the practical procedure for conducting the survey. The refined questionnaire was used in the residential sector of the Kurdistan region to get the perceptions of construction practitioners with respect to enhancing collaborative environments.

Later sections explain the mechanism of data analysis. Descriptive statistics are used to understand the background of respondents. The Kruskal-Wallis test was utilised to identify whether there were any differences between the perceptions of different groups of practitioners. Later, factor analysis was adopted to analyse factors of collaboration. The results of factor analysis led to the identification of 6 final factors to increase collaboration in the construction industry. The final section describes the identified factors in detail. All statistical tests in this chapter are performed using IBM SPSS Statistics 24.

5.2 Development of the questionnaire:

In this research, the primary method of data collection was a questionnaire. Questionnaires are one of the most used and effective ways of collecting data from large samples. A questionnaire is referred to as a general method of data collection in which responders are asked to answer a set of predetermined and standardised questions (Saunders, Lewis, Thornhill, et al., 2009). To develop the questionnaire, an intensive review of global literature about collaboration in the construction industry was undertaken. The purpose of the review was to identify a set of potential factors that are essential for promoting collaboration, explained in section 2.8. Those potential factors were used to develop an empirical questionnaire survey. Each factor was converted to (a) question/questions on the survey instrument. In addition to the questions driven from the literature regarding factors of collaboration, literature about construction projects in the Kurdistan region was also used to develop the questionnaire. For instance, research on Kurdistan projects insists that construction projects are lacking technology resources and availability of skilled staff (Neamat & Yitmen, 2017; Shatz et al., 2014; Zebari & Ibrahim, 2016). Two questions were added to the survey to ask about the effects of these issues on collaborative practices.

Although questionnaires can be used as the only method of data collection, it is recommended to use questionnaires with other types of data collection such as structured interviews and face-to-face discussions to ensure the reliability of instruments (Saunders, Lewis, Thornhill, et al., 2009). Therefore, in the pilot study stage,

interviews with construction industry experts were used to refine the self-administered questionnaire for the final data collection.

In order to obtain an acceptable response rate and reliable data, the questionnaire design stage is vital. In the case of developing a new questionnaire, it should be tested for validity to ensure that questions are measuring what is intended to be measured (Kazi & Khalid, 2012). These authors added that any new instrument should also to be tested for reliability which deals with the consistency of the collected data and the techniques used in data analysis. Many researchers have explained validity in terms of external validity, content validity, criterion-related validity and construct validity. For example, Saunders, Lewis, Thornhill, et al. (2009) have described the validity categories as follow:

- *External validity* concerns the generalisability of the findings of the questionnaire, based on sample size and quality of the sample selected.
- *Content validity* is the extent to which the questions of the questionnaire adequately cover the research questions. To obtain this, literature reviews and discussion with others can be used. Content validity can be obtained by asking experts to comment on the repetitiveness of the questions before the data collection.
- *Criterion-related validity* measures the ability of the questions, measures, to predict accurately.
- *Construct Validity* is the extent to which a question actually measures the constructs intended to be measured. Construct validity deals with

appropriateness of a data collection device for addressing the research questions.

The following steps have been used to ensure the validity of the questionnaire and its ability to obtain reliable data:

- The relevant literature has been reviewed to ensure that the instrument covers the subject that it is designed to measure. From this, the most pertinent factors have been chosen and used for designing the questionnaire.
- Discussions with the supervisory panel and related experts helped in ensuring the comprehensiveness of the questionnaire.
- To ensure that the measures of the questionnaire are adequate, the researcher has attended survey design workshops and consulted survey experts.
- A trial-run of the questionnaire was carried out in the UK, to gain some feedback on the survey and help refine it.
- After revising the questionnaire based on the first trial run, the instrument was pilot-tested in the Kurdistan region with professionals of the construction sector through interviews and self-administrated questionnaires.
- The questionnaire was refined and prepared for the main data collection.

5.3 Pilot tests:

The pilot studies aimed to ensure that the questions were intelligible, easy to understand, unambiguous, as well as ascertain the time taken for answering the questionnaire. Before using a questionnaire for the data collection it needed to be pilot tested. Pilot studies help to refine and sense-check questionnaires so that in the next

stage of data collection respondees will not face any problem in answering questions, and data analysis is robust. Pilot studies enable a questionnaire instrument to obtain some assessment in terms of validity and the reliability of the data (Saunders, Lewis, Thornhill, et al., 2009). A sample size of pilot studies is suggested to be similar to the final sample of data collection. However, the sample size also depends on the constraints of cost and time. In many cases it is not possible to spend a long time on the pilot study stage. Bell (2014) recommended that, even in the most pressed of times, every questionnaire must be given a trial-run, even if it is simply with family or friends. In the absence of pilot tests, it is not possible to know whether the device will succeed or not. In this research 11 face-to-face interviews were conducted with construction industry practitioners. In addition to that, 10 self-administered questionnaires were sent to professionals as hard copies and soft copies, using Google forms for online copies. Those pilots, with experts in the Kurdistan residential sector, helped in verifying the designed questionnaire. The details of participants and the survey instrument of pilot study stage are shown in Appendix D.

Practitioners were asked to respond to a set of predetermined questions about improving collaborative working in residential projects. Respondees also discussed the design of the device, comprehensiveness of questions, and time required to answer the questions. Similar approaches to using interviews with questionnaires to obtain validity and reliability have been used by other researchers within the construction industry such as Hughes et al. (2012) and Meng (2012). Interviewees gave their perception of the relationship between collaborative working and the performance of residential building projects. Construction industry experts were asked to rate the importance of factors

needed to increase the level of collaboration, in order to increase project performance regarding energy consumption.

In addition to rating those factors, in the last section of the questionnaire, professionals were given a chance to comment and add any other element that they think was needed for consideration to enhance collaboration. The responders were asked: *''Please add any additional factor that you think needs to be considered to improve collaboration in residential projects''.* This question aimed at finding additional factors that can improve collaborative working, alongside the mentioned factors. Respondees emphasised the importance of contract type. Although the effect of contract was considered in the preliminary questionnaire because some of the mentioned factors depend on the type of contract, such as involvement of main contractor and subcontractors; respondees insisted that the type of contact must be mentioned specifically in the survey instrument. They urged that contact type is a decisive element of collaboration and other factors can not compensate its effects. An interviewee stated *''Type of the contact is very important, it encourages either fragmentation or collaboration''*. Another respondee emphasised the role of contact by stating *''all involved parties are bonded to the terms of contract and documents related to the types of contract''*. Therefore, based on the feedback from practitioners of the construction industry in the Kurdistan region, a question concerning the appropriateness of the type of contact was added to the questionnaire instrument.

Furthermore, besides the interviews, 10 self-administrated questionnaires were collected. The feedback from these pilot studies was essential in terms of clarity of questions, language and general design of the instrument. A principal purpose of the

pilot studies is to check the format of questions, wording and to discover where the instructions are unclear (Bell, 2014). The preliminary questionnaire used a 5-point Likert scale ranging from *strongly agree* to *strongly disagree* for rating collaboration factors. The aim was to understand to what level experts agree that those factors are critical for collaboration. However, the scale caused some confusion; participants of self-administrated pilots had different interpretations for scale measurement. Some of them used the scale as their level of agreement with the importance of factors, while others used it as their level of agreement with the presence of such factors in Kurdistan projects. Respondees suggested using a scale that clearly explains that the rating is about the importance of elements for improving collaboration practices. Therefore, based on this feedback, the scale was changed to range from the *least important* to *most important*. The questionnaire instrument used in pilot studies and the refined questionnaire for the final data collection are shown in Appendix D and E respectively.

5.4 Conducting the survey

In this section, the procedure for conducting the survey is explained, an overview of the design, sample size, and distribution of the survey.

5.4.1 Overview of the questionnaire design

The survey was designed to achieve the objective of identifying the necessary factors to improve collaboration. A collaborative process that leads to minimising the gap between the actual and designed energy consumption of residential buildings. Respondees of the questionnaire were asked to give their opinion on the level of importance of a specific factor of collaboration.

The survey consisted of two main sections, respondents' profile and collaboration in residential projects. Firstly, to ensure eligibility of participants, the part of the *Respondents profile* was designed to collect some background information about participating professionals, such as the type of organisation they work for and years of experience in the industry. The second section of the survey, which was the fundamental part of the questionnaire, consisting of 23 questions concerning the process of developing collaboration. In this section, respondents were asked to rate the importance of some factors, which are required to enhance collaborative environments.

The importance level of the factors was rated by using a 5-point Likert scale, ranging from 1 as *least important* to 5 as *most important*, shown in Table 5.1 below.

Table 5-1 The scale measures of the questionnaire instrument, 5-point Likert scale

1	2	3	4	5
least important	slightly important	moderately important	important	the most important

A Likert scale is a widely used approach for scaling responses in research. In this study, the Likert scale was used to ask responders to rate the importance of a range of factors. Jamieson (2004) explained that typical Likert scales consist of categories of responses; the data collected using Likert scales fall into the ordinal type of measurements. In ordinal data, variables are ordered to some categories, where the distance between those categories is unknown. Other researchers such as Hughes et al. (2012) and Akintoye et al. (2000) have used Likert scales to rate the opinion of practitioners about the importance level of various attributes and factors in the construction industry.

Factors identified from the global literature about improving collaboration (explained in section 2.8) were used to develop the survey questions. Each factor is represented in the form of a question/questions. In addition to the questions that were developed from the global literature, a review of the construction projects in the Kurdistan region also contributed to developing the questions. Three questions were extracted from a review of the Kurdistan construction industry concerning a lack of skills and technologies, and ways to evaluate project performance. A similar process was followed by Meng (2012) who developed a questionnaire based on factors gleaned from the literature to survey the opinion of participants about improving performance in terms of construction projects. Later, all the provisional questions were checked during the pilot study stage and were subsequently revised where appropriate. Participants were given a chance to add any question that they thought was missing from the survey. Consequently, a question concerning the type of contract to be used was added to the questionnaire based on recommendations of the respondees. Details of the pilot study are presented in section 5.3. The summary of development of survey questions from the literature and pilot studies is outlined in Table 5.2 below. The full questionnaire instrument can be found in Appendix E.

Table 5-2 Development of survey questions

Questions of the questionnaire	Origins of the questions
(1) All involved parties in the project trust each other	Trust factor (section 2.8.1)

(2) All parties trust that terms of the contract will be implemented	Trust factor (section 2.8.1)
(3) The type of contract is appropriate for the project	Added during pilot studies (section 5.3)
(4) Communication lines are open and clear between different teams	Communication factor (section 2.8.2)
(5) Communication lines are open and clear between members of the same team	Communication factor (section 2.8.2)
(6) Stakeholders are using ideas from different participants to improve project performance	Communication factor (section 2.8.2)
(7) Mutual goals are set between the key participants of the project	Mutual goals factor (section 2.8.3)
(8) Key parties understand the clear and shared vision of the project	Mutual goals factor (section 2.8.3)
(9) A clear process for conflict resolution is set in the project	Conflict resolution factor (section 2.8.4)
(10) Senior management is committed to delivering the project vision	Top management support factor (section 2.8.5)
(11) Senior management is encouraging all members of the project team	Top management support factor (section 2.8.5)
(12) All involved stakeholders are committed to the project vision	Commitment factor (section 2.8.6)

(13) A strategic plan of benefits and risk sharing is set between involved parties	Gain-pain sharing factor (section 2.8.7)
(14) The cultural difference of involved project participants affects the way they behave	Culture factor (section 2.8.8)
(15) Each party provides the appropriate resources to deliver the project vision	Resource sharing factor (section 2.8.9)
(16) Each party is willing to share their resources with other parties	Resource sharing factor (section 2.8.9)
(17) The main contractor is involved at the beginning of the project life cycle	Early involvement of key participants (section 2.8.10)
(18) The major subcontractors are brought in at an early stage of the project	Early involvement of key participants (section 2.8.10)
(19) A systematic way to evaluate the performance of the project process is used	From literature of Kurdistan (sections 3.5 and 3.6)
(20) Roles and responsibilities of all team members are defined at an early stage of the project	Clear roles factor (section 2.8.11)
(21) Roles and responsibilities of participants are clear to everyone	Clear roles factor (section 2.8.11)
(22) The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project	From literature of Kurdistan (sections 3.5 and 3.6)
(23) There are enough skilled staff and workers to perform different tasks in the project	From literature of Kurdistan (sections 3.5 and 3.6)

5.4.2 Sample size

The targeted population is the stakeholders in the Kurdistan residential construction sector. Those stakeholders perform different roles in residential projects such as contractor, consultant, client and supplier. All these stakeholders and companies are registered with the Kurdistan Contractors Union (KCU). Therefore, to identify the number of companies working in the sector, the KCU was contacted. According to data they provided, 3,000 registered companies are working in public and private sectors of housing. Since in most cases, it is difficult to survey a complete population, sampling is necessary (Fellows & Liu, 2015). However, a representative sample needs to have theoretical and practical values as close as possible to those that would be obtained from surveying the entire population. Denscombe (2014) explained that sample size depends on four factors which are the size of the research population, the accuracy of the estimates, level of confidence and variation in the population. In many cases, population size acts as the external factor, beyond the calculation and assumptions of the researcher; it is a given number. The effect of population size is more significant in smaller populations. For instance, if a population size exceeds 5,000 its effects on the required sample size will be reduced to a minimum.

Blair, Czaja, and Blair (1996) presented a statistical method to calculate sample size as follows:

$$Sample\ size\ = \frac{\frac{z^2 x\ p\ (1-p)}{c^2}}{1 + \left(\frac{z^2\ x\ p(1-p)}{c^2 N}\right)}$$

N = population size, C = margin of error, Z = z value , p= percentage of picking the choice

Fellows and Liu (2015) suggested assuming a confidence level of 95 %, which results in Z value of 1.96, and a margin of error 5%. A confidence interval of 95% means that if the survey is repeated over and over again, the outcomes will match the outcome of the actual population 95% of times. It is also suggested to use p-value of 50% because it requires bigger sample sizes (Denscombe, 2014). The p-value is the percentage of the sample that will respond in a given way, and 50% (50/50 evenly divided) is the worst-case scenario because people could answer either way (Creswell, 2014). Applying these assumptions to the population size of this project, 3,000, the ideal sample will be 341. However, in many cases, researchers use a margin of error of 10% (Blair et al., 1996). In that case, sample size for a population of 3,000 will be 94 cases.

Denscombe (2014) insisted that sample size also depends on practical situations such as the constraints of cost and time. The author explained that there are some general guidelines that can help in the process such as comparing the sample size to other similar studies. Additionally, for statistical purposes, a sample size should not be less than 30 cases.

5.4.3 Survey distribution and response rate

The survey targeted construction practitioners in the public and private sectors of residential building projects in the Kurdistan region. The questionnaire was distributed using hard copies and soft copies. To identify potential respondents and to ensure a representative sample for the study, responsible organisations were contacted such as the Ministry of Construction and Housing and the KCU. Those organisations were contacted to get their consent and to provide information regarding the means for

getting the opinion of the construction industry practitioners. Potential respondents were identified based on information received from those organisations. Respondents were required to be active professionals involved in public or private sectors of housing in the Kurdistan region.

According to Fellows and Liu (2015), two main techniques can be employed to obtain a research sample: random sampling and non-random sampling. Random sampling is preferable for relatively large samples. However, selecting a sample also depends on practicality and constraints of cost and time. In many cases, it is impractical to choose participants randomly and therefore non-random decisions may to be made. Denscombe (2014) suggested that the idea of random sampling should be weighed against the savings that can be made using other approaches such as cluster sampling, while retaining the principles of random selection and probability laws. The author explained that by adopting cluster sampling, the researcher could save a great deal of time and money, which mostly would have been spent on travelling to research sites. Cluster sampling has been utilised in construction industry research for reasons of practicality and efficiency. For instance, Tanko and Anigbogu (2012) used cluster sampling to determine the sample for a questionnaire survey between construction projects. The study adopted cluster sampling to identify which projects to include for the survey, when looking at the factors that affect the safety of workers on construction projects in Nigeria. In this study, the population comprised 3,000 construction organisations located in three different governorates of the Kurdistan region: Erbil, Dohuk, and Sulaymaniah. It was impractical to obtain a completely random sample as the majority of these organisations lacked internet services and participants needed to

be visited in person. Moreover, excessive travelling would have consumed time and costs beyond the budget available for the PhD project.

Cluster sampling was therefore more appropriate for this study. This involves dividing a population into groups or clusters in which inter-group variations are likely to be small while intra-group variations are larger (Fellows & Liu, 2015). In this technique, clusters are selected randomly and the total number of cases within all clusters constitutes the sample size. Usually, clusters include members that are believed to differ from one another. The sample can be grouped into clusters according to any naturally occurring situation; for example, geographical area (Saunders, Lewis, & Thornhill, 2009). In this study, a list of organisations provided by the Kurdistan Contractors Union provided the sampling frame; these organisations were based in different local administrative areas in the Kurdistan region (Erbil, Dohuk, and Sulaymaniah). Clusters were then randomly selected from the organisations that were reachable. The clusters were similar to one another but they included participants from different professions with varying levels of experience in the construction industry. Barreiro and Albandoz (2001) argued that cluster sampling produces accurate results when clusters are homogeneous between themselves, but each cluster includes different members in such a way as to represent the population. Details of the survey participants can be found in section 5.5.1.

The main strategy for distribution was the physical delivery of hard copies (paper version) to construction organisations. After a period of two weeks, the organisations were revisited to collect completed surveys, or to remind the professionals to fill out the questionnaire. Moreover, to get a representative sample, online surveys were also used, Google forms were adopted to distribute the survey online. Accordingly, around 750

questionnaires were delivered to potential responders in hard and soft copies. The contacted practitioners were performing various roles in the housing sector such as clients, project managers, main contractors, subcontractors and design team members. The process of the survey distribution was undertaken over three months starting from July 2018.

After collecting the surveys, the process of initial data screening was undertaken and the questionnaires that were missing data were excluded. Finally, 227 questionnaires were included for the data analysis (193 hard and 34 soft copies). Details of respondents are presented in the next section. Inserting this number, 227, into the sample size equation, explained in the previous section, results in a margin of error of 6.25%. It is important to recognise that this margin is bigger than the targeted margin of 5%, however, in real-life, samples sizes depend on many constraints of cost and time (Denscombe, 2014). This margin is also considered as an acceptable ratio according to Czaja and Blair (2005).

This process of data collection resulted in a response rate of 30.2%. The response rate is considered a positive rate in the construction industry; many researchers have obtained lower responses rates. For examples, 26.7% was obtained by Black et al. (2000) and 25% by Iyer and Jha (2005) in similar research in the construction industry. Also, the final sample size collected, 227, is larger than samples used by many other authors in research on the construction sector, such as Meng (2012) when identified key elements for improving supply chain collaboration in the UK, and Cheng and Li (2002) when investigated factors for enhancing partnering process.

5.5 Descriptive statistics:

The developed questionnaire contains a mixture of nominal, scale and ordinal data. However, most of the collected data are ordinal data as it has been collected using a 5-point Likert scale. The data analysis started with basic descriptive statistics to provide a summary of the collected sample and to better understand the nature of the data. The descriptive statistics contain frequency distributions, a measure of central tendencies as means and medians, and a measure of dispersion as standard deviation.

5.5.1 Respondent's background

5.5.1.1 Type of organisation of respondents

The respondents of the survey consisted of professionals from different organisations. Project managers are the largest group and represent 33% of the respondents; 19% of respondents were from contractors, including main and subcontractors. Professionals from the design teams and client representatives accounted for similar percentages each for 17%. Additionally, 14% of respondents ticked *other* option mainly consisting of academics in universities and government employees. Table 5.3 show details about the background of the participants.

5.5.1.2 Work experience

Table 5.3 below shows the experience of the respondents of the survey in years. 81% of participants had a minimum of 6 years experience in the construction industry. As can be seen, 26% had more than 15 years experience and 19% of professionals had between 11-15 years experience. The largest group of the participants was professionals with experience of 6-10 years, 36%. Only 19% of respondees had fewer than 5 years

experience. The participants of the survey had significant experience in construction projects. Therefore, it can be concluded that the data set collected from this sample is reliable.

Table 5-3 Profile of respondents to the questionnaire survey

Years of experience in construction			Type of job		
	Frequency	Percentage		Frequency	Percentage
Less than 5	44	19	Client's Representative	38	17
6-10	81	36	Project Manager	74	33
11-15	44	19	Design Team	38	17
More than 15	58	26	Main Contractor	32	14
Total	227	100	Sub-Contractor	12	5
			Other	33	14
			Total	227	100

5.5.2 Kruskal–Wallis test

Kruskal-Wallis is a non-parametric test used to investigate differences between two or more independent variables. It transforms scores to ranks and compares the mean ranks of each group; it is preferred to a parametric one-way ANOVA when the normality assumption is violated, such as in Likert-scale data (Hecke, 2012). The Kruskal-Wallis test was used to determine whether there were any differences between the perceptions of practitioners based on their job type or years of experience in the construction industry.

5.5.2.1 Comparing groups based on the type of job

First, Kruskal-Wallis was used to determine whether there was any difference between sample groups based on the organisation they work for. The respondents were asked to rate the importance of 23 variables that contribute to improving collaboration on a Likert scale ranging from 1= least important to 5= most important. A p-value of less than 0.05 indicated a significant difference between the groups. Table 5.4 presents the results of the Kruskal-Wallis test based on the type of job held by participants. This shows that the difference between groups is nonsignificant for the majority of variables (21 out of 23). This means that the type of organisation participants work for does not affect their opinion on collaboration elements for most of the variables. However, there is a significant difference between the perceptions of practitioners for two variables: *''(8) Key parties understand the clear and shared vision of the project''* and *''(14) The cultural differences of involved project participants affect the way they behave''*. These differences were further investigated by scrutinising the median and mean of participant groups.

Table 5-4 Difference between the perception of participants based on the type of their job

Variables (survey questions)	Kruskal-Wallis H	df	Asymp. Sig.
(1) All involved parties in the project trust each other	0.835	5	0.975
(2) All parties trust that terms of the contract will be implemented	6.153	5	0.292
(3) The type of contract is appropriate for the project	3.285	5	0.656
(4) Communication lines are open and clear between different teams	4.943	5	0.423

(5) Communication lines are open and clear between members of the same team	6.133	5	0.294
(6) Stakeholders are using ideas from different participants to improve project performance	7.548	5	0.183
(7) Mutual goals are set between the key participants of the project	8.954	5	0.111
(8) Key parties understand the clear and shared vision of the project	16.957	5	0.005
(9) A clear process for conflict resolution is set in the project	8.672	5	0.123
(10) Senior management is committed to delivering the project vision	4.578	5	0.469
(11) Senior management is encouraging all members of the project team to deliver the vision	6.785	5	0.237
(12) All involved stakeholders are committed to the project vision	4.354	5	0.500
(13) A strategic plan of benefits and risk sharing is set between involved parties	4.223	5	0.518
(14) The cultural differences of involved project participants affect the way they behave	14.086	5	0.015
(15) Each party provides the appropriate resources to deliver the project vision	5.346	5	0.375
(16) Each party is willing to share their resources with other parties	5.803	5	0.326
(17) The main contractor is involved at the beginning of the project life cycle	3.301	5	0.654
(18) The major subcontractors are brought in at an early stage of the project	10.527	5	0.062
(19) A systematic way to evaluate the performance of the project process is used	4.100	5	0.535
(20) Roles and responsibilities of all team members are defined at an early stage of the project	7.112	5	0.212
(21) Roles and responsibilities of participants are clear to everyone	9.553	5	0.089
(22) The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project	5.157	5	0.397

(23) There are enough skilled staff and workers to perform different tasks in the project	6.640	5	0.249

- ***Key parties understand the clear and shared vision of the project***

Table 5.5 shows the median and means of groups for the variable ''Key parties understand the clear and shared vision of the project''. This indicates that the median and mean of the design team, client representative, and project manager groups are clearly higher then both contactor groups (main contractor and sub contactor) and the 'other' group. Thus, understanding a clear and shared vision is the priority of senior professionals in construction projects such as designers, clients and project managers. Although this factor remains important throughout the chains of hierarchies, contactors might focus more on practical tasks and dealing with works. Consequently, this variable was rated lower in contractor groups in the Kurdistan region.

Table 5-5 Difference between the median and mean of groups regarding whether key parties understand the clear and shared vision of the project

What type of organisation do you work/worked for?	N	Mean	Median
Client's Representative	38	3.61	4.00
Project Manager	73	3.48	4.00
Design Team	38	3.71	4.00
Main Contractor	32	3.47	3.50
Sub-Contractor	12	2.42	2.00
Other	33	3.06	3.00
Total	226	3.42	4.00

- ***The cultural differences of involved project participants affect the way they behave***

By contrast, Table 5.6 shows that cultural differences were rated higher by contractor groups and other groups than clients, design teams, and project managers. In the Kurdistan region, there is an abundance of low skilled workers from neighbouring countries such as Syria, Iran and Turkey, many of whom end up working in construction projects (World Bank, 2015). The fact that contractors have direct links with workers on construction sites who come from different countries and cultures may explain why they rated the variable of cultural difference higher than other groups. For example, clients, unlike contractors, do not deal directly with workers on construction sites and are less exposed to people from different countries and cultures. Indeed, Table 5.6 shows that among all the groups clients rated this variable lowest.

Table 5-6 Difference between the median and mean of groups regarding whether the cultural differences of involved project participants affect the way they behave

What type of organisation do you work/worked for?	N	Mean	Median
Client's Representative	38	2.92	3.00
Project Manager	74	3.11	3.00
Design Team	38	3.42	3.00
Main Contractor	32	3.78	4.00
Sub-Contractor	12	3.50	4.00
Other	33	3.76	4.00
Total	227	3.34	3.00

5.5.2.2 Comparing groups based on experience in the industry

Differences between the opinions of groups based on years of experience in the construction industry were also investigated. The results of the Kruskal-Wallis test indicate that these differences are nonsignificant for almost all the variables (22 out of 23). This indicates that years of experience had no impact on the opinions of participants regarding elements of collaboration. Professionals with various levels of experience had similar opinions on improving collaboration in the Kurdistan region. The only exception was in the first variable *''All involved parties in the project trust each other''*. The results are presented in Table 5.7:

Table 5-7 Difference between the perception of participants based on type of their job

Variables (survey questions)	Kruskal-Wallis H	df	Asymp. Sig.
(1) All involved parties in the project trust each other	9.200	3	0.027
(2) All parties trust that terms of the contract will be implemented	0.503	3	0.918
(3) The type of contract is appropriate for the project	0.665	3	0.881
(4) Communication lines are open and clear between different teams	4.851	3	0.183
(5) Communication lines are open and clear between members of the same team	7.209	3	0.066
(6) Stakeholders are using ideas from different participants to improve project performance	2.328	3	0.507
(7) Mutual goals are set between the key participants of the project	3.270	3	0.352
(8) Key parties understand the clear and shared vision of the project	3.680	3	0.298
(9) A clear process for conflict resolution is set in the project	2.409	3	0.492

(10) Senior management is committed to delivering the project vision	4.099	3	0.251
(11) Senior management is encouraging all members of the project team to deliver the vision	4.215	3	0.239
(12) All involved stakeholders are committed to the project vision	4.223	3	0.238
(13) A strategic plan of benefits and risk sharing is set between involved parties	3.757	3	0.289
(14) The cultural differences of involved project participants affect the way they behave	3.825	3	0.281
(15) Each party provides the appropriate resources to deliver the project vision	2.928	3	0.403
(16) Each party is willing to share their resources with other parties	1.222	3	0.748
(17) The main contractor is involved at the beginning of the project life cycle	0.503	3	0.918
(18) The major subcontractors are brought in at an early stage of the project	2.457	3	0.483
(19) A systematic way to evaluate the performance of the project process is used	6.083	3	0.108
(20) Roles and responsibilities of all team members are defined at an early stage of the project	4.342	3	0.227
(21) Roles and responsibilities of participants are clear to everyone	1.951	3	0.583
(22) The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project	2.428	3	0.488
(23) There are enough skilled staff and workers to perform different tasks in the project	4.158	3	0.245

- ***All involved parties in the project trust each other***

Table 5.8 presents differences in the perceptions of groups regarding the variable of trust. Professionals with more than 15 years of experience rated the variable the highest

(according to mean). This could be because experienced participants have come to realise the importance of trust more than other groups. However, participants with 11-15 years of experience rated the variable lower than other groups.

Table 5-8 Difference between the median and mean of groups regarding whether all involved parties in the project trust each other.

How many years of experience do you have in the construction sector?	N	Mean	Median
Less than 5 years	44	3.70	4.00
6-10 years	81	3.75	4.00
11-15 years	44	3.20	3.00
more than 15 years	58	3.90	4.00
Total	227	3.67	4.00

5.6 Data exploration:

Data exploration is one of the first steps of data analysis used by researchers to understand the data. In data exploration, descriptive and inferential statistics can be used to describe the characteristics of samples.

In descriptive analysis researchers mainly use a measure for a central tendency; a value that tries to explain a set of data by determining its central position. There are different measures of central tendencies such as mean, median and mode. All these measures of central tendencies have been used widely by researchers. However, based on the conditions of data, using some of the tests becomes more appropriate than others. Boone and Boone (2012) recommended using median and mode as the measures of central tendency for Likert type data. Median is a middle value in a set of data, and mode

is the most frequent score in the set of data. Table 5.3 shows the median, modes and the sample size for the survey questions.

Another purpose of data exploring is to see whether the data are normally distributed or not. Skewness and Kurtosis are the popular tests to check the normality of the data. However, the main data analysis technique used in this study is the principal axis factoring of factor analysis, in which the data are not assumed to be normally distributed (Costello & Osborne, 2005; Floyd & Widaman, 1995). Therefore, non-normally distributed data are considered suitable for the statistical test used in this research.

Table 5.9 ranks items on questionnaires based on their median and mode. These are both high, which highlights the importance of questions eliciting the perceptions of professionals in the Kurdistan region. The first five questions in Table 5.3 have a median of 4.0 (''important'') and a mode of 5 (" most important''). These questions concern communication lines, the involvement of the main contractor, and managing the roles of team members. These factors were also identified as crucial in the global literature. Additionally, the availability of skilled staff was also ranked at the highest level. This is because the Kurdistan region lacks skilled staff and therefore it is a vital factor for improving collaboration (Shawkat et al., 2018).

Most questions (15 out of 23) had a median and mode of 4.0, indicating a response of ''important'' on the scale. Only three questions were rated lower and had a median of 3 (''moderately important''). These questions concerned using the ideas of different participants, cultural differences, and the involvement of subcontractors.

Appendix F presents histograms of all questions to help elucidate the shape of the distribution of the answers.

Table 5-9 Descriptive analysis for ordinal data

Question number	N= 227		Median	Mode
	Valid	Missing		
(5) Communication lines are open and clear between members of the	227	0	4.0	5
(17) The main contractor is involved at the beginning of the project life cycle	227	0	4.0	5
(20) Roles and responsibilities of all team members are defined at an early stage of the project	227	0	4.0	5
(21) Roles and responsibilities of participants are clear to everyone	227	0	4.0	5
(23) There are enough skilled staff and workers to perform different tasks in the project	227	0	4.0	5
(1) All involved parties in the project trust each other	227	0	4.0	4
(2) All parties trust that terms of the contract will be implemented	227	0	4.0	4
(3) The type of contract is appropriate for the project	226	1	4.0	4
(4) Communication lines are open and clear between different teams	227	0	4.0	4
(7) Mutual goals are set between the key participants of the project	225	2	4.0	4

(8) Key parties understand the clear and shared vision of the project	226	1	4.0	4
(9) A clear process for conflict resolution is set in the project	226	1	4.0	4
(10) Senior management is committed to delivering the project vision	227	0	4.0	4
(11) Senior management is encouraging all members of the project team	227	0	4.0	4
(12) All involved stakeholders are committed to the project vision	227	0	4.0	4
(13) A strategic plan of benefits and risk sharing is set between involved parties	226	1	4.0	4
(15) Each party provides the appropriate resources to deliver the project vision	227	0	4.0	4
(16) Each party is willing to share their resources with other parties	227	0	4.0	4
(19) A systematic way to evaluate the performance of the project process is used	227	0	4.0	4
(22) The project teams are provided with enough technological resources during the whole life of the project	227	0	4.0	4
(6) Stakeholders are using ideas from different participants to improve project performance	226	1	3.0	4
(14) The cultural difference of involved project participants affects the way they behave	227	0	3.0	4
(18) The major subcontractors are brought in at an early stage of the project	227	0	3.0	4

5.7 Exploratory Factor Analysis (EFA)

Factor analysis is a statistical approach that strives to explain relationships among a set of observed variables (participants' Likert scale answers) in a smaller number of unobserved variables, called *factors*. It is a dimension reduction technique used to reduce data to a more manageable size, whilst retaining as much information as possible (Field, 2013). This multivariate technique is used to investigate the underlying structure of relations or correlations among a large set of variables to yield a smaller number of factors. The underlying structure is something that cannot be measured directly and called the latent variable. The technique is to measures another set of variables that could be intercorrelated under the latent variable.

Factor analysis combines intercorrelated variables and groups them under one factor rather than a larger number of separated variables. The retained factors or underlying dimensions are interpreted in order to represent data in a more meaningful way, relative to the initial variables. Floyd and Widaman (1995) explained that factor analysis uses a matrix of correlations or covariances among measured items or variables to explain covariance among measured items in more general groups of latent variables. The authors added that factor analysis is also used for data reduction, with measured items combined to form a smaller set of indices with maximal reliability and variability.

The identified clusters from Exploratory Factor Analysis (EFA) are called *factors* in the case of principal axis factoring, or *components* in the component analysis. Other researchers have used factor analysis to rate aspects of collaborative working in the construction industry. For example, in Hong Kong, Chan, Chan, et al. (2004) adopted

factor analysis to determine critical success factors for developing partnering from a data set collected through a five-point Likert scale. Similarly, Chan, Ho, and Tam (2001) used factor analysis to reduce the number of factors that underlie the success of the design and build procurement route in the construction industry.

5.7.1 Sample adequacy test (KMO)

Since factor analysis requires relatively large samples compared to some other statistical tests, it is necessary to ensure that the sample collected is adequate for performing the analysis. Kaiser-Meyer-Olkin (KMO) tests the suitability of the sample for factor analysis. KMO represents the ratio of squared correlation between variables to squared partial correlation between variables (Field, 2013). KMO is the most popular test for examining the adequacy of a sample to conduct a factor analysis process. KMO values range between 0 to 1, values close to 1 indicate that patterns of correlations are compact, and factor analysis should give reliable and distinct factors. Kaiser (1974) provided a guideline to access the value of KMO:

0.90s, marvellous

0.80s, meritorious

0.70s, middling

0.60s, mediocre

0.50s, miserable

Below 0.50, unacceptable.

The value of KMO for the sample of this research was 0.889 that indicates that the sample is of good quality to conduct a reliable factor analysis process, see Table 5.4 below.

5.7.2 Bartlett's test of sphericity

Another indicator of the suitability of data for factor analysis is Bartlett's Test of Sphericity. It tells if the correlation matrix is different from the identity matrix (Field, 2013). In an identity matrix where correlation coefficients between variables are zero, factor analysis cannot be used. The null hypothesis of this test is that the correlation matrix is an identity matrix. A significant value in Bartlett's test indicates that correlations are different from zero; a significance level of less than 0.05 ($p<0.05$) is required to indicate that the correlation matrix is not an identity matrix (Field, 2013). In Table 5.10, the value of 1727.985 means that the data are approximately Chi-Square distributed with a degree of freedom 253, and level of significance <0.5. These statistics suggest that the correlation matrix is significantly different from an identity matrix, and the null hypothesis can be rejected. The correlations between all variables can be found in the Correlation Matrix in Appendix G.

Table 5-10 KMO and Bartlett's test results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.889
Bartlett's Test of Sphericity	Approx. Chi-Square	1727.985
	df	253
	Sig.	0.000

The values of both KMO and Bartlett's test prove that the sample is suitable for conducting factor analysis.

5.7.3 Extraction method

Yong and Pearce (2013) explained that the concept of factor analysis is that the observable variables can be reduced to fewer underlying variables that have a shared variance, and can explain the interrelationships among original variables. This process involves two main consecutive steps factor extraction and factor rotation. The extraction is about choosing the type of model; and rotation is to improve interpretability by rotating factors because unrotated factors are vague (Yong & Pearce, 2013). There are several methods of extraction in software packages to perform factor analysis. Principal Component Analysis (PCA) and Principal Factor Analysis (PFA) are two popular methods among researchers. Both PCA and PFA are used to reduce the number of variables to smaller groups that can be managed in a simpler way. Despite their similarities, Field (2013) explained that PCA and PFA are different in calculating the variance between variables. Considering that the total variance of a variable in a correlation matrix consists of common variance (communality) which is the shared variance with another variable, and unique variance that is the variance specific to one measure. There is also a portion of common variance called random or error variance. As PFA attempts to find common underlying dimensions, it is mainly concerned with finding the amount of common variance. In contrast, PCA assumes that all the variance is common between the variables, also assumes there is no error variance at all.

PCA is the default option in many software packages and that is the reason for its popularity according to Costello and Osborne (2005). PCA is computed regardless of any underlying structure produced by the latent variable. Costello and Osborne (2005) firmly preferred PFA arguing that researchers rarely collect data without any idea of a correlation between variables. Generally, exploratory factor analysis or PFA is considered as a stronger form of data analysis (Brown, 2009b).

In this thesis, a set of potential factors were identified from the literature and used to develop a questionnaire of 23 dependent variables. Therefore, the author was aware of some underlying dimensions that exist between variables. Consequently, PFA *(Principal Axis Factoring in SPSS)* was considered as the appropriate extraction method for conducting factor analysis process.

5.7.4 Rotation method

The next stage is to choose a rotation method. Rotation is an attempt to clarify the data and represent it more simply. It is a process of rotating factor axes dimensions determined in the initial extraction of factors to obtain a simple structure (Brown, 2009a). This technique helps researchers to relate mathematical calculations to theoretical entities. Rotations cannot change or improve the basic aspects of the process of the analysis such as improving the total variance explained. There are two types of rotations, orthogonal and oblique. Orthogonal rotations ensure that factors are uncorrelated, while oblique rotations allow for correlations among factors. Generally, orthogonal rotations are more popular because the results are easier to interpret. However, in social science, researchers are usually aware that factors are correlated, so

using orthogonal rotation could result in a valuable loss of information (Costello & Osborne, 2005). Therefore, oblique rotations might deliver more accurate results.

To make a decision on which rotation to be used, Brown (2009a) suggested performing factor analysis with an oblique rotation and looking for values around ±0.32 and above in the Factor Correlation Matrix. If the correlations exceed 0.32 there is enough correlation between factors to warrant oblique rotation. In contrast, if the values are lower than 0.32 an orthogonal rotation could be used.

In Table 5.5, it can be noted that there are several correlation coefficients larger than 0.32 which is an indicator that correlation exists between variables. Consequently, an oblique rotation will be appropriate. The values of 0.32 or larger are highlighted in brown in Table 5.11. From 5 rotation types available in SPSS, it is advised to use *Varimax* in the case of orthogonal and *Direct Oblimin* for oblique rotation in order to obtain the cleanest structure (Brown, 2009a).

For this research, factors of collaboration are related to each other. Therefore, theoretically, some correlations between those factors are expected, and by looking at Factor Correlation Matrix it can be stated that an oblique rotation is a suitable choice. Direct Oblimin was used as the type of oblique rotation.

Table 5-11 Factor Correlation Matrix.

Factor	1	2	3	4	5	6
1	1.000	.142	.265	.253	.359	.374
2		1.000	.175	.325	.057	.174
3			1.000	.279	.384	.441
4				1.000	.318	.270
5					1.000	.387
6						1.000

Rotation Method: Oblimin with Kaiser Normalization.

5.7.5 Factor extraction

Another decision that researchers need to make is how many factors to retain. Basically, the eigenvalue associated with each factor indicates the importance of that factor. Therefore, factors with large eigenvalues are retained. An eigenvalue is the amount of variance accounted for by a factor; when an eigenvalue is less than one it means that the factor accounts for less variance than a variable (Floyd & Widaman, 1995). The popular method is to establish Kaiser's criteria which suggest keeping all factors with eigenvalues greater than one.

Costello and Osborne (2005) suggest that after extraction the solution that provides the *cleanest* factor structure - loadings above 0.3 with few or no cross-loadings- is the best fit for the data. Cross-loading is the case when variables have high loadings on more than one factor, and that complicates the interpretation of results. Using the cut-off point of 0.3 in this sample of data, only one variable was loaded on two factors. The variable of *''roles and responsibilities are clear to everyone''* was loaded on communication and systematic process factors, and since it was loaded higher on the

latter factor, those loading was kept. Accordingly, Kaiser's criterion to keep factors with eigenvalues greater than one provides a clean factor structure. Therefore, Kaiser's criterion was adopted, and six factors with eigenvalues larger than one were retained. Table 5.12 shows the retained factors with their percentage of variance, the proportion of variance accounted for by those factors. The communalities of variables, a total variance for a particular variable explained by all factors, are shown in Appendix G.

Table 5-12 Total variance explained by retained factors

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	7.261	31.569	31.569	6.738	29.295	29.295	3.698
2	1.774	7.713	39.283	1.234	5.364	34.659	1.821
3	1.487	6.464	45.747	.973	4.233	38.892	3.586
4	1.215	5.281	51.028	.658	2.862	41.754	2.694
5	1.031	4.481	55.509	.484	2.105	43.860	3.573
6	1.019	4.430	59.938	.480	2.087	45.947	3.984

Extraction Method: Principal Axis Factoring.

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

5.7.6 Reliability of the scale:

A reliability test is a measure undertaken to ensure that the scale of the instrument is reliable. Fellows and Liu (2015) explained that Cronbach's Alpha (α) is the most frequently used reliability test among researchers and recommended using it with factor analysis. The authors also presented a formula for calculating Alpha coefficient, using matrices of the number of variables and correlations between them, as below:

$$(\alpha) = \frac{N\,r}{1 + (N-1)\,r}$$

N = number of variables, r = average inter-variable correlation for all variables.

In this study, Cronbach's Alpha was used to test the consistency and reliability of the questionnaire variables. Alpha coefficient ranges from 0-1 and values above 0.7 are desirable. The Alpha coefficient calculated for the items in the questionnaire instrument was 0.896 which suggests the reliability of the scale.

Table 5-13 Reliability test output from IBM SPSS 24

Cronbach's Alpha	No of items
0.896	23

5.7.7 Discussion of the results

This section outlines the results of factor analysis. The input of 23 variables or questions to SPSS for undertaking factor analysis process resulted in identifying 6 factors. The

factor structure and composition from variables are shown in Table 5.14. Factor loadings can also be seen in the table, which are regression weights to predict observed variables from the latent variables. The full factor loadings and unrotated factor matrix can be found in Appendix G. Comparing rotated factor loadings with unrotated loadings indicates that rotation has helped in presenting the matrix more clearly. Like the unrotated matrix, most of the values are loaded high on the first factor and extremely low on the last two factors. Therefore, rotation helped in distributing variables onto factors in a way that made interpretation easier.

Those final factors are ordered based on the variance shared by each factor which indicates their level of importance and their contribution to improving collaboration.

Table 5-14 Factor structure of Principal Axis Factoring

Items	Eigenvalues	Factor Loadings	% of variance	Cumulative %
Factor 1. Project Vision				
(10) Senior management is committed to delivering the project vision		0.591		
(11) Senior management is encouraging all members of the project team to deliver the vision		0.576		
(12) All involved stakeholders are committed to the project vision		0.451		
(8) Key parties understand the clear and shared vision of the project		0.450		
(7) Mutual goals are set between the key participants of the project		0.416		
(6) Stakeholders are using ideas from different participants to improve project performance	7.261	0.326	29.295	29.295
Factor 2. Behaviour of participants				
(14) The cultural difference of involved project participants affects the way they behave		0.680		
(15) Each party provides the appropriate resources to deliver the project vision		0.528		
(16) Each party is willing to share their resources with other parties	1.774	0.494	5.364	34.659
Factor 3. Communication				
(22) The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project		0.567		
(4) Communication lines are open and clear between different teams		0.496		
(5) Communication lines are open and clear between members of the same team		0.495		
(23) There are enough skilled staff and workers to perform different tasks in the project	1.487	0.439	4.233	38.892

Factor 4. Relationship definition				
(17) The main contractor is involved at the beginning of the project life cycle		0.603		
(18) The major subcontractors are brought in at an early stage of the project		0.495		
(20) Roles and responsibilities of all team members are defined at an early stage of the project	1.215	0.389	2.862	41.754
Factor 5. Contractual Agreements				
(1) All involved parties in the project trust each other		0.650		
(2) All parties trust that terms of the contract will be implemented		0.566		
(3) The type of contract is appropriate for the project	1.031	0.361	2.105	43.860
Factor 6. Systematic Process				
(13) A strategic plan of benefits and risk sharing is set between involved parties		0.663		
(19) A systematic way to evaluate the performance of the project process is used		0.462		
(21) Roles and responsibilities of participants are clear to everyone		0.438		
(9) A clear process for conflict resolution is set in the project	1.019	0.391	2.087	45.947

Extraction Method Principal Axis Factoring

Rotation Method: Oblimin with Kaiser Normalization

5.7.7.1 Project Vision (Factor 1)

The first factor accounted for 29.29% of the total variance, as can be seen in Table 5.7. Six variables fall under this factor and their factor loading are: *senior management commitment to vision* (0.591); *seniors encouraging members to deliver vision* (0.576); *stakeholders' commitment to vision* (0.451); *understanding shared vision* (0.45); *setting mutual goals* (0.416); *using different ideas* (0.326).

The amount of variance accounted for by this factor indicates that establishing a shared vision is the most important element for delivering projects in a collaborative manner. The variance of this factor alone is greater than the variance accounted for by all other factors combined. Analysis of the perceptions of construction practitioners in the Kurdistan region showed that collaboration primarily depends on the steps undertaken at the beginning of projects to establish a shared vision. In a similar study, Cheng and Li (2002) recommended that, in the preparation stage, involved parties should agree on a shared vision and address any concerns they have in order for the collaborative process to succeed. Therefore, developing a collaborative framework in the housing sector needs to start with the establishment of a shared vision. If this is successfully achieved, there is a high probability that collaboration is going to be effective between all parties.

It is essential for every project to have a clear vision to clarify its purpose, eliminate confusion and to encourage participants to contribute to the project. Construction projects need to have a comprehensive vision that is understandable by all project participants and inspires members to stay focused throughout the project life cycle. Variables under this factor show the vital role of senior management in delivering project objectives through setting mutual goals, commitment to the vision and

encouraging project members to understand and to stay committed to the project vision. The primary mission of the senior management is to develop, communicate and maintain project vision in order to have successful outcomes (Christenson & Walker, 2004). A project vision must be clearly understood, motivational, and credible; it also needs to be both challenging and demanding.

It is important to establish a powerful vision statement, and document projects vision clearly. A vision statement outlines the desirable outcomes of the project and gives a strategic direction to deliver such outcomes. To set an adequate vision statement, senior management must play a critical role to encourage participants share ideas and set mutual goals and develop understanding between members.

5.7.7.2 Behaviour of participants (Factor 2)

This factor represents 5.36% of the total variance explained and contained three variables of *cultural difference of participants* (0.68), *each party providing appropriate resources* (0.528) and *each party willing to share resources* (0.494).

Although the variance shared by this factor is considerably less than the variance shared by the previous factor, project vision, it is nevertheless responsible for the second largest amount of variance (5.36%). This shows that the behaviour of involved participants is a vital factor in ensuring collaborative team working in construction projects, enabling them to deliver high performing projects and minimise the performance gap. Negative behaviour from the involved stakeholders can hinder any collaborative process and lead to the breakdown of construction teams.

Cultural differences have a direct effect on the way project participants behave and interact with other participants. The behaviours of participants are critical in willingness to share resources for the project. Koutsikouri et al. (2008) indicated the critical role of participant behaviours in delivering a successful project and argued that careful attention must be paid to the behaviour of members in order to achieve project objectives. Collaborative working depends on a series of behaviours based on which participants interact, share resources and complete tasks (Patel et al., 2012). The behaviour of participants is an overarching factor that has an essential role at every stage of construction projects. This factor preserves its importance from the beginning of the project idea until the end of the project life cycle.

5.7.7.3 Communication (Factor 3)

Factor 3 represents 4.233% of the total variance and includes four variables: *project teams are provided with enough technological resources* (0.567), *communication lines are open and clear between member of the same team* (0.496), *communication lines are open and clear between different teams* (0.495) and, *there are enough skilled staff and workers to perform different tasks* (0.439). Accounting for 4.233% of variance, communication is the factor ranked third in the results of the factor analysis. This indicates that communication is an important factor in the collaboration process. The importance of this factor increases when the lack of technology and skilled staff in the Kurdistan region are taken into consideration, as these are necessary for good communication.

Clearly, the importance of communication has increased in modern construction. It is necessary to provide construction projects with enough technological resources to

communicate designs and to share information between stakeholders. Alongside technological resources, construction projects are required to have an adequate number of skilled staff to deal with that technology and perform related tasks. Clarity in communication lines is crucial to develop well-connected teams with high flexibility that improve collaboration performance in construction projects (Nursin & Latief, 2018). Clear communication channels are vital enablers for collaboration in construction projects that make information flow more accurate and available at the right time (Koolwijk, van Oel, Wamelink, & Vrijhoef, 2018). The study explained that, regardless of delivery methods used, such as integrated project delivery systems or traditional systems, communication and technologies remain critical to develop collaboration in construction projects in a way that leads to more effective teams and improving performance.

In the Kurdistan region, lack of skilled staff and technological resources are the main contributors to the underperformance of teams in technical processes in the construction industry (Abramzon et al., 2016). Therefore, delivering this factor in the region is a primary challenge for senior management of construction projects, and careful attention needs to be paid to ensure that communication factor is supplied. Projects need to be provided with enough technology, hardware and software packages. Also, there should be sufficient professionals with desired skills to undertake projects at the required level.

5.7.7.4 Relationship definition (Factor 4)

This factor accounted for 2.862% of the variance and compromised of three variables which are: *the main contractor involved at the beginning of the project* (0.603), *the major*

subcontractors are brought in at an early stage (0.495) and *roles and responsibilities are defined at an early stage* (0.389). This factor accounted for less variance than previous factors and slightly more than the next two factors. It is the fourth most important factor according to the results of the factor analysis, which was conducted on the perceptions of practitioners in the Kurdistan region.

To obtain a well-defined relationship among parties, all related parties must be involved at an early stage; roles and responsibilities of participants should be identified by agreement between stakeholders. Other researchers such as Shelbourn et al. (2007) and Bidabadi et al. (2015) have indicated the importance of early involvement of key stakeholders and identifying roles and responsibilities at an early stage to achieve effective collaboration.

Relationship deterioration has resulted in many issues in construction projects such as delays, cost overruns, and quality defects. The only way to overcome such problems is to define relationships in the early stages of projects by involving all related parties. The central principle of relationship definition in collaborative approaches is to establish an integrated entity that works collaboratively to achieve a mutual goal (Xue et al., 2010).

5.7.7.5 Contractual agreements (Factor 5)

The fifth factor contributed 2.105% of the total variance explained and variable included were *all involved parties trust each other* (0.650*), all parties trust that terms of contract will be implemented* (0.566) and *the type of the contact is appropriated for the project* (0.391). Contractual agreements and systematic process accounted for similar levels of variance (2.105% and 2.087%, respectively) and were ranked as the final two factors required to deliver a collaborative process. There is a considerable gap between the

variance shared in the first factor (project vision, 29.295%) and these two factors. However, for a project to be delivered successfully, all factors need to be considered carefully. If any factor is missing, the collaboration process can be hindered.

This factor shows the importance of contractual agreements and their contribution to building trust between parties. Managing contractual agreements in a way that increases trust between construction participants is one of the most difficult tasks in the industry. Wong, Cheung, Yiu, and Pang (2008) illustrated that adequate contractual agreements are capable of establishing trust and strengthening relationships that could have a remarkable effect on raising the performance of construction projects. Contractual agreements, through identifying fair obligations and rights, are able to reduce uncertainties and bring comfort and confidence to all affected parties. These documents need to be explainable to all stakeholders and include fair risk allocation in order to have an impact on enhancing the overall performance of a project. Khalfan, McDermott, and Swan (2007) explained that type of contact employed forms the basis of relationships and trust between contracting parties and could have a significant positive influence in increasing the performance of the construction projects. As the adversarial ways of contacting have resulted in many issues, by establishing fair contacts, the construction industry can move away from a blame-culture, increase trust between parties and improve its outcomes (Khalfan et al., 2007).

5.7.7.6 Systematic process (Factor 6)

This factor accounted for 2.087% of the total variance and consisted of four variables that are: *strategic plan of benefit and risk sharing* (0.663), *a systematic way to evaluate performance of process* (0.462), *role and responsibilities are clear* (0.4380) and *clear*

process for conflict resolution (0.391), consequently this factor was labelled as 'systematic process'.

This factor indicates that every construction project needs to have a systematic process to share risks, evaluate performance, solve conflicts and to clarify roles of members responsible for such tasks. Besides setting mutual agreements at the beginning of the projects, planning a systematic way to govern projects to achieve that goal is essential. Construction projects need to have adequate approaches to manage the process and to avoid damaging consequences (Mills, 2001). A systematic process can increase confidence and certainty among involved parties.

5.8 Chapter summary

This chapter presented the data collection and data analysis processes. It commenced with the presentation of the survey design. The use of the survey in the housing sector of the Kurdistan region was explained. Then, the chapter explained the techniques used for analysing those collected data. The process of factor analysis, as the primary data analysis method, was described in detail. The procedure of data analysis resulted in 6 factors as being critical for improving collaboration in both sectors of housing in the Kurdistan region, public and private. The factors will be used in the next chapter to develop a collaborative framework for the housing sector in the region

6 Chapter Six: Framework Development

6.1 Introduction

This chapter uses factors identified from the factor analysis process to develop a framework that aims to implement collaboration effectively in construction projects. In addition to conceptualising the framework using results from the previous chapter, 10 semi-structured interviews were conducted at a senior level with participants from different construction organisations.

The developed framework has two main characteristics; firstly, in order to determine in which stage the factors should be provided, they are distributed over project lifecycle stages. These project lifecycle stages considered in this study are explained in the next section. Secondly, each factor is demonstrated in the form of a set of enabling conditions or tasks. For satisfying each factor, all required conditions under that factor should be met. This allocation is described in a later section. Then, the process of conducting interviews with construction industry experts to validate the framework is outlined. The results of interviews and perception of construction professionals are also discussed.

6.2 Construction project lifecycle stages

Projects in the construction industry, like many other industries, pass through several steps before being delivered to end-users. In this research, the Royal Institute of British Architects (RIBA) 2007 plan of work is utilised to explain project lifecycle stages. The RIBA 2007 plan of work is used because of its international recognition and widespread

use. Additionally, in Kurdistan, there is a significant lack of standards and regulations in the building projects (Shawkat et al., 2018) and, like in many countries in the Middle East, a significant amount of construction projects use protocols similar to British standards (RTI International, 2008). This is due to the close economic relationship between the Middle East and the UK, which has resulted in the dominance of British architects, engineers and project managers (Gerges et al., 2017). Furthermore, the stages explained in the RIBA Plan of Work 2007 are very similar to steps followed in the region. RIBA Architecture (2008) divided the project lifecycle into five main phases: preparation, design, pre-construction, construction and use (Table 6.1). Since this study focuses on delivering the projects, only the first four stages are considered as outlined below.

Table 6-1 RIBA plan of work 2007 adopted from (RIBA Architecture, 2008).

Preparation		Design			Pre-Construction			Construction	
Appraisal	Design Brief	Concept	Design Development	Technical Design	Production Information	Tender Documentation	Tender Action	Mobilisation	Construction to Practical Completion

6.2.1 Preparation

A construction project starts with an idea to cover a need. A plan to improve productive capacity or to add to public services. Different solutions might be proposed before

identifying a suitable option. A feasibility study is undertaken to determine whether the solution can proceed as a project or whether it can be delivered in a realistic way. The project is evaluated in terms of targets, cost, timeline, and available resources. Then, the initial statement of client requirements is established to identify demands and constraints. The client needs to spend adequate time on the early stages to deliver the projects successfully and to reduce variations in later stages of design and construction (Zou, Zhang, & Wang, 2007).

6.2.2 Design

A design professional, usually an architect, develops conceptual design plans for the project. Then, to develop detailed design plans and drawings, various specialist engineers need to be involved in the design team. The team specifies details and obtains clients' approval to proceed with specified information. Later, in the technical design stage, the task is to refine and amplify basic design suggestions by various parties, to develop documents to be used in the construction process (Bennett, 2007). The author added that all major decisions about the entire project are made at the technical design stage. Design team's reports to the client usually set detailed drawings, preliminary quantities of material and refined cost details. Developing accurate plans in the design stage helps participants to be clear about their responsibilities in the later stages of the project lifecycle, specifically in the construction phase. Chan, Scott, and Chan (2004) agreed that designers play a critical role in construction projects from inception to completion. The design stage is complicated; therefore, it is essential to involve all main stakeholders, such as contractors, to work collaboratively to deliver project goals

(Bemelmans et al., 2012). This collaboration will increase practical experience, reduce design changes and smooth the delivery of projects.

6.2.3 Pre-Construction

This stage refers to the selection of organisation that conducts the construction works, the contractor, and the tendering process. Bennett (2007) explained that the tendering process is performed in different ways, such as prequalification tendering, open tendering, invited tender, and negotiation. In prequalification tendering, only qualified contractors are allowed to submit tenders based on experience, competence, financial conditions and firm's legal status. In contrast, in open tendering, all interested firms can submit tenders. After receiving the tenders and evaluating, client teams will decide on electing the prefered bid. Invited tender is another method in which prequalified firms will be invited to submit tenders. Those organisations are invited to offer proposals to conduct the construction process. Then tenders are evaluated in a similar way to the open tendering method. Negotiated tendering can also be used, in which the client invites a single organisation to submit an offer to carry out the work. Usually, the invitation is based on a successful experience between the client and the contractor. If the negotiations were successful, the agreement is reached. Otherwise, a counter- offer can be made or the proposal might be rejected, and another party will be invited (Bennett, 2007).

Is necessary to allow adequate time for the tendering stage and to provide sufficient details. In some cases, in order to gain time for construction works, clients tend to shorten the bid-awarding phase (Iyer & Jha, 2005). This short time in negotiations with

the contractor can result in claims, disputes, delays and cost overruns. A collaborative process between governing parties is essential in the pre-construction stage to ensure that potential contractors are selected carefully.

6.2.4 Construction

The process of appointing a contractor could be extended to the mobilisation stage of the construction phase. Commonly, mobilisation refers to the works carried out after selection of the contactor but before the start of work on site. The process is supervised by the project manager or the construction manager, on behalf of the client. Usually, the project manager will hold an arranged meeting with the contractor to finalise contract-related tasks. Later, the necessary project information will be issued to the contractor, and practical construction works will commence. Site hand over to the contractor will take place as the last stage before the actual commencement of construction works on the site. It is vital at this stage to provide all information required to parties responsible for construction works to avoid delays and underperformance. Harris and McCaffer (2013) described that the main contractor is responsible for the execution of works under the terms of the contract and for delivering client needs. Therefore, it is the responsibility of the principal contractor to consider appropriate ways to use to be in line with the required standards. In addition to the main contactor, many other parties need to be appointed such as subcontractors, specialists and consultants. However, the involvement of those different parties is at different stages; some of them may not even meet each other (Winch, 2010). That is one reason for fragmentation in construction projects. Enhancing a collaborative environment between

those involved parties is crucial to provide steady progress and deliver client needs (Baiden et al., 2006).

6.3 Distribution of collaboration factors over the project lifecycle and enabling conditions

Many authors, in various countries, have explored factors to improve collaborative approaches to working in the construction industry. For instance, Black et al. (2000) in the UK, Lu and Yan (2007) in China, Bidabadi et al. (2015) in Iran and Nursin and Latief (2018) in Indonesia have looked at identifying factors to enhance collaboration methods. However, despite a considerable amount of literature on factors of collaboration, there is still a lack of research on how to deliver such factors and at what stage of the project lifecycle those factors need to be delivered. Therefore, this section will present the distribution of the factors of collaboration over the project lifecycle stages. The purpose of this distribution is to present the factors in a practical way and to be able to identify when they should be provided. It is important to recognise that construction practitioners understand practical tasks more than theoretical explanations. The aim is to provide construction managers with a pragmatic guide to implement the framework. Therefore, to clarify how to provide those factors, each factor is divided into a set of tasks or enabling conditions which must be satisfied to ensure any given specific factors can be delivered. Those enabling conditions stem from the results of different phases of the research. Firstly, the comprehensive review of global literature about construction practices helped in conceptualising tasks that are required to deliver collaboration. Secondly, the literature about the housing sector in

Kurdistan revealed the missing elements that are necessary for this process. Thirdly, the outcomes of analysing the perception of the construction practitioners in the region through factor analysis identified the most essential conditions.

During the implementation of the framework, if the tasks under a factor are undertaken successfully, then that factor will be considered as provided and the process will move onwards to the next factor. In the case of a missing task under factors, the process should reconsider that factor before moving to the next steps. The enabling conditions were further validated during the interview process with construction experts to ensure that the framework is applicable in the housing sector in the Kurdistan region. The details of the distribution of enabling condition under each factor are presented in this section. A later section will outline the validation interviews. Table 6.2 demonstrates the framework factors, factor variance, tasks required to deliver factors and sections of the thesis that explains those tasks. The final framework is shown in Figure 6.2.

Table 6-2 Framework factors and tasks required to deliver those factors

Factor (variance %)	Tasks	Source of the tasks (sections explained)
(1) Project vision (29.29%)	Establish project vision	Factor analysis (5.7.7.1)
	Appoint collaboration champion	Literature review (6.3.1) & interviews (6.5.2)
	Obtain seniors approval to vision	Factor analysis (5.7.7.1)
(2) Behaviour of participants (5.36%)	All parties recognise cultural differences	Factor analysis (5.7.7.2)
	Identify roles and responsibilities	Factor analysis (5.7.7.2)
	Parties agree to provide and to share resource	Factor analysis (5.7.7.2)
(3) Communication (4.233%)	Establish clear communication lines	Factor analysis (5.7.7.3)
	Provide adequate technological resources	Factor analysis (5.7.7.3)
	Assign skilled staff to smart tasks	Factor analysis (5.7.7.3)

(4) Relationship definition (2.862%)	Identify potential partners	Factor analysis (5.7.7.4)
	Identify roles and responsibilities	Factor analysis (5.7.7.4)
(5) Contractual agreements (2.105%)	Prepare contractual documents	Factor analysis (5.7.7.5)
	Ensure all parties trust terms of contracts	Factor analysis (5.7.7.5)
	Sign selected contract terms	Factor analysis (5.7.7.5)
(6) Systematic process (2.087%)	Set risk sharing process	Factor analysis (5.7.7.6)
	Set conflict resolution process	Factor analysis (5.7.7.6)
	Set performance evaluation system	Factor analysis (5.7.7.6)

[Icon made by Vectors Market from www.flaticon.com]

[Icon made by DinosoftLabs from www.flaticon.com]

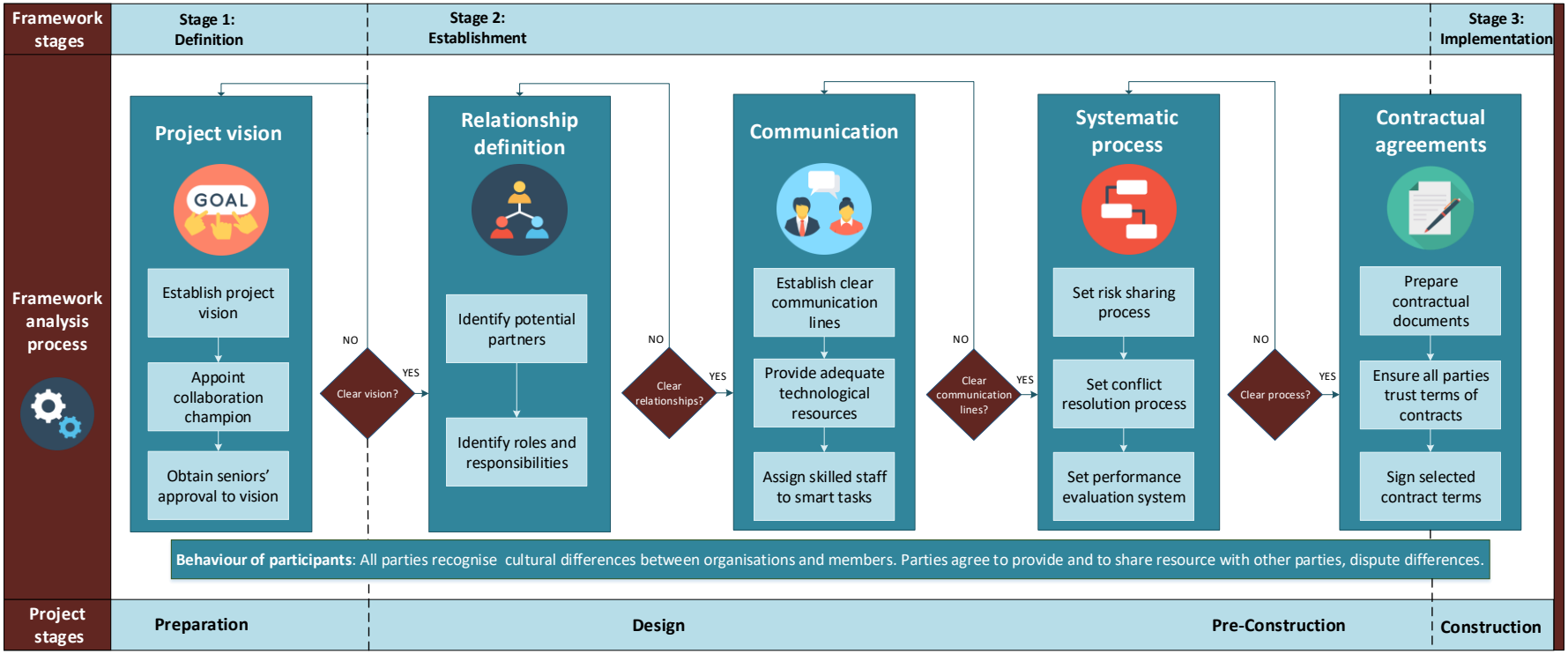


Figure 6-1 The developed framework for improving collaboration

6.3.1 Project vision

The framework commences with establishing a shared project vision at the beginning of the preparation stage. The shared project vision is one of the most critical factors that contribute to the success of a project. The key project stakeholders must agree on a mutual vision for the project at the beginning. The early establishment and maintenance of the project vision are the most significant tasks for senior management (Christenson & Walker, 2004). The authors explained that project vision should have certain characteristics such that it must be understood, motivational, credible and demanding. After agreement on the common vision, the framework suggests that client and contractor agree to appoint a collaboration champion to manage the process. Since involved stakeholders change over the project lifecycle, appointing a collaboration champion from the preparation stage will provide essential continuity throughout the process. The collaboration champion could help in transferring information, duties, and legal obligations between parties. Other authors used proportionate approaches, for examples, to enable partnering researchers have recommended appointing an experienced facilitator to explain the concept of collaborative working and manage the process adequately (Cheng & Li, 2002; Cheng et al., 2000). Similarly, in RIBA Green Overlay (2007), in order to obtain sustainability targets, the client could consider appointing a sustainability champion. Later, the collaboration champion will be responsible for evaluating the process and for checking whether enabling conditions are met at each stage of the project delivery. The first task of the collaboration champion will be obtaining senior management's approval on the vision. To form a collaborative delivery process, top management should agree on the shared vision (Cheng & Li, 2002).

Therefore, to provide the first factor, three conditions must be met: establishing project vision, appointing a collaboration champion, obtaining senior management's approval.

6.3.2 Relationship definition

By the end of the preparation stage, the complexity of construction projects increases rapidly due to the need to involve several parties. Starting from the concept design stage, design teams need many experienced professionals from different areas to undertake the required duties. Additionally, besides the members of the design team, the involvement of practitioners with practical experience on construction works is necessary. Lack of involvement of key participants, such as contractors and subcontractors, has resulted in a lack of practical experience at the design stage (Eriksson, 2010). Subsequently, designs are lacking buildability and clarity that makes it difficult for construction teams to understand intricate details. Therefore, it is important to involve contractors and subcontractors to bring practical experience into the design stage (Chan, Chan, et al., 2004). Consequently, the framework recommends identifying potential partners at the very beginning of the design stage. However, determining stakeholders is not enough to have well-defined relationships. The success of collaborative relationships could only be achieved by establishing clearly defined roles and responsibilities (Koutsikouri et al., 2008). Therefore, after identifying potential partners, the next step will be identifying the roles and responsibilities of those parties.

6.3.3 Communication

The next task is to determine how these stakeholders approach each other and communicate. Establishing communication lines is a necessary step towards enhancing

collaboration. Especially, an agreement between the client and the main contactor to communicate and share information. Black et al. (2000) indicated that clear communication channels between contractors, clients and consultants could minimise problems happening on construction sites. It can facilitate the exchange of contract documents, drawings and specifications. Then, through fast communication, many issues could be dealt with promptly, and delays are reduced (Bidabadi et al., 2015). Various approaches can be used as a means for improving communication, such as scheduled or on-site meetings. The main principle is to have a clear idea of how to approach each other. The next task is to ensure there are adequate technological resources, hardware and software packages, to enable effective communication on construction projects. Technology adoption is essential to achieve a collaborative process in construction projects (Arayici et al., 2011). Technological resources might be simple tools as emails to sharing information through clouds or advanced construction management software. The third task under the communication factor is to appoint skilled staff to deal with that technology. Since many projects face a lack of skilled personnel in the Kurdistan region (Abramzon et al., 2016), it is essential to undertake this task carefully.

6.3.4 Systematic process

After identifying relationships and communication approaches, project stakeholders must agree on a systematic way to deliver the project. It is necessary to decide on a systematic process before awarding contacts and actual starting of work on the construction sites. A systematic process should identify ways to share risks, solve conflicts and evaluate performance between construction parties (Lu & Yan, 2007). The

systematic process in this framework commences by identifying a process for risk-sharing between participants. Meng (2013) insisted lack of risk-sharing methods is the most significant barrier to implementing collaboration. Therefore, construction parties must agree on a risk-sharing process before awarding contacts. The next decisive element of process definition is setting a gain-pain sharing approach. Conflicts exist in all projects; however, having a clear strategy to deal with those disputes could reduce their effects to a minimum (Xue et al., 2010). The last component is to determine a process to evaluate project performance under the supervision of the collaboration champion. It is important to continuously assess performance to ensure the collaboration process is working effectively (Wu et al., 2008). Therefore, to deliver a systematic process, strategies must be set for risk sharing, conflict resolution and performance evaluation.

6.3.5 Contractual agreements

Another crucial factor in the framework is contractual documents, particularly as most of the adversarial relationships in the construction project have resulted from harsh terms in traditional contacts (Khalfan et al., 2007). Construction projects can overcome those issues and implement collaborative principles only by employing the right types of contractual documents (Akintan & Morledge, 2013). Indeed, Hughes et al. (2012) described collaboration as a process that depends on the use of the correct terms of contracts in which everyone understands and respects other personnel's roles and responsibilities. In a collaborative process, contracts should be awarded after involved organisations define relationships, communication approaches and a systematic management process. Contractual documents need to be prepared to include gain- pain

sharing and all other agreed terms between parties. Then, it is important to ensure that all parties trust the terms of the contracts to build a collaborative environment (Khalfan et al., 2007). The last stage before awarding the work will be signing the agreed terms of contacts. This stage should be done before entering the construction stage. However, in many cases, additional services might be required, that need the involvement of new suppliers. Subsequently, additional contractual documents might be required during the construction stage as well. Nevertheless, subsequent contracts should be subject to the same considerations to ensure collaboration.

6.3.6 Behaviour of participants

The behaviour of participants is an essential factor in any project and its importance increase in a complex industry such as construction. The behaviour of people involved acts as an overarching factor; it affects projects from the very beginning to the last stages of project delivery. A major challenge facing adopting collaborative approaches in the construction industry is that it requires a change in behaviour and attitudes of participants (Koraltan & Dikbas, 2002). It is necessary to recognise and respect the cultural and behavioural difference among project practitioners. Despite those differences, involved parties should agree to provide and share resources to achieve a collaborative process. Managing behaviours is vital because collaboration depends very much on individual behaviour (Bresnen & Marshall, 2000a). The behaviour of participants can be labelled as *'the soft factor'* in this framework. Shelbourn et al. (2007) described the behaviour of people as a soft factor that needs to be improved throughout the project lifecycle. In many cases, enabling conditions of soft factors are seen as ambiguous. To clear this confusion and provide a practical guide on how to deliver this

factor, this framework requires two conditions. Firstly, all parties should recognise and respect the cultural differences between organisations and individuals. Many issues that hamper collaboration practices are due to cultural differences of people (Nursin & Latief, 2018). Particularly these differences could affect the way parties share resources with others. Therefore, the second condition is that all parties agree to provide and to share resources with other parties, despite their differences. It is necessary to ensure resource sharing among construction teams (Cheng et al., 2000), because performing some tasks on projects may require resources that belong to different parties.

6.4 The process of conducting the interviews

The final factors determined from factor analysis were used to develop a framework to implement collaboration. Then, 10 interviews are undertaken in order to validate the framework with practitioners of the construction industry. All the interviewees are the professionals that already participated in the first stage of data collection. Where in the first stage of data collection, a questionnaire survey was used to determine the importance of factors of collaboration. At the interview stage, senior professionals of the construction industry are targeted, those that have considerable experience and hold key positions in their organisations. Because only one group of practitioners was required for the interviews, a stratified random sampling technique was adopted.

Fellows and Liu (2015) describe stratified sampling as a non-random sampling technique in which the population occurs in certain strata or groups and the data are collected from specific strata. After selecting a stratum to be surveyed, a simple random sampling technique is adopted to choose participants within the stratum. This is an effective

technique in terms of reducing cost and time as it involves small samples from requested strata only (Saunders, Lewis, & Thornhill, 2009). In the first stage of data collection, the questionnaire survey, participants were divided into four strata based on their experience in the construction industry. These were practitioners with less than 5 years of experience, 6-10 years, 11-15 years, and more than 15 years. In this stage, the targeted group was the fourth stratum comprising professionals with more than 15 years of experience.

It was discovered in the first stage of data collection that the Ministry of Construction and Housing and the Kurdistan Contractors Union are responsible for registering and keeping details of construction stakeholders in Kurdistan. Also, both organisation gave consent to be contacted again in the validation stage and showed support for this research. Furthermore, in the Kurdistan region, construction industry organisations adopt a system to distribute construction practitioners based on their level of experience. Therefore, to identify an adequate sample for interviews, a random sample was selected between active professionals in public or private sectors of housing that have a minimum of 15 years of working experience. A consent form and a participant information sheet were sent to those potential participants, and after they signed and returned the consent form, experts were contacted for conducting the interviews. The participant information sheet and the consent form can be seen can be found in Appendix B and C respectively.

The sample of interviewees included professionals from different construction organisations but all within stratum of professionals of above 15 years of experience. The job type of interviewees is shown in the table below:

Table 6-3 Profile of the interviewees

Type of job	Frequency	Percentage
Project Manager	3	30
Contractor	3	30
Client's Representative	2	20
Designer	2	20
Total	10	100

The interviews were undertaken through Skype with each interview lasting around 30 minutes. The participants were asked a range of questions about the developed framework. Since the framework included a graphical representation of the process, hard copies, in the form of PDF files, of the framework were sent to the participants before the interviews. The file included the framework and primary aspects to be discussed during the interviewees, see Appendix H. These hard copies are necessary to make sure that interviewees had a chance to understand and read the details of the framework. Nevertheless, during the interviews, the framework was explained in detail for interviewees, then a range of prepared questions was asked; an open discussion followed each question. The experts interviewing provided an in-depth understanding of the applicability of the collaborative framework in the construction industry of the Kurdistan region.

The interview questions were designed to discuss four main aspects of the framework. Firstly, the participants were asked to give their general view of the framework and whether the whole process makes sense or not. Secondly, the interviewees were asked

if they agree with the suggested means of framework implementation by appointing a collaboration champion to supervise the process. Thirdly, participants were asked about the expected barriers that framework implementation may face. Finally, participating professionals were given a chance to add any additional recommendation or change that they think is needed. The framework was revised based on experts opinions; the final framework is shown in Figure 6.1.

6.5 Analysis and discussion of the results

The data collected in interviews are processed and analysed using Nvivo 12, which is effective software for analysing interview data (Bazeley & Jackson, 2013). Interview records were transcribed and analysed for identifying common themes. An example of interview transcript and identifying themes can be found in Appendix I. This qualitative process of qualitative analysis resulted in three themes in transcripts, which are benefits, challenges of implementation and recommendations on the framework. See the Nvivo 12 output in Figure 6.5 below. Those identified themes are related to different aspects and tasks in the framework. The outcomes of the data analysis and opinions of experts are discussed below under 4 subsections based on the sequence of the interview questions.

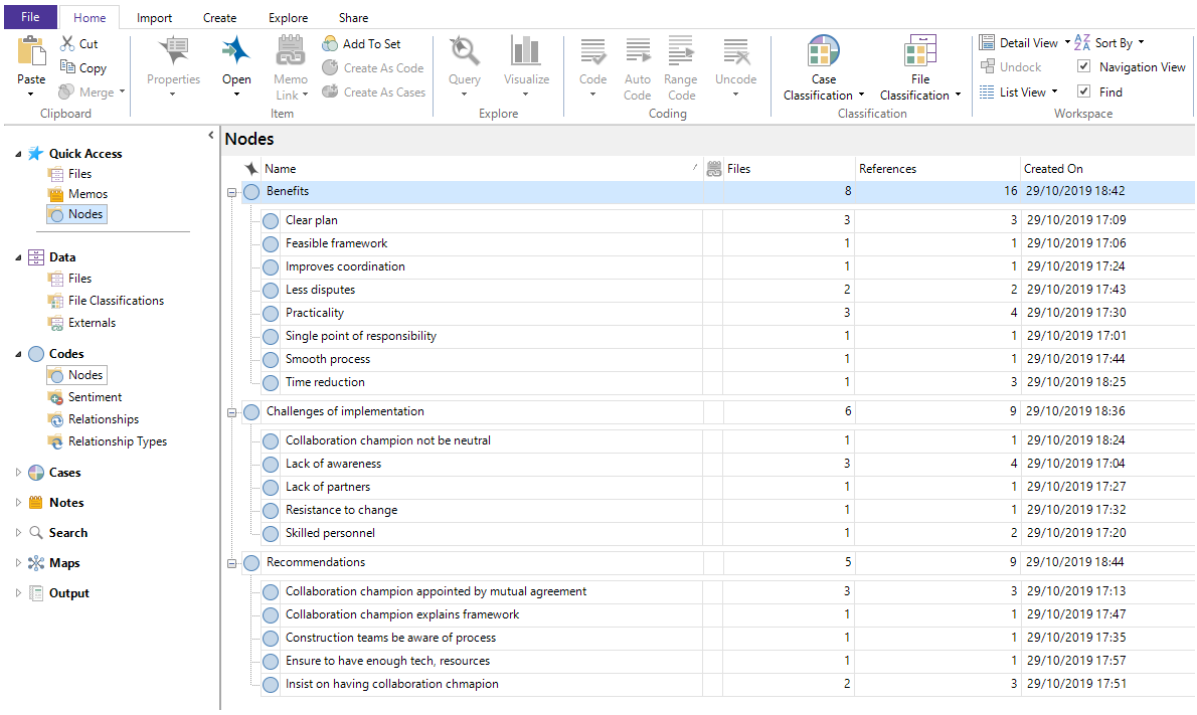


Figure 6-2 Nvivo output for interview analysis

6.5.1 The feasibility and satisfaction with the framework

The first aspect in the interviews was to understand whether experts were satisfied with the framework in general or not. Responses of interviews help in ensuring that the conceptual framework is authentic and reliable (Burke & Gaughran, 2007). The distribution of the tasks over the RIBA plan work was discussed with experts. All the interviewees had a consensus and agreed on the feasibility of the framework. The interviewees agreed that framework consists of a sensible and a clear process that can be implemented, one of the interviewees quoted *'' the swim lane is very clear and designed with adequate process……. it will give a better output if it applied to any project''.* Another participant said *''The framework looks sensible and feasible and includes all needed aspects''.* Professionals also pointed to the practicality of the framework *''the framework is practical, and is not that difficult to implement''*. Since this

collaborative approach is not familiar in Kurdistan, it was necessary to ensure applicability and practicality of the framework in the region (Koraltan & Dikbas, 2002).

6.5.2 Collaboration champion for managing the process

The second aspect discussed with interviewees was appointing a collaboration champion as a means for implementation of the framework. The respondees strongly agreed on appointing collaboration to lead the process. An interviewees stated *''insisting on appointing collaboration champion for managing the process is very important''*. An expert explained that having a collaboration champion appointed mutually between client and contactor will reduce change orders happening on projects, consequently reducing disputes. The interviewees also heightened that appointing a collaboration champion will be beneficial to clarify roles and responsibilities *''as a specific person will hold the responsibility to implement the framework''*. Similarly, another interviewee agreed that appointing collaboration champion will help in defining responsibilities clearly ''*you can see who is responsible for supervising and monitoring the process*''. Collaboration is aided by clarifying roles regarding managing the process (Patel et al., 2012).

Furthermore, it was discussed that appointing collaboration champion can ensure that all factors are delivered *''in my point of view, it does make sense to appointing a collaboration champion for managing the process to make sure and focus on that every factor of the framework is smoothly ongoing according to the scheduled time. Also, this appointing will be a benefit to lead the whole collaboration on its right path''*. A

respondee added to that by providing a smooth project; this appointment could reduce the possibility of delays happening on projects to a minimum.

However, an interviewee described that for this appointment to be effective, senior management should make sure collaboration champion is hired by a mutual agreement between client and contractor and acts as a joint staff of both parties.

6.5.3 Barriers to implementation

Regarding the challenges that framework implementation might face experts referred to several points. When asked about the obstacles this process might face, lack of awareness towards collaboration was the most frequent. For instance, an expert answered *''the lack of awareness of construction industry practitioners of the importance of the role of collaboration in project success''* another one responded *''proper understanding of the key aspects present in the collaborative framework by practitioners in various construction projects because they do not know that much about collaboration''*. Similarly, AlSanad (2015) found that a lack of awareness is the main barrier facing implementing modern construction practices in Kuwait. The author called for an increasing level of awareness of construction stakeholders through training, workshops, and seminars. An interviewee explained that lack of awareness could result in resistance to change because construction practitioners are used to traditional ways of project delivery. *''I think resistance to change always exists when you want to apply something new in construction projects''*. However, the construction industry could overcome this resistance by increasing the awareness of stakeholders toward the benefits of collaboration (Arayici et al., 2011). Similarly, in these interviews, the

participants agreed that enhancing the level of awareness towards the benefits of collaborative practices can reduce resistance to change and increase the number of partners willing to engage in collaborative projects. Therefore, responsible organisations must put effort into increasing the level of awareness in the construction industry in order to overcome the barriers of adopting collaborative processes.

Moreover, the lack of skilled personnel to undertake the tasks of the framework was another barrier from the analysis of the interviews. Since the construction industry in Kurdistan struggles with the availability of skilled staff (Shawkat et al., 2018), it is necessary to ensure there are enough qualified personnel to undertake specific tasks.

6.5.4 Additional recommendations

In the final part of the interviews, participants were given a chance to add additional comments that they have on the collaborative framework. A point raised was to make sure that construction projects are provided with enough technological resources required to perform smart tasks. It is a real challenge to embed technology in collaborative working frameworks in the construction industry (Xue et al., 2010). Especially in developing countries where the construction industry faces poor technological development (Elkhalifa, 2016). Thus, construction stakeholders in Kurdistan region need to make sure construction projects are provided with adequate technological resources. Additionally, a respondent stated that construction teams should be aware of the collaborative framework related responsibilities. It is obvious that the clarity of roles and responsibilities is a primary condition of collaboration (Meng, 2013). Another participant explained that the collaboration champion needs to

explain the process to all involved parties and ensure there is an adequate understanding of the process between parties *''collaboration champion should make sure client and contractor understand tasks and factors within the framework and they know what are their responsibilities''*. Therefore, the collaboration champion must be a professional that has an in-depth understanding of collaborative working and can determine the responsibilities of involved parties. Proposals for implementing the framework in the residential sector are identified in the next section.

6.6 Recommendations for implementing the framework in the Kurdistan region

The results of this project were derived from two stages of surveys in the Kurdistan region: questionnaires and interviews. The primary stage was an industry wide-questionnaire in the Kurdistan region, the results of which are expected to be implemented in the housing sector. However, it is important to acknowledge that the circumstances in which the survey was completed may have differed from one participant to another. Consequently, this might have affected their responses to the questions. Firstly, the questionnaire was presented in the English language, which is not the first language of the population in this area, even though construction practitioners in the region have an appropriate level of English and deal with the majority of documents and writings in English (RTI International, 2008). The available knowledge and information about construction are also in English in Kurdistan. For similar reasons, Fong and Shen (2000) prefered to use English rather than the local language for writing their questionnaire when they explored a new project delivery method for the

construction industry in Hong Kong. Nevertheless, difference in English level between participants might therefore have affected their responses. Secondly, some respondents preferred to answer the questionnaire immediately and hand it back to the researcher. The presence of the researcher and explanations given to respondents while completing the survey might also have affected the responses, although such explanations were given to all participants. Thirdly, the questionnaires were distributed in both hard and soft copies; consequently, 193 hard copies (paper vision) and 34 soft copies (Google forms) were collected. These two administration methods were used to obtain a representative sample for the study. While exploring strategies for conducting surveys, Van Selm and Jankowski (2006) recommended utilising mixed-mode strategy, using both paper-based and online versions of questionnaires, to increase the response rate and to cover a wider population. However, the use of two different formats might also have resulted in different outcomes, as it cannot be guaranteed that completing a survey on paper is exactly the same as completing it online. Although, at all stages of the project the researcher tried to reduce such effects to a minimum in order to apply the outcomes in the region.

The residential construction industry in the Kurdistan region comprises of public and private sectors. Private sector projects could show more flexibility in implementing collaboration than public sector projects. A reason for that is government policies that impose many restrictions on public construction projects. These regulations do not help in enhancing collaboration practices and producing houses that consume less energy. In the public sector, in most cases, contracts are awarded on a lowest-bid basis, which results in selecting unqualified contractors by focusing on reducing cost and sacrificing

quality and other success criteria. Also, in traditional contracting, improving collaboration is restricted; for example, bringing in contractors and subcontractors early in the design stage of the construction process is limited. In the private sector, organisations are not faced with such solid restrictions compared to public projects and, organisations are more likely to adopt new ways of working. Implementing new approaches such as collaboration in a conservative sector needs to be done gradually.

Therefore, to implement this collaborative framework in the Kurdistan region a significant effort needs to be spent. The KRG could demand that new approaches to be applied in public projects by imposing new policies on the construction sector through responsible governmental bodies such as the Ministry of Construction and Housing. The new rules need to make construction organisations obligated to agree on a project vision and to set a mutual goal at the preparation stage of projects. Given that the government is the client and the top management in public project, to impose new rules governmental bodies must show full support. The client and contractors need to be clear about project vision toward achieving business targets before selecting an appropriate project delivery method. The KRG must make sure both client and contractor are obliged to appoint a collaboration champion to manage the process. This can also be inspected through quality control teams of the Ministry of Planning, which are responsible for supervising the construction sector (public and private) and ensuring the quality of products.

The second factor in the framework is relationship definition, which needs to be ensured at the beginning of the design stage. It is essential that all involved parties understand and define relationships collaboratively before awarding contracts (Shelbourn et al.,

2007). This can be achieved by involving contractors at an early stage and by defining relationships between involved parties. In the Kurdistan region, the majority of the construction projects are performed using Desing-Bid-Build project delivery method. Responsible organisations, Ministry of Construction and Housing in the public sector and Kurdistan Board of Investment in the private sector, enter a contract with design companies or architects to prepare fully detailed designs. In many cases, those designs are prepared by foreign companies outside the Kurdistan region, particularly in large residential complexes which are the most common type of construction in the region. Later, the developed design is made available in competitive bidding for interested parties, and contractors are selected based on the lowest-bid principles. This approach restricts the early involvement of contractors and subcontractors. Therefore, the KRG needs to impose regulations in the housing sector to change this delivery method. They need to ensure that contractor and subcontractor are selected and involved in preparing design details. The new rules should be legislated by the Ministry of Planning and forced by the Mistry of Construction and Housing.

The next factor in the framework sequence is to make sure that communication lines are open and clear between parties. To clarify communication lines, KRG should overcome some shortcomings such as lack of technological resources and a clear lack of skilled staff (Abramzon et al., 2016). In order to overcome the lack of skilled workers, the KRG could undertake two steps. Firstly, since a vast number of unskilled labour from neighbouring countries work in the region, the KRG needs to restrict importing foreign workers only to skilled people. Then, local construction workers need to be provided with the necessary training and courses to raise their level of awareness towards

modern construction practices. This process will increase human resources and facilitate implementing collaborative methods of working.

Besides selecting the right organisations to carry out the works and clarifying communication lines between them, to implement a project successfully, the KRG needs to ensure that involved parties agree on a systematic way to deliver projects. Such systematic planning should clarify steps to solve disputes, to evaluate project performance and to share risks. This enhancement could only be achieved through strategic planning and the formation of new policies. The KRG needs to impose regulations to ensure this systematic process is defined before awarding contracts.

Later, through contractual agreements, as a legally-binding stage, duties can be transferred to the identified organisations that meet requirements. However, contractual agreements also need to be revised and improved in order to change the adversarial construction sector into a collaborative one. For example, at the bid awarding stage, the KRG can ensure that cost considerations focus on lifecycle costs, not simply the lowest initial cost. In an attempt to enable a collaborative approach in the Turkish construction sector Koraltan and Dikbas (2002) suggested that contractor selection should be based on the most economically beneficial offer, not the lowest bid. Since the lowest bid is not always the most economical option, collaboration has significant advantages related to cost reduction, this can open a way to move away from the traditional way of contacting. This involvement from the government will help the construction industry to improve construction practices and move away from the adversarial routes (Bekr, 2015).

Construction practitioners in the Kurdistan region are used to traditional ways of project delivery; consequently, they behave according to those adversarial relationships. In order to change participant behaviour toward integrated approaches and spreading the culture of collaboration, a considerable effort needs to be expended. In this process, research centres and universities could help government departments in increasing awareness toward collaborative approaches and in providing training courses for practitioners. Organising seminars and introductory workshops can be used as an effective tool for this change. For instance, in 2017, the Ministry of Construction and Housing in partnership with Salahaddin University held its first forum to explore and adopt new technologies to the construction sector in the Kurdistan region (MOCAH, 2017). More comprehensive forums and presentations can be organised to explain the benefits of collaboration and the effects of collaboration on improving construction industry products that could encourage stakeholders to implement collaborative approaches. Later on, workshops and seminars could aim to create a sufficient implementation system of collaboration. For example, Arayici et al. (2011) described that major benefits can be gained from presentations about the implementation of collaboration and technologies in construction projects such as a rapid increase of awareness. The authors added that resistance to change decreases as practitioners realise the advantages of a new approach.

Through implementing collaboration in the public sector, construction companies will be obligated to use such approaches. This step can make those organisations realise the advantages of collaborative working and increase their interest in applying such methods of working in the private sector. Cheng et al. (2000) presented a case study

after several companies raised interest in collaborative working, to overcome severe future market challenges, and signed a partnering agreement. The companies cooperated in previous years and completed some projects together but all of them with no partnering experience. After the agreement was signed, companies hired a facilitator with considerable experience in collaborative approaches. The facilitator formed a team consisting of a senior member of each company. The facilitator expanded the concepts of collaborative working to the team and with the support from top management successful partnering was formed. Since construction projects face similar problems in developing countries (Sweis et al., 2008). Proportionate arrangements can be developed between construction organisations in the Kurdistan region. Actually, in Kurdistan, a considerable number of international organisations exist that have experience in collaborative approaches of working. KRG could benefit from their experience in legislating and imposing new rules in the construction industry.

6.7 Chapter summary

This chapter presented the final framework in the form of factors of collaboration to improve construction practices. Factors of collaboration are distributed over the project lifecycle stages, and each factor is divided into a set of tasks required to enable that specific factor. The RIBA plan of work was utilised to identify project lifecycle stages. The framework suggests appointing a collaboration champion to manage the process. Furthermore, to implement collaboration successfully, involved stakeholders in the construction industry need to work together to increase awareness of practitioners.

The developed framework was the primary aim of the project, and contains the outcome of all project phases. Various methods were used to achieve the project aim, such as a review of the global literature, questionnaires, and interviews. The questionnaire was the main method of data collection, and most of the outcomes are based on the analysis of the questionnaire data. The questionnaire data were collected using cluster sampling. It was found to be impractical to stick to the idea of random sampling for the purpose of this study. The population of the study was distributed across the three cities of the Kurdistan region; Erbil, Dohuk and Sulaymaniyah. Travelling to all these cities would have involved significant cost and time. Also, in Kurdistan, many construction organisations do not have access to the internet, or have only limited access. Cluster sampling is an effective way to overcome those practicality issues (Denscombe, 2014), and it has found to be suitable for use in the construction industry (Tanko & Anigbogu, 2012). Therefore, cluster sampling was adopted. Based on the data provided by the Kurdistan Contractors Union, selected organisations were contacted. Selected clusters, similar to the population, included participants from different professions such as project managers, designers, contractors and clients. Nevertheless, using a non-random technique might mean that some members of the population did not have a chance to be selected for the study. This can be seen as a limitation.

The questionnaire was distributed in paper-based and online versions (Google forms) to obtain a representative sample. Combining these two methods has been suggested as an effective way of achieving a representative sample (Van Selm & Jankowski, 2006). However, adopting different methods of questionnaire administration might mean that

participants perceive the survey differently. Consequently, using one method might result in more accurate outcomes.

Additionally, , the survey was written in English, given that professionals in the region have a good level of English (RTI International, 2008), and given that English, as a second language, has been adopted in construction industry surveys (Fong & Shen, 2000). It can still be said that English is not the first language in Kurdistan, and this may have affected the results. However, during interaction with the researcher, the participants did not have any difficulty in understanding the questions. Additionally, none of the participants raised any issue regarding the use of the English language. Therefore, the use of the English language was appropriate for the survey.

The choices made for the data collection process resulted in the collection of 227 questionnaires across the region and a response rate of 30.2%, which are considered positive numbers in the construction industry. Researchers have used smaller sample sizes in similar research on construction projects, including Meng (2012) and Cheng and Li (2002). Researchers have also obtained lower response rates, for instance, 26.7% by Black et al. (2000) and 25% by Iyer and Jha (2005). Therefore, it can be stated that an adequate sample was collected in this study, and that the data collection process used in this study is valid.

Various methods were used to analyse these collected data. Kruskal-Wallis test was used to see if there is any difference between perceptions of different groups of participants about elements of collaboration. The test revealed the perceptions of practitioners remain the same about the majority of the questions, regardless of their job type and their experience in the construction industry. Kruskal-Wallis test was useful to

understand that construction practitioners at different levels of the industry rate elements of collaborative working similarly, and high.

Additionally, factor analysis was a helpful technique used to extract the most important factors of collaboration from 23 questions on the questionnaire. Factor analysis was found effective in identifying the underlying relations between questions and categorising those questions under six factors. Factor analysis was also found to be a suitable method for determining factors of collaborative working and procurement routes in the construction industry by different authors Chan, Chan, et al. (2004) and Chan et al. (2001).

The outcomes of the factor analysis were used to develop a framework, presented in section 6.3, to improve collaborative working and reduce the performance gap. Later, the framework was validated by interviewing a senior group of construction professionals. 10 professionals were interviewed with an experience of more than 15 years through Skype. It could have been more effective to meet those professionals face to face and discuss the outcomes of the project with them. However, visiting Kurdistan for a third time in the duration of the PhD, after the first two visits for pilot studies and main questionnaire, was not feasible, considering money and time. Therefore, online interviews were used which was found to be an adequate way to validate the framework. Those inteviews were necessary to ensure the applicability and suitability of the developed framework for the housing sector in Kurdistan.

Various methods used in different phases of this PhD project can indicate the results of the project are reliable. However, it needs to be acknowledged that the results were based on the opinion of professionals and there is no guarantee that they were

completely objective when answering the survey. Furthermore, although the Kurdistan region can represent many other countries at a similar stage of development, these results are limited to the construction industry in Kurdistan.

7 Chapter Seven: Conclusions and Recommendations

7.1 Introduction

This chapter presents the final conclusions of the study. The next section will describe how the research objectives where accomplished. Then, the contribution to knowledge to answer identified research gaps is explained. Later sections present limitations and recommendations for further research.

7.2 Conclusions

The principal aim of this study was to improve collaboration in order to minimise the performance gap in residential projects in the Kurdistan region. It began with an exploration of global literature on performance gap issues and the contribution collaboration makes to minimising this gap. Issues relating to the performance gap and lack of collaboration were then investigated in relation to the Kurdistan region. The process of investigating the housing sector in Kurdistan involved a review of literature on the construction industry, a questionnaire, and interviews with experts. The main data collection technique was an industry-wide questionnaire administered to participants working in the housing sector in the Kurdistan region (see section 5.4). The data collected through the questionnaire were analysed using factor analysis. This resulted in the following six factors being identified as necessary to ensure a collaborative process: project vision, participant behaviour, communication,

relationship definition, contractual agreements, and systematic process. The process of factor analysis is presented in section 5.7.

These factors were then used to develop a collaborative framework for the housing sector. The process of developing the framework is presented in chapter six, and the final framework is shown in section 6.3. Interviews with construction experts were then conducted to validate the framework. The interview process was needed to ensure the applicability and feasibility of the framework in the Kurdistan region. The interview process is presented in section 6.4. Section 6.6 presents recommendations for implementing the developed framework in the Kurdistan region.

This process was based on a set of objectives that were developed to deliver the main aim of the project. The remainder of this section reviews how these objectives were accomplished in relation to the research findings.

Objective I: To explore the performance gap in residential building projects and causes of the performance gap, then demonstrate it in the context of the Kurdistan region.

The literature explains that residential buildings consume a significant amount of energy and that consumption is expected to increase in the future, mainly due to the exponential increase in population. However, despite the fact that buildings consume a large amount of energy, the review revealed that there is a significant gap between expected and achieved performance. Residential buildings are not performing as expected in terms of using energy. Researchers have pointed to many issues and deficiencies in projects delivery practices that cause this gap, such as design changes, incorrect assumptions that are made in the design stage, lack of awareness of energy

specifications and poor practices during the construction stage. Section 2.2 and 2.3 explain the performance gap and the reasons for this gap in detail.

In the Kurdistan region, the review of literature about residential projects reveals that those projects are a principal contributor to economic developments. However, despite their importance, residential buildings are consuming a considerable amount of energy and the performance is far from anticipated. The sector faces many challenges, such as lack of regulations and a considerable lack of awareness towards energy consumption. Section 3.5 and 3.6 demonstrate the performance of projects in the housing sector in the Kurdistan region.

Objective II: To investigate the effects of collaboration in minimising the performance gap in residential building projects.

Review of the literature showed that a lack of collaboration in the construction industry is an important reason for the performance gap. The analysis of the literature review insisted that improving collaboration is essential in construction projects to overcome this underperformance case. The literature highlighted that traditional approaches for project delivery, which lack collaboration, have resulted in many deficiencies in project performance regarding energy consumption. There is a clear lack of communication between project delivery stages, particularly design and construction. The review suggests construction practitioners are used to a blame culture and adversarial relationships and in order to change that significant effort that needs to be spent.

The limited literature on construction projects in the Kurdistan region also highlighted the lack of collaboration in the housing sector which has resulted in underperformance

of projects. The analysis of literature indicated that project delivery approaches do not encourage early involvement of key stakeholders such as contractors and subcontractors, and practitioners lack awareness of collaborative practices. Those obstacles hinder reducing the consumed energy in the housing sector.

In addition to the literature review, the questionnaire survey also contributed to achieving this objective. The survey was seeking to identify factors of collaboration that can minimise the performance gap. Additionally, in the first stage of the survey (pilot studies), participants were given a chance to add any factor that they think is necessary to overcome the problem of energy consumption in the housing sector.

Objective III: To identify the potential factors that improve collaboration and verify such factors in the context of Kurdistan residential projects.

A considerable literature exists about factors of collaboration. Therefore, in order to accomplish this objective, an in-depth review was undertaken. Most closely related articles from 2000 to 2019 were reviewed, and the most frequently mentioned factors were determined. This process resulted in identifying 11 potential factors from 35 reviewed articles; details are presented in section 2.8.

Later, in pilot studies, participants were asked if those factors are necessary for Kurdistan or if there are any missing factor that needs to be added. In this stage, the type of contract was added to other factors that were identified from the literature. All the factors were used to develop a questionnaire that aimed at finding local factors of collaboration in Kurdistan.

Objective IV: To determine the level of importance of factors in residential projects in Kurdistan.

An industry-wide questionnaire was used in the Kurdistan region to glean local information and perceptions of construction practitioners regarding the importance of factors for delivering an effective process of collaboration.

The identified factors from the literature were used to develop a questionnaire instrument. The main part of the instrument consisted of 23 questions, asking participants to rate the importance of those items on a five-point Likert scale. The questionnaire instrument was distributed over the construction practitioners. Finally, 227 questionnaires were collected from professionals performing various roles in the housing sector in the Kurdistan region such as clients, project managers, contractors, subcontractors and designers. See section 5.4 and 5.5.

Objective V: To identify the final critical factors from factor analysis.

The collected data were analysed using factor analysis, section 5.7. Six factors were extracted through performing exploratory factor analysis on 23 variables developed from a synthesis of the literature and perception of practitioners in the construction sector. The critical factors initiated in this investigation were: project vision, the behaviour of participants, communication, relationship definition, contractual agreements and systematic process.

Objective VI: To develop and validate a framework to improve collaboration in residential projects in Kurdistan.

The final factors were used to develop a framework that aims at enhancing collaborative practices. Each factor is explained in the form of a set of conditions, in order to deliver that specific factor those conditions must be met. Additionally, those enabling conditions were distributed over the project life cycle in order to be able to determine at which stage factors need to be provided. Later, 10 interviews were conducted with senior construction professionals in Kurdistan. The interviews were used to validate the developed framework and ensure its applicability in the region. The details of this procedure are in chapter 6.

To summarize, in order to enable collaboration in construction the KRG needs to impose new policies on the construction sector through responsible organisations. It is essential to impose new policies at bid awarding stage and contractor selection. In this process, the KRG could benefit from the experience of international companies that work in the region in legislating and implementing new rules. Since practitioners of the industry are used to adversarial relationships, it was suggested that KRG could work with universities and research centres to broaden awareness toward collaborative approaches by organising training and workshops. To date, construction projects use traditional approaches and the industry is fragmented; however, there are opportunities to improve construction practices and move the industry toward collaborative working in the Kurdistan region.

7.3 Contribution to knowledge

After the review of past literature, it was discovered that research had investigated factors of collaboration in the construction industry. However, there still is a need to develop ways on how to deliver such factors, especially in developing countries. Additionally, there is also an apparent lack of research on establishing factors of collaboration could reduce energy consumption in the residential sector. Therefore, building on the existing literature about collaborative working and building performance in the construction industry, this study provides greater insight into the effects of collaboration in reducing energy consumption in residential projects. The study adds to knowledge about factors of collaboration in the construction industry. By using several techniques of review of literature, an empirical questionnaire survey and interviews with experts, the study provides a framework to improve collaboration in the industry based on factors of collaboration. Additionally, the developed framework determines the required tasks in each stage of project delivery to ensure collaboration.

This is the first research to explore reasons for high energy consumption in the residential sector in the Kurdistan. Despite the evident importance of the housing sector of the region, no research was found that looks at reasons for the energy gap in the Kurdistan region. Similarly, there was an absence of previous research that investigate improving collaboration in the construction industry of the Kurdistan region. This research identified a set of local factors of collaboration specific to the construction sector in the Kurdistan region. Also, in the framework, it demonstrates the required conditions to provide construction projects with a collaborative process in the region.

Therefore, the study offers a great understanding for academics and practitioners in the construction industry in the Kurdistan region and significantly contributes to knowledge about the construction industry.

7.4 Limitations

Like any other study, this research has its limitations. It would have been better to validate the framework in a real project and examine it practically. Practical validation would have given a great understanding of the outcomes of the implementation of the developed framework. However, due to constraints of time and cost, it was impossible to test the framework practically within the PhD project.

Additionally, it not possible to guarantee that respondents of surveys have not been subjective in their responses. Also, using a non-random sampling technique for data collection and different methods of questionnaire administration can be seen as limitations. The study is based on the practitioners view in the construction industry in the Kurdistan region. Therefore, the findings are limited to the context of that region. Although construction projects face similar problems in developing countries, in order to generalise results in a broader context, different procurement routes, governmental policies and contact types used need to be considered.

7.5 Recommendations for further research

Considering that in the Kurdistan region scarce literature exists on construction projects in general, and collaboration practices in particular, further research is necessary. The KRG needs to build partnerships with academic centres and universities to investigate

the situation and to change the adversarial sector to a more collaborative environment and to produce better performing buildings. Several research topics can be suggested for future, outlined below:

1. There is a considerable gap towards identifying the energy consumed in buildings. Research to empirically determine the amount of energy consumed in the domestic and non-domestic buildings in the Kurdistan region is very necessary.
2. Future research could use factors found in this research and develop systematic approaches to implement each factor individually; for example, it could establish systematic ways to improve communication lines in construction projects in the region.
3. Researchers also need to look at the difference between collaboration practices in the private and public construction sectors. How each sector can implement collaboration and increase adoption of collaborative approaches in a systematic way.
4. Investigating differences in collaborative working between the various levels of supply chains. For instance, the level of collaborative relationships between clients and contractors should be studied. Similarly, relationships among contractors and their subcontractors are necessary to be understood and improved.
5. Further study can also use specific construction projects as case studies to practically test the framework developed in this research. Based on the in-depth implication, improvements can be made.

6. Researchers can investigate how the adoption of smart technologies can improve collaboration. Studying level of awareness toward technology-based construction in the region is needed to enhance integration in construction.

7.6 Chapter summary

This chapter of the thesis presented final conclusions about the results and explained contribution to knowledge to fill research gaps. Research limitations were also outlined. The final section provided some recommendations for future research.

References

Abramzon, S., Burger, N., Glick, P., Kumar, K., Montemayor, C. K., Mejia Gonzalez, N. J., Setodji, C. M. (2016). Calculating the Gross Regional Product of the Kurdistan Region-Iraq: Rand Corporation Santa Monica, CA.

AECOM. (2015). Middle East Handbook Property and Construction Handbook 2015 Edition.

AECOM. (2016). Middle East Handbook Property and Construction Handbook 2016 Edition.

Ahmad, S. B. S., Svalestuen, F., Andersen, B., & Torp, O. (2016). A Review of Performance Measurement for Successful Concurrent Construction. Procedia - Social and Behavioral Sciences, 226, 447-454. doi: 10.1016/j.sbspro.2016.06.210

AIA National. (2007). Integrated project delivery: A guide. American Institute of Architects, California.

Akintan, O. A., & Morledge, R. (2013). Improving the Collaboration between Main Contractors and Subcontractors within Traditional Construction Procurement. Journal of Construction Engineering, 2013, 1-11. doi: 10.1155/2013/281236

Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). A survey of supply chain collaboration and management in the UK construction industry. European Journal of Purchasing & Supply Management, 6(3-4), 159-168.

Akram, O. K., Ismail, S., & Franco, D. J. (2016). The Significant of Urban Form of Erbil City, Iraq. International Journal of Engineering Technology, Management and Applied Sciences, 4(2), 96-101.

AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. Procedia Engineering, 118, 969-983.

Amin, R. M., & Al-Din, S. S. M. (2019). Evaluation of the Sustainable Aspects In Housing Sector To Overcome Housing Stress In Northern Iraq. International Journal of Contemporary Urban Affairs, 3(1), 67-81.

Antoni, C. (2005). Management by objectives–an effective tool for teamwork? The International Journal of Human Resource Management, 16(2), 174-184.

Arayici, Y., Coates, P., Koskela, L., Kagioglou, M., Usher, C., & O'reilly, K. (2011). Technology adoption in the BIM implementation for lean architectural practice. Automation in Construction, 20(2), 189-195.

Arditi, D., & Gunaydin, H. M. (1998). Factors that affect process quality in the life cycle of building projects. Journal of Construction Engineering and Management, 124(3), 194-203.

Austin, B., & Charlson, A. (2013). The performance gap: causes and solutions. Arup, London.

Azhar, Carlton, W. A., Olsen, D., & Ahmad, I. (2011). Building information modeling for sustainable design and LEED® rating analysis. Automation in Construction, 20(2), 217-224.

Azhar, Kang, Y., & Ahmad, I. U. (2014). Factors Influencing Integrated Project Delivery in Publicly Owned Construction Projects: An Information Modelling Perspective. Procedia Engineering, 77, 213-221. doi: 10.1016/j.proeng.2014.07.019

Baiden, B. K., Price, A. D. F., & Dainty, A. R. J. (2006). The extent of team integration within construction projects. International Journal of Project Management, 24(1), 13-23. doi: 10.1016/j.ijproman.2005.05.001

Barnard, M. (2013). Not The Iraq You Know: But the Iraq that Could Be. Harvard International Review, 34(4), 32.

Barreiro, P. L., & Albandoz, J. P. (2001). Population and sample. Sampling techniques. Management mathematics for European schools, 1(1), 1-18.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. The Qualitative Report, 13(4), 544-559.

Bayramoglu, S. (2001). Partnering in construction: Improvement through integration and collaboration. Leadership and Management in Engineering, 1(3), 39-43.

Bazeley, P., & Jackson, K. (2013). Qualitative data analysis with NVivo: SAGE publications limited.

Bekr, G. A. (2015). Causes of delay in public construction projects in Iraq. Jordan Journal of Civil Engineering, 159(3091), 1-14.

Bell, J. (2014). Doing Your Research Project: A guide for first-time researchers: McGraw-Hill Education (UK).

Bemelmans, J., Voordijk, H., & Vos, B. (2012). Supplier-contractor collaboration in the construction industry: A taxonomic approach to the literature of the 2000-2009 decade. Engineering, Construction and Architectural Management, 19(4), 342-368.

Bennett, F. L. (2007). The management of construction: A project lifecycle approach: Routledge.

Berg, B. L. (2001). Qualitative research methods for the social sciences. California State University, Long Beach: Allyn and Bacon.

Bernard, H. R. (2017). Research methods in anthropology: Qualitative and quantitative approaches: Rowman & Littlefield.

Bidabadi, Z. T., Hosseinalipour, M., Hamidizadeh, M. R., & Mohebifar, A. (2016). Supply chain collaboration within the Iranian construction industry. Organization, Technology and Management in Construction: an International Journal, 8(1), 1437-1445.

Bidabadi, Z. T., Hosseinalipour, M., Hamidizadeh, M. R., Mohebifar, A. H., & Dorostkar, O. (2015). Collaboration: The key to success in construction supply chain. IJISET - International Journal of Innovative Science, Engineering & Technology.

Black, C., Akintoye, A., & Fitzgerald, E. (2000). An analysis of success factors and benefits of partnering in construction. International Journal of Project Management, 18(6), 423-434.

Blair, J., Czaja, R. F., & Blair, E. A. (1996). Designing surveys: A guide to decisions and procedures: Sage Publications.

BMI Research. (2014). Iraqi Kurdistan: Construction Over Energy. from http://www.bmiresearch.com/articles/iraqi-kurdistan-construction-over-energy

Boone, H. N., & Boone, D. A. (2012). Analyzing likert data. Journal of Extension, 50(2), 1-5.

Brace, I. (2018). Questionnaire design: How to plan, structure and write survey material for effective market research: Kogan Page Publishers.

Bresnen, M., & Marshall, N. (2000a). Building partnerships: case studies of client–contractor collaboration in the UK construction industry. Construction Management & Economics, 18(7), 819-832.

Bresnen, M., & Marshall, N. (2000b). Motivation, commitment and the use of incentives in partnerships and alliances. Construction Management & Economics, 18(5), 587-598.

Bresnen, M., & Marshall, N. (2000c). Partnering in construction: a critical review of issues, problems and dilemmas. Construction Management & Economics, 18(2), 229-237.

Brown, J. D. (2009a). Choosing the right type of rotation in PCA and EFA. JALT Testing & Evaluation SIG newsletter, 13(3), 20-25.

Brown, J. D. (2009b). Principal components analysis and exploratory factor analysis &ndash Definitions, differences, and choices. Statistics, 13(1).

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of Building Information Modelling (BIM). International Journal of Project Management, 31(7), 971-980. doi: 10.1016/j.ijproman.2012.12.001

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? Qualitative Research, 6(1), 97-113.

Burke, S., & Gaughran, W. (2007). Developing a framework for sustainability management in engineering SMEs. Robotics and Computer-Integrated Manufacturing, 23(6), 696-703.

Burrell, G., & Morgan, G. (1979). Sociological paradigms and organisational analysis: Elements of the sociology of corporate life: Ashgate.

Cao, D., Wang, G., Li, H., Skitmore, M., Huang, T., & Zhang, W. (2015). Practices and effectiveness of building information modelling in construction projects in China. Automation in Construction, 49, 113-122. doi: 10.1016/j.autcon.2014.10.014

Cataldo, M., Wagstrom, P. A., Herbsleb, J. D., & Carley, K. M. (2006). Identification of coordination requirements: implications for the Design of collaboration and awareness tools. Paper presented at the Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work, New York.

Chan, A. P., Chan, D. W., Chiang, Y. H., Tang, B.-S., Chan, E. H., & Ho, K. S. (2004). Exploring critical success factors for partnering in construction projects. Journal of Construction Engineering and Management, 130(2), 188-198.

Chan, A. P., Chan, D. W., & Ho, K. S. (2003). Partnering in construction: critical study of problems for implementation. Journal of Management in Engineering, 19(3), 126-135.

Chan, A. P., Ho, D. C., & Tam, C. (2001). Design and build project success factors: multivariate analysis. Journal of Construction Engineering and Management, 127(2), 93-100.

Chan, A. P., Scott, D., & Chan, A. P. (2004). Factors affecting the success of a construction project. Journal of Construction Engineering and Management, 130(1), 153-155.

Charmaz, K., & Belgrave, L. L. (2007). Grounded theory. The Blackwell encyclopedia of sociology.

Chastas, P., Theodosiou, T., & Bikas, D. (2016). Embodied energy in residential buildings-towards the nearly zero energy building: A literature review. Building and Environment, 105, 267-282.

Cheng, E. W., & Li, H. (2001). Development of a conceptual model of construction partnering. Engineering, Construction and Architectural Management, 8(4), 292-303.

Cheng, E. W., & Li, H. (2002). Construction partnering process and associated critical success factors: quantitative investigation. Journal of Management in Engineering, 18(4), 194-202.

Cheng, E. W., Li, H., & Love, P. (2000). Establishment of critical success factors for construction partnering. Journal of Management in Engineering, 16(2), 84-92.

Chiocchio, F., Forgues, D., Paradis, D., & Iordanova, I. (2011). Teamwork in integrated design projects: Understanding the effects of trust, conflict, and collaboration on performance. Project Management Journal, 42(6), 78-91. doi: 10.1002/pmj.20268

Christenson, D., & Walker, D. H. (2004). Understanding the role of “vision” in project success. Project Management Journal, 35(3), 39-52.

Clarke, N. (2012). Leadership in projects: what we know from the literature and new insights. Team Performance Management: An International Journal, 18(3/4), 128-148.

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. Practical Assessment, Research & Evaluation, 10(7), 1-9.

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches: Sage publications.

Creswell, J. W., & Poth, C. N. (2017). Qualitative inquiry and research design: Choosing among five approaches: Sage publications.

Creswell, J. W., & Tashakkori, A. (2007). Differing perspectives on mixed methods research: Sage Publications Sage CA: Los Angeles, CA.

Czaja, R. F., & Blair, J. (2005). Designing surveys: A guide to decisions and procedures: Sage Publications.

Dar-Mousa, R. N., & Makhamreh, Z. (2019). Analysis of the pattern of energy consumptions and its impact on urban environmental sustainability in Jordan: Amman City as a case study. Energy, Sustainability and Society, 9(1), 15.

de Wilde, P. (2014). The gap between predicted and measured energy performance of buildings: A framework for investigation. Automation in Construction, 41, 40-49. doi: 10.1016/j.autcon.2014.02.009

Denscombe, M. (2014). The good research guide: for small-scale social research projects: McGraw-Hill Education (UK).

Dikmen, I., Birgonul, M. T., Ozorhon, B., & Eren, K. (2008a). Critical success factors for partnering in the Turkish construction industry. Paper presented at the Conference Proceedings of the 24th Annual ARCOM Conference held in Cardiff.

Dikmen, I., Birgonul, M. T., Ozorhon, B., & Eren, K. (2008b). Critical success factors for partnering in the Turkish construction industry. Paper presented at the Procs 24th Annual ARCOM Conference, Cardiff.

Directive, C. (2010). Directive 2010/75/EU of the European Parliament and of the Council. Off. J. Eur. Union L, 334, 17-119.

Edmonds, G. A. (1979). The construction industry in developing countries. Int'l Lab. Rev., 118, 355.

Elkhalifa, A. (2016). The magnitude of barriers facing the development of the construction and building materials industries in developing countries, with special reference to Sudan in Africa. Habitat International, 54, 189-198.

Erdogan, B., Anumba, C. J., Bouchlaghem, D., & Nielsen, Y. (2008). Collaboration environments for construction: Implementation case studies. Journal of Management in Engineering, 24(4), 234-244.

Eriksson. (2010). Improving construction supply chain collaboration and performance: a lean construction pilot project. Supply Chain Management: An International Journal, 15(5), 394-403.

Eriksson, & Westerberg, M. (2011). Effects of cooperative procurement procedures on construction project performance: A conceptual framework. International Journal of Project Management, 29(2), 197-208.

Faris, H. M. A. (2015). Causes of delays in construction projects in Kurdistan region of Iraq. (MSc Dissertation), University of Portsmouth. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=ir00242a&AN=upp.18873&site=eds-live

http://eprints.port.ac.uk/18873/1/UP750549.pdf

http://eprints.port.ac.uk/18873/ Available from EBSCOhost ir00242a database.

Fedoruk, L. E., Cole, R. J., Robinson, J. B., & Cayuela, A. (2015). Learning from failure: understanding the anticipated–achieved building energy performance gap. Building Research & Information, 43(6), 750-763. doi: 10.1080/09613218.2015.1036227

Fellows, R., & Liu, A. (2015). Research methods for construction: John Wiley & Sons.

Field, A. (2013). Discovering statistics using IBM SPSS statistics: sage.

Floyd, F. J., & Widaman, K. F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. Psychological Assessment, 7(3), 286.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. Qualitative inquiry, 12(2), 219-245.

Fong, P. S.-w., & Shen, Q. (2000). Is the Hong Kong construction industry ready for value management? International Journal of Project Management, 18(5), 317-326.

Foucquier, A., Robert, S., Suard, F., Stéphan, L., & Jay, A. (2013). State of the art in building modelling and energy performances prediction: A review. Renewable and Sustainable Energy Reviews, 23, 272-288. doi: 10.1016/j.rser.2013.03.004

Gerges, M., Austin, S., Mayouf, M., Ahiakwo, O., Jaeger, M., Saad, A., & Gohary, T.-E. (2017). An investigation into the implementation of Building Information Modeling in the Middle East. Journal of Information Technology in Construction (ITcon), 22(1), 1-15.

Giang, D. T., & Pheng, L. S. (2011). Role of construction in economic development: Review of key concepts in the past 40 years. Habitat International, 35(1), 118-125.

Griffiths, S. (2017). A review and assessment of energy policy in the Middle East and North Africa region. Energy Policy, 102, 249-269. doi: 10.1016/j.enpol.2016.12.023

Grilo, A., Zutshi, A., Jardim-Goncalves, R., & Steiger-Garcao, A. (2013). Construction collaborative networks: the case study of a building information modelling-based office building project. International Journal of Computer Integrated Manufacturing, 26(1-2), 152-165.

Guerra-Santin, O., Christopher Tweed, A., & Gabriela Zapata-Lancaster, M. (2014). Learning from design reviews in low energy buildings. Structural Survey, 32(3), 246-264.

Halawa, W. S., Abdelalim, A. M., & Elrashed, I. A. (2013). Financial evaluation program for construction projects at the pre-investment phase in developing countries: A case study. International Journal of Project Management, 31(6), 912-923.

Haron, N. A., Soh, R., Ana, R. P. Z., & Harun, A. N. (2017). Implementation of Building Information Modelling (BIM) in Malaysia: A Review. Pertanika Journal of Science & Technology, 25(3).

Harris, F., & McCaffer, R. (2013). Modern construction management: John Wiley & Sons.

Hecke, T. V. (2012). Power study of anova versus Kruskal-Wallis test. Journal of Statistics and Management Systems, 15(2-3), 241-247.

Heravi, G., & Qaemi, M. (2014). Energy performance of buildings: The evaluation of design and construction measures concerning building energy efficiency in Iran. Energy and Buildings, 75, 456-464. doi: 10.1016/j.enbuild.2014.02.035

Hughes, D., Williams, T., & Ren, Z. (2012). Differing perspectives on collaboration in construction. Construction Innovation, 12(3), 355-368.

IEA. (2010). World Energy Outlook 2010. Paris.

Invest in Group. (2016). Kurdistan Review Forging Ties Globally. Erbil.

Investment Board. (2017). List of Licensed Projects in Kurdistan Region: Department of Information and Studies.

Issa, N. S. C., & Al Abbar, S. D. (2015). Sustainability in the Middle East: achievements and challenges. International Journal of Sustainable Building Technology and Urban Development, 6(1), 34-38.

Iyer, K., & Jha, K. (2005). Factors affecting cost performance: evidence from Indian construction projects. International Journal of Project Management, 23(4), 283-295.

Jabary, K., & Hira, A. (2013). The Kurdish Mirage: A Success Story in Doubt. Middle East Policy, 20(2), 99-112.

Jamieson, S. (2004). Likert scales: how to (ab) use them. Medical Education, 38(12), 1217-1218.

Kahvandi, Z., Saghatforoush, E., Alinezhad, M., & Noghli, F. (2017). Integrated Project Delivery (IPD) Research Trends. Journal of Engineering, Project & Production Management, 7(2).

Kaiser, H. F. (1974). An index of factorial simplicity. Psychometrika, 39(1), 31-36.

Kazi, A. M., & Khalid, W. (2012). Questionnaire designing and validation. Journal of the Pakistan Medical Association, 62(5), 514.

Khalfan, M. M., McDermott, P., & Swan, W. (2007). Building trust in construction projects. Supply Chain Management: An International Journal, 12(6), 385-391.

Koolwijk, J. S. J., van Oel, C. J., Wamelink, J. W. F., & Vrijhoef, R. (2018). Collaboration and Integration in Project-Based Supply Chains in the Construction Industry. Journal of Management in Engineering, 34(3), 04018001.

Koraltan, S. B., & Dikbas, A. (2002). An assessment of the applicability of partnering in the Turkish construction sector. Construction Management & Economics, 20(4), 315-321.

Koutsikouri, D., Austin, S., & Dainty, A. (2008). Critical success factors in collaborative multi-disciplinary design projects. Journal of Engineering, Design and Technology, 6(3), 198-226.

Kożuch, B. (2009). The culture of collaboration. Theoretical aspects. Journal of Intercultural Management, 1(2), 17-29.

Kożuch, B., & Sienkiewicz-Małyjurek, K. (2016). Factors of effective inter-organizational collaboration: a framework for public management. Transylvanian Review of Administrative Sciences, 12(47), 97-115.

Krosnick, J. A. (2018). Questionnaire design The Palgrave Handbook of Survey Research (pp. 439-455): Springer.

Lababedi, A., & Choufany, H. M. (2013). HERE COMES KURDISTAN! UAE: HVS Global Hospitality Services.

Latham, S. M. (1994). Constructing the team. Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry: HMSO.

LeCompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. Review of Educational Research, 52(1), 31-60.

Lewin, K. (1946). Action research and minority problems. Journal of Social Issues, 2(4), 34-46.

Lietz, P. (2010). Research into questionnaire design. International Journal of Market Research, 52(2), 249-272.

Liu, Y., van Nederveen, S., & Hertogh, M. (2017). Understanding effects of BIM on collaborative design and construction: An empirical study in China. International Journal of Project Management, 35(4), 686-698. doi: 10.1016/j.ijproman.2016.06.007

Lopes, J., Ruddock, L., & Ribeiro, F. L. (2002). Investment in construction and economic growth in developing countries. Building Research & Information, 30(3), 152-159.

Lu, S., & Yan, H. (2007). A model for evaluating the applicability of partnering in construction. International Journal of Project Management, 25(2), 164-170.

Menezes, A. C., Cripps, A., Bouchlaghem, D., & Buswell, R. (2012). Predicted vs. actual energy performance of non-domestic buildings: Using post-occupancy evaluation data to reduce the performance gap. Applied Energy, 97, 355-364. doi: 10.1016/j.apenergy.2011.11.075

Meng, X. (2012). The effect of relationship management on project performance in construction. International Journal of Project Management, 30(2), 188-198. doi: 10.1016/j.ijproman.2011.04.002

Meng, X. (2013). Change in UK construction: moving toward supply chain collaboration. Journal of Civil Engineering and Management, 19(3), 422-432.

Mesa, H. A., Molenaar, K. R., & Alarcón, L. F. (2016). Exploring performance of the integrated project delivery process on complex building projects. International Journal of Project Management, 34(7), 1089-1101. doi: 10.1016/j.ijproman.2016.05.007

Mills, A. (2001). A systematic approach to risk management for construction. Structural Survey, 19(5), 245-252.

Ministry of Construction & Housing. (2017). Residential units database in the Kurdistan region (1992-2017).

Ministry of Planning. (2013). Kurdistan Region of Iraq 2020: A Vision for the Future. Kurdistan Regional Government.

MOCAH. (2017). Kurdistan Regional Government Construction Forum Proceedings Report. Erbil: Ministry of Construction and Housing.

Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. Journal of Mixed Methods Research, 1(1), 48-76.

Morrell, P. (2015). Collaboration for Change: The Edge Commission Report on the Future of Professionalism| Edge Debate: London: The Edge Commission, May.

Motawa, I., & Carter, K. (2013). Sustainable BIM-based Evaluation of Buildings. Procedia - Social and Behavioral Sciences, 74, 419-428. doi: 10.1016/j.sbspro.2013.03.015

Mustafa, F. A. (2017). Performance assessment of buildings via post-occupancy evaluation: A case study of the building of the architecture and software engineering departments in Salahaddin University-Erbil, Iraq. Frontiers of Architectural Research, 6(3), 412-429.

Natali, D. (2007). The spoils of peace in Iraqi Kurdistan. Third World Quarterly, 28(6), 1111-1129.

Neamat, S., & Yitmen, I. (2017). Factors Affecting the Innovation and Competitiveness in Kurdistan Region of Iraq Construction Industry. International Journal of Advanced Engineering Research and Science, 4(2).

Nursin, A., & Latief, Y. (2018). Critical Success Factors in Developing Collaborative Design-Build Project Team to Improve Project Performance. In MATEC Web of Conferences (Vol. 159, p. 01025). EDP Sciences.

Nyström, J. (2005). The definition of partnering as a Wittgenstein family-resemblance concept. Construction Management and Economics, 23(5), 473-481.

Öberg, C. (2016). What creates a collaboration-level identity? Journal of Business Research, 69(9), 3220-3230. doi: 10.1016/j.jbusres.2016.02.027

Ofori, G. (2000). Challenges of construction industries in developing countries: Lessons from various countries. Paper presented at the 2nd International Conference on Construction in Developing Countries: Challenges Facing the Construction Industry in Developing Countries, Gaborone, November.

Ofori, G. (2007). Construction in Developing Countries. Construction Management and Economics, 25(1), 1-6. doi: 10.1080/01446190601114134

Ofori, G. (2015). Nature of the construction industry, its needs and its development: A review of four decades of research. Journal of construction in developing countries, 20(2), 115.

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. Information & management, 42(1), 15-29.

Oyegoke, A. S., Dickinson, M., Khalfan, M. M., McDermott, P., & Rowlinson, S. (2009). Construction project procurement routes: an in-depth critique. International Journal of Managing Projects in Business, 2(3), 338-354.

Patel, H., Pettitt, M., & Wilson, J. R. (2012). Factors of collaborative working: a framework for a collaboration model. Appl Ergon, 43(1), 1-26. doi: 10.1016/j.apergo.2011.04.009

Pérez-Lombard, L., Ortiz, J., & Pout, C. (2008). A review on buildings energy consumption information. Energy and Buildings, 40(3), 394-398.

Phua, F. T. T. (2006). When is construction partnering likely to happen? An empirical examination of the role of institutional norms. Construction Management and Economics, 24(6), 615-624. doi: 10.1080/01446190500521256

Rached, F., Hraoui, Y., Karam, A., & Hamzeh, F. (2014). Implementation of IPD in the Middle East and its Challenges. Proceedings International Group for Lean Construction, 293-304.

Rahman, S. H. A., Endut, I. R., Faisol, N., & Paydar, S. (2014). The importance of collaboration in construction industry from contractors' perspectives. Procedia-Social and Behavioral Sciences, 129, 414-421.

Randrup, N., Druckenmiller, D., & Briggs, R. O. (2016). Philosophy of Collaboration. In 2016 49th Hawaii International Conference on System Sciences (HICSS) (pp. 898-907). IEEE.

RIBA Architecture. (2008). RIBA Outline Plan of Work 2007. from https://www.architecture.com/

Robinson, J. F., Foxon, T. J., & Taylor, P. G. (2016). Performance gap analysis case study of a non-domestic building. Proceedings of the Institution of Civil Engineers - Engineering Sustainability, 169(1), 31-38. doi: 10.1680/ensu.14.00055

Roschelle, J., & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem solving. In Computer supported collaborative learning, pp. 69-97. Springer, Berlin, Heidelberg, 1995.

Rowlinson, S. (2017). Building information modelling, integrated project delivery and all that. Construction Innovation.

RTI International. (2008). Kurdistan Region Economic Development Assessment.

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research Methods for Business Students. England: Prentice Hall: London.

Saunders, M., Lewis, P., & Thornhill, A. (2015). Understanding research philosophies and approaches. Research Methods for Business Students, 4, 106-135.

Saunders, M., Lewis, P., Thornhill, A., & Wilson, J. (2009). Business research methods. Financial Times, Prentice Hall: London.

Schade, J., Olofsson, T., & Schreyer, M. (2011). Decision-making in a model-based design process. Construction Management and Economics, 29(4), 371-382. doi: 10.1080/01446193.2011.552510

Shatz, H. J., Constant, L., Luoto, J. E., Smith, A., & Abramzon, S. (2014). An assessment of the present and future labor market in the Kurdistan region—Iraq: Rand Corporation.

Shawkat, L. W., Al-Din, S. S. M., & Kuzović, D. (2018). Opportunities for Practicing Sustainable Building Construction in Kurdistan Region, Iraq. Journal of Contemporary Urban Affairs, 2(1), 96-101.

Shelbourn, M., Bouchlaghem, N., Anumba, C., & Carrillo, P. (2007). Planning and implementation of effective collaboration in construction projects. Construction Innovation, 7(4), 357-377.

Shen, Hao, Q., Mak, H., Neelamkavil, J., Xie, H., Dickinson, J., Xue, H. (2010). Systems integration and collaboration in architecture, engineering, construction, and facilities management: A review. Advanced Engineering Informatics, 24(2), 196-207.

Shen, & Wu, Y. (2005). Risk concession model for build/operate/transfer contract projects. Journal of construction engineering and management, 131(2), 211-220.

Snow, C. C. (2015). Organizing in the Age of Competition, Cooperation, and Collaboration. Journal of Leadership & Organizational Studies, 22(4), 433-442. doi: 10.1177/1548051815585852

Soderberg, N., & Phillips, D. (2015). State-Building in Iraqi Kurdistan: New York NY: Institute for the Study of Human Rights, Columbia University, http://humanrightscolumbia. org/sites/default/files/documents/peace-building/state_building_kurdistan. pdf (accessed 3 February 2016).

Strauss, A., & Corbin, J. (1994). Grounded theory methodology. Handbook of Qualitative Research, 17, 273-285.

Sweis, G., Sweis, R., Hammad, A. A., & Shboul, A. (2008). Delays in construction projects: The case of Jordan. International Journal of Project Management, 26(6), 665-674.

Tanko, B. L., & Anigbogu, N. (2012). The use of personal protective equipment (PPE) on construction sites in Nigeria. Paper presented at the In: Laryea, S., Agyepong, SA, Leiringer, R. and Hughes, W.(Eds) Procs 4th West Africa Built Environment Research (WABER) Conference, 24-26 July 2012, Abuja, Nigeria.

Tellis, W. M. (1997). Introduction to case study. The Qualitative Report, 3(2), 1-14.

Thormark, C. (2002). A low energy building in a life cycle—its embodied energy, energy need for operation and recycling potential. Building and Environment, 37(4), 429-435.

Tulenheimo, R. (2015). Challenges of Implementing New Technologies in the World of BIM – Case Study from Construction Engineering Industry in Finland. Procedia Economics and Finance, 21, 469-477. doi: 10.1016/s2212-5671(15)00201-4

Tuohy, P. G., & Murphy, G. B. (2014). Closing the gap in building performance: learning from BIM benchmark industries. Architectural Science Review, 58(1), 47-56. doi: 10.1080/00038628.2014.975780

Turiera, T., & Cros, S. (2013). Co-business: 50 examples of business collaboration. Barcelona: Infonomia/Zero Factory SL Available at:< http://www. co-society. com/wp-content/uploads/CO_business_2013. pdf, 8.

UNEP SBCI. (2009). Buildings and climate change: Summary for decision-makers. United Nations Environmental Programme, Sustainable Buildings and Climate Initiative, Paris, 1-62.

Vaaland, T. I. (2004). Improving project collaboration: start with the conflicts. International Journal of Project Management, 22(6), 447-454.

Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. International Journal of Production Economics, 111(2), 299-315. doi: 10.1016/j.ijpe.2006.11.030

van Dronkelaar, C., Dowson, M., Spataru, C., & Mumovic, D. (2016). A Review of the Regulatory Energy Performance Gap and Its Underlying Causes in Non-domestic

Buildings. Frontiers in Mechanical Engineering, 1. doi: 10.3389/fmech.2015.00017

van Gassel, F. J. M., Láscaris-Comneno, T., & Maas, G. J. (2014). The conditions for successful automated collaboration in construction. Automation in Construction, 39, 85-92. doi: 10.1016/j.autcon.2013.12.001

Van Selm, M., & Jankowski, N. W. (2006). Conducting online surveys. Quality and quantity, 40(3), 435-456.

Vermeulen, N., Parker, J. N., & Penders, B. (2013). Understanding life together: a brief history of collaboration in biology. Endeavour, 37(3), 162-171. doi: 10.1016/j.endeavour.2013.03.001

White, T., Dec, M., Troy, D., & Thornton, B. (2008). Effective early collaboration between engineers and architects for successful energy-efficient design. Proceedings of SimBuild, 3(1), 182-189.

Winch, G. M. (2010). Managing construction projects: John Wiley & Sons.

Winther, B. N., & Hestnes, A. G. (1999). Solar versus green: the analysis of a Norwegian row house. Solar Energy, 66(6), 387-393.

Wong, W. K., Cheung, S. O., Yiu, T. W., & Pang, H. Y. (2008). A framework for trust in construction contracting. International Journal of Project Management, 26(8), 821-829.

Wood, D. J., & Gray, B. (1991). Toward a comprehensive theory of collaboration. The Journal of Applied Behavioral Science, 27(2), 139-162.

World Bank. (2015). THE KURDISTAN REGION OF IRAQ. Assessing the Economic and Social Impact of the Syrian Conflict and ISIS: International Bank for Reconstruction and Development.

Wu, S., Greenwood, D., & Steel, G. (2008). Exploring the attributes of collaborative working in construction industry. Northumbria Working Paper Series: Interdisciplinary Studies in the Built and Virtual Environment, 1(2), 135-147.

Xue, X., Shen, Q., & Ren, Z. (2010). Critical review of collaborative working in construction projects: business environment and human behaviors. Journal of Management in Engineering, 26(4), 196-208.

Yassen, A. O. (2019). The Prospects for Durable Solutions for Syrian Refugees in the Kurdistan Region of Iraq: A Case Study of Erbil Governorate Camps. Refugee Survey Quarterly, 38(4), 448-469.

Yeung, J. F., Chan, A. P., & Chan, D. W. (2007). The definition of alliancing in construction as a Wittgenstein family-resemblance concept. International Journal of Project Management, 25(3), 219-231.

Yong, A. G., & Pearce, S. (2013). A beginner's guide to factor analysis: Focusing on exploratory factor analysis. Tutorials in Quantitative Methods for Psychology, 9(2), 79-94.

Yuce, B., & Rezgui, Y. (2017). An ANN-GA semantic rule-based system to reduce the gap between predicted and actual energy consumption in buildings. IEEE Transactions on Automation Science and Engineering, 14(3), 1351-1363.

Zebari, H. N., & Ibrahim, R. K. (2016). Methods & Strategies For Sustainable Architecture In Kurdistan Region, Iraq. Procedia Environmental Sciences, 34, 202-211.

Zero Carbon Hub. (2014). Closing the gap between design and as-built performance End of term report. London.

Zou, P. X., Zhang, G., & Wang, J. (2007). Understanding the key risks in construction projects in China. International Journal of Project Management, 25(6), 601-614.

Appendices

Appendix A: Reseach Ethics form

Technology Faculty Ethics Committee

ethics-tech@port.ac.uk

Date 27/04/18

Hazhar Faris

School of Civil Engineering and Surveying

Dear Hazar,

Study Title:	Improving collaboration to minimise the energy gap between design and as-built performance in residential building projects
Ethics Committee reference:	TECH 2018 - H.F- 01

The Ethics Committee reviewed the above application by an email discussion between the dates of 29/03/18 and 13/04/18. Comments were fed back to the applicant and a revised application has been considered under Chairs action due to the imminent pilot data collection phase.

Ethical opinion

A favourable ethical opinion of the survey has been given under Chairs Action based on the applicants response to the initial review by 3 members of the Committee based on the revised application and supporting documentation.

Conditions of the favourable opinion

- Ensure that there is consistency in the application as some sections refer only to an online questionnaire survey when visits and interviews are described in other sections
- That the Risk Assessment and Business Case Form is signed by the HoS and UEB before any data collection.
- That "The research does not involve any fieldwork." Is removed from 8.3. as the visits to contractors could be defined as field work.
- That the list of appendices is updated to show correct version numbers and that "Evidence From External Organisation Showing Support" is removed

Recommendations: (You should give these due consideration but there is no obligation to comply or respond)

- That you consult with a statistical advisor (e.g. Dr Lodwick) concerning your data analysis concerning the appropriateness of Factor Analysis and what other techniques you may apply to your data analysis.
- Check the form for any typos or mistakes,

The favourable opinion of the EC does not grant permission or approval to undertake the research. Management permission or approval must be obtained from any host organisation, including University of Portsmouth, prior to the start of the study.

Summary of discussion at the meeting

In V1 of the submission the reviewers required more information about the need for travel and Participant Information to be included. These have been supplied and considered under Chairs Action due to the imminent pilot data collection phase and travel arrangements already being place.

Documents reviewed

The documents reviewed at the meeting were:

Document	*Version*	*Date*
Application Form	2	27/2/2018
Peer / Independent Review	1	19/02/2018
Evidence From External Organisation Showing Support	1	06/01/2018
Questionnaire	2	27/2/2018
Risk Assessment Form(s)	1	15/03/2018

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements set out by the University of Portsmouth

After ethical review

Reporting requirements

University of Portsmouth

Faculty of Technology

The attached document acts as a reminder that research should be conducted with integrity and gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Notification of serious breaches of the protocol
- Progress reports
- Notifying the end of the study

Feedback

You are invited to give your view of the service that you have received from the Faculty Ethics Committee. If you wish to make your views known please contact the administrator ethics-tech@port.ac.uk

Please quote this number on all correspondence: TECH 2018 - H.F- 01

Yours sincerely and wishing you every success in your research

Professor John Williams

Chair Technology FEC

Email: ethics-tech@port.ac.uk

Appendix B: Participant information sheet for interviews

University of Portsmouth

School of Civil Engineering

and Surveying

Portland Building

PARTICIPANT INFORMATION SHEET

Title of Project: Improving collaboration to minimise the energy gap between design and as-built performance in residential building projects

Name and Contact Details of Researcher: Hazhar Faris, hazhar.faris@port.ac.uk

Name and Contact Details of Supervisor: Mark Gaterell, mark.gaterell@port.ac.uk

Ethics Committee Reference Number: TECH 2018 - H.F- 01

1. Invitation

I would like to invite you to take part in my research study. Joining the study is entirely up to you, before you decide I would like you to understand why the research is being done and what it would involve for you. I will go through this information sheet with you, to help you decide whether or not you would like to take part and answer any questions you may have. I would suggest this should take about 15 minutes. Please feel free to talk to others about the study if you wish. Do ask if anything is unclear.

I am Hazhar Faris, PhD student at the University of Portsmouth

2. Study Summary

This study is concerned with improving collaboration in the construction industry which is important because of its effects on energy consumption in housing projects. We are seeking participants that are involved in a housing project, and have a good level of experience in housing projects. Participation in the research would require you to attend online interview and take approximately 1 hour of your time.

3. What is the purpose of the study?

The purpose of this study is to contribute to minimising the energy gap between design and as-built performance in residential building projects in Kurdistan region of Iraq by improving collaboration between construction industry participants. .The study aims at providing a framework to be implemented in the construction industry to improve that collaboration.

4. Why have I been invited?

You are invaded based on your experience in the housing projects in Kurdistan region. We found that you have sufficient knowledge and expertise that can validate this research.

5. Do I have to take part?

No, taking part in this research is entirely voluntary. It is up to you to decide if you want to volunteer for the study. We will describe the study in this information sheet. If you agree to take part, we will then ask you to sign the attached consent form, dated 27/09/2019, version number 1.

6. What will happen to me if I take part?

The interview will take maximum of 1 hour of your time and it will be video recorded. Your valuable perceptions will be used to validate our research.

7. Expenses and payments

Participation in this research is voluntary. There is no recompense for this research.

8. Anything else I will have to do?

No

9. What data will be collected and / or measurements taken?

The data collected will be your views and perceptions on improving collaboration in the construction industry in order to minimise energy gap.

10. What are the possible disadvantages, burdens and risks of taking part?

The study may make take up to 1 hour of your time. There is no other risks.

11. What are the possible advantages or benefits of taking part?

You will not receive any direct personal benefits from participating but construction industry stakeholders may benefit from the results of this work by using results of this study to improve project performance.

12. Will my data be kept confidential?

You will not be asked any personal questions. The research does not involve collecting any personal data of participants. Additionally, the collected data will anonymously be saved in the UoP N drive and will be accessible only to authorised personnel of the University.

The data, when made anonymous, may be presented to others at academic conferences, or published as a project report, academic dissertation or in academic journals or book. It could also be made available to any commissioner or funder of the research. Anonymous data, which does not identify you, will be publicly shared at the end of the project and made open access. A CC-BY licence will be applied to this publicly shared data. This will allow anyone else (including researchers, businesses, governments, charities, and the general public) to use the anonymised data for any purpose that they wish, providing they credit the University and research team as the original creators. No restrictions will be placed on this shared anonymised data limiting its reuse to only non-commercial ventures.

The raw data, which would identify you, will not be passed to anyone outside the study team without your express written permission. The exception to this will be any regulatory authority which has the legal right to access the data for the purposes of conducting an audit or enquiry, in exceptional cases. These agencies treat your personal data in confidence. The raw data will be retained for a minimum of 10 years. When it is no longer required, the data will be disposed of securely (*e.g.* electronic media and paper records / images) destroyed.

13. What will happen if I don't want to carry on with the study?

As a volunteer you can stop any participation in this interview at any time, or withdraw from the study at any time before 31/01/2020 without giving a reason if you do not wish to. If you do withdraw from a study after some data have been collected you will be asked if you are content for the data collected thus far to be retained and included in the study. If you prefer, the data collected can be destroyed and not included

in the study. Once the research has been completed, and the data analysed, it will not be possible for you to withdraw your data from the study.

14. What if there is a problem?

If you have a query, concern or complaint about any aspect of this study, in the first instance you should contact the researcher if appropriate. If the researcher is a student, there will also be an academic member of staff listed as the supervisor whom you can contact. If there is a complaint and there is a supervisor listed, please contact the Supervisor with details of the complaint. The contact details for both the researcher and any supervisor are detailed on page 1.

If your concern or complaint is not resolved by the researcher or their supervisor, you should contact the Head of Department:

The Head of Department

School of Civil Engineering and Surveying

University of Portsmouth

Portland Building,

Portland Street,

Portsmouth (UK)

PO1 3AH

Dr Stephanie Barnett

+44 (0)23 9284 2461

stephanie.barnett@port.ac.uk

If the complaint remains unresolved, please contact:

The University Complaints Officer

+44 (0) 23 9284 3642 complaintsadvice@port.ac.uk

15. Who is funding the research?

Self-funded

16. Who has reviewed the study?

Research involving human participants is reviewed by an ethics committee to ensure that the dignity and well-being of participants is respected. This study has been reviewed by the Technology Faculty Ethics Committee and been given favourable ethical opinion.

Thank you

Thank you for taking time to read this information sheet and for considering volunteering for this research. If you do agree to participate your consent will be sought; please see the accompanying consent form. You will then be given a copy of this information sheet and your signed consent form, to keep

Appendix C: Consent form for interviews

University of Portsmouth

School of Civil Engineering

and Surveying

Portland Building

CONSENT FORM

Title of Project: Improving collaboration to minimise the energy gap between design and as-built performance in residential building projects

Name and Contact Details of Researcher: Hazhar Faris, hazhar.faris@port.ac.uk

Name and Contact Details of Supervisor: Mark Gaterell, mark.gaterell@port.ac.uk

University Data Protection Officer: Samantha Hill, 023 9284 3642 or data-protection@port.ac.uk

Ethics Committee Reference Number: TECH 2018 - H.F- 01

Please initial box

1. I confirm that I have read and understood the information sheet dated 30/09/2019 version 1 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. ☐
3. I understand that data collected during this study will be processed in accordance with data protection law as explained in the Participant Information Sheet (dated 30/09/2019 version 1). ☐
4. I consent for video of me to be taken during the interview for use in scientific presentations and publications (with my identity obscured). ☐
5. I consent for video of me to be taken during the interview for use by the study team only (my image will not be shown to others / and will be destroyed after the data has been analysed). ☐

6. I consent for my interview to be video recorded. The recording will be transcribed and analysed for the purposes of the research ☐

7. I agree to take part in the above study. ☐

Name of Participant: Date: Signature:

Appendix D: Pilot studies

Profile of respondents to the pilot studies

Years of experience in construction			Type of job		
	Frequency	Percentage		Frequency	Percentage
Less than 5	6	29	Client's Representative	4	19
6-10	8	38	Project Manager	5	24
11-15	1	4	Design Team	1	4
more than 15	6	29	Main Contractor	5	24
Total	21	100	Sub-Contractor	2	10
			Other	4	19
			Total	21	100

The survey instrument used in pilot studies:

Respondents profile

1. What type of organisation do you work/worked for? *
   Mark only one oval.
   - ◯ Client's Representative
   - ◯ Project Manager
   - ◯ Design team
   - ◯ Main Contractor
   - ◯ Sub-Contractor
   - ◯ Other

2. How many years of experience do you have in the construction sector? *
   Mark only one oval.
   - ◯ Less than 5 years
   - ◯ 6-10 years
   - ◯ 11-15 years
   - ◯ More than 15 years

Collaboration Measurement

This section aims at measuring the degree of collaboration based on factors of collaboration. Factors needed to improve collaborative working in residential building projects.

3. All involved parties in the project trust each other *
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

4. All parties trust that terms of the contract will be implemented *
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

5. **Communication lines are open and clear between different teams** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

6. **Communication lines are open and clear between members of the same team** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

7. **Stakeholders are using ideas from different participants to improve project performance** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. **Mutual goals are set between the key participants of the project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. **Key parties understand the clear and shared vision of the project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. **A clear process for conflict resolution is set in the project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

11. **Senior management is committed to delivering the project vision** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. **Senior management is encouraging all members of the project team to deliver the vision** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

13. **All involved stakeholders are committed to the project vision** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

14. **A strategic plan of benefits and risk sharing is set between involved parties** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

15. **The cultural difference of involved project participants affects the way they behave** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. **Each party provides the appropriate resources to deliver the project vision** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

17. **Each party is willing to share their resources with other parties** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

18. **The main contractor is involved at the beginning of the project life cycle** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

19. **The major subcontractors are brought in at an early stage of the project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

20. **A systematic way to evaluate the performance of the project process is used** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

21. **Roles and responsibilities of all team members are defined at an early stage of the project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

22. **Roles and responsibilities of participants are clear to everyone** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

23. **The project teams are provided with enough technological resources during the whole life of the project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

24. **There are enough skilled staff and workers to perform different tasks in the project** *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Further Comments

25. Please add any additional factor that you think needs to be considered to improve collaboration in residential projects

Appendix E: Questionnaire instrument

Residential Building Projects Survey

Title of Project: Improving collaboration to minimise the energy gap between design and as-built performance in residential building projects
Residential buildings are consuming a large amount of energy. One of the reasons for this consumption is found to be lack of collaboration between involved parties. Collaboration, a joint effort toward a group goal, has been proven to be a successful way to improve the performance of building projects. However, delivering a collaborative process is found to be a challenge, and factors contributing to this process may vary in different locations.
This questionnaire aims at measuring the level of importance of areas that affect collaboration in the residential projects in the Kurdistan. The data will be used to develop a framework that aims at improving collaboration in order to minimise the gap between the designed and actual performance of buildings regarding energy consumption.

*Required

Confidentiality statement

This survey is a part of a PhD project at the University of Portsmouth. You are invited to give your opinion on your experience in the Kurdistan building projects. Participation in this research is entirely voluntary. The collected data will made anonymous and the confidentially will be kept. If you wish, you can withdraw from the survey at any time. Your opinion and thoughts are important and your participation is highly appreciated.
Thank you for taking time to read this section, if you agree to participate please follow next step to fill the questionnaire.

UNIVERSITY OF PORTSMOUTH

Respondents profile

1. What type of organisation do you work/worked for? *
Mark only one oval.

- ◯ Client's Representative
- ◯ Project Manager
- ◯ Design team
- ◯ Main Contractor
- ◯ Sub-Contractor
- ◯ Other: _____

2. How many years of experience do you have in the construction sector? *
Mark only one oval.

- ◯ Less than 5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ More than 15 years

Collaboration in Residential Building Projects

Please rate the following areas according to their level of importance to deliver effective collaboration. (Using a scale of 1= least important, 2= slightly important, 3= moderately important, 4= important and 5= most important).

Importance to enable effective collaboration:

3. **All involved parties in the project trust each other** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

4. **All parties trust that terms of the contract will be implemented** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

5. **The type of contract is appropriate for the project** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

6. **Communication lines are open and clear between different teams** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

7. **Communication lines are open and clear between members of the same team** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

8. **Stakeholders are using ideas from different participants to improve project performance** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

9. **Mutual goals are set between the key participants of the project** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

10. **Key parties understand the clear and shared vision of the project** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

11. **A clear process for conflict resolution is set in the project** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

12. **Senior management is committed to delivering the project vision** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

13. **Senior management encourage all members of the project team to deliver the vision** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

14. **All involved stakeholders are committed to the project vision** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

15. **A strategic plan of benefits and risk sharing is set between involved parties** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

16. **The cultural difference of involved project participants affects the way they behave** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

17. **Each party provides the appropriate resources to deliver the project vision** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

18. **Each party is willing to share their resources with other parties** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

19. **The main contractor is involved at the beginning of the project life cycle** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

20. **The major subcontractors are brought in at an early stage of the project** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

21. **A systematic way to evaluate the performance of the project process is used** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

22. **Roles and responsibilities of all team members are defined at an early stage of the project** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

23. **Roles and responsibilities of participants are clear to everyone** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

24. **The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project** *
Mark only one oval.

	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

25. **There are enough skilled staff and workers to perform required tasks in the project** *
Mark only one oval.

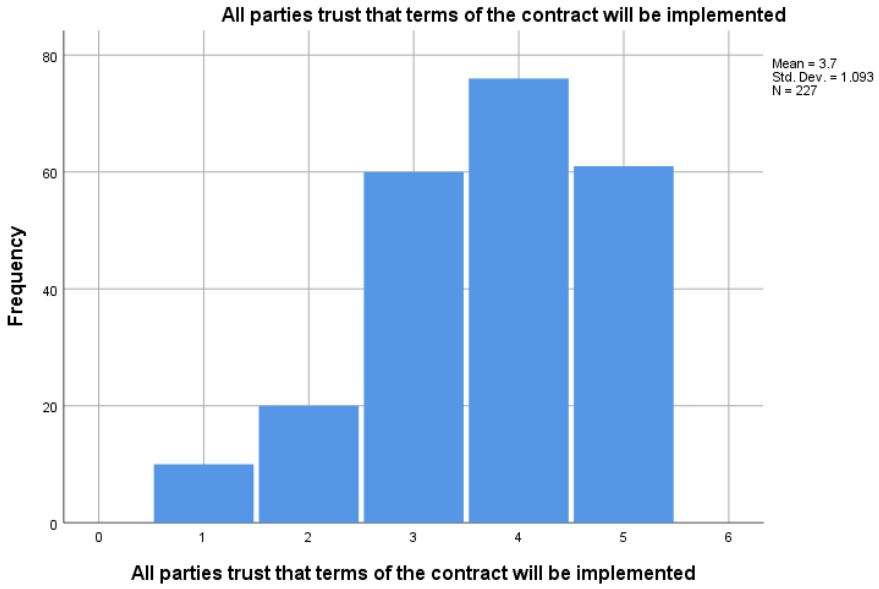
	1	2	3	4	5	
Least Important	◯	◯	◯	◯	◯	Most Important

Appendix F: Histograms

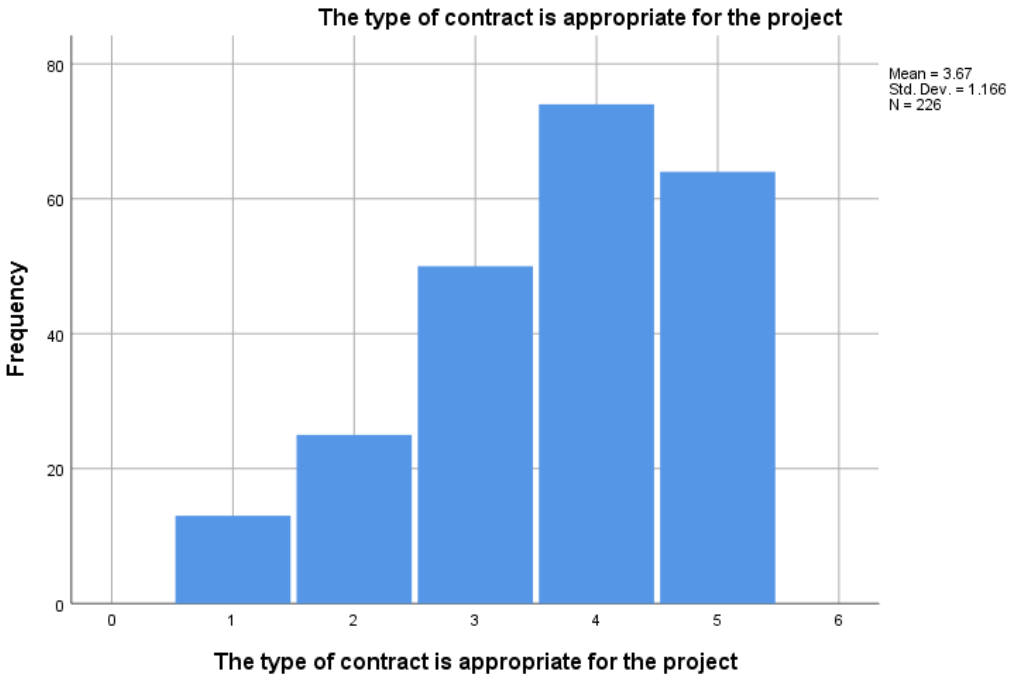
Shape of distribution of questionnaire survey answers

Question 1:

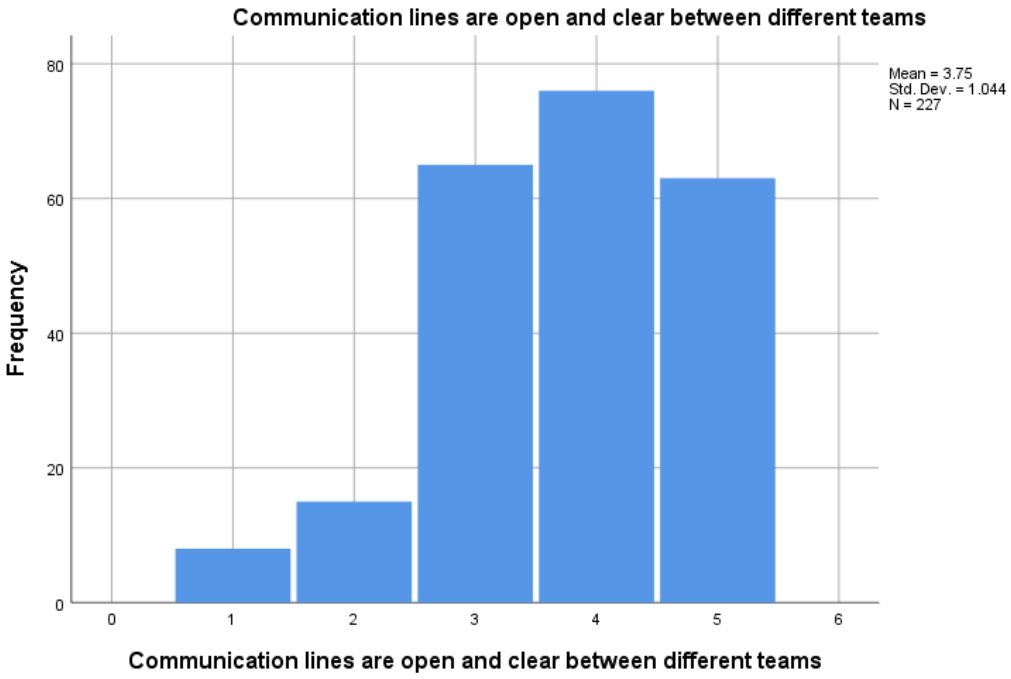
Question 2:



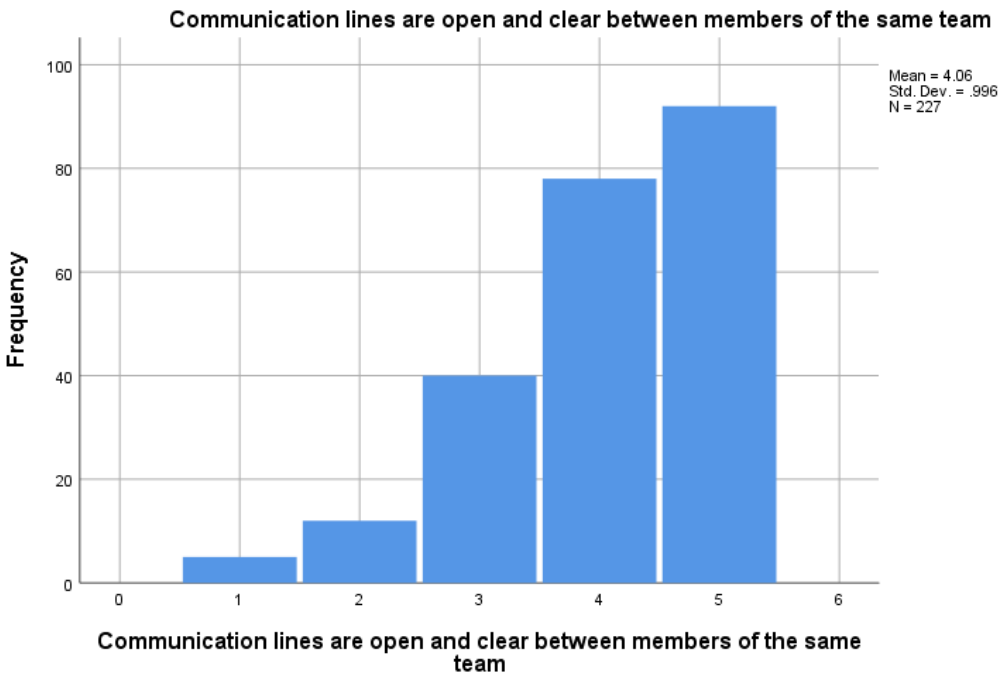
Question 3:



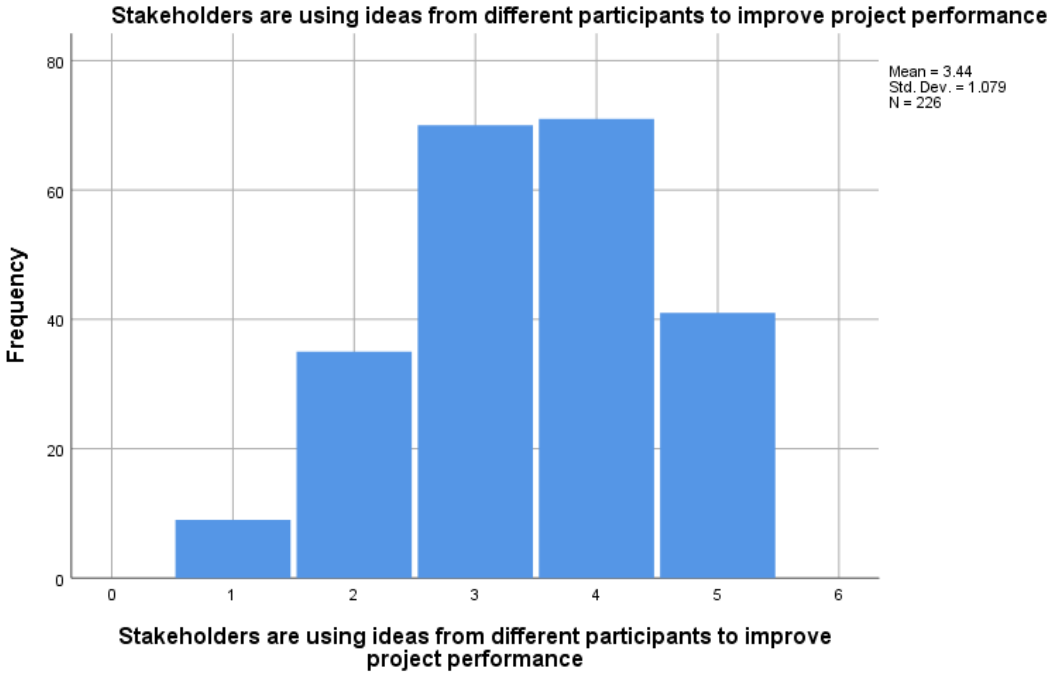
Question 4:



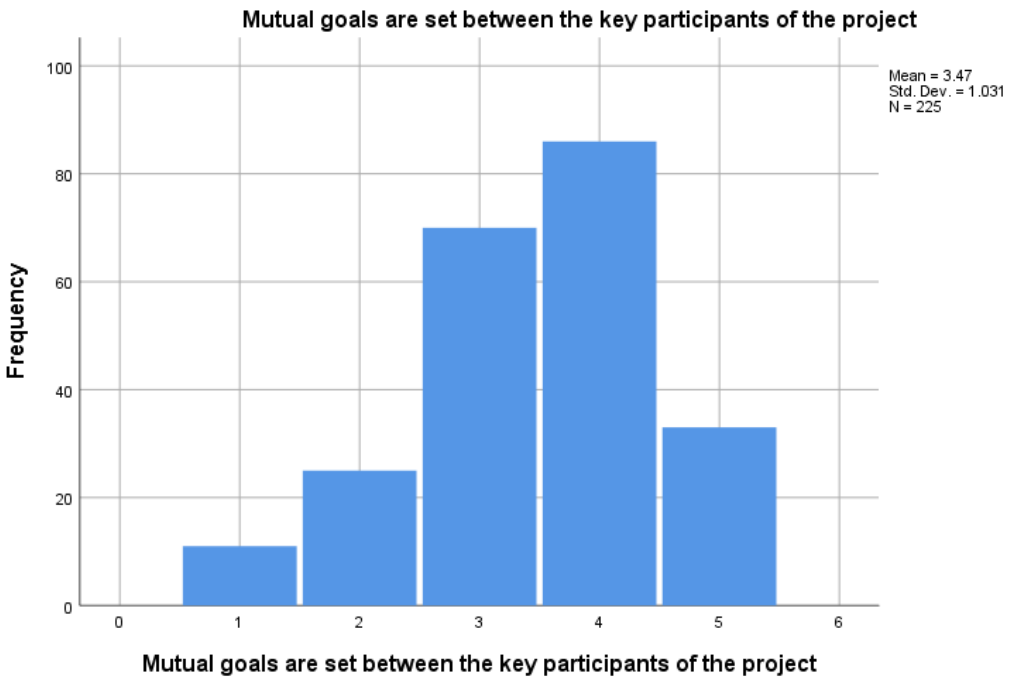
Question 5:



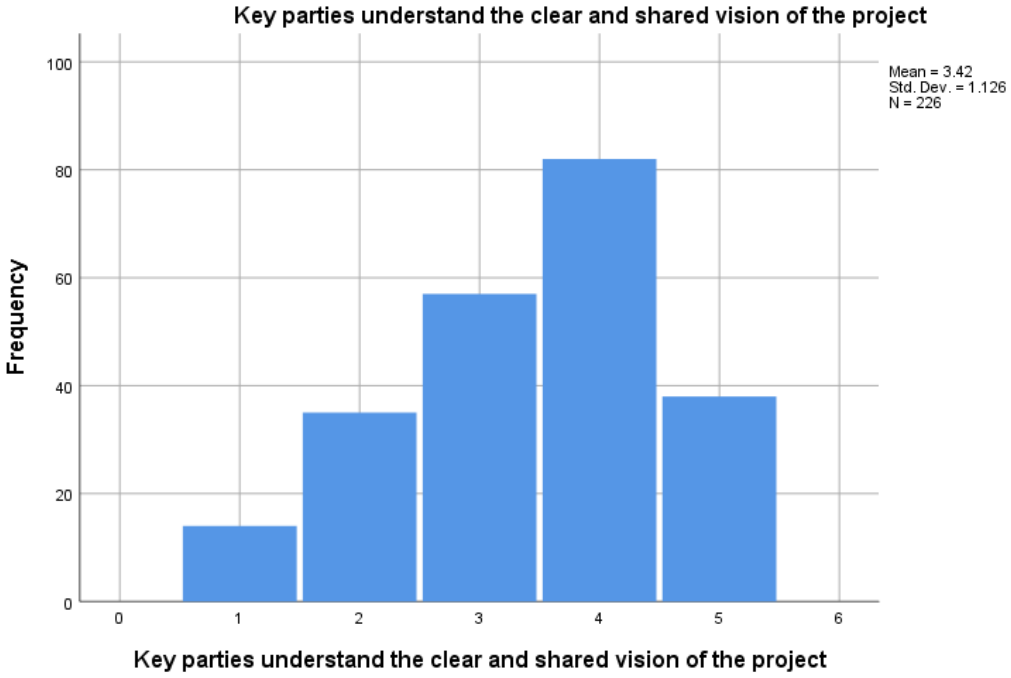
Question 6:



Question 7:



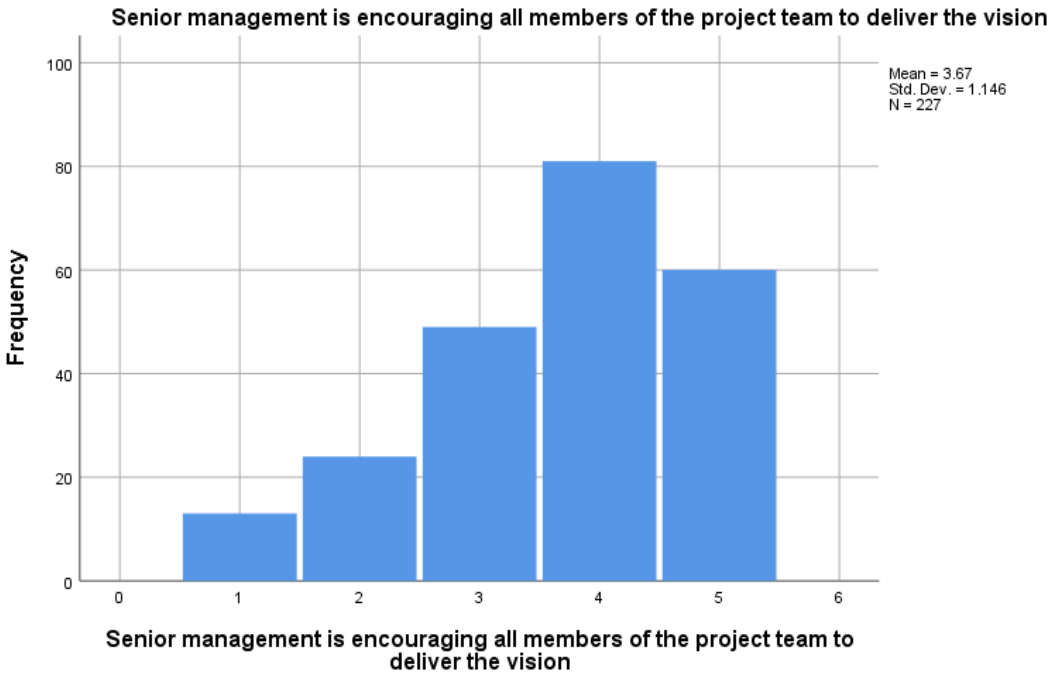
Question 8:



Question 9:

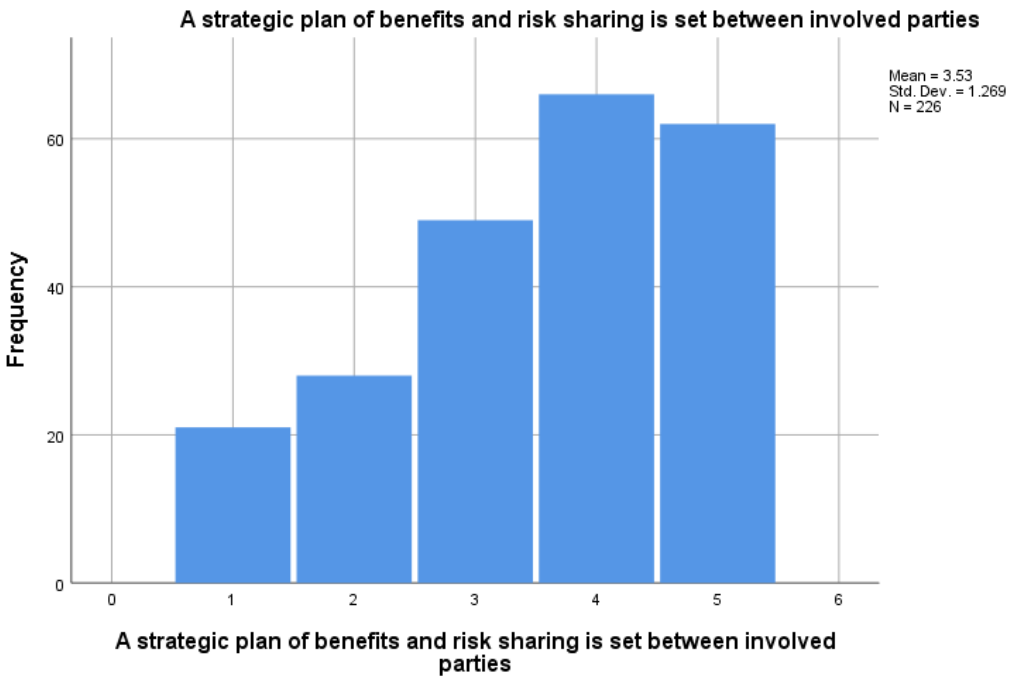
Question 10:

Question 11:

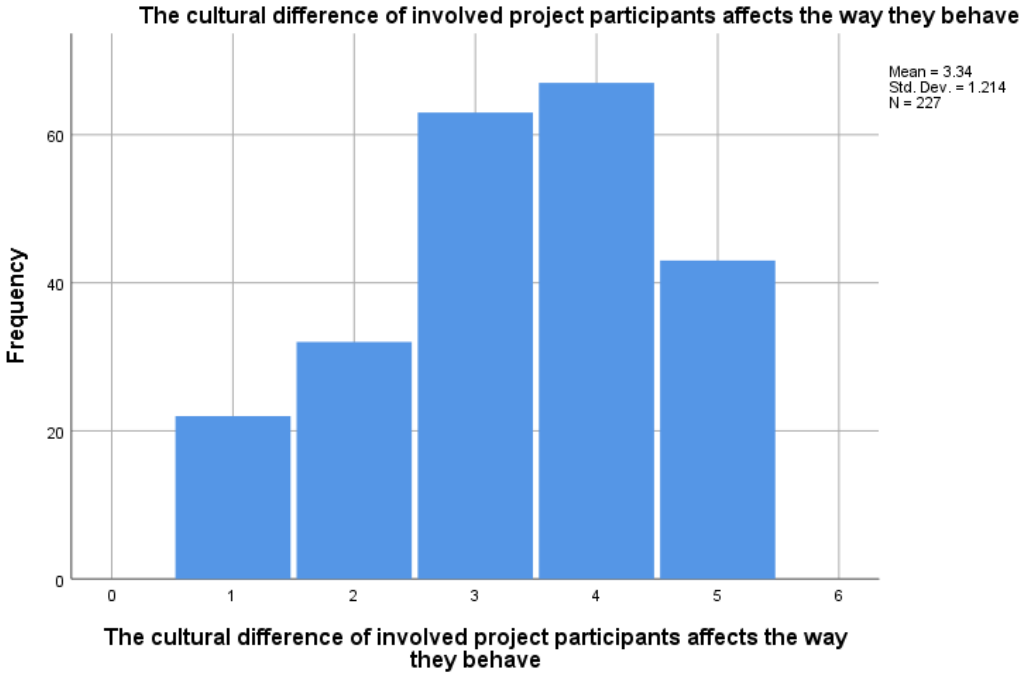


Question 12:

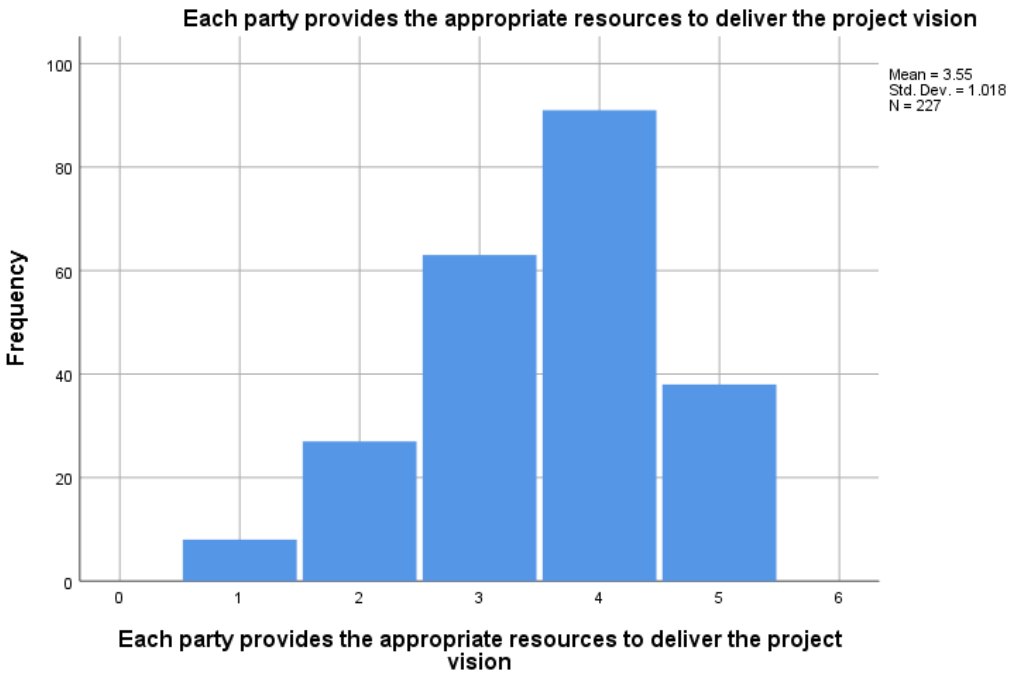
Question 13:



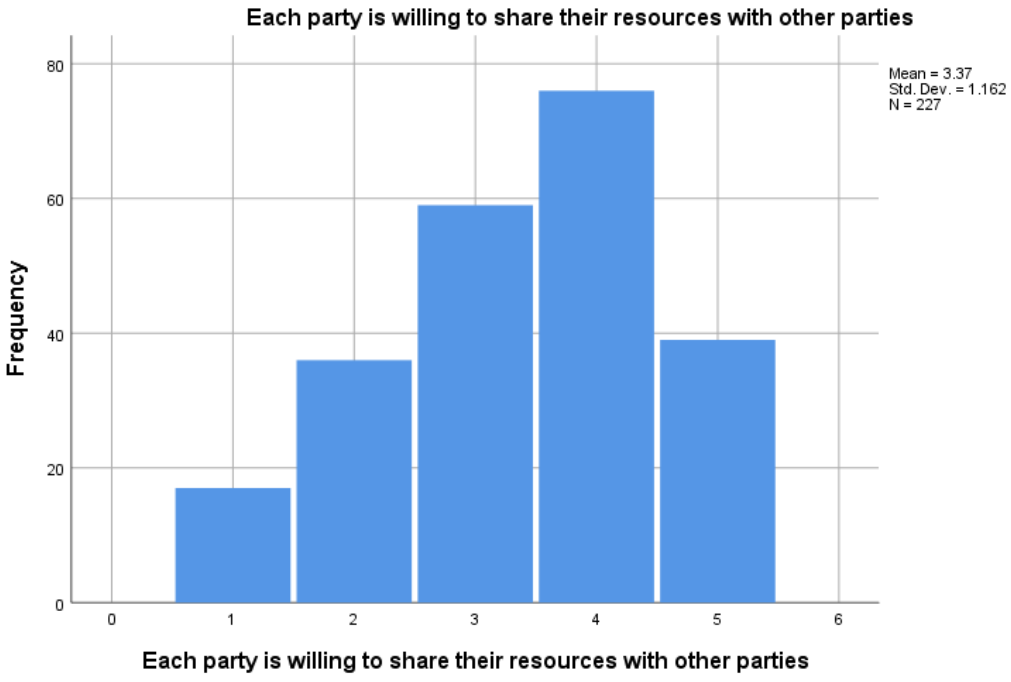
Question 14:



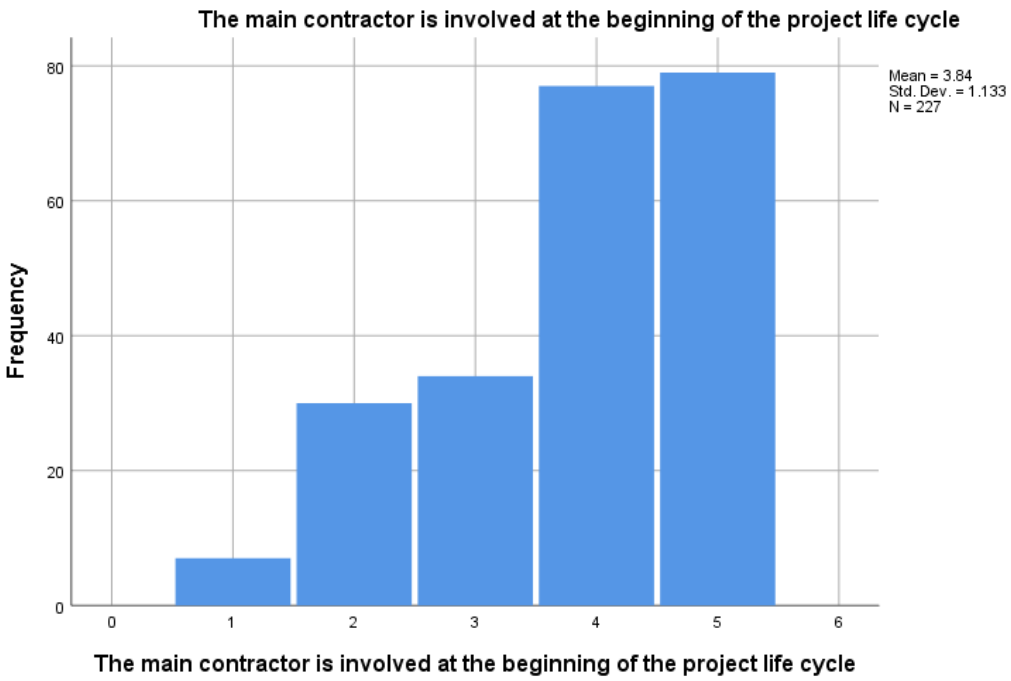
Question 15:



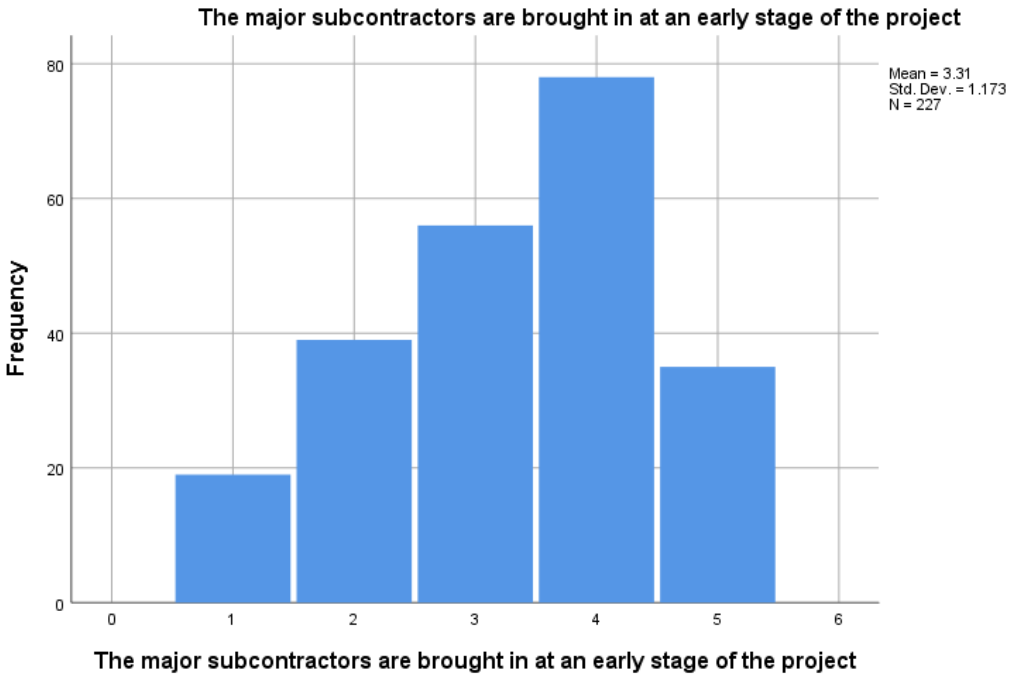
Question 16:



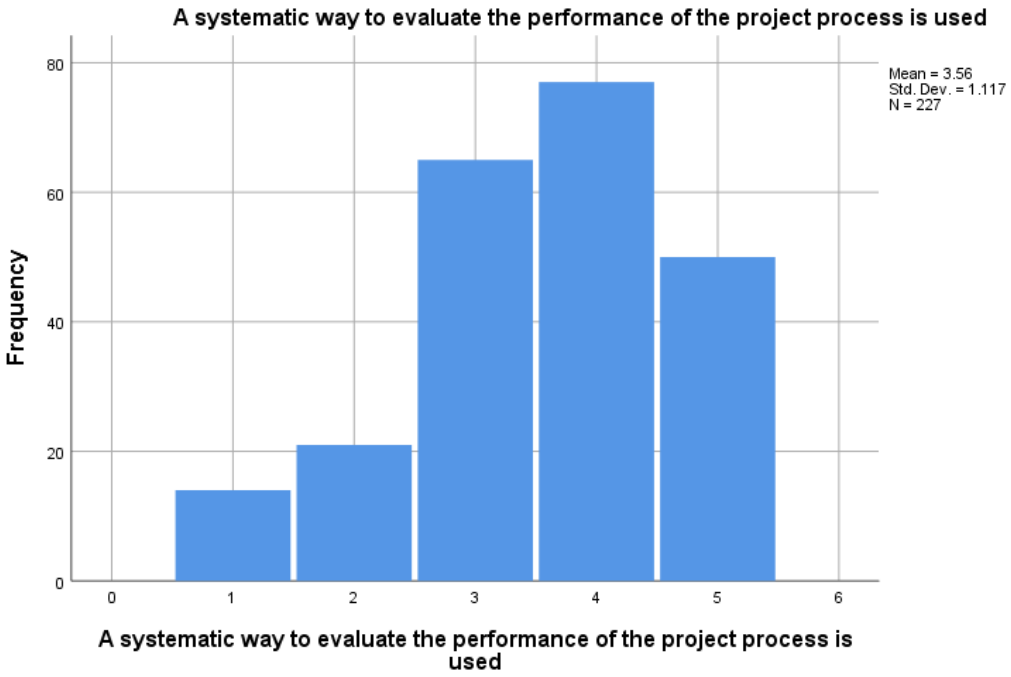
Question 17:



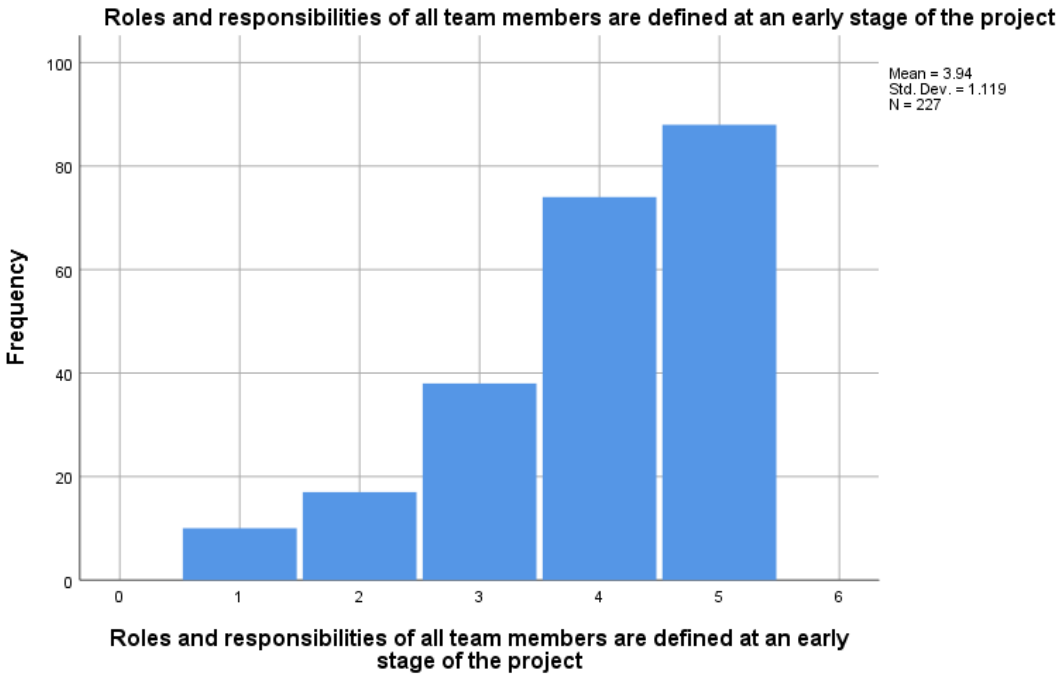
Question 18:



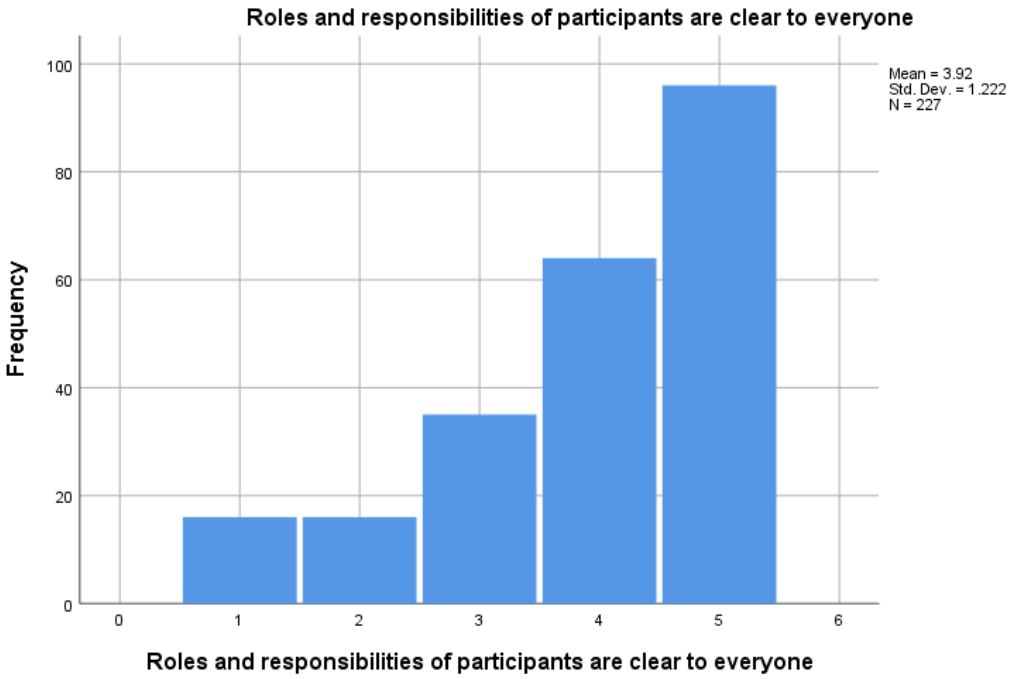
Question 19:



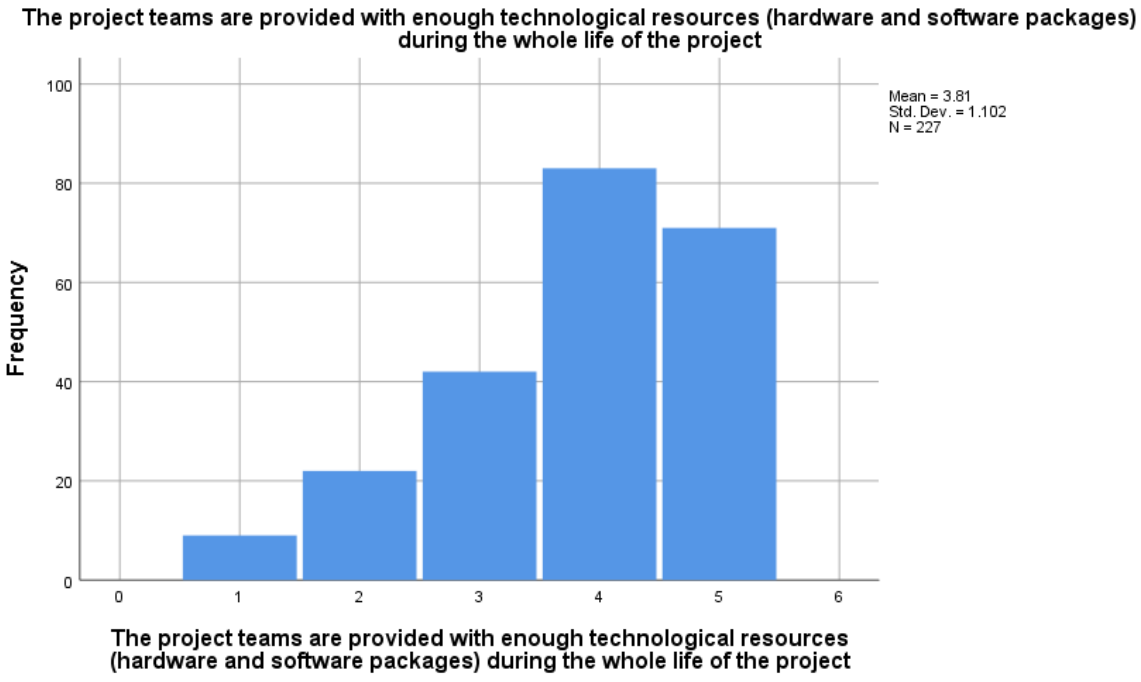
Question 20:



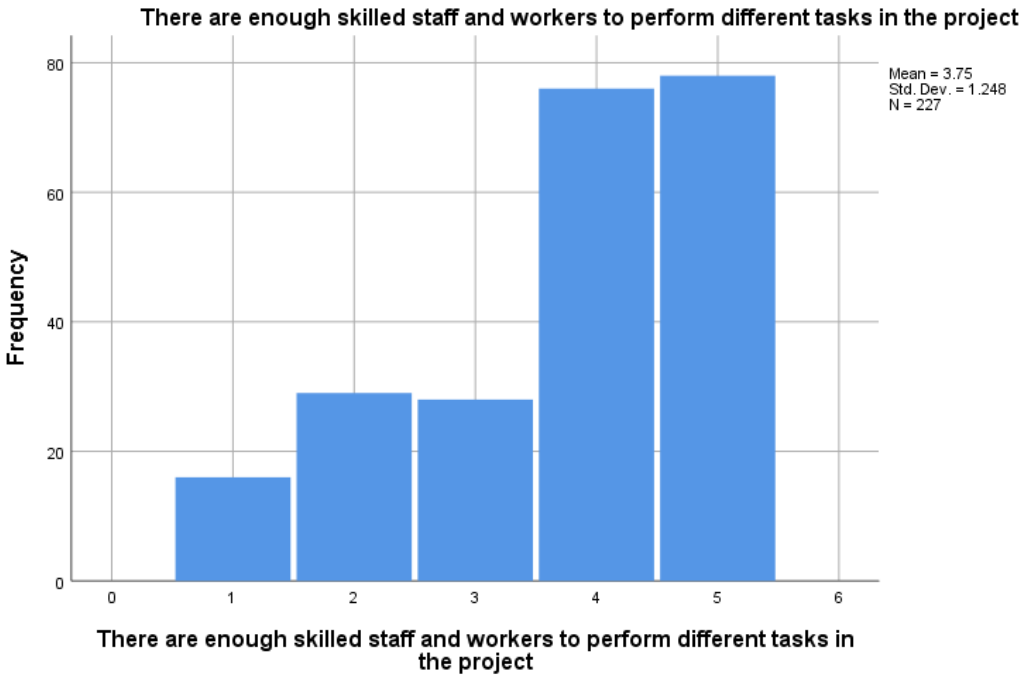
Question 21:



Question 22:



Question 23:


There are enough skilled staff and workers to perform different tasks in the project
Mean = 3.75
Std. Dev. = 1.248
N = 227
Frequency
80
60
40
20
0
0
1
2
3
4
5
6
There are enough skilled staff and workers to perform different tasks in the project

Appendix G: Factor analysis

Communalities

	Initial	Extraction
(1) All involved parties in the project trust each other	.407	.526
(2) All parties trust that terms of the contract will be implemented	.389	.467
(3) The type of contract is appropriate for the project	.428	.424
(4) Communication lines are open and clear between different teams	.363	.415
(5) Communication lines are open and clear between members of the same team	.327	.347
(6) Stakeholders are using ideas from different participants to improve project performance	.307	.239
(7) Mutual goals are set between the key participants of the project	.424	.399
(8) Key parties understand the clear and shared vision of the project	.460	.485
(9) A clear process for conflict resolution is set in the project	.367	.394
(10) Senior management is committed to delivering the project vision	.463	.549
(11) Senior management is encouraging all members of the project team to deliver the vision	.496	.529
(12) All involved stakeholders are committed to the project vision	.552	.610
(13) A strategic plan of benefits and risk sharing is set between involved parties	.531	.637
(14) The cultural difference of involved project participants affects the way they behave	.328	.492
(15) Each party provides the appropriate resources to deliver the project vision	.342	.426
(16) Each party is willing to share their resources with other parties	.298	.425
(17) The main contractor is involved at the beginning of the project life cycle	.266	.361

(18) The major subcontractors are brought in at an early stage of the project	.359	.443
(19) A systematic way to evaluate the performance of the project process is used	.394	.427
(20) Roles and responsibilities of all team members are defined at an early stage of the project	.409	.409
(21) Roles and responsibilities of participants are clear to everyone	.476	.519
(22) The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project	.431	.511
(23) There are enough skilled staff and workers to perform different tasks in the project	.504	.533

Extraction Method: Principal Axis Factoring.

Unrotated Factor Matrix[a]

	Factors					
Variables	1	2	3	4	5	6
All involved stakeholders are committed to the project vision	0.706	0.031	-0.306	0.041	0.122	-0.008
A strategic plan of benefits and risk sharing is set between involved parties	0.678	0.107	0.011	-0.194	0.035	-0.357
There are enough skilled staff and workers to perform different tasks in the project	0.633	-0.246	0.234	-0.107	-0.080	0.014
Senior management is encouraging all members of the project team to deliver the vision	0.620	0.058	-0.250	-0.236	-0.075	0.132
Senior management is committed to delivering the project vision	0.603	0.091	-0.292	-0.026	-0.277	0.120
Roles and responsibilities of participants are clear to everyone	0.601	0.035	0.363	-0.063	-0.008	-0.143
The type of contract is appropriate for the project	0.597	-0.216	-0.075	0.031	0.116	0.001
Key parties understand the clear and shared vision of the project	0.589	-0.252	-0.265	-0.016	0.018	-0.056
Mutual goals are set between the key participants of the project	0.575	-0.083	-0.208	-0.124	0.046	-0.012

A systematic way to evaluate the performance of the project process is used	0.573	-0.005	0.229	-0.095	0.117	-0.152
Roles and responsibilities of all team members are defined at an early stage of the project	0.558	0.137	0.168	0.179	-0.122	-0.060
All involved parties in the project trust each other	0.554	-0.225	0.121	0.284	0.270	0.025
A clear process for conflict resolution is set in the project	0.554	-0.197	-0.093	-0.106	0.083	-0.149
The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project	0.549	0.123	0.385	-0.040	-0.205	0.061
Communication lines are open and clear between different teams	0.543	-0.101	0.143	-0.026	-0.059	0.293
All parties trust that terms of the contract will be implemented	0.534	-0.256	-0.035	0.274	0.111	0.166
Communication lines are open and clear between members of the same team	0.489	-0.037	0.196	-0.124	-0.070	0.220
The major subcontractors are brought in at an early stage of the project	0.473	0.259	-0.243	0.227	-0.136	-0.153
Stakeholders are using ideas from different participants to improve project performance	0.446	-0.045	-0.137	0.033	-0.093	0.098
Each party provides the appropriate resources to deliver the project vision	0.436	0.385	0.126	-0.160	0.191	0.097
The main contractor is involved at the beginning of the project life cycle	0.353	0.195	0.031	0.339	-0.253	-0.140
The cultural difference of involved project participants affects the way they behave	0.165	0.627	-0.125	-0.156	0.152	0.095
Each party is willing to share their resources with other parties	0.315	0.428	0.063	0.295	0.204	0.102

Extraction Method: Principal Axis Factoring.
a. 6 factors extracted. 11 iterations required.

Rotated Factor Matrix (full factor loadings)

Variables	Factors 1	2	3	4	5	6
Senior management is committed to delivering the project vision	0.591	0.041	0.182	0.274	-0.077	0.066
Senior management is encouraging all members of the project team to deliver the vision	0.576	0.167	0.190	-0.026	-0.039	-0.099
All involved stakeholders are committed to the project vision	0.451	0.191	-0.098	0.100	0.299	-0.177
Key parties understand the clear and shared vision of the project	0.450	-0.124	-0.045	0.037	0.251	-0.215
Mutual goals are set between the key participants of the project	0.416	0.055	0.026	-0.025	0.138	-0.228
Stakeholders are using ideas from different participants to improve project performance	0.326	-0.004	0.134	0.121	0.115	0.024
The cultural difference of involved project participants affects the way they behave	0.126	0.680	-0.054	-0.018	-0.174	-0.004
Each party provides the appropriate resources to deliver the project vision	0.010	0.528	0.199	-0.074	0.025	-0.176
Each party is willing to share their resources with other parties	-0.147	0.494	-0.020	0.222	0.295	0.101
The project teams are provided with enough technological resources (hardware and software packages) during the whole life of the project	-0.075	0.053	0.567	0.235	-0.079	-0.151
Communication lines are open and clear between members of the same team	0.127	0.065	0.496	-0.047	0.065	-0.026
Communication lines are open and clear between different teams	0.182	0.036	0.495	-0.027	0.201	0.080
There are enough skilled staff and workers to perform different tasks in the project	0.102	-0.161	0.439	0.020	0.137	-0.286
The main contractor is involved at the beginning of the project life cycle	-0.013	-0.040	0.033	0.603	0.005	-0.006
The major subcontractors are brought in at an early stage of the project	0.263	0.122	-0.163	0.495	0.026	-0.079
Roles and responsibilities of all team members are defined at an early stage of the project	-0.021	0.056	0.228	0.389	0.099	-0.142

All involved parties in the project trust each other	-0.080	0.003	0.056	0.038	0.650	-0.136
All parties trust that terms of the contract will be implemented	0.155	-0.065	0.120	0.068	0.566	0.082
The type of contract is appropriate for the project	0.244	-0.034	0.065	-0.010	0.361	0.206
A strategic plan of benefits and risk sharing is set between involved parties	0.157	0.110	-0.014	0.160	-0.065	0.663
A systematic way to evaluate the performance of the project process is used	-0.063	0.091	0.188	0.028	0.139	0.462
Roles and responsibilities of participants are clear to everyone	-0.146	0.045	0.345	0.151	0.054	0.438
A clear process for conflict resolution is set in the project	0.260	-0.069	-0.007	-0.021	0.182	0.391

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 26 iterations.

Correlation Matrix (Pearson's correlation)

	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 13	Q 14	Q 15	Q 16	Q 17	Q18	Q 19	Q 20	Q 21	Q 22	Q 23
Q 1	1.000	0.477	0.416	0.297	0.307	0.245	0.240	0.374	0.327	0.196	0.232	0.371	0.312	-0.085	0.209	0.219	0.185	0.210	0.336	0.305	0.367	0.235	0.348
Q 2		1.000	0.408	0.327	0.231	0.278	0.273	0.352	0.304	0.344	0.268	0.384	0.221	-0.072	0.132	0.173	0.144	0.221	0.276	0.310	0.253	0.197	0.395
Q 3			1.000	0.276	0.285	0.242	0.418	0.369	0.388	0.333	0.421	0.484	0.344	-0.003	0.139	0.125	0.187	0.179	0.380	0.311	0.319	0.240	0.401
Q 4				1.000	0.363	0.275	0.342	0.313	0.260	0.308	0.338	0.335	0.244	-0.023	0.247	0.196	0.094	0.169	0.295	0.334	0.331	0.383	0.413
Q 5					1.000	0.292	0.249	0.190	0.222	0.271	0.351	0.247	0.284	0.059	0.258	0.110	0.159	0.128	0.290	0.196	0.362	0.364	0.381
Q 6						1.000	0.240	0.350	0.304	0.368	0.210	0.368	0.280	0.096	0.154	0.076	0.202	0.227	0.194	0.164	0.157	0.253	0.223
Q 7							1.000	0.458	0.308	0.349	0.419	0.509	0.454	0.054	0.198	0.157	0.079	0.294	0.261	0.271	0.264	0.236	0.359
Q 8								1.000	0.423	0.367	0.407	0.512	0.342	-0.036	0.179	0.007	0.170	0.294	0.298	0.249	0.278	0.178	0.372
Q 9									1.000	0.316	0.338	0.407	0.439	0.000	0.174	0.056	0.085	0.247	0.388	0.238	0.283	0.228	0.396
Q 10										1.000	0.558	0.430	0.395	0.177	0.222	0.161	0.279	0.375	0.222	0.331	0.264	0.253	0.327
Q 11											1.000	0.483	0.401	0.200	0.324	0.101	0.152	0.316	0.299	0.283	0.303	0.248	0.321
Q 12												1.000	0.468	0.224	0.248	0.273	0.217	0.417	0.312	0.348	0.320	0.278	0.384
Q 13													1.000	0.151	0.368	0.186	0.239	0.367	0.459	0.346	0.496	0.328	0.450
Q 14														1.000	0.371	0.298	0.058	0.179	0.119	0.129	0.051	0.119	-0.062
Q 15															1.000	0.312	0.121	0.189	0.288	0.264	0.321	0.295	0.192
Q 16																1.000	0.253	0.281	0.176	0.232	0.167	0.202	0.081

Q 17																	1.000	0.334	0.210	0.333	0.193	0.239	0.183
Q 18																		1.000	0.197	0.320	0.195	0.252	0.118
Q 19																			1.000	0.279	0.448	0.393	0.423
Q 20																				1.000	0.497	0.408	0.331
Q 21																					1.000	0.453	0.402
Q 22																						1.000	0.487
Q 23																							1.000

Qn: question number

Appendix H: Interview questions

Residential Building Projects Survey

Title of Project: Improving collaboration to minimise the energy gap between design and as-built performance in residential building projects
Residential buildings are consuming a large amount of energy. One of the reasons for this consumption is found to be lack of collaboration between involved parties. Collaboration, a joint effort toward a group goal, has been proven to be a successful way to improve the performance of building projects. However, delivering a collaborative process is found to be a challenge, and factors contributing to this process may vary in different locations.
In this research, we have used a questionnaire survey to collect perceptions of construction professionals about improving collaboration in the construction industry in Kurdistan. We have then used the results to develop a framework that aims at improving collaboration in the residential construction projects.

*Required

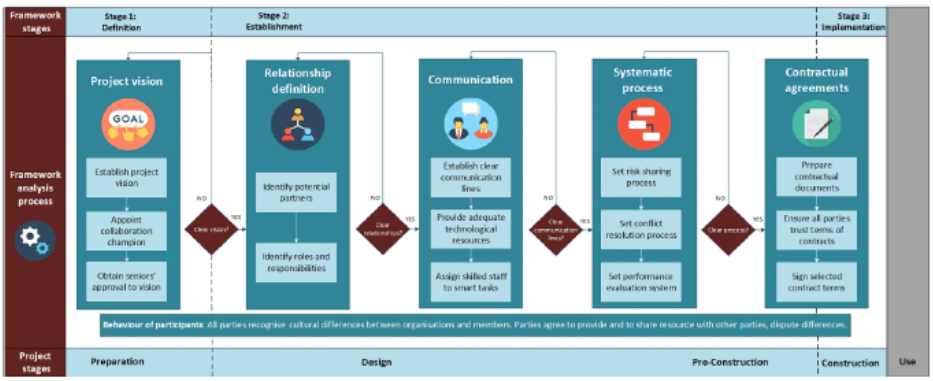
Confidentiality statement

This survey is a part of a PhD project at the University of Portsmouth. You are invited to give your opinion on a framework about collaboration in the construction industry. Participation in this research is entirely voluntary. The collected data will made anonymous and will remain confidential. If you wish, you can withdraw from the survey at any time. Your opinion and thoughts are important and your participation is highly appreciated.
Thank you for taking time to read this section, if you agree to participate please follow the next step.

UNIVERSITY OF PORTSMOUTH

COLLABORATION FRAMEWORK

The aim of the following framework is to improve collaboration on construction projects. Please look at the framework outlined below in order to answer the following questions



The framework consists of six factors: project vision, relationship definition, communication, systematic process, contractual agreements and behaviour of participants. These factors are distributed over the project lifecycle stages: preparation, design, pre-construction and construction. Each factor is divided into a set of tasks (conditions). To provide the specific factor, those tasks must be undertaken. If the tasks under a factor are undertaken successfully, the process will move on to the next step and so on. Additionally, the framework suggests appointing a collaboration champion at the preparation stage by agreement between the client and contractor. Then, the collaboration champion will be responsible for monitoring and delivering collaboration process.

1. **Does the framework make sense?** *

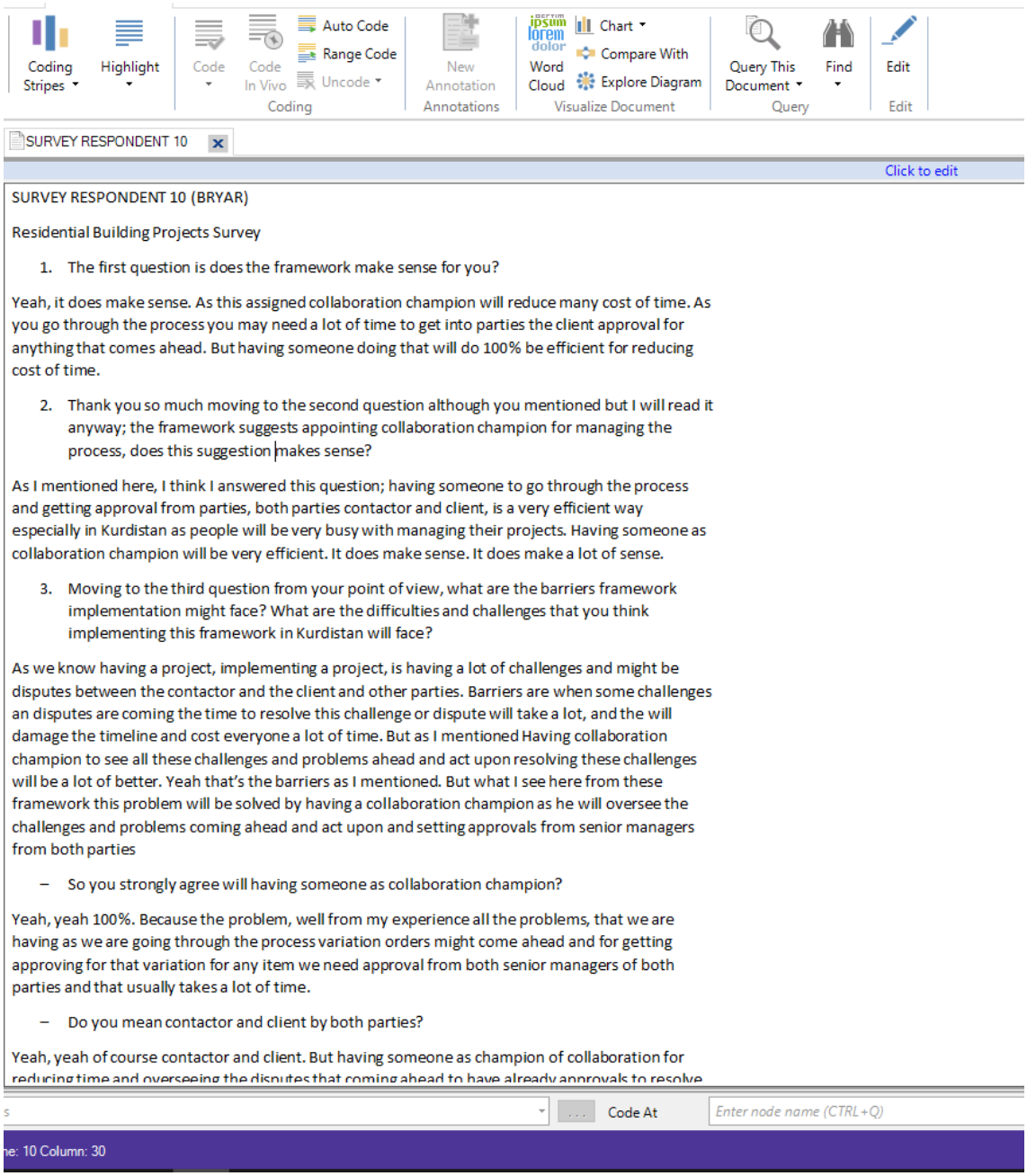
2. **The framework suggests appointing collaboration champion for managing the process. Does this suggestion make sense?** *

3. **From your point of view, what are the barriers framework implementation might face?** *

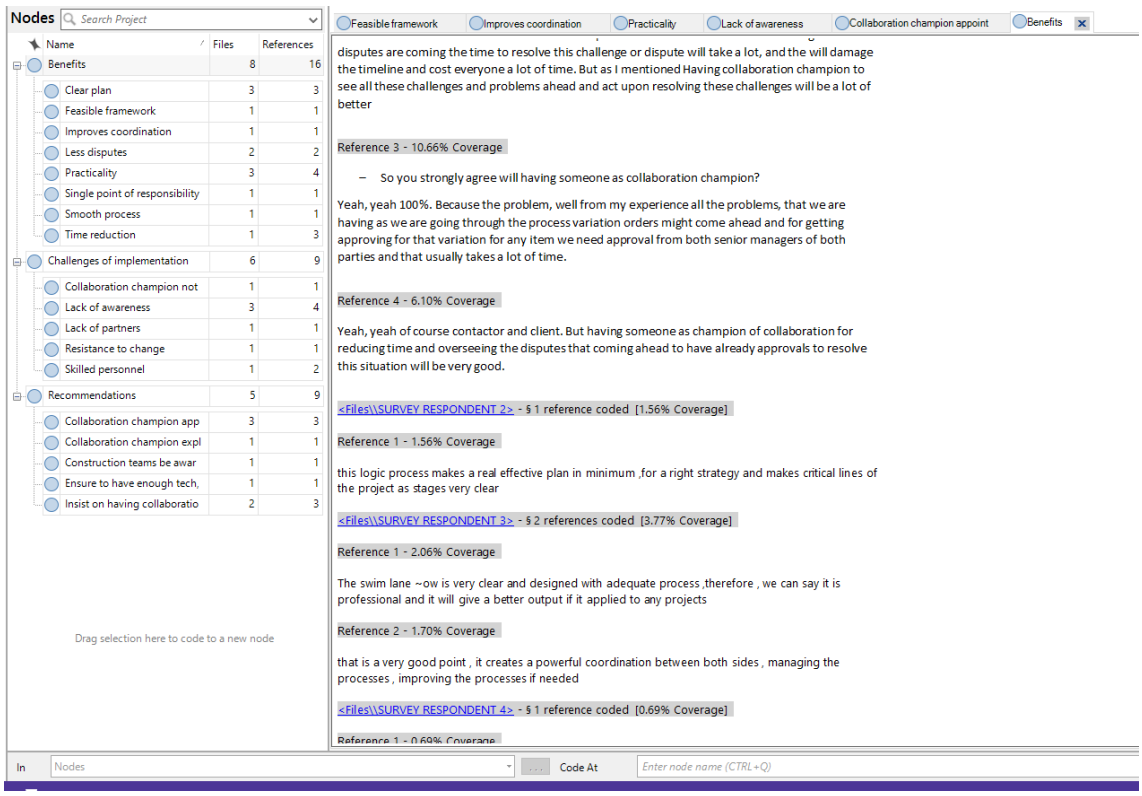
4. **Please add any additional recommendation that you have** *

Appendix I: An example of Nvivo analysis

Interview transcript in Nvivo:



Identifying themes in interview transcripts:



FORM UPR16

Research Ethics Review Checklist

Please include this completed form as an appendix to your thesis (see the Research Degrees Operational Handbook for more information

Postgraduate Research Student (PGRS) Information				Student ID:	750549
PGRS Name:	Hazhar Mohammed Ameen Faris				
Department:	SCES	First Supervisor:	Mark Gaterell		
Start Date: (or progression date for Prof Doc students)	01/02/2017				
Study Mode and Route:	Part-time ☐	MPhil ☐	MD ☐		
	Full-time ☒	PhD ☒	Professional Doctorate ☐		

Title of Thesis:	Improving Project Collaboration to Minimise the Energy Performance Gap in Residential Construction. Case study of Kurdistan
Thesis Word Count: (excluding ancillary data)	44777

If you are unsure about any of the following, please contact the local representative on your Faculty Ethics Committee for advice. Please note that it is your responsibility to follow the University's Ethics Policy and any relevant University, academic or professional guidelines in the conduct of your study

Although the Ethics Committee may have given your study a favourable opinion, the final responsibility for the ethical conduct of this work lies with the researcher(s).

UKRIO Finished Research Checklist:
(If you would like to know more about the checklist, please see your Faculty or Departmental Ethics Committee rep or see the online version of the full checklist at: http://www.ukrio.org/what-we-do/code-of-practice-for-research/)

a) Have all of your research and findings been reported accurately, honestly and within a reasonable time frame?	YES ☒ NO ☐
b) Have all contributions to knowledge been acknowledged?	YES ☒ NO ☐
c) Have you complied with all agreements relating to intellectual property, publication and authorship?	YES ☒ NO ☐
d) Has your research data been retained in a secure and accessible form and will it remain so for the required duration?	YES ☒ NO ☐
e) Does your research comply with all legal, ethical, and contractual requirements?	YES ☒ NO ☐

Candidate Statement:

I have considered the ethical dimensions of the above named research project, and have successfully obtained the necessary ethical approval(s)

Ethical review number(s) from Faculty Ethics Committee (or from NRES/SCREC):	TECH 2018 - H.F- 01

If you have *not* submitted your work for ethical review, and/or you have answered 'No' to one or more of questions a) to e), please explain below why this is so:

Signed *(PGRS)*:		**Date:** 19/05/2020

UPR16 – April 2018