STAKEHOLDER MANAGEMENT WITHIN BIM IMPLEMENTED PROJECTS IN THE UK CONSTRUCTION INDUSTRY

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ABSTRACT

Over the last decade, the use of Building Information Modelling (BIM) has proliferated to manage the increasing complexity of construction projects. Project managers face challenges while managing stakeholders on BIM-implemented projects because the BIM concept is still relatively new to many stakeholders. The implementation of BIM brought new and complex activities to the already complex process of project management, which led to radical change in the working practices of project stakeholders and generated risk for diverse areas. In this study, the challenges, techniques, enablers and benefits of managing stakeholders within BIM-implemented projects were investigated. This exploratory study adopts a qualitative approach with an interpretative stance at its core, which is an appropriate approach to adopt when the variables and theory base are not known. Pilot study was conducted to test the research instrument. A total of 23 semi-structured interviews were conducted in the UK, via purposive and snowball sampling techniques. The data gathered was analysed using content analysis and the NVivo 11 Pro software. The findings include a persisting low understanding of the BIM concept in project team, especially the client. The users' resistance to change, and disintegration of BIM and traditional teams leads to unanticipated issues. Holding face-to-face meetings with client at the onset of a project for discussing BIM process and arranging frequent meetings of BIM users among themselves are the key techniques of mitigating issues proactively. Furthermore, organisations should create a sharing and learning environment to encourage and facilitate adoption of BIM. The effective management of stakeholders leads to generating good quality information, avoiding unanticipated issues and assists in understanding the result clearly. A descriptive framework was developed and validated. This framework provides requirements that needs to be integrated during stakeholder management in BIM projects. Every construction project has a unique set of stakeholders. Therefore, project managers should conduct a BIM assessment of all key stakeholders and develop a bespoke stakeholder management plan based on that. BIM has a huge potential to manage stakeholders effectively on construction projects. Even the roles that are not directly/indirectly related to BIM can benefit from increased and better communication and collaboration. Communication, collaboration, stakeholder engagement, trust, common goals, technology and people are at the core of managing stakeholders within BIM projects. Top management should proactively support stakeholder management plan because the lack of knowledge and understanding of BIM among project participants on an ongoing project may lead to conflicts. Larger organisations should help smaller organisations on BIM-implemented projects because smaller organisations usually do not have enough budget to train their staff. To date, researchers have focused on implementation of BIM and stakeholder management aimed at the micro level with little attention to the effect of new digital ways of working with stakeholder. This research provides a richer understanding and awareness of the enablers and techniques, which organisations have to focus on while making strategies in order to face minimum resistance from stakeholders. The study is unique in a way that it considers BIM from a management perspective, especially the stakeholder management. The previous studies have identified challenges of BIM in isolation. The enablers, techniques and benefits pertaining stakeholder management were identified and prioritised in the context of BIM. Furthermore, this study has established new ways which managers can adopt to manage stakeholders in addition to technical approaches.

Keywords: Benefits, Building Information Modelling (BIM), challenges, construction projects, qualitative research, stakeholder management, techniques.

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APM – Association for Project Management

BEP – BIM Execution Plan

BIM – Building Information Modelling

BPM – Building Product Model

BSI – British Standards Institution

CDE – Common Data Environment

CIC – Construction Industry Council

CIFE – Centre for Integrated Facility Engineering

CMC – Computer-mediated communication

CMR – Construction Manager at Risk

CSFs – Critical Success Factors

DB – Design-Build

DBB – Design Bid Build

DIM – Digital Information Modelling and Management

EIR – Employer's Information Requirements

FAME – Financial Analysis Made Easy

HS2 – High Speed 2

ICT – Information and Communication Technology

IGLC – International Group for Lean Construction

IPD – Integrated Project Delivery

IS – Information Systems

IT – Information Technology

LCPs – Lean Construction Practices

LOD – Level of Detail

NBIMS – National Building Information Model Standard

NBS – National Building Specification

PAS – Publicly Available Specification

PLQs – Plain Language Questions

PM4D – Project Model and Fourth Dimension

PMBOK – Project Management Body of Knowledge

PPPs – Public Private Partnerships

QDA – Qualitative Data Analysis

RFID – Radio Frequency Identification Devices

SMP – Stakeholder Management Process

SRI – Stanford Research Institute

STEP – Standard for the Exchange of Product Data

TIDP – Task Information Delivery Plan

TPS – Toyota Production System

UK – United Kingdom

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DEDICATION

This thesis is dedicated to:

My parents

And

My wife

DECLARATION

The PhD candidate has conducted all the research, and no portion of the research referred to in this thesis has been submitted in support of an application for another degree or qualification at this or any other university or other institution of learning.

Chapter 1 : INTRODUCTION

This chapter discusses the research problem, research aim, objectives, research questions, benefits of the research and contribution to knowledge. Furthermore, it also presents the structure of the thesis.

1.1 The statement of the problem

Construction projects are becoming much more complex and create challenges in both social and technical domains, making it difficult for large projects to be managed (Wang *et al.*, 2020 and Alshawi and Ingirige, 2003). One of the complexities is the enormous range of diverse stakeholders that can be related to projects (Bryde *et al.*, 2013), which has escalated complications between the relationships of various stakeholders in the construction industry (Wang *et al.*, 2020). Construction projects attract interest from diverse stakeholders, and they affect and are affected by this enormous number of stakeholders (Olander, 2007) who each has their own needs and expectations that they want to be fulfilled. These needs and expectations are often in conflict with one another. It is unlikely that all will be addressed adequately, giving rise to different priorities and conflicts (Olander, 2007 and Karlsen, 2002). It is a significant challenge in the construction industry to make employees from different organisations work collaboratively towards a common goal (Tauriainen *et al*., 2016).

For managing the increasing complexity of the projects, information and communication technology (ICT) is being deployed more frequently. Over the last decade, the proliferation of Building Information Modelling (BIM) has been a significant shift in terms of ICT use in the construction industry (Mellado and Lou, 2020 and Bryde *et al.*, 2013). In project management, less than 5% of projects related to software fail due to technical risks and immature technologies. The primary reason for their failure is people-related issues (McManus, 2002), as innovation in IT takes place in a controlled environment, but its implementation involves complex interactions of people in the workplace dealing with the technology (Peansupap and Walker, 2005). Furthermore, the construction industry is a project-based industry and diverse project teams come together to deliver a project. The teams change depending on the projects. This unique nature of the construction industry contributes significantly to increasing the time required for innovations to be integrated into working practices (Hochscheid and Halin, 2020). BIM implementation has brought new and complex activities to the already complex process of project management (Liu *et al*., 2017), thus affecting the processes and work practices within organisations. Therefore, it has led to radical change in the working practices of project stakeholders and generated risk for diverse areas (Lindblad and Vass, 2015 and Khosrowshahi and Arayici, 2012). Therefore, BIM implementation is a risky process for organisations (Hochscheid and Halin, 2020). Effective management, coupled with successful integration of tools and methodologies, is imperative to deliver projects successfully (Mellado and Lou, 2020).

There is a great deal of literature discussing the technical capabilities of 3D, 4D and 5D aspects of BIM, ranging from their common uses such as visualisations, project planning and cost estimations, to highly advanced uses: for instance, Providakis *et al.* (2019) merged 3D visualisation data with geotechnical data to predict and assess the settlement effect induced by tunnelling on nearby buildings; Sheikhkhoshkar *et al.* (2019) used 4D BIM to develop an automated programme for the correct positioning of concrete joint layouts to mitigate the adverse effects of incorrect placing of the joints while concrete pouring; Guerra *et al.* (2020) used a 4D BIM simulation approach to minimise the production of waste during construction stage and to maximise reuse and recycling of the waste; and Chen *et al.* (2019) merged 5D BIM with Radio Frequency Identification Devices (RFID) to reduce uncertainties and to improve the coordination process between supply chains in pre-fabricated projects. However, there is a lack of research explaining how the implementation of BIM affects the management aspect of projects, especially stakeholder management, i.e., **what challenges they are facing, how BIM can assist and what techniques can assist in managing stakeholders. Therefore, this research will explore the effect of BIM on stakeholder management.**

1.2 Research aim and objectives

This research aims to explore how BIM enhances stakeholder management in the UK construction industry and explore any associated challenges. In order to do this, the following objectives will be examined:

1. To explore stakeholder management and BIM concepts in the context of the construction industry.
2. To explore how BIM can assist with stakeholder management.
3. To investigate the key challenges that construction organisations face while managing stakeholders within BIM-implemented projects.
4. To explore the key techniques organisations are using for managing stakeholders effectively.
5. To study the key benefits of managing stakeholders effectively within BIM-implemented projects.
6. To develop and validate a framework for managing stakeholders effectively within BIM-implemented projects.

1.3 Research questions

The following research questions were posed for the study:

- How does BIM assist in stakeholder management?
- What are the key challenges of managing stakeholders within BIM-implemented projects?
- What are the key techniques used to manage stakeholders within BIM-implemented projects?
- What are the key benefits of managing stakeholders within BIM-implemented projects?

1.4 The development of the research questions and their usage

The research questions were developed after critically reviewing the literature. The first research question 'how does BIM assist in stakeholder management' was developed following a review on the topics of stakeholder management and BIM. There is a wide variety of literature on how BIM can assist architects, engineers and quantity surveyors to design buildings better, efficiently and within the iron triangle of cost, time and quality. However, there is a paucity of literature discussing how it can also help project managers to manage projects more efficiently, especially stakeholder management.

The second research question 'what are the key challenges of managing stakeholders within BIM-implemented projects' was developed after identifying various challenges of BIM implementation and the critical success factors of stakeholder management. The challenges identified in the literature are neither interpreted in the terms of stakeholder management nor are they prioritised to identify the key challenges project managers face.

The third question ‘what are the key techniques used to manage stakeholders within BIM-implemented projects’ was developed after reviewing the literature on various stakeholder management processes and tools. As BIM processes require project stakeholders to work differently, it is of paramount importance to investigate the techniques managers use to tackle the unique challenges that arise in the context of BIM-implemented projects.

The last research question ‘what are the key benefits of managing stakeholders within BIM-implemented projects’ was developed after reviewing the literature on the benefits of BIM and the benefits of stakeholder management. There is a clear need to establish benefits in the context of BIM projects. The developed research questions are used in the form of a research instrument (Appendix D).

1.5 Operational definition of stakeholder management, BIM and stakeholder management within BIM-implemented projects

The operational definition of stakeholder management is adopted from the APM Body of Knowledge (2012, p. 116) which defined stakeholder management as “the systematic identification, analysis, planning and implementation of actions designed to engage with stakeholders.” The operational definition of BIM is adopted from Succar (2009, p. 357) as “a set of interacting policies, processes and technologies that generate a methodology to manage the essential building design and project data in digital format throughout the building’s life cycle.”

The operational definition of stakeholder management within BIM-implemented projects is proposed as:

The systematic identification, analysis and planning of actions to implement BIM tools, protocols and procedures effectively to develop and maintain productive relationships with stakeholders in addition to an organisation's already established practice of managing stakeholders.

1.6 Research methodology in brief

Due to the lack of literature on the topic, this study adopted an exploratory approach. The research is inductive due to its constructivist ontological stance. Purposive sampling and snowball sampling were adopted for recruiting participants. Primary data were obtained from 23 semi-structured interviews, which were analysed using content analysis with the help of NVivo 11 Pro software.

1.7 Theoretical background of the research

The theoretical background of this research is based on the Technology-Organisation-Environment (TOE) theory. It is an organisational-level theory which explains how the context of an organisation affects the adoption and implementation of an innovation. It organises organisational context into three categories, namely the technological, organisational and environmental contexts, and explains how these three elements influence the technology adoption decisions of an organisation (Baker, 2011).

Technological context – incorporates the technologies which an organisation is already using and also the technologies which are in the market, but an organisation is not using yet (Baker, 2011). These technologies may include either equipment or practices (Alshamaila and Papagiannidis, 2013).

Organisational context – refers to characteristics and resources of a firm, including linking structures between employees, firm size, number of slack resources and intra-firm communication processes. Stating the importance of innovation in a firm's overall strategy, emphasising the history of innovation in an organisation, developing a skilled executive team which can effectively disseminate the vision of an organisation's future and rewarding innovation both formally and informally, etc. are parts of top management leadership behaviour and communication processes (Baker, 2011).

Environmental context – refers to an environment in which an organisation operates. It deals with the structure of the industry, presence or absence of technology providers (technology support infrastructure), competition and the regulatory environment. For instance, powerful competition can stimulate the adoption of technology and dominate firms in a value chain can influence others to adopt technology (Baker, 2011).

Other theories which deal with ICT innovation and adoption are the diffusion of innovation (DOI) theory, theory of planned behaviour, theory of reasoned action and the technology acceptance model. The TOE and DOI theories are similar in many aspects, which are depicted in Table 1.1.

Table 1.1: Similarity between TOE theory and DOI theory (adapted from Baker, 2011)

TOE theory	**DOI theory**
Technological context	Technological characteristics of innovation
Organisational context	Individual leader characteristics; internal characteristics of organisational structure
Environmental context	External characteristics of organisation

Despite being similar, the TOE theory was adopted because of the following reasons discussed by Alshamaila and Papagiannidis (2013):

1. Due to its environmental context, TOE theory explains intra-firm innovation adoption better than DOI theory.
2. It has a more solid theoretical basis and empirical support.
3. Compared to DOI theory, TOE theory overcomes the dominance of technological context in a better way. Therefore, it provides a better platform to distinguish between the innate qualities of an innovation and broader environmental context, motivations and capabilities of an adopting organisation.
4. Other theories used in adopting ICT frameworks can be considered as variants of the TOE theory in which some dimensions of the TOE theory are subdivided.

1.8 Benefits of the research

The study will be of benefit to project managers and contractor organisations who face challenges in effectively managing stakeholders within BIM-implemented projects. The results of the study will:

1. Increase the project managers' awareness of how they can leverage BIM to make informed decisions for managing stakeholders.
2. Raise project managers' awareness of the challenges they would encounter on BIM-implemented projects of managing stakeholders.
3. Inform the top management of construction companies of the areas in which they should formulate strategies for improving stakeholder management in their organisations.
4. Raise awareness about the techniques which can assist in managing stakeholders within BIM-implemented projects.
5. Assist more effectively with collaboration between stakeholders within BIM-implemented projects.

1.9 Contribution to the body of knowledge

This research adopted an exploratory approach and hence, contributed practically, leading to the following empirical findings:

- This study has established new ways which managers can adopt to manage stakeholders in addition to technical approaches.
- This study has identified new challenges of stakeholder management and prioritised the existing ones, in a way that has not been done before.
- This study has identified and prioritised the enablers and techniques which managers should focus on from the onset of a project to align stakeholders with the project's objectives.
- This study has prioritised the benefits of managing stakeholders.
- This study has developed a framework for managing stakeholders within BIM-implemented projects that will assist project managers in formulating strategies and using BIM tools more effectively for managing stakeholders.

1.10 Scope and limitations

This study was focused on the UK construction industry. Nevertheless, the findings can be replicated in construction industries in other nations that have adopted BIM or are willing to adopt BIM. Furthermore, some of the findings (especially the challenges identified in this study) can be replicated in other industries that are looking to integrate information technology (IT) to modernise their working practices. As the research is geographically limited to the UK construction industry, similar research can be performed in other countries. The findings can then be compared. Being qualitative in nature, the sample size of this study was limited. So, quantitative research can be adopted to investigate the variables provided by this study on a larger scale.

1.11 Structure of the thesis

This thesis follows a logical sequence, commencing with Chapter One (Introduction) and ending with Chapter Nine (Conclusions and recommendations). The structure should enable the reader to understand how the research objectives were accomplished. The overview of the structure is presented in Figure 1.1. The rest of this thesis is structured is as follows:

Chapter Two is based on a literature review of the topic of stakeholder management. It begins by critically discussing the definition of the term “stakeholders” and examines various classifications related to stakeholders. Subsequently, it proceeds to explore stakeholder theory, the critical success factors for stakeholder management, stakeholder management processes and stakeholder management tools. This chapter addresses part of objective one of this research.

Chapter Three is also based on a literature review. It critically discusses the literature on topics related to Building Information Modelling (BIM). It commences by discussing the definition of BIM. Subsequently, it covers the key areas, i.e., factors that affect the efficiency of BIM, the effect of a procurement approach on BIM, a discussion on BIM publications and benefits and barriers in BIM implementation. This chapter addresses part of objective one of this research.

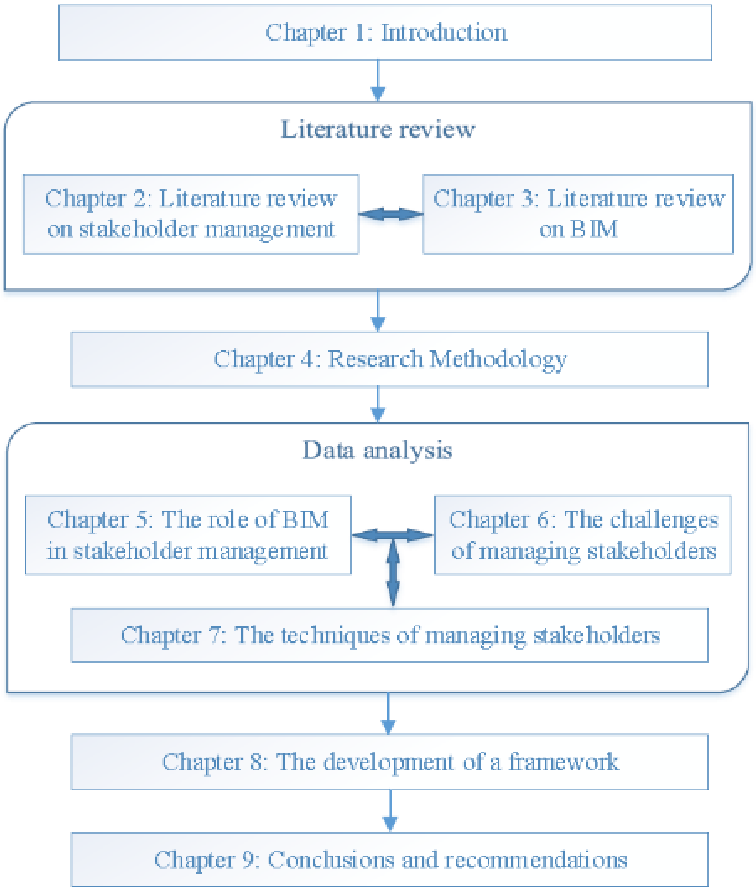

Figure 1.1: Structure of the thesis

Chapter Four discusses the research methodology adopted. It discusses the researcher's stance on research philosophies, research methodology, sampling, pilot study and data analysis method, among others.

Chapter Five discusses the results from both the pilot study and the main study. It presents the results from the preliminary questions asked at the beginning of the interviews. This is followed by pertinent questions. The chapter discusses the role BIM plays in stakeholder management, which is covered under five themes: enhances the pre-planning process, improves collaboration, a better understanding of the project workflow, improves communication and improves information flow. Chapter Five concludes with a summary indicating that the assistance of BIM in the pre-planning process is a key role in stakeholder management. This chapter addresses objective two of this research.

Chapter Six focuses on the challenges that make stakeholder management difficult in BIM-implemented projects. It discusses five key themes that emerged from the data analysis: lack of understanding of the BIM concept, resistance to change, lack of integration of BIM technologies, lack of incentives, training and education issues. This chapter concludes that a lack of understanding of the BIM concept is the key factor creating issues among stakeholders within BIM-implemented projects. This chapter addresses objective three of this research.

Chapter Seven discusses the key techniques that should be adopted to effectively manage stakeholders. It discusses four key themes: learning experience, meetings, online collaboration, and creating a sharing and learning environment. This chapter concludes that the learning experience is a key technique for managing stakeholders. This chapter examines the benefits of managing stakeholders and addresses objective four and five of this research.

Chapter Eight explains the development of a framework and addresses objective six of the study.

Chapter Nine focuses on the conclusions and recommendations drawn from this study.

Chapter 2 : LITERATURE REVIEW – STAKEHOLDER MANAGEMENT

2.1 Introduction to Chapter 2

In the 1990s, the ‘stakeholder approach’ resulted in an effective way to understand an organisation in its habitat, which aimed to extend management’s horizon of roles and responsibilities to incorporate claims and interests of non-stockholding entities, rather than only focusing on profit maximisation (Mitchell *et al.*, 1997). The terms ‘stakeholder’, ‘stakeholder theory’, ‘stakeholder model’ and ‘stakeholder management’ are interpreted by different authors in different ways and are supported with diverse and usually contradictory arguments (Donaldson and Preston, 1995). Different stakeholders have different interests. Sometimes these interests conflict, and sometimes they align (Orts and Strudler, 2009).

A critical review of stakeholder management was conducted to address objective one. This chapter comprises 13 sections. The first section introduces the chapter. The second section critically reviews the literature on the definition of the term ‘stakeholder.’ The third section discusses stakeholders as perceived by the construction industry. The fourth section discusses the literature on various types of stakeholder classifications. The fifth and sixth sections critically review stakeholder theory and stakeholder management, respectively. The seventh section discusses Critical Success Factors (CSFs) for managing stakeholders. Stakeholder management processes (SMP) and stakeholder mapping tools follow this in the eighth and ninth sections, respectively. The 10th section discusses the consequences of not managing stakeholders. The 11th section discusses the case studies, and the 12th section presents the research gap. The chapter closes with a summary.

2.2 Definitions of Stakeholder

According to Clayton (2014, p. 6), the Oxford English Dictionary (OED) (2^{nd} ed, 1991) tracked roots of the word stakeholder back to 1708 and defined it as “the holder of a wager”, although the OED was uncertain as to why the word ‘stake’ was used. Ramirez (1999, p. 101) agreed that the word ‘stakeholder’ originated in 1708 but defined the term as “a person who holds the stake or stakes in a bet.” Olander (2007) described stake as actual or perceived benefits or risks/harms due to the activities of an organisation.

According to Clayton (2014) and Freeman and Reed (1983), the Stanford Research Institute (SRI) started exploring the terms ‘shareholder’ and ‘stockholder’ in 1963, coined the term ‘stakeholder’ from the research conducted and incorporated the term ‘stakeholder’ into their corporate planning process. According to Mitchell *et al.* (1997), the concept originated from the idea of corporate social responsibility. During the late 1960s and early 1970s, apart from the researchers at the SRI very few researchers endeavoured to work on the concept of stakeholders. This was the primary reason the concept matured gradually during this period (Freeman and Reed, 1983).

There are many definitions of the term ‘stakeholder,’ which can be broadly divided into two categories: namely, broad definitions and narrow definitions. Broad definitions are based on an opinion that virtually anyone can affect or be affected by a firm’s actions, whereas narrow definitions are based on the practical reality that managers cannot attend to all actual or potential claims. Hence, managers have to prioritise various things. The narrow view defines stakeholders in terms of their straight relation to an organisation’s core economic interests, based on the pragmatic reality that resources, time and attention are limited. Moreover, managers have limited patience to deal with external constraints and have limited cognitive capacity.

On the contrary, the broad view covers entities that may or may not have genuine claims but can affect the interests of those who do have valid claims (Mitchell *et al.*, 1997 and Phillips, 2003). From the broad view perspective, animals, plants, non-living entities such as ecology or natural environment and even the unborn generations are also stakeholders if they are potentially affected by the actions of an organisation (Amaeshi, 2010). However, researchers such as Phillips (2003), who are in favour of a narrow perspective, argued that if everyone is a stakeholder to everyone, then the term is useless in itself. They further argued that such a stakeholder theory which requires managers to pay attention to those who have no relationship with the organisation would be extremely comprehensive, which will consequently make it less useful.

Various researchers and bodies of knowledge have defined the term 'stakeholder' in multiple ways. There is no consensus globally on the definition of the word 'stakeholders.' For instance, Mitchell *et al.* (1997) listed a whole set of definitions in chronological order. Freeman (1984, p. 46) gives the most famous, broadest definition of 'stakeholder': "any group or individual who can affect or is affected by the achievement of the firm's objectives." Jergeas *et al.* (2000) have mentioned four different definitions proposed by various researchers. All these definitions are different from the definition proposed by the Project Management Body of Knowledge (PMBOK). Even the definition in the PMBOK 4th edition (2008) is different from the definition in the PMBOK 5th edition (2013).

The PMBOK 4th ed. (2008, p. 23) states that "stakeholders are persons or organisations (e.g., customers, sponsors, the performing organisation, or the public), who are actively involved in the project or whose interests may be positively or negatively affected by the performance or completion of the project." Meanwhile, the PMBOK 5th edition (2013, p.

30) states that “a stakeholder is an individual, group, or organisation who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project.” There is a clear distinction between the two definitions, with the second definition being broader in range. The word ‘persons’ is in plural form in the first definition, which is divided into the singular and plural form in the second definition (by using words ‘individual’ and ‘group’). Moreover, the first definition incorporates those who are actively involved in the project as stakeholders, whereas from the following definition, it can be inferred that even those who are not actively involved but still involved to some extent are also stakeholders. Furthermore, the PMBOK 5th edition’s definition expands the boundary to include even those who perceive they would be affected by the outcomes of the project. The inclusion of this point makes the scope of the term ‘stakeholder’ virtually limitless. The Association for Project Management (APM) 6th edition (2012, p. 116) defines stakeholders as “individuals or groups with an interest in the project, programme or portfolio because they are involved in the work or affected by the outcomes.” This definition is similar to the definition in PMBOK 4th edition (2008) and is less broad in scope.

Freeman’s (1984) definition is such a broad definition that it only excludes those from the stakeholder list who cannot affect the firm (have no power) and are not affected by it (have no relationship or claim) (Mitchell *et al.*, 1997). Due to the comprehensiveness of this definition, it fails to provide any normative base for the identification of stakeholders (Argandona, 1998). Orts and Strudler (2002) stated that virtually anyone or anything could affect or be affected by the actions or decisions of an organisation. It makes the stakeholder domain so broad that the term itself becomes meaningless and so utterly complex to be of any practical use.

One of the most famous narrow view definitions is proposed by Clarkson (1994), who described stakeholders as voluntary or involuntary risk-bearers. The author described voluntary risk-bearers as those who are under some risk because they have invested some capital (financial or human) or something valuable in an organisation. Involuntary risk-bearers are those who are at risk due to the activities of an organisation. The author specified that without an element of risk, there is no stake. He perceived stake as something which can be lost. However, Clarkson's definition in 1995 is contradictory to his own 1994 definition. Clarkson's 1995 definition states, "stakeholders are persons or groups that have, or claim, ownership, rights, or interests in a corporation and its activities, past, present, or future. Such claimed rights or interests are the results of transactions with, or actions taken by, the corporation, and maybe legal or moral, individual or collective" (1995, p. 106). Now, basing interest on the element of morality means it is a broad view definition. Even Orts and Strudler (2002) argued that Clarkson's narrow view definition is more plausible than the broad one.

Bourne and Walker (2006) mentioned that a stake could be ownership, an interest or a right. An 'interest' is a situation in which an individual or a group of individuals will be affected by a decision. A 'right' can be a legal or moral one. An 'ownership' is the legal authority of an asset.

Freeman and Reed (1983) proposed a definition based on both views. In the broad view, they defined stakeholders as "an individual or group who can affect the achievement of an organisation's objectives or who is affected by the achievement of an organisation's objectives". This definition is similar to the definition proposed by Freeman in 1984. Their narrow definition is identical to the definition proposed by the Stanford Research Institute (SRI) in 1963 as "those groups on which the organisation is dependent for its continued survival”. The SRI in 1963 defined it as “those groups without whose support the organisation would cease to exist” (Freeman and Reed, 1983, Mitchell *et al.*, 1997 and Olander, 2007).

Donaldson and Preston (1995, p. 67) defined stakeholders as “persons or groups with legitimate interests in procedural and/or substantive aspects of corporate activity.” This view is narrow because it does not consider who perceives they have a stake (whether it is legitimate or not) as stakeholders. However, it creates an ambiguity regarding whose interests will be considered legitimate. Donaldson and Preston (1995) further stated that stakeholders are identified depending on their interest in an organisation. This viewpoint increases the domain of ‘stakeholder’ considerably, because virtually anyone could be the stakeholder. Hence, both statements are contradictory to each other.

Olander (2007) defined stakeholders as those individuals or groups of individuals who have a vested interest in the success of a project and the environment in which the project gets executed. For this definition, they defined vested interest as someone who possesses all or at least one attribute from power, legitimacy and urgency.

Jespen and Eskerod (2009), in their empirical research, investigated that project managers did not prefer to list all the potential stakeholders in their analysis because they considered the number of potential stakeholders would be unlimited. Project managers preferred to develop a list of only crucial stakeholders. Moreover, project managers found it difficult to visualise all the stakeholders at the beginning of the project. Thus, project managers said that it was difficult to perform a detailed stakeholder analysis at the beginning of the project, and said it was not worthwhile even to perform one. Furthermore, project managers postulated that it was impossible to foresee interactions with stakeholders in the far future. Moreover, the contributions required from the stakeholders may vary during different stages and due to unforeseeable activities of the project.

Therefore, it can be inferred that project managers do not adopt a broad view perspective when it comes to delivering projects in a real-world scenario. Young (2013) also stated to prioritise stakeholders. Otherwise, the list can be huge. If project managers give time to all, they may not be able to finish the project; thus, they need to be aware of the presence of these stakeholders and their potential impact on their projects.

Most of these definitions are composed of all three aspects of the stakeholder theory, which are descriptive, instrumental and normative. For instance, the proposed definitions clearly reflect that organisations have stakeholders, which is the descriptive element of stakeholder theory. Regarding the instrumental element, the first part of the definitions proposed by PMBOK (2008) – "who are actively involved in the project"; PMBOK (2013) – "who may affect"; Freeman's (1984) definition – "who can affect"; APM (2012) – "they are involved in the work", explicitly reflects the instrumental aspect of stakeholder theory. These argument points explicitly state that some persons or groups can affect the objectives of a project. Hence, if their interests are not taken care of, they can be a barrier to the successful accomplishment of the project's goals.

The phrases "whose interests may be positively or negatively affected"; "be affected by or perceive itself to be affected by"; "or affected by the outcomes", reflect the normative aspect of stakeholder theory. Furthermore, the phrase in PMBOK (2013) "or perceive itself to be affected by" is an extreme example of the moral (which is normative) aspect of stakeholder theory. It can be inferred from this that it is important to consider the interests of diverse stakeholders prudentially because these stakeholders will be affected by the operations of the project, although they cannot affect the project.

In general, the various definitions define stakeholders ranging from who are actively involved in the project to those who perceive they have an interest in the activities of a project (Jergeas *et al.*, 2000). According to Donaldson and Preston (1995), the broad set of stakeholder definitions reflects morality from their interpretation. Hence, the normative aspect of stakeholder theory is the basis for a broad set of stakeholder definitions. Perhaps, due to the discussion mentioned above, Orts and Strudler (2002) called it a blurred and relatively vague concept.

2.3 Stakeholders in the construction industry

Initially, shareowners, lenders, customers, society, employees and suppliers were listed as stakeholders by the SRI (Freeman and Reed, 1983). Persons, owners, users, organisations, legal authorities, project managers, designers, societies, insurance companies, suppliers, process and service providers, subcontractors, facilities managers, competitors, banks, regulatory agencies, neighbourhoods, institutions, community representatives, government bodies, customers, visitors, regional development agencies, media, environmentalists and even the natural environment can act as genuine or potential stakeholders (Mitchell *et al.*, 1997, Chinyio and Akintoye, 2008 and Aaltonen and Sivonen, 2009).

Heravi *et al*. (2015) has classified clients, consultant and designing teams, project management teams, contractors, sub-contractors, suppliers, employees, local communities, funding bodies and government bodies as major stakeholders on a construction project.

Karlsen (2002) investigated that clients and end-users are the most prominent stakeholders because clients define and finance the project, while end-users decide the usefulness of the project. Furthermore, they identified that consultants are equally important stakeholders as compared to contractors and suppliers. Moreover, they identified that clients, contractors, end users, public authorities and line organisations play an equal role in creating problems for the project. However, the research they conducted was a blend of several industries, namely construction, IT and product and organisational development projects. It can be inferred that most of the major stakeholders are composed of internal stakeholders.

2.4 Classification of stakeholders

2.4.1 General classification

The facts related to project management are socially constructed perspectives that an individual develops. This is due to the reason that facts are merely an interpretation of complex ideas (Walker *et al.,* 2008). Hence, different researchers have classified stakeholders into different categories depending on their perceptions, such as internal and external, inside and outside, direct and indirect; primary and secondary, vested and non-vested stakeholders (Chinyio and Olomolaiye, 2010 and Jergeas *et al.*, 2000), and strategic and moral (McManus, 2002).

Internal stakeholders are the stakeholders who form project coalitions or support projects financially, whereas external stakeholders are the stakeholders who are considerably affected by the project's actions (Chinyio and Olomolaiye, 2010). Olander (2007) defined internal stakeholders as those who involved actively in project execution. Cleland and

Ireland (2006) stated that internal stakeholders play a crucial role in managing the projects.

‘Primary stakeholders’ mean the stakeholders whose continuous participation is necessary for the survival of the organisation. On the other hand, the secondary stakeholders are those who are affected by an organisation’s actions or can affect an organisation’s actions, but they are not necessary for the organisation’s survival (Chinyio and Olomolaiye, 2010). Due to this reason, Jepsen and Eskerod (2009) stated that primary stakeholders should be given more attention than secondary stakeholders. Cleland and Ireland (2006) categorised owners, investors, suppliers and functional groups into this category. The authors classified media, environmental organisations and local communities under the category of secondary stakeholders.

‘Vested stakeholders’ means those stakeholders who have a vested interest in the success of a project and can affect that success by withholding or giving resources. To the contrary, ‘non-vested stakeholders’ means the stakeholders who affect and are affected by the project but have no control over the allocation of resources (Jergeas *et al.*, 2000).

According to McManus (2002), strategic stakeholders are those who can affect the organisation. Hence, managers must address their interests so that the project can achieve its objectives. On the other hand, moral stakeholders are those who are affected due to the activities of a project. They demand some balancing of their interests.

Some stakeholders can be members of more than one classification. So, it is a smart decision to draw a multidimensional plot of stakeholders to capture the full complexity of the situation. Usually, antagonistic stakeholders are fewer in number, but they can be extremely dangerous for project success (Chinyio and Olomolaiye, 2010).

2.4.2 Classification based on attributes

Mitchell *et al.* (1997) classified stakeholders based on the interrelationship of three attributes, namely power, legitimacy and urgency. They proposed these attributes to determine the salience of stakeholders so that managers can choose them accordingly.

Different authors have divided power into different categories. For instance, Mitchell *et al*. (1997) mentioned three types of power, namely coercive, utilitarian and normative. Bourne and Walker (2005) mentioned seven types from the literature (coercive, connection, reward, legitimate, referent, information and expert) and three types (position, personal and political) of power. Mitchell *et al.* (1997) perceived power as the ability to influence an organisation. According to Chinyio and Olomolaiye (2010), power means an ability to persuade, induce or coerce the activities of others. It is demonstrated when one stakeholder manages to impose his or her requirements on other stakeholders. Willer *et al.* (1997, p. 573) defined power as “the structurally determined potential for obtaining favoured payoffs in relations where interests are opposed.” The ‘structurally determined potential’ means that the nature of the relationship (who is dependent on whom) and how much determines who has power (McManus, 2002). Jepsen and Eskerod (2009) stated that power in the context of stakeholder management means the ways the stakeholders can affect the project if there is a conflict, and whether stakeholders can increase their power by collaborating with other stakeholders. Willer *et al*. (1997) argued that power is a different element than influence. Influence does not need to always be due to power. Olander (2007) argued that, based on an empirical analysis, power is the most prominent attribute to be considered (rather than legitimacy and urgency) while making project decisions.

Suchman (1995, p. 574) described legitimacy as "a generalised perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions." The author described three bases for legitimacy, namely pragmatic (which is similar to power), cognitive (which is habitual), and moral (which is normative). Mitchell *et al.* (1997) and Yang *et al.* (2014) adopted this definition for their research. They acknowledged that this definition is imprecise and difficult to operationalise. However, they argued that this definition of legitimacy is acceptable because the social system within which legitimacy is achieved is a system of various analyses, the most common of which are individual, organisational and societal. Furthermore, they argued that legitimacy could be defined and justified differently at various levels of a social organisation.

Chinyio and Olomolaiye (2010) defined legitimacy as the perception of a claim's validity related to a stake. On one side, this perception can be based on the norms, values, beliefs and definitions stated in Suchman's (1995) definition of legitimacy. On the other side, the claimant may perceive that his/her claim is based on these elements, but in reality, it would not be. Even according to Suchman (1995), legitimacy is created subjectively, but is possessed objectively. It is due to the reason that legitimacy is an assumption or perception which represents a reaction of an observer to the organisation as they see it. Olander (2007) defined legitimacy as some risk, whether it is beneficial or harmful relative to an organisation.

According to Phillips (2003), the broad and narrow views of the stakeholder definitions create ambiguity about the scope of the term 'legitimacy.' Phillips (2003) introduced the concept of 'normative legitimacy' and 'derivative legitimacy' to solve the ambiguity of the term 'legitimacy'. The author's argument is based on the theory of fairness proposed by Phillips (1997). Phillips (2003) contradicted the attributes of power and legitimacy in the taxonomy proposed by Mitchell *et al*. (1997). The author argued that the concept of derivative legitimacy solves the issues which Mitchell *et al.* (1997) failed to resolve, such as stakeholder latency and vagueness of stakeholder theory.

Furthermore, the author argued it also addressed the issue of the term 'influencers' mentioned by Donaldson and Preston (1995). Basically, Phillips (2003) has perceived coercive power as derivative legitimacy. In other words, coercive power as the basis of derivative legitimacy. However, according to Jones *et al*. (2007), most of the researchers who have addressed the topic of legitimacy considered 'moral' as the basis for legitimacy. Furthermore, they argued that basing legitimacy on power and habit would be against the tenet of stakeholder theory – which is the moral justification for a stakeholder and an organisation's relationship. However, moral claims are not treated in the same manner by all organisations. The firm-as-contract theory considers the legitimate stakeholders as those who are contractually bound with the organisation. However, the firm-as-contract theory also considers the environmental-related groups as stakeholders by believing that they have loose quasi-contracts with the organisations involved (Donaldson and Preston, 1995).

Urgency is the extent to which stakeholders' claims require instant action. Mitchell *et al.* (1997) argued that urgency is composed of two attributes. They are time sensitivity and criticality. Time sensitivity means the extent after which stakeholders do not accept a delay to attend to their relationships or claims by managers. Criticality means how important that relationship or claim is to the stakeholder.

Olander (2007) argued that power is the most critical attribute that affects the decision-making process of a project. This is because power is an essential element required to raise the impact level. Hence, managers should pay more attention to stakeholders having power for taking proactive actions to manage the negative effects they can put on project outcomes. The author assigned power a value of 0.4, and 0.3 to legitimacy and urgency during data analysis. He did acknowledge all three attributes were of roughly equal importance, although power was slightly more important when compared to the other two. The stakeholders who possess the attribute of legitimacy are the risk bearers. Hence, it is also crucial from a moral perspective to address their needs carefully because they may try to get power, either by themselves or by forming coalitions with other stakeholders. So, in either scenario, the project manager may lose control over the project management process. According to Bourne and Walker (2005), the nature of power, its source, its influence and how it is exercised to manipulate or to contribute to cooperative relationships, all shape procurement strategies and the relationships that develop from them.

2.5 Stakeholder theory

There are different theories to explain the various aspects of an organisation, for instance, neoclassical theory, behavioural theory, cooperative game theory, transaction cost theory, agency theory, firm-as-contract theory and stakeholder theory, among others. Different theories have different purposes. Therefore, they have different validity criteria and different implications (Donaldson and Preston, 1995). At one time, there was a norm that organisations should operate in such a way as to maximise the benefits of shareholders because it was believed that shareowners should be the prime beneficiaries of the organisation's activities. Stakeholder theory emerged to the respond to this belief and contradicted it (Philips, 1997 and Orts and Strudler, 2002). The belief that an organisation has a responsibility to other people and groups in addition to shareowners became what is widely known as stakeholder theory. It was argued that multiple groups have a stake in the operations of an organisation, and hence, managers should consider their stakes in decision making (Philips, 1997). According to Orts and Strudler (2009), the primary aim of stakeholder theory is to solve two major issues: how to manage people fairly and efficiently, and how to determine the extent of an organisation's moral responsibilities beyond its obligations to enhance its profits and economic value.

However, various researchers have argued that stakeholder theory is not a sufficient theory for business ethics (Phillips, 1997). For instance:

1) It does not assist in the identification of stakeholders (Orts and Strudler, 2009 and Phillips, 1997).
2) It is vague and overly broad (Orts and Strudler, 2009).
3) It neither provides a normative justificatory framework for its foundation nor a reference to any justificatory framework (Phillips, 1997 and Donaldson and Preston, 1995).
4) The diverse interests accepted in the stakeholder theories often conflict with each other (Orts and Strudler, 2002), and stakeholder theories do not suggest a concrete method of decision making to balance those diverse interests (Orts and Strudler, 2002 and Orts and Strudler, 2009).

For point 1, Orts and Strudler (2009) argued that the definition of the term ‘stakeholder’ is controversial in itself. Hence, any theory that will be developed based on a controversial term would be ineffective.

For point 2, Orts and Strudler (2009) argued that, based on semantic grounds, the terminology used in the definition of stakeholder theory – for example, once the relevant stakeholders have been identified, then their interests must be balanced – the terms ‘stakeholders’, ‘interests’ and ‘balanced’ are vague terms. However, they acknowledged that vagueness assists in mapping social concerns (ethical issues). But once the ethical issues are identified, the balancing approach (vagueness) does not practically help decision-makers to identify principles or criteria based on which they can make decisions. In other words, it does not assist making informed decisions to consider how strongly moral or instrumental considerations attached to them are. It also does not help in determining when an appropriate balancing has been achieved. The authors further argued that stakeholder analysis is different from stakeholder theory when answering questions related to the overall objective of a business and how the objective of a business is related to ethical values.

Orts and Strudler (2002) argued that stakeholder theory does not adequately address moral obligation for a business to obey the law. Furthermore, they argued that it does not address the issue of environment satisfactorily, i.e., to operate an organisation in an environmentally ethical and responsible way, even though several researchers have tried to incorporate the concept of the natural environment into the definition of the term stakeholder. The reason they stated is that stakeholder theory is limited to focus on the interests of only human participants. Hence, it does not provide credible, ethical principles to managers for dealing with issues that are not directly related to humans.

Argandona (1998) argued stakeholder theory did not have a solid base, and hence, proposed 'the theory of the common good' as its foundation. On this basis, stakeholders are those who have an interest in an organisation so that an organisation may have an interest in fulfilling their demands.

According to Bourne and Olander (2005), irrespective of the different views of different researchers about stakeholder theory, it is crucial to identify legitimate and valid stakeholders so that their influence on project activities can be anticipated. The main theme of stakeholder theory is the nature of the relationships between the stakeholders and the organisation. Moreover, in stakeholder theory, the top managers are considered to be the representatives of the organisation, and hence, they receive the vast amount of attention by researchers investigating the field (Jones *et al*., 2007). Donaldson and Preston (1995) argued there was an ambiguity about the nature and purpose of stakeholder theory during its evolution. Therefore, the authors divided stakeholder theory into three categories, namely descriptive, instrumental and normative theory (discussed in the subsequent sections). Donaldson and Preston (1995) noted that many researchers have used these three categories together to interpret the stakeholder literature, but inadvertently. For instance, the most famous author, Freeman, has also used these three aspects in his work.

The descriptive/empirical theory

The descriptive aspect of stakeholder theory means it is used by various researchers to describe and explain specific characteristics of an organisation, such as the nature of an organisation, the way managers think about managing, how board members think about the interests of corporate constituencies and how organisations are actually managed. It reflects and explains the past, present and future conditions of relations between an organisation and its stakeholders. It justifies itself by showing that the concepts of the theory correspond to observed reality (Donaldson and Preston, 1995).

The instrumental theory

The instrumental aspect of stakeholder theory means it is used by various researchers to identify the links between stakeholder management and the accomplishment of traditional organisational objectives, such as growth, profit and stability (Donaldson and Preston, 1995). The instrumental stakeholder theory argues that considering the interests of other stakeholders (or at least pretending to consider them) may assist in increasing value for shareholders (Orts and Strudler, 2002). It justifies itself by showing evidence between stakeholder management and organisational performance. However, the instrumental aspect does not explain in detail the link between stakeholder management and organisational performance (Donaldson and Preston, 1995). According to Orts and Strudler (2002), researchers who are in favour of the instrumental aspect assume, in the absence of persuasive evidence, that good ethical behaviour towards stakeholders will yield good economic results. Orts and Strudler (2002) argued that this is not always true because ethics and economic self-interest do sometimes conflict with each other. However, they acknowledged that if the assumption (that considering interests of all stakeholders will inevitably improve the primary benefits of all shareholders, or at least the organisation as a whole) stands true, then the instrumental aspect may serve as the normative base for stakeholder theory.

Donaldson and Preston (1995) argued that the studies conducted by various researchers on corporate social responsibility, in the 1980s and early 1990s, agreed either explicitly or implicitly that performing stakeholder management practices assisted in achieving traditional objectives of an organisation or better than rival approaches, which supports the instrumental aspect of the stakeholder theory.

The normative theory

The normative aspect of stakeholder theory means the theory is used by various researchers to interpret the function of an organisation and to provide guidance on the basis of moral or philosophical principles for operating and managing organisations. The relation between theory and observed facts and the relation between stakeholder management and traditional performance measures are not significant in the normative aspect of the stakeholder theory. It uses concepts like 'individual or group rights', 'social contract' and 'utilitarianism' as its basis for its justification. According to Jones *et al.* (2007), the normative aspect differentiates stakeholder theory from other theories, such as resource dependence theory, institutional theory and managerial theory.

The normative theory differs from the instrumental theory in the sense that it states if an organisation wants to achieve (or avoid) certain results, then do (or not do) certain things because they are the right (or wrong) things to do. Hence, the normative theory is categorical in nature. On the contrary, the instrumental theory states that if an organisation wants to achieve (or avoid) certain results, then adopt (or do not adopt) certain principles and practices. Hence, the instrumental theory is hypothetical in nature (Donaldson and Preston, 1995). Table 2.1 illustrates the difference between descriptive, instrumental and normative views of stakeholder theory.

Donaldson and Preston (1995) argued that the normative aspect is the core of stakeholder theory. Donaldson and Preston (1995) argued the normative aspect is based on hypothetical contract arguments, by relating it to the theory of property rights. Phillips

(1997) however, disagreed, and proposed a concept of 'fair play', also known as 'fairness', as forming the basis of the normative aspect. According to Phillips (1997), if anyone who is affected by the firm's operations is considered to be a stakeholder and an organisation is morally obliged to address their interests, then virtually anyone could be a stakeholder to anyone. This will make the term 'stakeholder' meaningless. Phillips (1997) argued that the concept of 'fairness' addresses this issue in a better way.

Table 2.1: The fundamental difference between three aspects of stakeholder theory (adapted from Jones *et al.*, 2007)

Theory	Descriptive	Instrumental	Normative
Feature	How does an organisation relate to its stakeholders	What happens when an organisation relates to its stakeholders in certain ways	How should an organisation relate to its stakeholders

According to Donaldson and Preston (1995), these three aspects (descriptive, instrumental and normative) of stakeholder theory have different values but are interrelated to each other (shown in Figure 2.1). The descriptive aspect of stakeholder theory is supported by the instrumental perspective at the second level because of its instrumental and predictive value. The normative aspect is regarded as the central core of the theory due to the descriptive accuracy of the theory presuming the truth of the normative aspect (as far as the normative aspect believes that managers and other agents act as if all stakeholders' interests have intrinsic value). Hence, acknowledging moral values and obligations makes the normative aspect the fundamental base of the stakeholder theory.

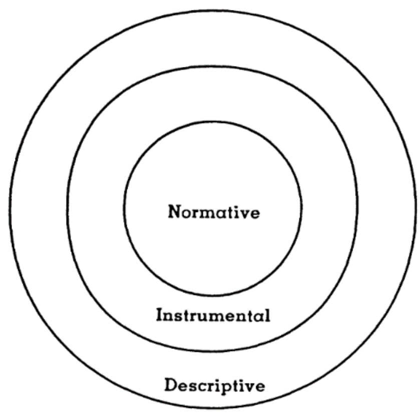

Figure 2.1: Three aspects of stakeholder theory and their interrelationships (Source: Donaldson and Preston, 1995)

Donaldson and Preston (1995) further argued that stakeholder theory is managerial in nature. It demands that managers acknowledge the diverse valid stakeholder interests and encourage them to react to those interests in a mutually supportive way, because it is a moral requirement for the legitimacy of the management function. It also recommends attitudes, structures and practices that constitute stakeholder management.

Heravi *et al*. (2015) stated that stakeholder theory should be focused on stakeholders who can put their contributions into a decision-making process and onto those stakeholders who would be affected by those decisions. Bourne and Walker (2006) stated that, irrespective of the view an individual enacts for stakeholder theory, the key point is to identify legitimate and valid stakeholders. Furthermore, to identify the power they possess and the influence they can exert on the project. This will assist in formulating appropriate strategies to increase positive influence and reduce the negative influence.

2.6 Stakeholder management

Project management originated from the construction and defence industry's need to plan, control and manage large and complex projects, such as hospitals, bridges and warships (Bourne and Walker, 2005). Management, in itself, means something has to be managed

(Wiig *et al.*, 1997). Stakeholder management is a crucial part of project management, as projects can be treated as a temporary coalition of stakeholders formed to create something (Jepsen and Eskerod, 2009). Furthermore, a project and its stakeholders can be perceived as a network in which individuals interact and exchange information, resources and outcomes (Karlsen, 2002). Cleland and Ireland (2006) argued that the management of project stakeholders means that the project is explicitly described in terms of individuals and groups that have an interest or a stake in the project. Hence, project team members, contractors, sub-contractors, suppliers and customers, among others, are always relevant.

Stakeholder management positively affects project management and management in general because positive and mutually supportive stakeholder relationships boost trust and stimulate collaborative efforts that increase relational wealth (organisational assets that arise from teamwork and familiarity) (McManus, 2002). Contributions, such as supporting decisions, specific deliverables and positive attitudes, among others, are required from supportive and influential stakeholders to deliver the project successfully (Jepsen and Eskerod, 2009). Stakeholder management is also considered a crucial part of the strategic management of an organisation (Cleland and Ireland, 2006). McManus (2002), in his research, identified inadequate stakeholder management as the critical factor leading to project failure, more so than other factors, such as lack of user involvement, lack of resources, unrealistic expectations, lack of executive support, lack of IT management and unclear objectives. A project is not treated as successful if it fails to meet the stakeholders' expectations, in spite of meeting the constraints of time, budget and quality (Bourne and Walker, 2005).

The APM Body of Knowledge 6th edition (2012, p. 116) defined stakeholder management as "the systematic identification, analysis, planning and implementation of actions designed to engage with stakeholders." Many researchers have proved that project stakeholder management is one of the most critical factors to make a project successful (Offenbeek and Vos, 2016 and Travaglini *et al*., 2014) because the project's success or failure significantly depends on the perceptions of every individual stakeholder backed by their ability and willingness to act either in favour or against the project (Bourne, 2005). According to Jepsen and Eskerod (2009), stakeholder management can be perceived as the continuous development of relationships with stakeholders to achieve a successful project outcome.

The project environment is usually high in uncertainty, complexity and ambiguity. These factors make stakeholder management more difficult because the project and its uncontrolled factors are interrelated (Yang *et al.*, 2011). The limited duration and unique nature of projects demand extra efforts from project managers to build effective project teams and stimulate trust among project stakeholders (Grabher, 2002). For these reasons, project managers should be aware of the social, cultural and organisational environment of the project (Wideman, 1990). Karlsen (2002) identified some reasons that create uncertainty and problems. They are decisions that were not taken, unexpected changes in specifications, the extreme focus of clients on detail, stakeholders who did not understand their roles in the project, end users who did not know their needs and unexpected changes in political guidelines.

Usually, many organisations have limited resources, and stakeholders compete to acquire these resources. As stakeholders have different priorities and objectives, the unequal distribution of resources among stakeholders can intensify conflicts among them

(McManus, 2002). Therefore, project managers have to allocate those resources optimally (Jepsen and Eskerod, 2009). Hence, stakeholder management also requires a balance of competing claims on resources between project and organisation, project and other projects and different parts of the project (Bourne, 2005), but the elements of complexity and uncertainty make it difficult to achieve this balance (Turner and Muller, 2003). Hence, team members must adapt quickly to work as a team (Yang *et al.*, 2011).

Due to the uncertainty and complexity of construction projects, the construction industry has a feeble record of stakeholder management over the last few decades (Yang *et al.*, 2009). In spite of stakeholders and the issues related to a project being different concepts, they are strongly interrelated. Still, the project management literature lags in analysing the links between stakeholders and the issues that may arise. Many researchers have proved that project stakeholder management is critical to make a project successful (Offenbeek and Vos, 2016). Unanticipated and conflicting interests of stakeholders, if not appropriately managed, can lead to a project failure (Bourne and Walker, 2005). Stakeholder management is about managing the expectations of stakeholders. Hence, there should be a debate on the definition regarding whose expectations should be managed (Jergeas *et al*., 2000).

2.7 Critical Success Factors (CSFs) for managing stakeholders

Concerning stakeholder management, Yang *et al.* (2011) described critical success factors (CSFs) as those practices and activities that should be performed for balancing stakeholders' interests and simultaneously ensuring that projects are moving forward. Critical success factors help the project team to know whether it is successfully managing stakeholders or not. Table 2.2 identifies the critical success factors and their references, along with their frequencies of being discussed in the literature.

Table 2.2: Critical success factors for stakeholder management

CSF's	References*
Managing stakeholders with social responsibilities	1 (1)
Exploring stakeholder needs and constraints to project	1, 3, 5, 9, 21 (5)
Communicating with and engaging stakeholders properly and frequently	1, 2, 3, 6, 7, 8, 9, 10, 12, 13 (10)
Understanding of stakeholder interest area	1, 7 (2)
Formalised process for identifying stakeholders	1, 2, 9, 19, 20, 21, 22, 23, 24 (9)
Keeping and promoting a good relationship	1, 2, 3, 7, 8, 11, 12 (7)
Analysing conflicts and coalitions among stakeholders	1 (1)
Accurately predicting the influence of stakeholders	1, 3, 23 (3)
Formulating appropriate strategies for the management of stakeholders	1, 21 (2)
Assessing attributes of stakeholders	1 (1)
Effectively resolving conflicts among stakeholders	1, 7 (2)
Formulating a clear statement of project missions (common goals, objectives and project priorities)	1, 2, 3, 4 (4)
Predicting stakeholder reactions to implementation of the strategies	1 (1)
Analysing the changes in stakeholder influences and relationships	1 (1)
Assessing stakeholder behaviour	1 (1)
Decisions taken without analysing consequences on stakeholders	3 (1)
Build and maintain a base of trust	3, 7, 10, 14 (4)
Early involvement of key project participants	4, 12, 15, 16, 17 (5)
Proactive interaction with affected stakeholders to mitigate potentially arising conflicts	3 (1)
Identifying necessary contributions required from stakeholders	21 (1)
Identifying benefits desired by stakeholders	21 (1)
Assessing the power of stakeholders relative to the project	21, 23 (2)

*1 = Yang *et al*. (2009) 2 = Jergeas *et al*. (2000) 3 = Olander and Landin (2008) 4 = Smith (2013) 5 = Bourne (2005) 6 = Bakens *et al.* (2005) 7 = Aaltonen *et al.* (2008) 8 = Rowlinson and Cheung (2008) 9 = Bourne and Walker (2005) 10 = Hartman (2000) 11 = Olander (2006) 12 = Yong and Mustaffa (2013) 13 = Khafaji *et al.* (2010) 14 = Schepper *et al.* (2014) 15 = Erkul *et al.* (2016) 16 = El-Gohary *et al.* (2006) 17 = Missonier and Loufrani-Fedida (2014) 18 = Donaldson and Preston (1995) 19 = McManus (2002) 20= Olander (2007) 21 = Jepsen and Eskerod (2009) 22 = Walker, Bourne and Rowlinson (2008) 23 = Bourne and Walker (2006) 24 = Cleland and Ireland (2006)

Table 2.2 shows that 'communicating with and engaging stakeholders properly and frequently' is the most frequently cited CSF for stakeholder management (mentioned by 10 authors). It is followed by 'formalised process for identifying stakeholders' (nine authors), which is followed by 'keeping and promoting a good relationship' (seven authors). It is further followed by 'exploring stakeholder needs and constraints to project' (five authors), which shares a similar stance with 'early involvement of key project participants' (five authors).

Communication

Jergeas *et al.* (2000) identified in their research that communication was a critical factor for stakeholder management and that it should be planned and should occur more frequently. Moreover, there was a need to improve communication with stakeholders. Communication should be proactive. Bourne and Walker (2006) argued that risk with stakeholders could be avoided by improving communication with them. The authors further stated that the power mind maps of stakeholders could be complex and constantly changing. Therefore, these maps should be maintained with a high level of priority. Maintenance in the form of active communication will help to manage them and will also provide early warnings of any potential threats.

Young (2013) also considered effective communication as the key to stakeholder management. Young (2013) recommended thinking of what should be told to key stakeholders and what should be told to other stakeholders. The author further recommended considering how to communicate with stakeholders, the frequency of communication and the way to get feedback from them. Furthermore, inform them how and when they will receive information.

Identifying stakeholders

On projects, stakeholders are usually numerous and sometimes difficult to identify (McManus, 2002). A project manager should be aware of the entire project process to identify potential stakeholders (Jergeas *et al.*, 2000). Stakeholders and their expectations should be identified before finalising the definition of the project and agreeing on the scope (Young, 2013). Stakeholder identification can assist with anticipating the type of power and influence stakeholders can exert on the project's activities (Walker, Bourne and Shelley, 2008). Stakeholders can play a crucial role in contributing knowledge, insights and support in developing a project brief as well as in executing a project (Bourne and Walker, 2005). According to Jergeas *et al.* (2000), the process of identifying stakeholders should be formal. Stakeholder theory does not clarify who should be considered as stakeholders and why (Phillips, 1997 and Phillips, 2003).

McManus (2002) stated that a 'contrast' or 'maximum variation' sampling technique should be used. In this technique, each individual is asked to identify another person who can have a totally different perception on the issue than the individual's own perception. Another technique they proposed is to draw a stakeholder map by brainstorming who the stakeholders could be. Karlsen (2002) suggested interviewing experts, brainstorming in group meetings and using checklists as several ways to identify the stakeholders. Furthermore, he suggested that the identification process should be carried out with participants of different backgrounds so everyone can uncover hidden stakeholders. Jepsen and Eskerod (2009) also suggested to brainstorm and further suggested they ask other people in the project to suggest stakeholders and to refer to a generic stakeholder list. Bourne and Walker (2006) suggested to brainstorm, to prioritise and rank them, and then to categorise them.

Relationship management

Jones *et al*. (2007) argued that stakeholder relationships are crucial for the organisation's effective operations. Managing the perceptions and understanding the exceptions of key stakeholders can build concrete relationships with stakeholders and enhance the probability of accomplishing the project successfully (Walker *et al.*, 2008). For instance, Jayasuriya *et al.* (2020) identified that poor stakeholder relationship management is a key factor leading to the failure of Public Private Partnerships (PPPs) projects.

Buy-in

The process for obtaining stakeholders' buy-in is dynamic and depends on the issues rather than stakeholders (Jergeas *et al.*, 2000). The authors mentioned four points that can be adopted to obtain stakeholders' buy-in. They are:

- Educating the stakeholders so that they can understand the purpose of the project.
- Communicating what the project is going to do in order to give the stakeholders peace of mind.
- Mitigating or changing the project in order to eliminate the raised concerns.
- Compensating stakeholders for balancing the negative effects they will suffer due to the project.

Stakeholder engagement

According to Bourne and Walker (2006), stakeholder engagement is a formal process of relationship management by which project teams or organisations engage with their stakeholders in order to align stakeholders' goals with project or organisations' goals. A stakeholder engagement plan should be treated as a crucial part of the risk management plan, while simultaneously acknowledging that stakeholder management is not risk management (Bourne and Walker, 2006).

In the construction industry, top stakeholders, such as a client and/or a project sponsor, are considered in decision-making, but stakeholders such as small sub-contractors and suppliers are often ignored and are not involved in the decision-making process. This leads to delays and an increase in costs due to problems with planning, logistics and production (Walker *et al.*, 2008). Jayasuriya *et al.* (2020) identified that developing and implementing effective strategies to engage stakeholders successfully is a crucial factor to mitigate the issues on PPP projects. The authors recommended that it is imperative for organisations to adopt effective stakeholder engagement practice.

2.8 The stakeholder management process (SMP)

Cleland and Ireland (2006) stated that there should be a formal and organised process for identifying and managing stakeholders. The formal process is required because multi-year projects undergo significant changes, hence making informal processes inadequate to manage stakeholders. The SMP is required to determine how the potential stakeholders can react to decisions, what impact their reaction can have on the project, and how the stakeholders can interact with each other, with the project's managers and professionals to affect the chances of success of a proposed strategy. Furthermore, they stated that stakeholder analysis during the planning stage assists immensely in formulating strategies for managing stakeholders for the life cycle of the project. Karlsen (2002) stated that stakeholder management processes assist in managing stakeholders in several ways, such as to become familiar with the project stakeholders or to ensure the balance between rewards and contribution. It also acts as a basis for managing the stakeholders, and to decide who should be involved in determining the project goals and how to measure success. Several processes have been identified from the literature, which are presented in Table 2.3.

Table 2.3: Stakeholder management processes

Elias *et al.* (2002)	**Karlsen (2002)**	**Bourne and Walker (2006)**	**Cleland and Ireland (2006)**	**Jepsen and Eskerod (2009)**	**Young (2013)**
Develop a stakeholder map of the project	Plan	Identify stakeholders	Identify stakeholders	Identify important stakeholders	Identify stakeholders
Prepare a chart of specific stakeholders	Identify	Prioritise stakeholders	Gather information on stakeholders	Characterisation of the stakeholders pointing out their: needed contributions, expectations concerning rewards for contributions, and power in relation to the project	Gather information about stakeholders
Identify the stakes of stakeholders	Analyse	Develop a stakeholder management strategy	Identify stakeholders' mission	Discussion about which strategy to use to influence each stakeholder	Analyse the influence of stakeholders
Prepare a power versus stake grid	Communicate		Determine stakeholders' strength and weakness		Decide strategy for communicating with them
Conduct a process level stakeholder analysis	Act		Identify stakeholder strategy		
Conduct a transactional level stakeholder analysis	Follow up		Predict stakeholder behaviour – define strategic issue, determine underlying forces, identify stakeholders, identify key stakes, evaluate stakeholder influence, modify project strategy		
Determine the stakeholder management capability of the R&D project			Implement stakeholder management strategy		
Analyse the dynamics of stakeholders					

2.8.1 Comparison and contrast of stakeholder management processes

The processes developed by Karlsen (2002) and Elias *et al*. (2002) are different from each other. Karlsen's (2002) process recommends planning the stakeholder management process before commencing it. It is a unique step that no other author has mentioned. Elias *et al*. (2002) sub-divided the step of identifying stakeholders, which provides more guidance as compared to Karlsen (2002).

2.9 Stakeholder mapping tools

While managing projects, project managers come across various stakeholders having different interests and different perceptions about the project (Davis, 2014). These stakeholders will come up with their own issues, which they expect project managers to solve. Some issues may be common among different stakeholders, but some may be raised by just one stakeholder. Many issues would be salient, but limited resources and time will force project managers to prioritise some issues over others (Jepsen and Eskerod, 2009). It is highly unlikely that the expectations of all the stakeholders can be met (McManus, 2002). Moreover, the behaviour of stakeholders towards the project changes with time (Elias *et al.*, 2002). Hence, this is a challenge for the project managers to discover ways to prioritise the right stakeholders from these complex issues in relation to the objectives of the project (Offenbeek and Vos, 2016 and Olander, 2007). Therefore, stakeholder analysis is an important part of the stakeholder management process, because it enables project managers to formulate strategies to address stakeholders' interests in a timely manner. The results obtained from the stakeholder analysis becomes the basis for decisions, objectives and plans for the project (Jepsen and Eskerod, 2009). The management process is crucial to determining the reactions of stakeholders to project decisions, the influence of their reactions on the project and their interactions with each other and with the project representatives in order to determine the chances of a successful proposed strategy. Furthermore, project stakeholders affect project management processes. Hence, it is crucial to identify stakeholders in order to plan and implement an effective stakeholder management process (Olander, 2007).

According to Jawahar and Mclaughlin (2001), the importance of stakeholders depends on an organisation's needs and the extent to which an organisation is dependent on those stakeholders relative to other stakeholders to fulfil its objectives. Thus, some stakeholders will get more priority than others at any given time. Moreover, stakeholders' priorities and concerns vary with time, and as such, the classification of stakeholders also varies accordingly in response to dynamic circumstances (Olander, 2007).

However, Jepsen and Eskerod (2009) investigated in their research that conducting stakeholder analysis at the beginning of the project rests on two crucial assumptions:

(a) Project managers can understand the nature of the stakeholder coalitions to identify which stakeholders are crucial. Furthermore, they can classify them on several aspects as well.
(b) The coalition of stakeholders is stable throughout the project.

Jepsen and Eskerod (2009) argued that the findings from their empirical research showed that these assumptions do not always hold true in a practical scenario. This is due to the reason that project managers may not have the resources or capabilities to gather the necessary information. Moreover, coalitions may be complex and continue to develop over time. Stakeholders may interact and influence each other in various ways.

The power-interest matrix

A commonly used matrix to map stakeholders in the construction industry is a power-interest matrix shown in Figure 2.2. According to Olander (2007), Johnson and Scholes proposed the power-interest matrix in 1999 to map stakeholders. In this matrix, stakeholders are classified depending on the power they possess relative to the project and the degree of interest they have in a project. This matrix helps to track the dynamism of stakeholders based on which bespoke communication strategies can be developed to engage them effectively. Moreover, it provides a visual presentation of stakeholders who could be potentially harmful to the project. For instance, a certain stakeholder (or a group of stakeholders) may be less harmful to the project at a particular time because that stakeholder may have less power despite having high interest. However, that stakeholder may acquire significant power (for instance, by making coalitions with other antagonistic stakeholders) as the project progresses. Therefore, the position of that particular stakeholder will change in the matrix from the bottom right quadrant to the top right quadrant. Therefore, the approach of engaging with that particular stakeholder will also change, and managers have to pay specific attention to address the concerns of that stakeholder to keep the project moving smoothly.

Power	High	Endeavour to keep these satisfied	Manage these constantly
	Low	Monitor and respond when necessary	Keep these informed regularly
		Low	High
		Interest	

Figure 2.2: A power-interest matrix to analyse stakeholders (Source: Chinyio and Akintoye, 2008)

Figure 2.3 represents a positioning of stakeholders in general. The client is the most powerful stakeholder on a project because the client controls financial resources and has more interest than other stakeholders as the client owns the project. Designers, contractors and sub-contractors are contractually bound to the project, so, they have high interest in the project. Contractors usually possess power over sub-contractors. The government, being a legislative body, can severely affect the project. However, projects are usually planned according to government legislations and have to receive approval from the planning authority. So, they satisfy government concerns. Therefore, the government does not usually take much interest in adversely affecting projects.

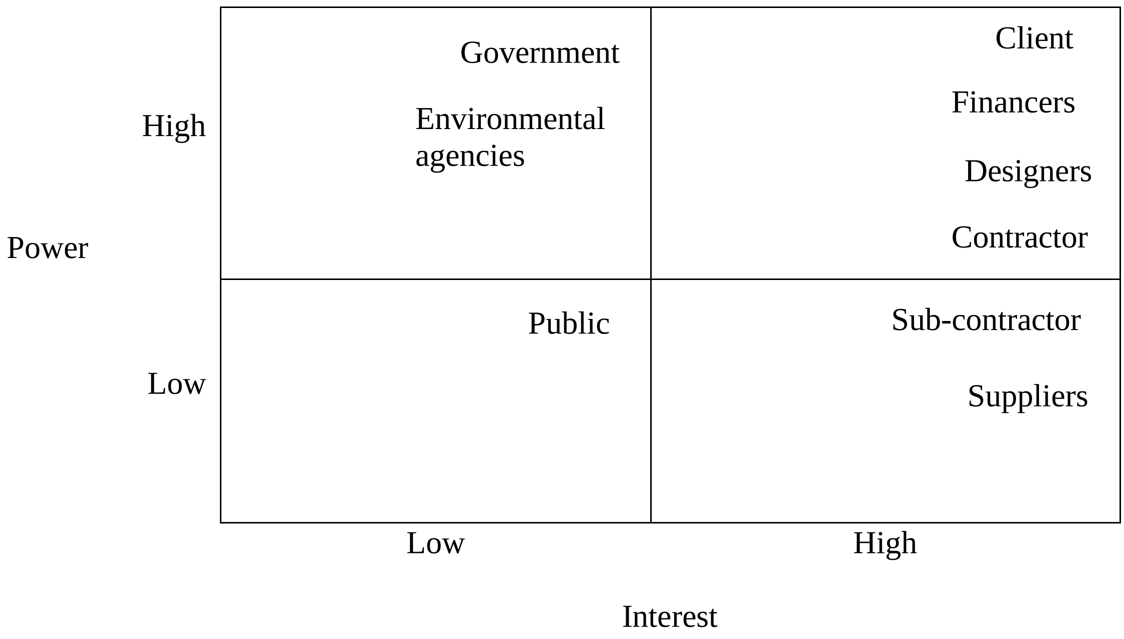

Figure 2.3 A hypothetical situation representing the position of stakeholders in a power-interest matrix

The impact-probability matrix

Olander and Landin (2005) addressed the need to grade power and interest attributes. According to Olander (2007), it is difficult to assess power relative to some scale, but the ‘impact’ of that power on a project can be assessed. ‘Interest’ is the evaluation of the probability that a stakeholder will have an impact on project decisions. Thus, the power/interest matrix can alternatively be analysed as the impact/probability matrix (Figure 2.4). Hence, this matrix will serve in a similar way as the power-interest matrix described above.

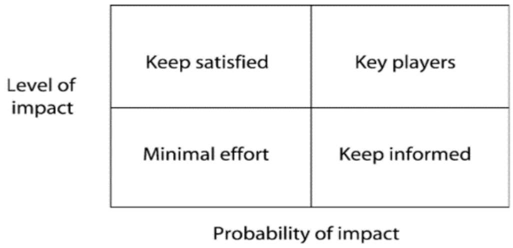

Figure 2.4: The stakeholder impact-probability matrix (Source: Olander, 2007)

The matrix used to track stakeholders should be updated regularly irrespective of its type. A dynamic matrix will not solve all problems, but it will facilitate organising complex situations, understanding situations collectively if stakeholders are compiled according to groups, suggesting up-to-date strategies for communicating and managing stakeholders, and helping to manage resources and time so that these can be used where maximum benefits can be achieved (Chinyio and Olomolaiye, 2010).

The power-predictability matrix

Newcombe (2003) discussed the power-predictability matrix to address the salience of stakeholders. The author used predictability as an attribute to map the salience of stakeholders instead of interest.

The stakeholder influence matrix

Young (2013) developed the stakeholder influence matrix. In this, stakeholders are listed in the first column. The second column will list their roles. The following columns will have four consecutive categories, namely decision-maker (who provides resources or resolves issues); direct influencer (who has direct input on the project activities or is affected by the activities); indirect influencer (who has little or no input but may be required to agree with some actions) and observer (who is not affected by the project activities but may try to affect activities).

The vested interest-impact index (ViII)

Bourne and Walker (2005) developed a tool called the ‘vested interest-impact index (ViII)’ to measure the potential influence of stakeholders, which is shown in Table 2.4. Bourne and Walker (2005) argued that stakeholders have a vested interest in a project’s success, which varies in intensity from very low to very high, and the impact of that interest can be analysed in intensity ranging from very low to very high as well. It consists of two parameters, namely vested interest levels (which means the probability of impact) and influence impact levels (which means the level of impact). The component impact is related to power in this tool that stakeholders may exert influence. The influence depends on the source of power. In simple terms, it basically describes the probability and level of stakeholder impact on project execution.

Table 2.4: Vested interest-impact index (Source: Bourne and Walker, 2005)

Stakeholder Interest	Stakeholders Vested Interest Intensity Index (ViII) value									
For colleagues and COP:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Develop team's skill base	VH	H	N	N	L	VL	H	VH	L	N
Enhance workplace environment										
Family-friendly policy										
Demonstrated lessons learned										
Exemplar of better practice										
High-profile/strategic project										

Vested Interest (v) levels 5 = Very high, 4 = High, 3 = Neutral, 2 = Low, 1 = Very low
Influence impact levels (i) 5 = Very high, 4 = High, 3 = Neutral, 2 = Low, 1 = Very low
Vested interest-Impact Index (ViII) = $\sqrt{\{v*i/25\}}$ eg if Vested Interest (v) level = 4 (high) and Influence impact levels (i) then ViII = $\sqrt{\{4*4/25\}} = \sqrt{\{16/25\}} = 0.80$ = high

The stakeholder impact index (SII)

Olander (2007) proposed a ‘stakeholder impact index’, a tool that analyses the relative importance of different stakeholders and the nature of their potential impact. Olander

(2007) argued that the vested interest-impact index of Bourne and Walker (2005) basically describes the probability and level of stakeholder impact on project execution, but for a comprehensive analysis of stakeholders, the nature of impact requires consideration as well. Olander (2007) further argued that it requires more attributes than just impact and probability to evaluate the total interest of stakeholders relative to the project. Project managers should be able to assess the stakeholders' attributes, classes and their position relative to the project. Hence, Olander (2007) incorporated two more concepts. They are attribute value (A) based on the stakeholder classes proposed by Mitchell *et al.* (1997), and the position value (Pos), namely active support, passive support, not committed, passive opposition and active opposition. The position any stakeholder holds sets its direction of impact on the decision-making process of a project.

According to Olander (2007), the stakeholder impact index requires evaluation of the attributes and position of stakeholders which, when combined with the vested interest index (ViII) builds a tool for the comprehensive analysis of stakeholders. Hence, the stakeholder impact index (SII) can be evaluated as a function of A, Pos and ViII.

The total stakeholder impact index for the project is:

$SII_{proj} = \sum SII_k$

where k = 1 to n number of stakeholders.

If SII_{proj} is positive, then the project has a favourable stakeholder impact, and if it is negative, then the stakeholder impact is unfavourable. Moreover, an efficient stakeholder management process should aim to increase the value of SII_{proj} and, at worst, should not at least allow to decrease it.

The stakeholder circle

The Stakeholder Circle (Figure 2.5) is a visualisation tool which is based on the concept of power and influence. It presents a visual picture of power possessed by a particular stakeholder, or a group of stakeholders, and the influence they can put on a project (Walker *et al.*, 2008).

It is composed of five steps, namely identify, prioritise, visualise, engage and monitor. In step two (prioritise), project managers have to prioritise stakeholders based on three attributes, namely power, proximity and urgency. They have to assign a value of 1 (low) to 4 (high) to the attributes power and proximity and 1 (low) to 5 (high) to the attribute of urgency. Based on this, the tool will generate a visual representation of the stakeholder circle (Walker *et al.*, 2008).

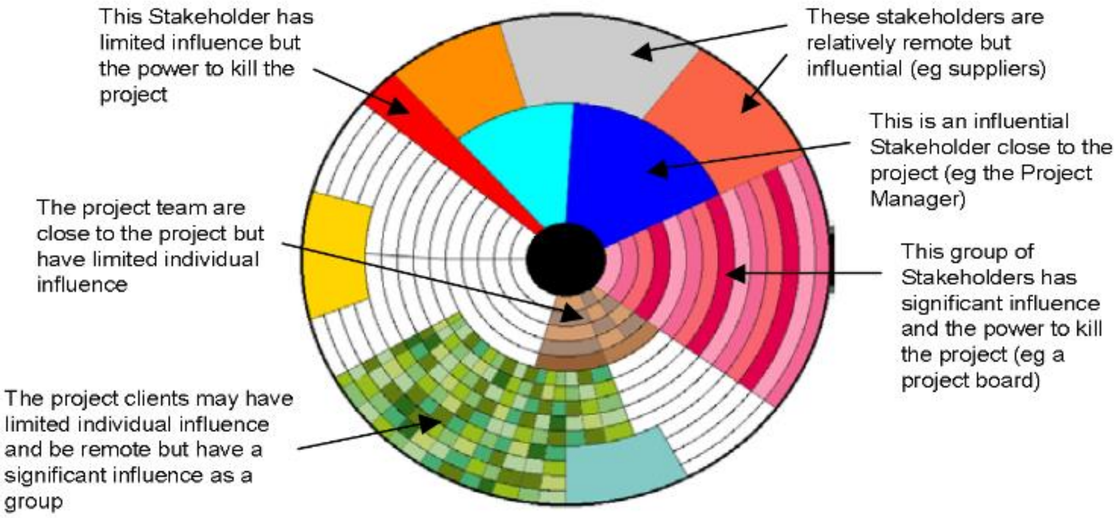

Figure 2.5: A prototype of the Stakeholder Circle tool (Source: Walker, Bourne, and Shelley, 2008)

2.9.1 Comparison of the stakeholder mapping tools

Contrast

The Stakeholder Impact Index (SII) uses two more attributes than the Vested Interest-Impact Index (ViII) to calculate the final position of stakeholders relative to the project.

The SII uses ‘legitimacy’ as an attribute to calculate the importance of a stakeholder, but the Stakeholder Circle uses ‘proximity’ as an attribute instead.

The SII can assist in anticipating the combined overall status of all stakeholders, i.e. whether they will be in favour of the project or against the project, whereas the ViII and Stakeholder Circle cannot do that.

The Stakeholder Circle provides a good visual representation of the stakeholders, which the SII and the ViII cannot do.

The similarity between the tools

All the stakeholder mapping tools involve the identification of stakeholders at their first stage. However, they do not by themselves assist in identifying those stakeholders. Assigning values to the attributes (vested interest, impact, power, legitimacy, urgency, position, proximity) depends on the experience of a project manager. Hence, the use of the tools is prone to error.

2.10 Consequences of not managing stakeholders

Inadequate management of stakeholders stimulates suspicion and conflict among stakeholders. Suspicion and conflict stimulate formal bargaining and restrict efforts and rewards to stipulated terms. Eventually, it leads to increased costs and project delays (McManus, 2002).

Bourne and Walker (2006) stated that antagonistic stakeholders can create immense trouble for the project manager in many ways, for instance, by changing the scope of the project, changing technical direction and by reducing funding, among others. They can even lead to the collapse of the project. Thus, project managers have to understand the stakeholders' influence and the efficacy of their actions to engage in active communication with them so that potential threats can be averted.

Jergeas *et al.* (2000) identified several disadvantages of not managing stakeholders adequately. They argued that those problems could be mitigated by incorporating stakeholders in front-end planning and making them part of the project team. Karlsen (2002) stated that the problems identified in their research could lead to project failure. Table 2.5 shows the disadvantages of not managing stakeholders.

Table 2.5: Disadvantages of not managing stakeholders

Disadvantages	**References***
Inadequate resources assigned to the project (both in quality and quantity)	1, 2
Increased cost	3
Lack of clear and comprehensive definition of project success	1
Negative public reaction	1, 2
Poor communication	2
Poor scope and work definition	1, 2
Project may even fail to start	1
Reduction in chances of working with those stakeholders in future	1
Time delay	3

Unanticipated interruption to project in some way	1
Unfavourable news about the project in the media	2
Unforeseen regulatory changes	1
Unsatisfied stakeholders from end results	1

*1 = Jergeas *et al.* (2000); 2 = Karlsen (2002); 3 = McManus (2002)

It is clear from Table 2.5 that inadequate stakeholder management can have severe consequences for the project. Therefore, it is crucial for project managers to handle them adequately. Thus, one of the objectives of this study is to investigate how BIM can assist in stakeholder management.

2.11 Case studies of inadequate stakeholder management

This section explores a number of examples of project failures that occurred due to inadequate stakeholder management.

(1) California Department of Motor Vehicles (DMV) initiated a project for modernising the driving licence and registration application process. The project was closed in 1993 after spending $45 million. All of this money was wasted. The key reasons for project failure were the lack of support from key stakeholders (including executives); lack of user involvement; unclear objectives; project managers having no power or influence over key stakeholders; poor perception of the project politically (in the beginning) and other political issues that were not addressed at the time and that damaged relationships with external stakeholders (McManus, 2002).

This case study is an epitome of project failures where IT was implemented to modernise traditional working practices. The case of BIM resembles this closely. BIM is also changing the traditional working practices of the construction industry through IT.

(2) Elias *et al*. (2002) mentioned the construction of a 27km-long highway project with a budget of NZ $245 million in New Zealand. The project was delayed due to the inability to resolve stakeholder issues.

(3) Olander and Landin (2005) discussed two case studies in Sweden in which projects were delayed due to stakeholder resistance. The first case was a housing project of 60 apartments. The project was delayed due to opposition from local residents. Consequently, a significant number of resources became obsolete, and the price of the project increased by around 10%. In the second case study, a railway track was to be constructed. Local residents opposed the proposed route. Consequently, the project was delayed by seven years.

(4) The London Heathrow Airport Terminal 5 faced opposition from various stakeholder groups such as local residents, local councils, community groups, the Heathrow Association of Control of Aircraft Noise (HACAN) and West London Friends of the Earth (WLFoE). The issues were related to increased pollution, increased noise levels and increased traffic. Consequently, this increased the length and cost of the planning phase of the project (Molwus, 2014).

(5) British Airport Authority (BAA), now called Heathrow Ltd., worked with STAR alliance for one year and proposed a sixth terminal and a new runway. The opposition from members of the public forced them to scrap the plan. The only option left was to redevelop terminal 2, for which both the parties signed a Memorandum of Understanding (MoU) in 2005 (Lundrigan *et al.*, 2014).

(6) Crossrail needed huge capital and the legal power to compulsory acquire the land needed, for which the approval was required from the UK parliament. To grant approval, the UK parliament had to approve the system-level goals and high-level scope based on a fixed budget. Various key stakeholders who were to contribute financially or having their assets interdependent on the plan made Crossrail agree to their demands and alter the plan. For instance, London Underground demanded Crossrail connect to their stations, while several private companies demanded the rights to design a station on their land. The plan was eventually submitted to Parliament. Subsequently, a new round of discussions commenced with local councils, the public, local businesses and individuals, among others, to gain their consent. This delayed the process, and it took eight years for Crossrail to finish negotiations and set the scope and budget for the project. However, even after this there was no legal commitment to identify the time scale for the project.

Crossrail’s top management offered non-binding commitments to win the support of the public and respective councils, such as refurbishments of the stations outside London. However, while delivering the project they reneged on their commitments to keep the project within budget and time limits, starting a conflict between top management and other stakeholders such as architects, the public and respective councils. Other stakeholders accused the management of not delivering on what was promised, arguing that the legacy would be a mediocre project rather than the world-class railway promised. The conflict escalated and was brought to the attention of the media, causing Crossrail to reverse their decision and refurbish the respective stations. Furthermore, the final design led to conflicts between Crossrail and several stakeholders such as local councils. For instance, one of the local councils demanded that Crossrail should build more toilets at the station. This was opposed by Crossrail. The matter went to Parliament, where the council got support from various ministers. Consequently, Crossrail was forced to meet the extra demands (Lundrigan *et al.*, 2014).

Crossrail also conducted an initiative to implement BIM level 2 to comply with the UK government requirements. However, designers, contractors and actors within the supply chain faced numerous challenges preventing them from fully implementing BIM level 2. For instance, Crossrail did not adopt the CIC BIM Protocol because a majority of the contracts were already granted and partially executed. Due to the lack of a CIC BIM Protocol, there was no clear protocol to govern the use of BIM. Furthermore, it created ambiguity about ownership of the BIM models, hindering hindered the building of trust and collaboration between designers and contractors. Moreover, there was lack of an in-depth BIM Execution Plan (BEP), which affected the clarity of roles and responsibilities of various stakeholders. Consequently, it made it difficult to get consistent progressive data deliverables from the contractors. There was no clear guidance provided for level of development (LOD) for the 3D models. There was no process to track the design changes at an object level. In addition to the shortage of technical skills required to develop 3D models, the knowledge and awareness of the BIM process among non-technical stakeholders was a prominent issue. 3D models were not part of the documented design assurance process. Therefore, the models developed were inconsistent with each other, which created many issues among stakeholders. In the Common Data Environment (CDE) implemented by Crossrail, designers and contractors could not easily manage changes at the object level. This made it difficult to assess the effect of design changes on other stakeholders (Smith, 2014).

Case studies 2, 3, 4, 5 and 6 are from the construction sector. These studies show how inadequate stakeholder management can affect projects in the construction industry.

2.12 Summary of Chapter 2

Stakeholder management and its process have been defined in this chapter. The stakeholder term was defined, and it was established that there is no consensus in the literature about the definition of the term 'stakeholders.' The normative theory is treated as the core of stakeholder theory. Communication is identified as the key critical success factor for managing stakeholders. Various stakeholder mapping tools were discussed.

Chapter 3 : LITERATURE REVIEW – BUILDING INFORMATION MODELLING

3.1 Introduction to Chapter 3

The nature of design and construction activities in the construction industry requires different organisations to work together and stay dependent on each other to deliver a bespoke product for the client. Each organisation or team in an organisation has its specialty, commitments, work patterns, individual interests, values and culture. Hence, they form a temporary organisation and make inter-dependent discipline decisions that affect the overall progress of the project. The complicated and varied relationships between different project participants make project management more difficult to manage (Liu *et al.*, 2017).

The construction industry is resistant and slow to change, with many traditional procurement and project delivery methods unchanged in decades (Smith, 2013). Over the last five decades, the construction industry has had very few innovations as compared to other industries. The Reinventing Construction report (2017) argued that the construction industry is one the least digital industries in the world. It is even less digital than the basic goods manufacturing industry. In 2016, the construction sector spent only £211 million (only 0.9% of the total UK R&D) on research and development, whereas the automobile industry spent £3.3 billion and the aerospace industry spent £1.9 billion in the UK (McKinsey & Company, 2017). However, within the construction industry, there were many innovations related to material research, energy efficiency (for instance, prefabrication, green-building designs, and eco-friendly materials) and installation methodologies. Nevertheless, the technologies used by construction management teams remained mostly the same (Hardin and McCool, 2015). However, Building Information Modelling (BIM) is affecting the traditional ways of working and collaborating; for example, the way in which designers and contractors share information (Liu *et al.*, 2017).

3.2 Definition of BIM

There is no universally accepted definition and explanation of BIM (Liu *et al.*, 2017 and Race, 2013). Both academia and industry have proposed their definitions. The attempts for defining BIM in the 1990s used terms such as virtual prototyping, electronic data model, digital model, integrated project database and digital representation of a facility. All these terms represented a technologically predominant aspect of BIM (Race, 2013).

The National Building Information Model Standard (NBIMS) defines BIM as a digital representation of physical and functional characteristics of a facility, creating a shared knowledge resource for information about it and forming a reliable basis for decisions during its life cycle, from earliest conception to demolition. This definition is used by many researchers, such as Sebastian (2011). However, this definition is not taken as the basis for this research because it does not present an explicit relationship between BIM and project stakeholder management because, in the first instance, it mainly gives a reflection of the technical aspect.

Succar (2009, p. 357) defined BIM as “a set of interacting policies, processes and technologies that generate a methodology to manage the essential building design and project data in digital format throughout the building’s life-cycle.” This definition is taken as the basis of this research because, according to Bryde *et al.* (2013), this definition promotes the holistic nature of BIM that also incorporates project management-related tools and processes in addition to the software that enables 3D modelling and input of information. Therefore, this perspective makes BIM a tool for project management. The use of words such as ‘policies’, ‘processes’, ‘methodology’ and ‘manage’ changed the perception to think about the broader implementation of BIM (Race, 2013). According to Race (2013), detecting clashes between HVAC installations and structural elements, or designing, coordinating and constructing a complex cladding system, cannot be called BIM because this aspect contributes very little to a revolution for the management of information throughout the project’s lifecycle. BIM acts as a repository of information (Johansson *et al.*, 2015) having a technical core with a social aspect that reflects the social and institutional implications of a designed product. Hence, it is considered as a socio-technical system (Wong and Zhou, 2015 and Liu *et al.*, 2017). According to Eadie *et al.* (2013), the implementation of BIM can affect all processes in a project organisation. Therefore, it should not merely be considered as a software tool. Usually, people misunderstand BIM by treating it as a single model or database (Fazli *et al.*, 2014).

3.3 History of BIM

The concept of BIM was developed in the mid-1970s by Eastman and was called ‘Building Description Systems’ (Cao *et al.*, 2015), and it originated at the Georgia Institute of Technology (Rokooei, 2015). Digital building descriptions using objects that belong to predefined classes were called ‘Building Product Models’, which is now known as BIM. The concept was envisaged in the late 1970s but became famous in 1985 when the ISO’s STEP (Standard for the Exchange of Product Data) standardisation project was started. STEP aimed to resolve the need for data exchange for a vast number of manufacturing industries (Howard and Bjork, 2008).

According to Cerovsek (2011), different models having common features instigated an idea to have a common model, which can be used by several tools in project communication. The common model was coined as the 'Building Product Model' (BPM) and is now known as BIM. BPM was defined as the total sum of information about a building. The term 'Building Information Modelling' (BIM) was first used in 2002 to describe virtual design, construction and facilities-management (Rokooei, 2015). However, Shoubi *et al.* (2015) stated that it was developed in the mid-1980s but only became popular recently.

According to Mihindu and Arayici (2008), the Helsinki University of Technology-600 (HUT-600) auditorium extension was among one of the first reported projects to have implemented BIM-related technology (the authors did not specify the time frame of the project). The Centre for Integrated Facility Engineering (CIFE) Stanford, which had an independent reviewing committee for this project, concluded in their 2002 report that the Project Model and Fourth Dimension (PM4D) approach helped expedite traditional design practices and promoted lifecycle approaches. However, CIFE discussed benefits related to the reduction in design iterations, helped to set a reliable budget for effective cost control and eliminated the need to re-enter data related to geometry, material properties and thermal values.

According to Mihindu and Arayici (2008), BIM was implemented in the construction of the Eureka Tower in Melbourne; its construction started in the middle of 2002 and it was finished in September 2006. The project was 92 stories with other extensions and had a budget of 500 million Australian Dollars. The architects decided to implement BIM (with no previous experience of implementing it), which led to the training of 15 to 20 staff members and up-gradation in computer hardware. Several design models were built. BIM's facilitated design analysed and evaluated to a greater extent, which was not possible with traditional 2D CAD and, which consequently, helped to make better decisions that eventually led to a functionally sound infrastructure. The architects eventually concluded that the benefits they reaped as an organisation were worth more than the cost of implementation.

3.4 Factors affecting the efficiency of using BIM

The efficiency of BIM depends mainly on two factors:

1. The level of collaboration among project participants.
2. The stage at which project participants have collaborated on one or more digital models (Eastman *et al.*, 2011).

Rokooei (2015) concurred with Eastman (2011) that project participants' characteristics influence the outcomes of BIM considerably as it needs all parties to get involved, and hence their attitudes act as an effective factor, especially the attitude of a project manager. Therefore, to use BIM optimally, all stakeholders have to be involved in the process (Hochscheid and Halin, 2020).

According to Porwal and Hewage (2013), if the contractor is not involved in the design phase of a project, then the power of BIM is limited. The authors further argued that the opportunities to get maximum benefits from BIM increases if team members get involved in the early design stages of a project. This is because the project stakeholders can get the maximum possible details at an early stage of the project, which can facilitate many decisions, and hence, it provides a more reliable base to make decisions than traditional approaches (Mihindu and Arayici, 2008). Moreover, BIM makes it easy to see the consequences of decisions made, which eventually enables project managers to perform effectively (Fazli *et al.*, 2014).

The close collaboration of the designer and the builder at an early stage of a project, if enabled by BIM, can make it a strong and effective process (Fazli *et al.*, 2014). Cao *et al.* (2015) identified that the integrated usage of BIM in both the design and construction stages considerably led to higher performance in task efficiency improvement, task effectiveness improvement and overall BIM success, and concluded that the usage of BIM in limited amounts may not yield higher efficiency in design activities, and its discrete use may also reduce the productivity of early design activities.

3.5 Procurement approach and BIM

This section builds upon the previous section and discusses the effect of a procurement approach to BIM performance. It will discuss the traditional procurement approach, Integrated Project Delivery (IPD) in particular and briefly examine the Design-Build (DB) and Construction Manager at Risk (CMR) approaches.

3.5.1 The traditional procurement approach

Out of the four above mentioned approaches, the traditional procurement approach (Design Bid Build (DBB) or traditional contract) is the least favourable to reap the maximum benefits from BIM. This is due to the reason that it does not involve a contractor in the design phase (Eastman *et al.*, 2011). Once the owner agrees to the programme and the architects' conceptual design, engineers (such as structural, MEP) get involved in developing the design further. The result is a comprehensive set of construction drawings and specifications, which are used for permitting and bidding (Hardin and McCool, 2015). A contractor is selected through a tendering process, and generally, a low bidder is selected (Sebastian, 2011). Consequently, the contractor is forced to make its design models. If the design team's drawings have errors, omissions or inconsistencies, and the contractor's drawings are based on those specs, then at the construction stage, serious conflicts could arise between the design team and the contractor, which may significantly affect the cost of the project, as well as delay it (Eastman *et al.*, 2011). If contractors are allowed to participate in the design process, then BIM can provide a foundation for contractors and sub-contractors to coordinate MEP systems. This can save money for the sub-contractors by enabling them to prefabricate their systems from the models provided by designers. It can make the initial estimation process easier and give more clarity to project participants on the design and construction of the project (Hardin and McCool, 2015).

Sebastian (2011) conducted a case study of two hospital projects in the Netherlands. Both used the traditional procurement approach. In both projects, clients directly contacted designers, structural engineers and MEP engineers. In one of the projects, MEP engineers were not knowledgeable about using the Revit software that was agreed to be used by the design team during the planning stage. So, the conversion of the Revit model from and to was still required. Similar issues can happen with contractors as well because they get involved at later stage, and at that time, if contractor's firm is incapable of using similar software or is using different software, then a significant amount of work will be required to make the designer's model compatible with the contractor's model (but in the case study it was not specified if this issue happened with contractors as well).

The projects were procured using the traditional procurement approach, and therefore a significant amount of effort was made to promote cross-discipline collaboration. A long preparation phase was set up between the architect, the structural engineer and the MEP engineers before commencing the design. This phase aimed to develop a common vision for collaborating optimally using BIM as Information Communication and Technology (ICT) support. During the preparation phase, a document was developed that defined the common ambitions for the project and the collaborative working process. Furthermore, a semi-formal contract was signed among design team members to promote collaboration among themselves and interaction with end-users to address life-cycle requirements. Despite these efforts, it was still difficult to get the team members to collaborate. The reasons for this, identified by Sebastian (2011), are that in the traditional procurement approach, the involvement of actors is short for a particular project phase, their roles are specific, liabilities and responsibilities are limited, and they do not get any tangible incentives for integrated collaboration.

3.5.2 Use of BIM in ‘Design and Build’ and ‘Construction Manager at Risk’

The Design and Build (DB) approach provides excellent opportunities to unleash the potential of BIM to reap maximum benefits for the project from inception to demolition because, in the DB approach, only one entity is responsible for both the design and construction processes. Hence, the contractor can make changes to the design in the design stage, and it is easy for the entity to implement BIM by having the design team collaborate with other teams at the design stage to generate a final BIM model (Eastman *et al.*, 2011).

The CMAR is like DBB; the only difference is that the contractor is involved in the design phase. The owner signs two contracts with the contractor. A contract is completed for both the design phase and another for the construction phase. The client and the design team have to decide when to involve the contractor and whether to involve a subcontractor (and, if so, at which stage). The advantage of CMAR over the traditional approach is that the contractor can add input and can help solve potential issues before construction commences (Hardin and McCool, 2015).

3.5.3 Use of BIM in Integrated Project Delivery (IPD)

The IPD approach works similarly to the DB approach by making different teams work collaboratively from the early design stage until the handover of the project (Eastman *et al.*, 2011). IPD is an emerging trend for project delivery, uniting different disciplines, and turning the construction process into a collaborative process. All project participants are encouraged to work towards project objectives rather than individual objectives. This improves efficiency through all phases of a project and, hence, optimises the value of the project (Rokooei, 2015).

In an integrated approach, the client has a contractual relationship with one main party, who is responsible for both design and construction. The payment for the supply chain depends on the performance (functional and technical) of a facility measured over a certain period of time. If the minimum requirement set by a client is met, the supply chain will get an additional bonus (as an incentive) according to the client's gain (Sebastian, 2011). IPD argues to share profit and loss of the client among all project teams (as an incentivisation) because partnering with different entities is common, but that does not push project participants to work collaboratively. The real approach to promote collaboration requires incentivisation so that project participants have a good reason to work together by sharing pains and gains (Smith, 2013).

Hardin and McCool (2015) mentioned some advantages and disadvantages of IPD. A few of the advantages mentioned are as follows: the IPD approach incentivises collaboration; the contractor's decision can incorporate quantitative and qualitative aspects rather than solely price-based ones; the approach provides a platform to contractors for managing costs by continuously enabling them to conduct estimates throughout the design process; it rewards innovation rather than just encouraging it; it has the potential to bring change orders to zero. The disadvantages specified are that the IPD approach requires trust and collaboration among the team to succeed; the architects and contractors usually spend more time to win the contract, which costs more money; and the IPD approach is not yet accepted by any public sector agency.

The IPD approach has project participants well beyond the triad of the client, the contractor and the designer. At a minimum, it needs a robust collaboration among at least these three stakeholders from inception until the handover of a project. The critical factor for making IPD a successful approach is to assemble a team that is committed to working collaboratively and is capable of working together as an effective team. The fundamental principle of IPD is collaboration. Hence it can only be successful if project stakeholders share common values and work towards common goals. Therefore, the transition from the traditional approach to IPD requires a transition in the mindset of both the client and supply chain (Sebastian, 2011).

BIM comprises Information Communication and Technology (ICT) frameworks and tools that can support integrated collaboration based on the life-cycle design approach (Sebastian, 2011). BIM works effectively in the IPD approach because it sets common objectives for all project stakeholders, unlike the traditional approach in which project participants focus on their personal objectives more than the project's objectives (Smith, 2013). BIM tools enable project participants to communicate, visualise and analyse complex information holistically and cohesively. IPD is an integrated approach for delivering projects, and BIM has a technological interface that facilitates this approach (Rokooei, 2015). Hence, an IPD approach combined with BIM provides a state of collaboration which results in many advantages during the project lifecycle, such as improvement in efficiency, reduction in errors, ease to explore alternative approaches

(Porwal and Hewage, 2013), and continuous flow of information (Nical and Wodynski, 2016). Due to its collaborative nature, project participants can: assess, track and review the project, resolve conflicts and inconsistencies, make decisions when required, and execute the project successfully (Rokooei, 2015). The essence of BIM to support cross-disciplinary collaboration opens a new dimension in the roles and relationships of project stakeholders (Sebastian, 2011). However, merging BIM and IPD is not yet practical because of several reasons, such as education, trust, and liability, among others (Smith, 2013).

The more the number of project participants get involved in the design process, the better the output of the BIM process. Hence, the DB approach and IPD provide a more suitable environment for BIM to be effective throughout the project.

3.6 BIM documents and other government publications

The BIM process generates information models and their associated information that is used throughout the life cycle of buildings or infrastructure assets (PAS 1192-2:2013). This section will discuss the documents published by the British Standards Institution (BSI) in the context of stakeholder management only.

PAS 1192-2:2013

PAS 1192-2:2013 provides guidance for information management during the construction phase of a project. It is a crucial document for any BIM project because it describes the whole process of information management from inception till handover. Figure 3.1 shows the process mentioned in the PAS 1192-2. It explains the terminology, Employer’s Information Requirements (EIR), the BIM Execution Plan (BEP) and the Common Data Environment (CDE), among other topics.

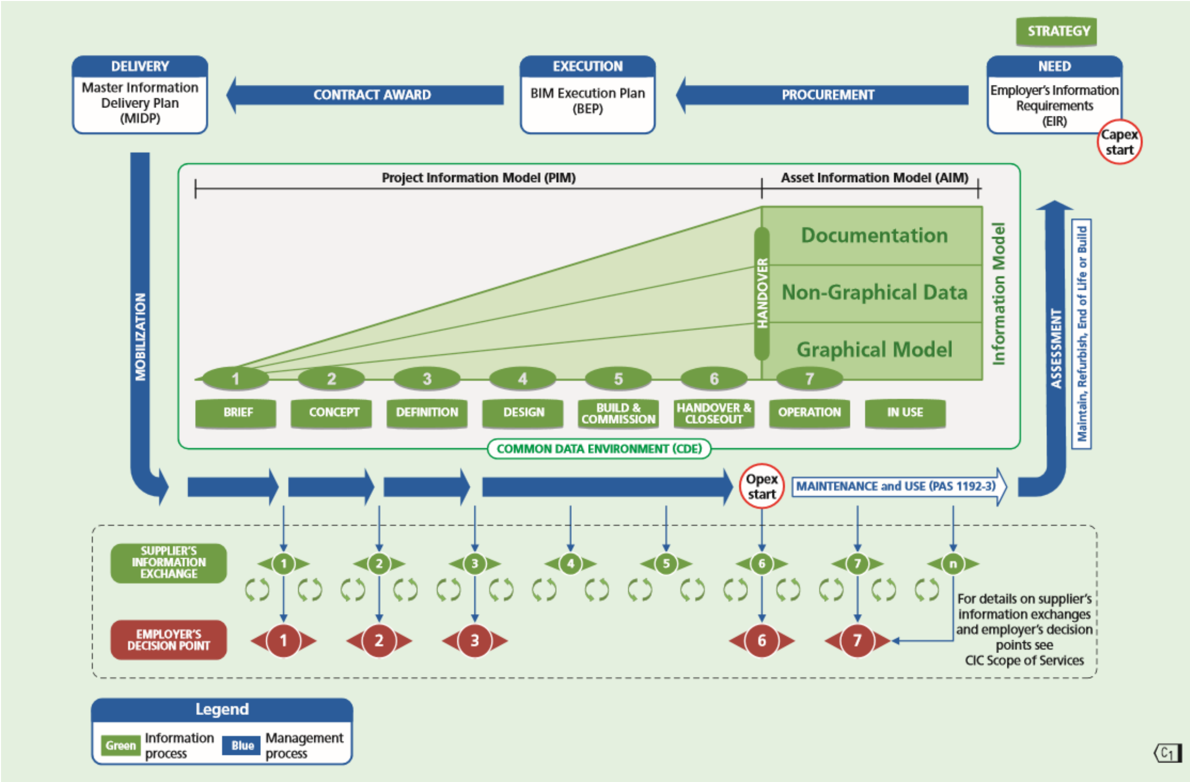

Figure 3.1: Information management process (Source: PAS 1192-2:2013)

It is clear from Figure 3.1 that the BIM process starts from the top right box 'need' if it is a stand-alone new project and from the right-hand arrow if it is a refurbishment project.

Employer's Information Requirements (EIR)

PAS 1192-2:2013 and the EIR are coherent documents in terms of providing guidance for stakeholder management within BIM implemented projects. The Employer's Information Requirements (EIR) is a document that is designed to be included in the tender documents for the procurement process of both the design and construction team. It is a crucial document with regards to communicating information requirements and information management requirements. It divides its content into three parts: technical, management and commercial. The 'management' aspect demands the explicit description of the coordination and clash detection process, and the collaboration process as well from the bidders.

Moreover, it demands explicit explanations about standards to be used, and the roles and responsibilities of each party. For instance, for the collaboration process, it asks the bidders to specify how frequently they will collaborate, details of model review workshops, and other collaborative working practices (EIR Version 7, 2013). This will make project stakeholders overcome the boundaries of procurement approaches (for example, traditional procurement approach) and contractual barriers, and make them collaborate and coordinate with each other. this is because, as Liu *et al*. (2017) investigated, legal and contractual issues often become barriers for project stakeholders to work collaboratively.

Furthermore, Plain Language Questions (PLQs) should also be included in the EIR. Employers and suppliers should agree on what data and other deliverables will be required to answer PLQs. These requirements will be documented in the post-BEP in the form of a Task Information Delivery Plan (TIDP). Depending on the nature of the questions, the response should be provided in a combination of PDFs, COBie, and native file formats (NBS, 2019).

BIM Execution Plan (BEP)

BEP has two parts: pre-contract BEP and post-contract BEP. The pre-contract BEP is a response document to the EIR. When organisations bid for winning a tender, they have to include a pre-contract BEP in their tender documents, which will specify how the requirements set by the employer in the EIR will be met. Once the contract is awarded, the post-contract BEP will specify everything in detail. It is basically a refined and more detailed version of the pre-contract BEP.

CIC BIM Protocol 2013

This is a document that will supersede any other document in the case of litigation. CIC BIM Protocol (2013) sets the responsibility for the employer to appoint an Information Manager who will not have any duty related to the design of a project. Out of the four key responsibilities stated in BIM Protocol (2013) for Information Manager, two are managing the processes and procedures for information exchange on projects and implementation of the BIM Protocol. This will help in making better decisions by preventing information loss, which usually occurs while exchanging information between various stakeholders, and preventing misinterpretation of information, which often leads to communication problems. Moreover, traditional ways of exchanging information in isolated files were also responsible for missing many opportunities for coordination.

CIC BIM Protocol 2018

CIC BIM Protocol 2018 is the second edition of the BIM Protocol 2013. In this edition, some clauses of BIM protocol 2013 have been amended and some new ones have been added. Project team members must attend the meetings with the Employer's Information Manager and other project team members for information coordination and resolutions of conflicts. If any party becomes aware of any inconsistency, conflict or ambiguity about the information, it must inform other parties for resolution.

Industrial Strategy Construction Sector Deal (2018)

Construction Sector Deal is based on Construction 2025. Its goal is to reduce the capital expenditure and whole life cycle cost of an asset by 33%, to reduce project delivery time by 50%, to reduce greenhouse gas emissions by 50%, and to reduce the trade gap of construction products and materials by 50%. In 2016, the industry's turnover was £370 billion and contributed around 9% to the total UK economy. However, the productivity of the industry has declined by 21% since 1997. A few reasons that have been cited as being responsible for this are the unpredictability of future work, the cyclical nature of the sector and a lack of collaboration in the industry. To tackle these challenges and to meet the goals set, the government has emphasised the importance of adopting digital techniques, offsite manufacturing, and a focus on whole life-cycle performance rather than on just capital expenditure. The UK government is investing on the adoption of digital technologies such as BIM, sensors, data analytics and smart system technologies to increase the efficiency of construction techniques. The government is working cohesively with the Centre for Digital Built Britain (CDBB) to promote the adoption of BIM standards. BIM methods developed by the UK have been adopted by many nations such as the USA, Brazil, Australia and Japan (HM Government, 2018).

3.7 Use of BIM in project management

The various aspects in which BIM can be helpful for project managers are:

(1) Communication – the characteristic of a federated model to input, modify and analyse data will enhance communication between different project participants and make them coordinate, thus reducing the disputes between different project participants. BIM acts as a repository of information and, thus, enables all stakeholders to assess the same version of data that consequently reduces the risk of poor communication (Rokooei, 2015). It facilitates communication among project participants relative to spatial, logistical, material, performance specifications and requirements (Love *et al.*, 2011). Moreover, as all the data is in 3D, it facilitates the use of real-time visualisation as a tool to share information and communicate ideas among different stakeholders (Johansson *et al.*, 2015 and Wong and Zhou, 2015).

The communication process among stakeholders in a project can be enhanced dramatically with the help of BIM. One of the reasons for this is that in BIM, a 3D model of a facility can be developed directly. 3D models are relatively easier to understand than 2D drawings, where a person has to analyse the drawing first and then visualise the 3D structure. Moreover, it takes less time and money to produce visualisations of a facility by using BIM tools because in traditional approaches, visualisations are always produced from scratch, whereas in BIM, they can be developed from previously constructed models as well. As communication is a key factor in developing mutual understanding about the objectives of the project among stakeholders, it satisfies the client's requirements as well (Fazli *et al.*, 2014). The new roles, such as BIM modeller and BIM coordinator, improve information quality and ensure better communication (Liu *et al.*, 2017).

(2) Collaboration – BIM provides opportunities for project managers to improve and promote collaboration among stakeholders (Bryde *et al.*, 2013) because different models prepared by different parties are federated into one model, so all parties are able to work on one model simultaneously as a team (Rokooei, 2015). Moreover, BIM provides opportunities for project participants to collaborate during the various stages of an asset's lifecycle by enabling them to create, amend, update, extract and reuse information throughout the project life cycle (Alreshidi *et al.*, 2017, Getuli, 2016 and Sebastian, 2011), which will reflect their roles and support the roles of others (Sebastian, 2011). Arayici *et al.* (2011) argued that BIM collaboration among stakeholders crosses organisational boundaries because it provides a time and place, restriction-free collaborative working platform (Sebastian, 2011) and boosts the project organisation's performance in its design and construction process (Arayici *et al.*, 2011). Constructability requires a collaborative approach, and the early involvement of stakeholders is beneficial. The more the involvement of key project participants at an early stage, the lower the risk will be at the construction stage (Smith, 2013). It is due to this reason that proper collaborative design and construction activities facilitate the efficient transfer of information, technological coordination, right resource allocation, knowledge creation and decreases conflicts (Liu *et al.*, 2017). Often in traditional construction practices, it requires the same information to be used many times by different project teams. BIM stores information on BIM servers in a digital format and can be reused directly from the models. This can help current intradisciplinary collaboration to evolve into multi-disciplinary collaboration on models (Singh *et al.*, 2011).

Collaboration between designers and contractors affects trust-related outcomes of a project, as well as operational outcomes. When designers and contractors collaborate intensely in the environment of BIM, they openly share information that enables other project participants to understand their expectations in a better way, helps to anticipate their actions and offers a willingness to help. Different project teams show a commitment to each other. This eventually generates an atmosphere of trust. Hence the trust between teams is enhanced (Liu *et al.*, 2017). Therefore, BIM enhances collaboration and promotes team building (Rokooei, 2015).

(3) Quantity take-offs – BIM tools can provide cost estimation, which can help project managers analyse their decisions and have an explicit view of other design alternatives in the design stage and throughout the project life cycle. Furthermore, quantity take-off items can help in the procurement procedure as well (Rokooei, 2015).

(4) Element-based models – BIM models are usually composed of objects, rather than geometries (such as line, surface, etc.). Thus, the whole model can be broken down into small and distinct objects, which facilitates a clear and defined project scope. This enables better estimation and management decisions (Rokooei, 2015).

(5) Time (4D) – BIM tools help project managers visualise the construction project at any time, which enables an explicit understanding of project stages (Rokooei, 2015). Visualisation can also be helpful in looking at a sequence of activities relative to plant, temporary structures and temporary supports, which can be helpful in detecting workflow clashes (Smith, 2013).

(6) Various analyses – BIM tools help perform various types of analyses, such as those related to energy efficiency, light and acoustics, among others. For instance, better solutions can be found after performing energy consumption analyses, such as changes in space, orientation, materials and mass, among others. This will help in making better decisions. Moreover, aesthetics can be improved by analysing different design options, as well (Rokooei, 2015).

(7) Clash detection – Geometrical design inconsistencies are a very common problem on construction projects. Merging different BIM models into a federated model will help in detecting the clashes (Rokooei, 2015), which will help increase savings (Smith, 2013).

(8) Constructability – The process of constructability can be defined as "the best utilisation of construction knowledge and experience in planning, design, procurement and field operations to achieve overall project objectives." The knowledge used by professionals to build the BIM model is usually very beneficial at the constructability stage and often includes suggestions from various team members (Smith, 2013, p. 1). BIM can help in reviewing and handling constructability issues and can also facilitate

‘Request for Information’ (RFI). Visual information can be helpful in showing problems (Rokooei, 2015).

3.8 Benefits of using BIM

There are numerous benefits of implementing BIM discussed in the literature. Table 3.1 depicts them. It is explicit from Table 3.1 that ‘facilitates design and construction alternatives’ is the top benefit of BIM because it is corroborated by six authors. It is followed by ‘less design and coordination errors’, ‘lower construction costs’ and ‘improves collaboration among stakeholders.’ All these three are corroborated by five authors; therefore, they share the same stance. ‘Facilitates design and construction alternatives’ is corroborated by four authors.

Table 3.1: Benefits of implementing BIM

S. no	Benefits	References*
1	Facilitates design and construction alternatives	1, 2, 3, 4, 5, 6
2	Facilitates cost, energy and lifecycle analysis	1, 5, 7, 8
3	Clash detection	5, 6, 7
4	Sustainability analysis	7, 9
5	Construction scheduling	7, 8
6	Offsite fabrication	7
7	Less design coordination errors	3, 5, 7, 8, 10
8	Decreased production cycle times	3, 5, 7
9	Lower construction costs	3, 5, 7, 10, 11
10	Boosts integration	8
11	Boosts information exchange	8, 10, 12
12	Environmental performance analysis	9
13	Improved safety performance	9
14	Improving efficiency of building operations	9
15	Promoting customer service quality	9
16	Reducing emergencies during the facility’s operational phase	9

17	Reducing waste from resources	5, 9, 11
18	Improves collaboration among stakeholders	2, 4, 5, 10, 11, 13
19	Reduces time consumed in documentation process	13
20	Enables automation of repetitive tasks	4, 5
21	Optimises construction information and links information sets	4
22	Enriched 3D rendering	2
23	New revenue and business opportunities	5

*1 = Mihindu and Arayici (2008); 2 = Alreshidi *et al.* (2017); 3 = Shoubi *et al.* (2015); 4 = Bradley *et al.* (2016); 5 = Rokooei (2015); 6 = Zheng *et al.* (2017); 7 = Cao *et al.* (2015); 8 = Love *et al.* (2011); 9 = Wong and Zhou (2015); 10 = Gaunt (2017); 11 = Eadie *et al.* (2013); 12 = Demian and Walters (2014) 13 = Bryde *et al.* (2013)

3.9 Barriers in BIM implementation

The lack of awareness, emphasis on BIM as an advanced version of CAD tools, and the underestimation of the capability of BIM to manage documents are the key factors identified by Singh *et al.* (2011) that hinder the adoption of BIM by non-design disciplines.

According to Rokooei (2015), personal beliefs considerably affect BIM implementation, as a survey has shown that if the project team members do not believe in the value and advantages of BIM, the outcome of BIM implementation on a project will not be satisfactory. This view is also supported by Hardin and McCool (2015), that behaviour is a key element for successfully integrating BIM. According to the researchers, future-forward behaviour is as important as the technologies and processes behind it. Table 3.2 depicts the various issues mentioned in the literature that are barriers to implementing BIM in the construction industry.

Table 3.2: Barriers in implementing BIM

S. No	Barriers	References*
1	Lack of trust to use data from models made by different teams	1, 2, 3
2	Interoperability	1, 2, 4, 5, 6, 13, 14
3	Onerous process to transfer data from 3D models to performance analysis applications	1
4	Client/owners resistance to change	1
5	Client/owners lack of knowledge	1
6	Client/owners less support to implement BIM	1, 7
7	Insufficient inter-organisational collaboration	1, 15
8	Lack of awareness and training among project participants	2, 5, 7, 8, 9, 10
9	Fragmented nature of AEC industry	2, 5, 10, 15
10	Industry's resistance to change traditional work practices	2, 5, 7, 10, 14
11	Hesitation to learn new concepts and technologies	2
12	Lack of clarity on roles, responsibilities and distribution of benefits and maintenance of BIM model throughout project lifecycle	2, 3, 5, 10, 11
13	Emergence of new roles (such as BIM Manager)	2, 11
14	Variance in market readiness across different geographies	2, 10
15	Network security	2
16	Design protection (Copyrights and Intellectual Property (IP))	2, 3, 5, 7, 11, 14
17	Improved and up-to-date curriculum for students so that they can appreciate the collaboration of tools	2, 9
18	Apprehension about how to integrate BIM into an organisation's modus operandi	2
19	Coordination of BIM process with business process	4, 5
20	Reliability	5
21	Legal and contractual issues related to BIM	5
22	Investment in software and hardware	7, 8, 9, 14
23	To develop an internal collaborative BIM workflow and procedures	8
24	Lack of expertise in an organisation	7, 10, 12, 14
25	Lack of additional project finance to support BIM	3, 7, 14
26	Project participant's unwillingness to share information	3, 7
27	Lack of immediate benefits from projects delivered to date	7, 14
28	Unsymmetrical BIM rewards between organisations	3, 10
29	Extra time consumed while reviewing models	3
30	Cost of maintaining BIM servers/platforms	13
31	Lack of government support	13
32	Lack of public policies	13
33	Lack of clarity in the adoption process	13
34	Lack of procedural implementation standards	13
35	Lack of strategic planning	13
36	Low return of investment	14

37	Lack of client demand	14
38	Unwillingness to share information	14, 15

*1 = Cao *et al.* (2015); 2 = Gu and London (2010); 3 = Liu *et al.* (2017); 4 = Bradley *et al.* (2016); 5 = Alreshidi *et al.* (2017); 6 = Grilo and Jardim-Goncalves (2010); 7 = Eadie *et al.* (2013); 8 = Rokooei (2015); 9 = Smith (2013); 10 = Singh *et al.* (2011); 11 = Sebastian (2011); 12 = Gaunt (2017); 13 = Hochscheid and Halin (2020); 14 = Mellado and Lou (2020); 15 = Okakpu *et al.*, (2020)

Table 3.2 clearly depicts that 'interoperability' is a key barrier in BIM implementation as it is corroborated by seven authors. It is closely followed by 'lack of awareness and training among project participants' and 'design protection' as both are corroborated by six authors. 'Lack of clarity on roles, responsibilities and distribution of benefits and maintenance of BIM model throughout project lifecycle' and 'industry's resistance to change traditional work practices' are corroborated by five authors.

3.10 Case studies of BIM implementation

This section will discuss and compare two case studies related to BIM implementation.

Dossick and Neff (2010) undertook a case study on the performance of MEP (mechanical, electrical and plumbing) workers on two BIM implemented projects and investigated that BIM robustly joined different teams together technologically, but they remained organisationally divided, often without timely access to critical information and decisions. The organisational barriers hindered the smooth exchange of information and decisions about the federated model, which led to a decrease in the effectiveness of the federated model.

Dossick and Neff (2010) found that the key reasons which affected the work of MEP detailers were that the information they needed was delayed, and there was improper coordination with other teams, a lack of information and much less authority for MEP workers to participate in the decision-making process, even though they met with each other frequently, shared information and resolved their technological conflicts. MEP detailers met weekly and exchanged information strictly, resolved disputes over space and conflicts by negotiating and jointly solved problems as a group. But the problem was in passing on information and models with other teams (such as architectural and structural). The MEP detailers were given design constraints from design documents, were made to work according to them and were provided with very limited access to discuss their issues with designers. Essentially, they were organisationally disconnected from the basic information they needed to do their jobs; despite being closely connected in solving problems in a technologically enabled coordination process provided by BIM.

One of Dossick and Neff's (2010) interviewees postulated that, even though BIM enables close collaboration and better information exchange among project participants, the power to make decisions in projects is often divided organisationally. This view is postulated by Porwal and Hewage (2013) as they stated that to reap the maximum benefits from BIM, diverse organisational, procedural and technical issues have to be addressed. Furthermore, Mihindu and Arayici (2008) stated that traditional construction processes need to be changed to reap the benefits of BIM. Traditional procurement methods treat design and construction processes separately. This hinders smooth communication and coordination between design and construction teams (Porwal and Hewage, 2013). According to Dossick and Neff (2010), the increase in intricacy in projects makes different project participants become experts in different areas. This diversification then demands communication, collaboration and coordination between them. The balance between integration and diversification of different working groups (and/or individuals) has been a problem for a long time in construction management. For instance, with the increase in complexity of the project, the design, development and construction of MEP (mechanical, electrical and plumbing) systems need more collaboration among MEP expertise as well as with architects, engineers and contractors, among others.

On the contrary, a case study conducted by Porwal and Hewage (2013) identified that BIM provided the platform to diverse workers of fragmented design and construction industries to unite together to address project-wide collaboration and assisted the project team in managing the client by establishing a coordination platform.

In a case study conducted by Porwal and Hewage (2013), a BIM manager was involved as well. The issues of decision making and information access were dealt with by co-locating the design team at the client's premises with an objective to create a collaborative work environment and to resolve dependency issues. Different models (including the MEP model) were brought together by a principal consultant in software called 'Navisworks' to detect clashes, and the process was repeated until all the major issues were resolved. Porwal and Hewage (2013) stated that dependencies of the designers on one another and on specialty contractors make detailed design coordination an intensive process. The detailing work for each department depends on the information provided by designers and other trade contractors. Therefore, to set a collaborative work environment, detailers are required to work alongside each other. This view is further supported by Fazli *et al.* (2014), who stated that there is a need for better integration of project teams and collaboration among all stakeholders in the construction industry. Furthermore, a shift from handling project-related information with a documents paradigm to an innovative project-integrated database paradigm is also required. BIM has the capability to assist immensely in both areas.

The case study conducted by Dossick and Neff (2010) was in 2010 when BIM adoption was in its infancy. BIM was used in their case study to detect clashes, without a focus on any other capability of BIM. There could also be a lack of knowledge to implement BIM effectively as no one acted as a BIM manager and all actions which are specified in a case study by Porwal and Hewage (2013) (to make BIM an effective tool) were not taken in the case study analysed by Dossick and Neff (2010).

Furthermore, new job designations, such as BIM managers, have emerged with an aim to foster coordination in developing and maintaining a federated model (Porwal and Hewage, 2013).

3.12 Lean construction and BIM

In 1990, Womack developed the concept of lean production to describe the implementation of lean production ideas (Bertelsen and Koskela, 2004) of the Toyota Production System (TPS) (Nguyen and Akhavian, 2019). The theoretical work of lean in construction was started by Koskela in 1992 with his famous Transformation Flow Value (TFV) theory in which the researcher conducted an initiative to apply lean production principles in the construction industry. This work laid the ground for lean construction to emerge as a discipline (Bertelsen and Koskela, 2004 and Aziz and Hafez, 2013). Subsequently, on recognising the potential benefits of adopting the lean production approach, International Group for Lean Construction (IGLC) coined the term ‘lean construction’ in 1993 (Babalola *et al*., 2019). This is defined as an approach to minimise waste in time, materials and effort to maximise value of the project (Nguyen and Akhavian, 2019).

The implementation of lean construction has increased over the past few years (Mellado and Lou, 2020). The USA, the UK and Brazil are the world leaders in its research. Concepts, tools, techniques, strategies and approaches that enable lean construction goals are called lean construction practices (LCPs) in lean construction. Therefore, LCPs are the means by which a lean thinking/philosophy can be implemented at the planning, design and construction stage of a project (Babalola *et al*., 2019). A reduction in wastage of material, decreased carbon emissions, reduced lead times, improvement in quality, improved value chain and an ability to identify waste are the main benefits of applying lean principles (Mellado and Lou, 2020).

Recently, lean construction and BIM are integrated due to their synergistic nature of reducing waste and improving construction processes (Nguyen and Akhavian, 2019). Waste reduction, improvements in the performance of projects, efficiency gains, reduction in re-work, increment in value, overall reduction of time by applying clash detection, improved flow, visualisation and collaborative planning are the practical benefits of BIM contributing towards lean construction (Mellado and Lou, 2020). Simulation, parametric modelling and the visualisation capabilities of BIM provide an opportunity to improve construction waste management planning (Guerra *et al.*, 2020). Sacks *et al*. (2010) identified 56 interactions between lean and BIM by combining 24 lean principles with 18 BIM functionalities. The authors found that 52 interactions were synergistic. Guerra *et al*. (2020) used a 4D BIM simulation approach to minimise the production of waste during the construction stage and to maximise the reuse and recycling of waste. On the other hand, Tauriainen *et al*. (2016) identified the issues in BIM implementation for structural and building services design management which can be mitigated by adopting lean approaches. In summary, the synergistic effect of lean approaches and BIM can help eliminate waste and add value to the project.

3.13 Stakeholder management and BIM – the research gap

Most of the literature has focused only on exploring the benefits of BIM related to 3D, 4D, 5D, waste management (lean construction) and sustainability (Green BIM). The benefits explored in the literature range from common benefits, such as visualisations, project planning and cost estimation, to advanced benefits; for instance, Providakis *et al.* (2019) merged 3D visualisations data with geotechnical data to predict and assess the settlement effect induced by tunnelling on nearby buildings, Sheikhkhoshkar *et al.* (2019) used 4D BIM to develop an automated programme for the correct positioning of concrete joint layouts to mitigate the adverse effects of incorrect placing of the joints while concrete pouring, Guerra *et al.* (2020) used 4D BIM simulation approach to minimise the production of waste during construction stage and to maximise reuse and recycling of the waste, and Chen *et al.* (2019) merged 5D BIM with Radio Frequency Identification Devices (RFID) to reduce uncertainties and to improve the coordination process between supply chains in pre-fabricated projects.

There is a lack of research exploring the benefits of BIM related to stakeholder management. A few researchers, namely Bryde *et al*. (2013), Smith (2013), Rookie (2015), Travaglini *et al*. (2014) and Fazli *et al*. (2014) have explored and specified the benefits of BIM related to project management, but they have not specified any tangible benefits related to stakeholder management (as stakeholder management is also a part of the role of project managers). However, it is acknowledged that those benefits will help project managers to make better decisions. Therefore, they will help project managers to manage stakeholders indirectly. There has been an abundance of literature over the past 10 years investigating BIM adoption from several perspectives, such as theoretical frameworks and conceptual models, macro adoption and barriers in implementing BIM (Hochscheid and Halin, 2020). However, there is a paucity of research investigating BIM implementation from a stakeholders' perspective; for instance, He *et al.* (2017) identified that, during the construction of Shanghai Tower, the technical aspect of BIM was not the inhibitor in its implementation. The difficulty in getting eight different BIM teams from diverse backgrounds to coordinate was the main barrier in BIM implementation. Therefore, there is a huge gap in the literature for exploring the challenges organisations are currently facing for managing stakeholders within BIM projects, and there is little research that examines how BIM can benefit stakeholder management, as well as an understanding of the techniques organisations are using for managing stakeholders. This study has provided a view of an unexplored aspect of BIM and has set a foundation to develop this view further.

3.14 Summary of Chapter 3

Implementation of BIM and making it a normal everyday working routine is an evolution, not a revolution. This section has critically discussed the definition of BIM, examined factors affecting its efficiency, explored the effect of a procurement approach on effectively using it, and has identified the benefits and barriers of implementing it. It is concluded that effective implementation of BIM demands collaboration among different disciplines. Different teams have to work together proactively; otherwise, they cannot see the benefits and poor implementation may even lead to disaster.

Chapter 4 : RESEARCH METHODOLOGY

4.1 Introduction to Chapter 4

This chapter provides an overview of the research methodology and discusses the research process adopted in this study. The chapter is divided into five parts. The first part introduces the contents of chapter 4. The second part describes the overview of the research process. The third part discusses how the literature review of chapters 2 and 3 was performed. The fourth part discusses the research strategy adopted for this study. The fourth part also includes discussion about research philosophies, research approach, research choice, data collection, and data analysis method. The fifth part presents a summary of the research methods adopted. The sixth part presents a summary of this chapter.

4.2 Overview of the research process

A robust methodology was developed for achieving the aim and objectives of this research. Figure 4.1 shows an overview of the methodology. It is clear from Figure 4.1 that the research process is broadly divided into three phases: literature review, research strategy, and output.

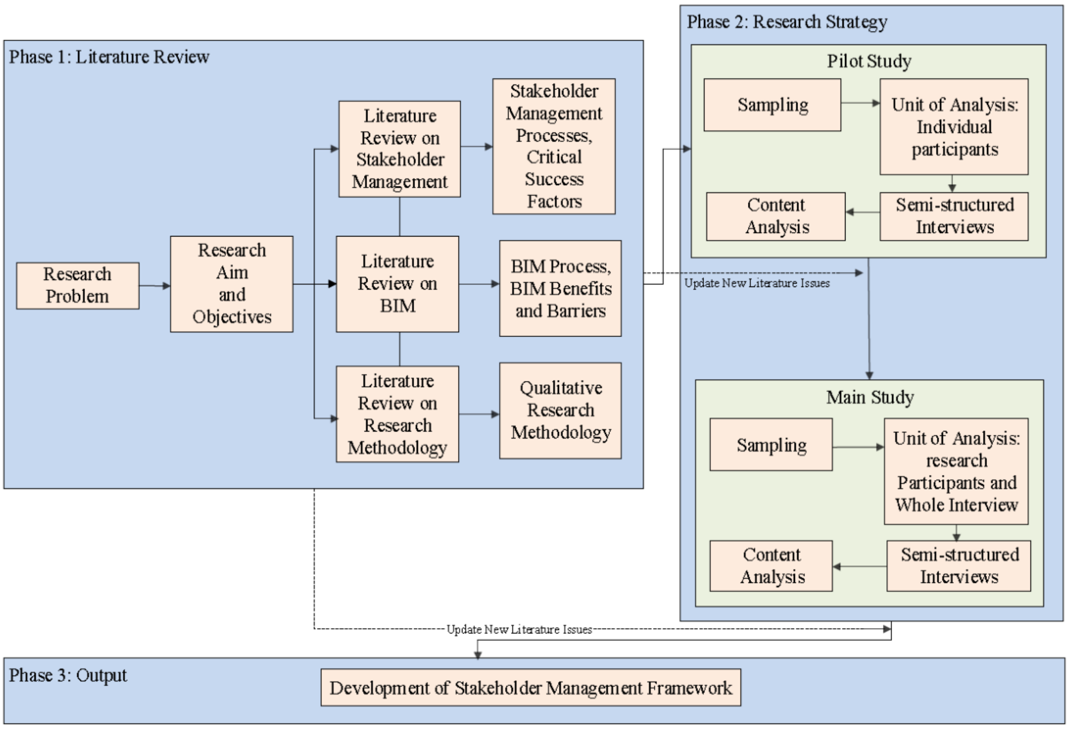

Figure 4.1: Overview of the research process

4.3 Literature review

The literature review was divided into two sections: literature review related to stakeholder management (chapter 2) and literature review related to BIM (chapter 3). An extensive literature review focused on stakeholder theory, stakeholder management processes, stakeholder mapping tools, and critical success factors (CSFs) for stakeholder management was performed. For the BIM section, the focus was on BIM documents, benefits of BIM, barriers for implementing BIM and characteristics of BIM.

Several sources were used for conducting a critical review of the literature. Diverse databases, such as SAGE Journals, EBSCOHOST, Web of Science, Business Source Complete, Google Scholar, Science Direct and Construction Information Service (CIS) were used through the university's database in addition to the university's library catalogue. Textbooks were used through the university's library. The required publications that were not in the university's subscription were accessed through an inter-library loan service. Journal and conference papers accessed were primarily related to the field of construction engineering, general and construction management and social sciences.

Researchers' supervisors recommended using the software NVivo Pro from the outset of the research. It was corroborated by Johnston (2006), who recommended using software from the inception in a project like a PhD thesis so that a researcher could adapt to it in the initial stages of a project if that software has to play a vital role in the later stages (which, in this case, was data analysis). Usage of software helped to generate mind maps from emerging themes and to link journal articles with other, similar articles. Figure 4.2 shows a screenshot of the literature review pertinent to the topic of 'stakeholders', whereas Figure 4.3 shows a screenshot of the literature review pertinent to the topic of BIM. The more detailed description of the usage of the software is discussed in section 4.4.5.2.

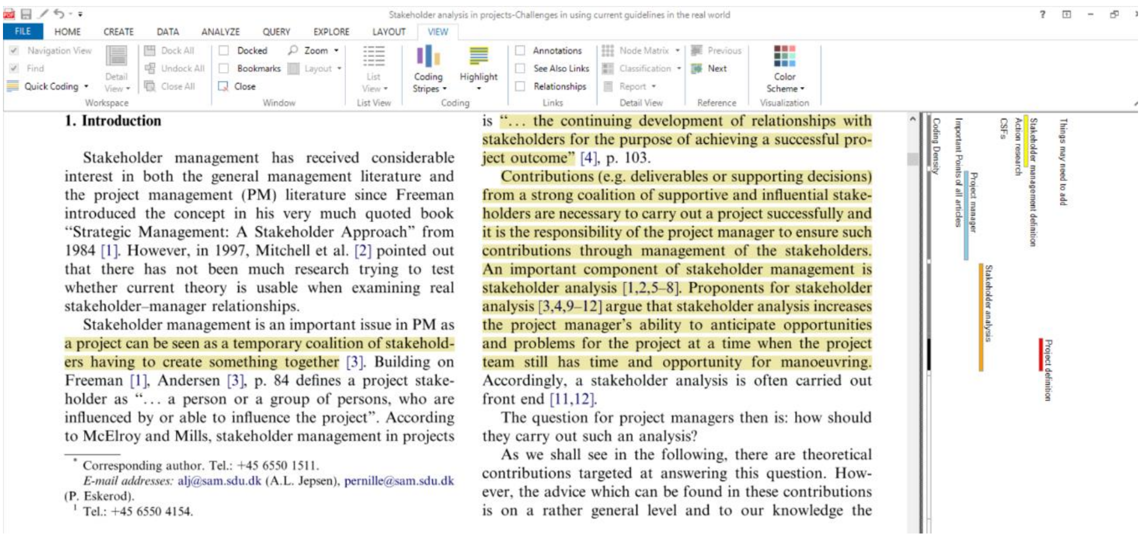

Figure 4.2: A glimpse of the usage of the NVivo 11 Pro software for the literature review

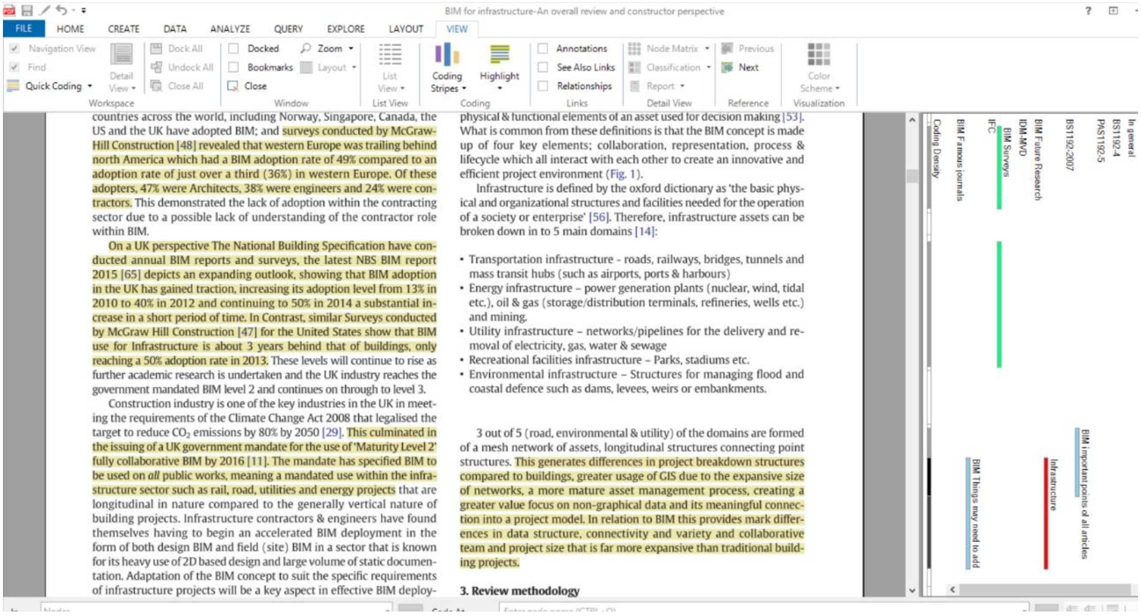

Figure 4.3: A further glimpse of the usage of the NVivo 11 Pro software for the literature review

4.4 Research strategy

Different authors have developed frameworks to guide the research strategy. For instance, Saunders *et al.* (2009) developed the 'research onion', which was updated in Saunders *et al.* (2016). Strang (2015) developed 'research design typology.' The two are virtually similar with subtle differences; for instance, they have different names for different stages. Saunders *et al.* (2016) have called the first stage 'philosophies', whereas Strang (2015) has called it 'research ideology.' This research has adopted the Saunders *et al.* (2016) framework, which its authors named 'the research onion.' Figure 4.4 shows the research onion. The framework is explained stage by stage in the subsequent sections, and the reasons for adopting a particular stance in each stage are discussed in their respective sections.

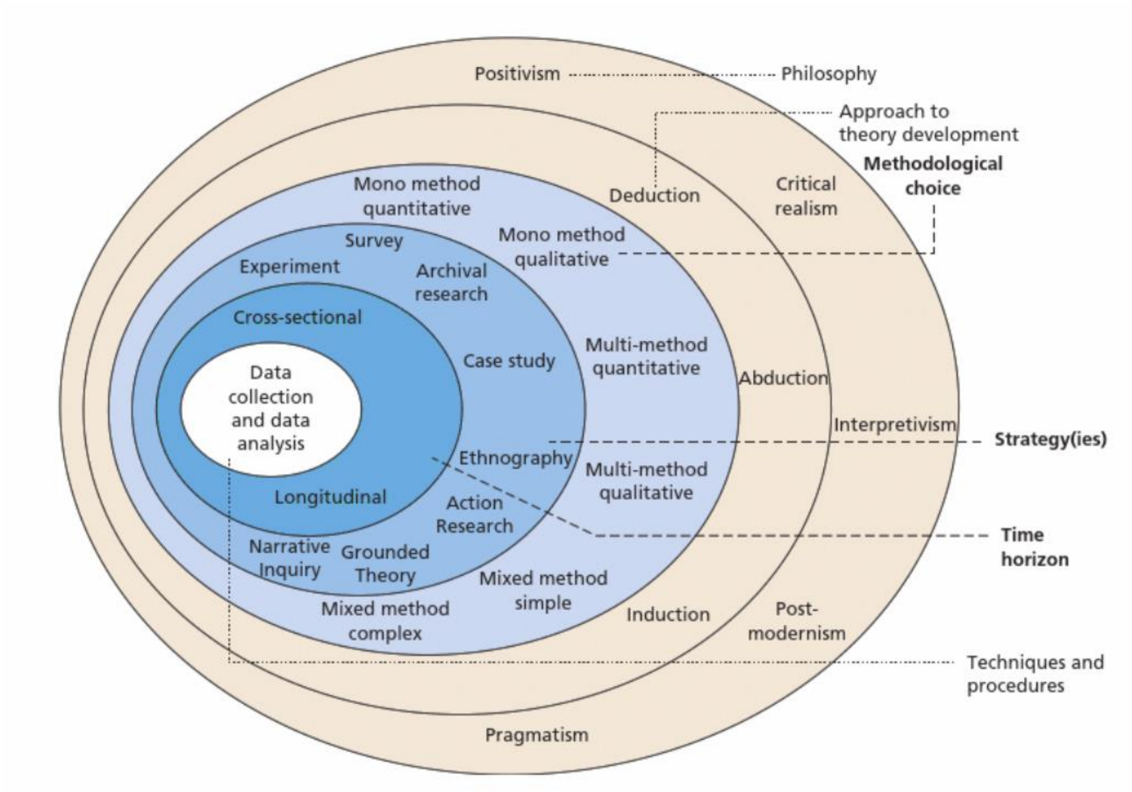

Figure 4.4: The research onion (Source: Saunders *et al*., 2016)

4.4.1 Research philosophies

"Philosophy means the use of abstract ideas and beliefs that inform the research" (Creswell, 2013, p.16). There are three types of 'philosophical assumptions', namely ontological assumptions, epistemological assumptions, and axiological assumptions. The terminology used in research on 'philosophical assumptions' varies among different authors, cultures, disciplines and industries (Strang, 2015). For example, Strang (2015) used the word 'ideology' for philosophical assumptions, whereas Saunders (2009) has used the word 'research philosophies.' Other authors have used terms such as world view, inquiry strategy, philosophy, design strategy, paradigm, epistemological framework, theoretical orientation, archetype and philosophical belief (Strang, 2015).

Research philosophical assumptions is a continuum with various stances. For example, Saunders *et al.* (2016) described five stances in these assumptions, i.e., positivism, critical realism, interpretivism, post-modernism and pragmatism. Strang (2015) described three stances, namely positivism, pragmatism and constructionism. However, Strang (2015) acknowledged that he had not included stances such as post-positivism, interpretivism, social constructivism, and other stances intentionally in their research on design typology.

4.4.1.1 Ontology

Ontological assumptions are related to the nature of reality and its characteristics (Saunders *et al.*, 2016 and Creswell, 2013). Saunders *et al.* (2016) have broadly divided ontological assumptions into two categories, i.e., objectivism and subjectivism. Objectivism further incorporates positivism and realism, while subjectivism incorporates interpretivism.

Positivism treats the world as being systematic and deductive, relying on theories to explain most behaviours and processes. Therefore, a positivist researcher commences by reviewing a priory theory (facts, laws). Based on that, a researcher creates a hypothesis that is to be tested. Instead of interpreting data, the researcher controls factors and uses techniques for describing and explaining relationships. Pure positivism is rarely used except in highly controlled situations, such as process testing and behavioural experiments (Strang, 2015). Research can be classified as positivist if there are formal propositions, variables are measured quantitatively, and testing of hypothesis and inferences are drawn from a representative sample to a stated population (Klein and Myres, 1999).

Subjectivism view is usually related to the terms constructionism or social constructionism (Saunders *et al.*, 2009), interpretivism, and phenomenology (Creswell, 2014). This assumption believes that reality is socially constructed (Saunders *et al.*, 2009). This approach is basically followed in qualitative research (Creswell, 2014). In qualitative research, researchers believe that a situation can have multiple realities. To prove a situation can have multiple realities, researchers use multiple forms of evidence in themes by using the actual words of the research participants for presenting different perspectives (Creswell, 2013).

Klein and Myers (1999) noted that interpretive research could assist researchers in understanding human thought and action in the social and organisational context. Moreover, it has the potential for investigating in-depth insights into a phenomenon, such as the development and management of systems, because it does not predefine dependent and independent variables. Instead, it focuses on the complexity of human sense-making, as the situation emerges by attempting to understand phenomenon through the meanings that people assign to them.

The constructivist ontological paradigm assumes that the social world, i.e., social relationships, organisations, and divisions of labour are not given entities. These are elements of the world, and ‘relations’ is an essential part because the world is produced and reinforced by humans through their actions and interactions. The world is not perceived to be composed of objects. Cognitive elements such as meanings, beliefs, and intentions are pivotal in the constructivist paradigm (Goldkuhl, 2012).

This study is qualitative in nature due to its constructivist ontological stance.

4.4.1.2 Epistemology

Epistemology can be referred to as a theory of knowledge (Strang, 2015). It is related to the topic of how acceptable knowledge is created in a field of study. Positivism and realism share a similar a kind of philosophical position, which is working with observable social reality. This is similar to the philosophical stance of a natural scientist. On the contrary, interpretivism argues that it is a must for a researcher to understand differences between humans for their role as social actors. Interpretivism involves a challenge for the researcher to enter the world of research subjects and understand the world from their perspective (Saunders *et al.*, 2009).

Ontological and epistemological assumptions are intertwined in interpretivism. The researchers are expected to interpret existing meanings shared by the research participants. In an interpretative paradigm, it is essential to understand the subjective meanings of research subjects because scientific knowledge related to social life is a second-order character. The knowledge developed from the personal experiences of subjects from daily life is a first-order character. The second-order constructs of social science must be based on the meaning and knowledge of the research subjects (first-order character) (Goldkuhl, 2012). According to Klein and Myres (1999), research participants are interpreters and co-producers of empirical data in interpretative stance. So, data generation should be treated as a social construction.

In qualitative research, a researcher tries to get as close as possible to the participants being studied. Therefore, subjective evidence is gathered based on the perceptions of individual persons. A researcher believes that this is how knowledge is created through the subjective experiences of individuals (Creswell, 2013). Research can be classified as interpretative if a researcher assumes that knowledge about reality can be gained only from social constructions such as shared meanings, language, consciousness, tools, and documents (Klein and Myres, 1999).

Therefore, the epistemological stance of this research can be viewed as being interpretative (constructivist), subjectively seeking meaning and developing understanding, and treating knowledge as a social construction.

4.4.1.3 Axiology

The axiological philosophical assumption is related to the researcher's values in the research (Saunders *et al.*, 2009) and their influence on the knowledge creation process (Biedenbach and Jacobsson, 2016). Qualitative research is value-bound (Lincoln and Guba, 1985). In general, axiology refers to the theory of beliefs, such as cultural values, aesthetic values, religious influences, and moral values. In business and management, the emphasis is not on the existence of axiology but on the importance of values in the mind of the researcher. The values driven by socio-culture impact the literature section and research design (Strang, 2015). Therefore, ethical issues were taken into consideration (refer to 4.4.4.1).

4.4.2 Research approach

Saunders *et al.* (2019) defined two types of approaches, namely inductive and deductive approaches. The inductive approach leads to theory development. Researchers who follow this approach are particularly concerned with the context in which the phenomenon takes place. Hence, studying a small sample of subjects could be more adequate than studying a large sample, which is usually done in the case of a deductive approach. The inductive approach usually deals with qualitative data, and the researcher can use multiple methods to collect data in order to develop different perspectives on the phenomenon. The deductive approach involves the creation and testing of hypotheses from theory, whereas, in an inductive approach, a theory is generated from the data analysis.

When there is an abundance of literature about the phenomenon to be studied, from which it is possible to develop a theoretical framework and hypothesis, a deductive approach is usually called for. In contrast, when the topic is new with limited literature, it is more appropriate to adopt an inductive approach in which data is collected and subsequently analysed, and themes are generated (Saunders *et al.*, 2016).

Therefore, due to the nature of the research (i.e., paucity of literature about the phenomenon to be studied), this research has adopted an inductive approach. An in-depth explanation of the inductive and deductive approach related to data analysis is discussed in the data analysis section (refer to 4.4.5.4).

4.4.3 Methodological choice

Quantitative and qualitative terms are used to distinguish basically between data collection and analysis techniques (Saunders *et al.*, 2019). Quantitative research is adopted to investigate answers to topics about relationships between measured variables; for instance, the number of employees in an organisation and annual turnover of that organisation. The purpose behind this is to predict, explain, and control a phenomenon (Suresh, 2006). The quantitative approach is also known as the traditional, experimental, and positivist approach.

On the contrary, qualitative research is an exploratory approach and is used to investigate a topic when the variables and theory base are not known. Qualitative research relates to the problems that can be best addressed by exploring a concept or phenomenon (Creswell, 2014). This approach aims to understand and describe the phenomenon from the points of view of the research participants (Suresh, 2006). Furthermore, it relates to exploring and understanding the perceptions that groups or individuals hold about human or social issues (Creswell, 2014). Qualitative research helps in understanding complex phenomena by helping researchers to understand the behaviours or cognitions of the people or organisations involved, as well as their beliefs, rituals, values and emotions. This can be achieved through four methods: i.e., talk and speech, documents and texts, observations, and visual objects (for example, drawings, videos, and photographs) (Ograjensek, 2016). It is a useful approach if a researcher is looking for insights into human experiences (Erlingsson and Brysiewicz, 2017). In qualitative research, the questions and procedures emerge, and the data is typically gathered in the respondents' settings. Data analysis evolves from specific to general themes, with the researcher interpreting the meaning of the data. The final report is flexible in nature (Creswell, 2014). According to Etikan *et al*. (2016), quantitative methods provide breadth of understanding, while qualitative methods provide depth of understanding.

Saunders *et al.* (2019) called this stage that of methodological choice. The authors have mentioned three different types of research choices, namely quantitative, qualitative and mixed methods. These are subdivided further which is shown in Figure 4.5.

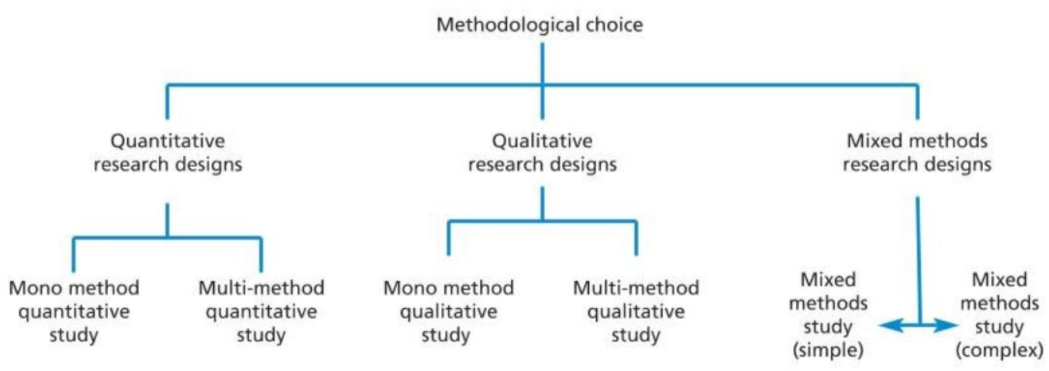

Figure 4.5: Methodological choice (Source: Saunders *et al.*, 2019)

In a mono method approach, a researcher chooses either a qualitative or a quantitative data collection technique and analyses data by choosing a corresponding qualitative or quantitative data analysis method.

In a multi-method approach, a researcher chooses more than one data collection technique. Data is analysed by choosing a corresponding data analysis method. The key point is that both qualitative and quantitative data collection methods cannot be adopted together. For instance, if a qualitative data collection method is adopted, then the subsequent data collection method must also be a qualitative method.

In mixed-method research, both qualitative and quantitative approaches for data collection can be used simultaneously (parallel) or one after another (sequential). Data is analysed using the method corresponding to the collection technique.

This study has adopted the mono-qualitative method in order to explore insights from BIM practitioners; there is a lack of literature due to the qualitative research characteristics mentioned.

4.4.4 Data collection

In this study, the pilot study and the main study use the same data collection technique. Therefore, it is explained only once.

4.4.4.1 Sampling

The term 'sample' means a representative piece or a part of the whole population that is chosen to demonstrate what the rest of the population looks like (Naoum, 2013). Sampling is broadly divided into two types of categories: probability sampling (random sampling) and non-probability (non-random) sampling. In probability sampling, it is possible to specify the probability of each element being selected in the sample. Usually, all the elements have the same probability of being selected (Diserens, 1985) because a random selection procedure is used (Etikan *et al*., 2016). On the other hand, in non-probability sampling, there is no way of estimating the probability of each element being selected in the sample. Furthermore, there is no assurance that every element has some probability of being selected (Diserens, 1985). In non-probability sampling, randomisation of elements is not an important factor. Instead, it focuses on subjective methods for selecting elements for including in the sample. The common reasons for adopting non-probability sampling are when the population is not well defined; when drawing inferences from the sample to the population is not much emphasised; it is cheaper than probability sampling (Etikan *et al*., 2016).

In this research, Robinson's (2014) approach was followed. The author has described a four-step approach for sampling in qualitative research, i.e., defining a sample universe, deciding on sample size, devising a sample strategy, and sourcing the sample.

Defining a sample universe – it is also known as 'study population' or 'target population.' It is a must to specify an inclusion and/or exclusion criterion for the sample at this stage. Inclusion criteria mean attributes an element has to possess for getting qualified for the sample, and exclusion criteria mean attributes which disqualifies an element from the sample (Robinson, 2014).

In this study, inclusion criteria were that construction organisations would only be from the UK construction industry. The research participants contacted were employees of organisations based in some cities of England, i.e., Wolverhampton, Birmingham, London, Bristol, Leeds, Cambridge, and Camberley, and the towns around these areas. However, these organisations operate all over the UK, and some were even multi-national companies.

Another inclusion criterion was that participants must be working on BIM implemented projects. The minimum experience was not considered to be mandatory because the UK government mandated BIM in 2011. It was only after this push by the government that most of the organisations started focusing on BIM. So, if the researcher had put a limit of say, five years of minimum experience, then most of the research participants would not have met the criteria because the data collection was started in 2017. Even the NBS 2014 report says 54% of the organisations which responded to their survey said they implemented BIM on some of their projects and not on all projects. It was dropped to 48% in the 2015 report, increased to 54% in the 2016 report, and 62% in the 2017 report.

Decide on sample size – there is not a set of rules to follow for deciding a sample size in qualitative research (Patton, 2002). A purposive sampling approach is usually used in qualitative research (Etikan *et al*., 2016). In purposive sampling, sample size is not a major concern (Mason, 2002). Purposive sampling techniques place primary emphasis on data saturation, i.e., data collection is continued till comprehensive understanding of a research topic is developed, and no new substantive information is required (Etikan *et al*., 2016 and Palinkas *et al*., 2013). In convenience sampling, as the sample size increases, statistical reliability increases as well (Etikan *et al*., 2016). On the contrary, in purposive sampling, sample size depends on data saturation and not on statistical reliability (Zhi, 2014). The sample size depends on what a researcher wants to explore, the purpose of research, what is at stake, what will be useful, what will have credibility, and what can be done with available time and resources (Patton, 2002).

The researcher analysed data simultaneously while data collection was going on. Rather than waiting till all data collection was over before starting to analyse, this saved time. This helped to identify the saturation point. The saturation point was reached after conducting 20 interviews. Marshall *et al*. (2013) argued that data saturation usually occurs between 10 and 30 interviews. Francis *et al*. (2010) recommended conducting three more interviews after data reached the saturation point, to test whether any new themes emerged or not, and then to close collection data. In the authors' research, data saturation reached at the 14th interview. Hence, he conducted 17 interviews in total. Following his approach, the researcher conducted three more interviews to verify the saturation point. No new data emerged. Hence, further data collection was stopped, thus making a total of 23 interviews.

Devise a sample strategy – The choice of sampling method depends on the research questions (Setia, 2016) and the type and nature of the study (Etikan *et al*., 2016). This is because each methodology has different expectations and standards for determining the number of elements (participants) required to achieve its objectives. Therefore, the sampling approach must be consistent with the objectives of the research (Palinkas *et al*., 2013). For instance, generalisation is the primary aim of probability sampling, whereas in-depth understanding is the primary aim of purposive sampling (Patton, 2002). Therefore, if a researcher wants to understand an issue in-depth rather than be concerned about generalising the results, then purposive sampling is an appropriate approach (Setia, 2016). Patton (2002) argued that the level of in-depth detail which can be achieved with purposeful sampling cannot be achieved with random probability sampling. Furthermore, random sampling is used when the specific characteristics of the subjects, such as their background, organisation size, and type of work, are not important, whereas non-random sampling outsets by choosing the names and addresses of subjects with particular characteristics (Naoum, 2013).

Considering the reasons mentioned above and the qualitative nature of this study, this study has adopted purposive sampling and snowball sampling. These are explained in the subsequent paragraphs.

Purposive sampling, also known as judgemental (or purposeful) sampling, does not need underlying theories and a set number of participants. The researcher decides what is required to be investigated and searches for participants that can provide that information from their knowledge and experience. The objective is to focus on individuals with particular characteristics who can assist in relevant research (Etikan *et al*., 2016). Patton (2002) described purposeful sampling as an approach for developing an in-depth understanding by selecting information-rich cases. By information-rich cases, the author means those cases which can provide enormous amounts of information about the key topics of the research phenomenon. As sampling is based on study purpose, the expectation is that each participant will provide unique and rich information which will add value to the research (Zhi, 2014). Studying information-rich cases develops insights and in-depth understanding, rather than empirically generalising results (Patton, 2002). Purposive sampling cannot be used if the variables are quantitative in nature; therefore, is commonly used in qualitative studies (Etikan *et al*., 2016).

Snowball sampling is also known as chain sampling, chain-referral sampling, and referral sampling (Robinson, 2014). In snowball sampling, interviewed participants are requested to recommend other participants who have similar characteristics (Palinkas *et al*., 2013 and Biernacki and Waldorf, 1981). It is among the most widely used methods in various disciplines of qualitative research (Noy, 2008 and Biernacki and Waldorf, 1981). It is extremely useful when respondents, through other sampling approaches, stop responding and for targeting hidden populations (Noy, 2008).

Source of the sample – many different types of techniques were used to get the contact details of the research participants, such as the Financial Analysis Made Easy (FAME), The Construction Index, LinkedIn and Eventbrite.

Firstly, the Financial Analysis Made Easy (FAME) database was used to search for construction companies. FAME was adopted because it allows to search companies based on several parameters such as their size, location, etc. It provides web link of their websites and phone number also. Furthermore, it was a subscribed database in the researcher’s university (FAME, 2017). Therefore, it provided a good starting point to search for construction companies in the UK. Construction companies’ websites were then consulted for the contacts. Secondly, The Construction Index database was used for finding organisations. Websites were searched for the contacts subsequently. It was adopted because it is a free online source to search for construction companies. Thirdly, LinkedIn was used for finding contacts. It was adopted because it is a social media site used by people especially for sharing their professional profiles. Being social media site, it is easily accessible via smartphone, tablet or computer. Furthermore, it is free and industry professionals can be searched by using keywords. Their profiles can be read prior to sending them invite for being part of the research. Therefore, it can be a valuable source for finding relevant research participants. Requests were sent via messages to professionals for participating in research. Lastly, the researcher used Eventbrite to find BIM events. It was adopted because it is a platform designed to search events related to diverse fields. Events can be paid or free. Researcher used BIM as a key word to find BIM events in the UK. The researcher attended many BIM events. The researcher developed contacts at events with the industry professionals. For doing so, the researcher informed them about the research topic and discussed the topic with them. Business cards of BIM professionals were taken by the researcher at all the events. Professionals were then contacted by email. The rationale for adopting these four approaches is as follows:

- Free and accessible to the researcher.
- Provide contact access.
- Easy to use.
- Sufficient to give a starting point which was going to be supplemented with snowball sampling.

Among the four approaches mentioned above, which were adopted by the researcher, attending BIM events and developing contacts stood out as a highly successful technique. The researcher contacted around 130 BIM professionals by email, whose details were found using the first two techniques. Only three professionals responded despite sending reminder emails every week. One participant responded through LinkedIn. Professionals met at BIM events responded to emails sent by the researcher. However, not all of the professionals responded to emails sent to them. Still, the rate was much higher compared to the previous three techniques. Those who interviewed were requested to recommend their peers (snowball sampling). Adopting snowball technique proved useful, and the researcher was able to get five participants through recommendation.

During this stage, Robinson (2014) recommended having ethical skills while contacting research participants. The author further recommended informing potential participants of research aim and information about the research, information about how their identity will be protected, and other information that could entice them to participate.

The author prepared four documents for complying with this guidance, i.e., an invitation letter, information sheet, consent form, and interview questions. The invitation letter described the context of the research. Assurance about keeping their details confidential was also discussed in the invitation letter. Information sheet specified aim of the research, context of the research, purpose of interviews, duration, and data storage. Consent form was used to take consent from the participants. Interview questions specified questions to be asked during the interview. These questions were emailed to all potential participants, but consent forms were not. Consent forms were taken by the researcher himself as a hard copy when the researcher went to conduct the interview. The participants were requested to sign the consent form before commencing interviews. The researcher also took hard copies of invitation letter, information sheet, and interview questions. Research context and data confidentiality were discussed again before commencing interviews so that participants could feel comfortable before commencing the interview. When the interview was finished, the researcher again assured them confidentiality about their identities. There were also interviews that were conducted using phone, Skype, and BlueJeans. In those cases, consent form was sent to participants by email, and they were requested to sign it and send it back. The copies of these four documents are attached in Appendix A, B, C, and D.

4.4.4.2 Profile of the research participants

Table 4.1 depicts the profile of the participants who took part in this study. The range of experience varies from one year to more than 40 years. Interviewee 1, interviewee 15, and interviewee 19 were the least experienced persons with an experience of one year and two years (for both interviewee 15 and interviewee 19), respectively. Interviewee 3, interviewee 4, interviewee 7, and interviewee 12 were the most experienced persons, with a minimum experience of 30 years. The average experience was 16.6 years. Furthermore, it is clear from Table 4.1 that participants belonged to diverse roles in different organisations. The roles varied from BIM coordinators to CEOs. This diversity in job title and experience ensured insights from people working at different levels and helped to identify common themes.

Table 4.1: Research participants' profiles

Interviewee	**Experience (years)**	**Role/Designation**	**Length of using BIM (organisation)**	**Organisation's BIM maturity level**
Interviewee 1	1	BIM coordinator	2 years	Between 1 and 2
Interviewee 2	17	Divisional engineering manager	10 years	Level 2
Interviewee 3	30 +	Design manager	2 years but has been using for 4 years	Between 1 and 2
Interviewee 4	38	Head of planning and digital construction	6 years	Level 2
Interviewee 5	10	BIM manager	6 years	Level 2
Interviewee 6	20 +	Project manager	6 years	Level 2
Interviewee 7	32	Commercial manager	6 years	Level 2
Interviewee 8	18	Design manager	6 years	Level 2
Interviewee 9	19	BIM Consultant	5 + years	It depends on the role

Interviewee 10	20	Digital manager	3 years	Level 2
Interviewee 11	20	CEO	20 years	Level 2
Interviewee 12	40 +	CEO	15 + years	Level 2
Interviewee 13	20 +	Assistant director	2 years	Level 1
Interviewee 14	15	Digital manager	10 + years	Level 2
Interviewee 15	2	Stakeholder liaise assistant	5 years	Level 2
Interviewee 16	12	Digital manager	5 years	Level 2
Interviewee 17	11	BIM Manager	10 + years	Level 2
Interviewee 18	12	Project manager	2 years	Level 1
Interviewee 19	2	BIM coordinator	2 years	Level 2
Interviewee 20	6	BIM-GIS Coordinator	2 years	Level 2
Interviewee 21	8	BIM manager	5 years	Level 2
Interviewee 22	9	BIM manager	3 years	Level 2
Interviewee 23	20 +	Information manager	8 years	Level 2

Table 4.1 also depicts the time frame for BIM use among research participants' organisations. Interviewee 11's organisation (interviewee started his organisation) has been using BIM for one and a half years, but, as a team, he has used it for approximately 20 years. Interviewee 11 was part of the team that created the first Level of Detail (LOD) standard. Moreover, interviewee 11 was also part of the team that created the first BIM contract and the first commercially available BIM application. Most of the interviewees have described their organisations as BIM Level 2.

4.4.4.3 Semi-structured interviews

There are three types of interviews: structured, semi-structured, and unstructured (Cachia and Millward, 2011). Structured and unstructured interviews are also called formal and informal, controlled and uncontrolled, inflexible and flexible, and standardised and unstandardized, respectively (Naoum, 2013). Unstructured and structured interviews form the extreme ends of the continuum, with semi-structured interviews in the middle of the continuum. Unstructured interviews may make findings difficult to compare if participants have not responded to the same questions (Knox and Burkard, 2009). Unstructured interviews do not control the responses of the participants (Mclntosh and

Morse, 2015). Structured interviews (Knox and Burkard, 2009) follow a highly structured method, usually composed of closed questions. This allows respondents to answer questions in a yes/no format. The advantage of structured interviews is that results are highly uniform. The disadvantage is that it prohibits the uncovering of unique and rich experiences which lie outside the scope of interview questions. According to Cachia and Millward (2011), structured interviews are not a suitable method for an inductive approach because it delimits the areas to explore to only the topics included in the questions. However, the collected data can be quantified and compared easily.

In this study, the research objectives and the nature of the information required informed to choose semi-structured interviews. Semi-structured interviews have characteristics from both structured and unstructured interviews (Cachia and Millward, 2011). The reasons for choosing semi-structured interviews are as follows:

- Semi-structured interviews allow the researcher to remain open and flexible so that they can explore research participants' experiences in more detail related to any particular area which emerges during the interview (Knox and Burkard, 2009).
- The data collected is comparable because the questions are asked in the same order.
- The data can be quantified (Mclntosh and Morse, 2015).

Hughes (2016) argued that interviews should be treated as a process rather than as an isolated activity. The author described several steps for this process. These steps were followed and are described below.

(1) **Pre-interview preparations** – The researcher developed three documents (the fourth document was a 'consent form' to carry as a hard copy for face-to-face

interviews) to email potential participants. The emails were written in a formal manner. Emails requested the participants' availability and gave them the opportunity to choose between a face-to-face, phone or Skype interview. Some participants responded by stating that they were comfortable with all of the methods. Whenever the researcher got an opportunity to do so, the researcher preferred face-to-face interviews. Hughes (2016) argued that the interactions that takes place between interviewer and interviewee during the interview planning (e.g., securing the agreement for providing an interview or finalising the date, time, and venue) form an image of the interviewer's professionalism in the interviewee's mind.

(2) **Introduction** – The researcher introduced the purpose of the interview to every interviewee before commencing the interview. Furthermore, the researcher also guided all of the interviewees through the interview process. Hughes (2016) recommends this as a good practice that provides both persons with a neutral starting point.

(3) **Beginning the interview** – the researcher asked for permission to record interviews. Confidentiality of the data was assured to the interviewees, and how it would be used was described. Interviews followed the template. Interviews started with generic questions, subsequently followed by pertinent questions.

(4) **During the interview** – Hughes (2016) recommended that interviewers let a rapport develop between an interviewee and the content an interviewee speaks by not judging the views of the interviewee. The author further recommended that interviewers listen actively to the interviewees. This recommendation was followed.

(5) **The researcher** – interviews were not ended suddenly. The researcher asked the question, "would you like to ask any question" to end interviews politely. Data

confidentiality was again reassured, although it was also assured at the beginning of the interview.

(6) **Post-interview** – an email expressing gratitude was sent to all interview participants. The email further mentioned the confidentiality of the data and assured them that when the research is completed, findings will be shared with them.

The interviews which were conducted using phone, Skype (an application), and BlueJeans (an application) followed the same process mentioned above.

Recording of interviews

Patton (2002) argued that irrespective of the type of interview and accuracy of the template, the conducted interview becomes invalid if a researcher fails to capture the actual words of the interviewee. Nothing can substitute for the raw data spoken by the interviewee. For this research, a phone, an iPad, and a Dictaphone were used simultaneously for recording interviews (face-to-face interviews). They were used simultaneously to avoid any potential disaster while recording and after recording the interview. For instance, the device may malfunction while recording or after recording, a file may get corrupted after recording, or a file may accidentally get deleted after recording. The interviews conducted on the phone were recorded using the iPad and Dictaphone simultaneously. The interviews conducted using Skype and BlueJeans (on iPad) were recorded using phone and Dictaphone simultaneously.

Equipment used for recording interviews

The following checks were performed on equipment to prevent any malfunctioning:

- It was made ensured that the phone and iPad were fully charged before commencing the interview.

- The researcher took a portable charger to charge the drained phone battery, which was discharged while travelling.
- New batteries were used in the Dictaphone.
- A pair of spare batteries was always available for any potential unanticipated circumstances.
- The Dictaphone was clean and in good condition and was always checked before going to the interview.

Actions before the interview

The following safety measures were adopted before commencing interviews:

- The phone and iPad were put on ‘do not disturb mode’ before any interview was commenced in order to avoid any incoming calls, messages, and notifications.
- The automatic screen locks of phone and iPad were switched to ‘never’ before commencing recording. This enabled the researcher to look at their screens uninterruptedly during the whole interview in order to see whether the equipment was recording continuously or not.
- A suitable folder was chosen in Dictaphone for recording interviews.
- The Dictaphone manual stated that when it starts recording, the light will flash. This was ensured by looking at the light that showed that it had started recording. The screen was looked at simultaneously to ensure it had started recording.

Actions during the interview

The following actions were performed to record interviews as clearly as possible:

- During the interviews conducted in public places, the researcher occasionally had to request the interviewees to speak a bit louder.

- The researcher held the phone and Dictaphone together in one hand (near the mouth of interviewee like a microphone) in interviews held in public places to make sure equipment recorded more of the interviewee's voice than other surrounding sounds.
- In interviews not conducted in public places, the phone, Dictaphone, and iPad were placed on a smooth surface as close as possible to the interviewee.
- The researcher was looking at the phone and iPad screens to make sure the devices were recording.
- The flashing light of the Dictaphone signified that the recording was proceeding smoothly.

Actions after the interview

The following actions were performed to prevent the loss of any recorded interviews:

- The interviews were transferred immediately to the researcher's personal laptop at the researcher's earliest convenience. For instance, transfers were completed as soon as the researcher arrived home after conducting a face-to-face interview and immediately after conducting an interview through the phone, Skype, or BlueJeans.
- The interviews were labelled clearly with the interview number followed by interviewee's name to avoid any confusion – for instance, "Interview 1 ABC", "Interview 2 DEF", and so on.

Place of the interview

Twenty-three interviews were conducted in total. From these, 18 interviews were conducted face-to-face, three on the phone, one through Skype, and one through BlueJeans.

4.4.4.4 Pilot study

You never test the depth of a river with both feet.

An African proverb from the Ashanti people in Ghana, this adage signifies the importance of a pilot study before commencing the main study (Thabane *et al*., 2010).

Pilot and feasibility studies are a crucial part of the research process. Their results can inform key research concerns, such as implementation and contextual factors (Donald, 2018). These types of studies provide an opportunity for the researcher to identify the challenges that can be encountered during data collection, such as the participants' ability to understand and answer the questions and the time required, among other challenges. Moreover, in the form of exploratory work, these studies can help to identify future areas of inquiry which can be achieved by conducting qualitative studies (Rensick, 2015).

There is a debate among academics about the distinction between the terms 'pilot' and 'feasibility.' Some researchers believe both terms are the same and have used the terms interchangeably, while others argue they are distinct (Donald, 2018). For instance, Rensick (2015), Thabane *et al*. (2010), Arnold *et al.* (2009), Vogel and Draper-Rodi (2017) stated that a pilot study is also known as a 'feasibility study', 'vanguard study/trials', 'pilot trial', 'small sample size study', and 'pilot randomised controlled trial', respectively, with Rensick (2014, p. 255) defining a pilot study as a "quantitative research testing the design of a larger planned efficacy trial or the intervention from a feasibility perspective rather than effectiveness." Teijlingen *et al.* (2001) also used the term interchangeably as the authors stated various reasons for conducting a pilot study, from which top two are for developing and testing the adequacy of research instruments, and for assessing the feasibility of a major study. Thabane *et al*. (2010) conducted a research on the definition of the term 'pilot studies' and concluded that both 'feasibility study' and 'pilot study' are a similar thing, as both are intended to guide the planning of a bigger subsequent study. However, authors do emphasise that the main goal of a pilot study is to assess the feasibility in order to avoid potential threats that can drown the whole research effort.

In contrast, authors such as Arain *et al.* (2010) argued that a pilot study is a miniature version of a full-scale study, to test whether the components of the main study can work cohesively or not. It is focused on the processes of the main study; therefore, resembles the main study in many aspects. When data from the pilot study is used for final analysis, it is called 'internal pilot,' and when data is excluded from the final analysis, it is known as 'external pilot.' The authors described the feasibility study as a piece of research conducted before the main study for estimating key parameters that will be needed for designing the main study. Arnold *et al.* (2009) stated three different definitions for the terms 'pilot trials', 'pilot work' and 'pilot study.' However, these are purely in the context of clinical research. The authors further argued that in literature, there is no clear distinction between a 'pilot study' and a 'feasibility study.' Furthermore, the authors discouraged the use of the term 'feasibility study' because feasibility studies do not encompass the scope of many pilot studies. In the context of clinical research, Vogel and Draper-Rodi (2017) divided feasibility studies into three categories: randomised pilot studies, non-randomised pilot studies (including qualitative studies), and feasibility studies that are not pilot studies.

Whitehead *et al*. (2014) mentioned four differences between pilot studies and feasibility studies. Pilot studies

- have stricter study methodology
- have an intention for further work

- are small mini versions of the main study
- focus on trial processes

Donald (2018) concluded that recent publications have started acknowledging ‘pilot studies’ and ‘feasibility studies’ as distinct approaches, with ‘feasibility studies’ being the subset of ‘pilot studies.’ The author further concluded that “all pilot studies are feasibility studies, but not all feasibility studies are pilot studies” (p. 66). The reasons stated by the author are:

- Pilot studies are considered as miniature trials; therefore, they evaluate feasibility and acceptability, in addition to investigating the implementation of trial processes.
- Pilot studies address the objectives of feasibility studies, but in addition, they also evaluate the effectiveness of trial processes, whereas feasibility studies do not evaluate effectiveness; this is left to the main study (Vogel and Draper-Rodi, 2017).

Considering the points of Whitehead *et al*. (2014), Donald (2018) and Arain *et al.* (2010), this preliminary research defines itself as an ‘internal pilot study.’

In this research, a pilot study was adopted to test the research instrument, which was questions in the form of semi-structured interviews. The objective was to test the questionnaire for validity and reliability. Teijlingen *et al.* (2001) suggested that testing the adequacy of the research instrument is one of the most valuable functions of the pilot study. Donald (2018) stated that pilot studies could inform implementation and contextual factors.

The first pilot interview was conducted in the third week of December 2017. Subsequently, Christmas break started. Few research participants responded in January and provided their availability for February 2018. The remaining four pilot interviews were conducted in a very short span and were over by the third week of February 2018. This gave the researcher the illusion that it would be easy to recruit the remaining required number of participants. However, this did not happen. It took more than five months to finish the remaining interviews. There were no interviews conducted in the month of May because participants did not provide their availability. This is in line with the Rensick's findings (2015), which stated that it is possible that the first five research participants are easily recruited. This can give the researcher a false sense of confidence that the rest of the participants can also be easily recruited. This may lead to a severe consequence; the researcher may not get enough resources to finish the research.

4.4.5 Data analysis

In this study, the data analysis technique is the same for both the pilot study and the main study. Therefore, it is explained only once:

4.4.5.1 Transcribing

- The 'oTransrcibe' tool was used for transcribing interviews. It is a free online tool with very easy-to-use user interface.
- Data was not paraphrased but transcribed word by word, as recommended by Mclntosh and Morse (2015).
- The researcher accepted help from the university's library staff when the researcher could not understand the words said by the interviewees.
- Four interviewees were given to a professional organisation for transcribing because those interviewees were very long (more than 1 hour and 30 minutes, on

average). When researcher transcribed the first interview, it did not take much time. This was due to the fact that the interview was not much longer, and the participant's accent was clear. When the researcher transcribed the second interview, it took four and a half days to transcribe it. The reasons were: the interview was long (more than one and half hours), the accent was sometimes difficult to understand, and the participant was speaking extremely fast. After transcribing, it turned out that the interview consisted of close to 11,000 words.

- The audio recording of all the interviews, which were transcribed using an external source, was listened to match the accuracy of the transcribed data, and corrections were made wherever required.

4.4.5.2 Use of Software

Johnston (2006) argued that due to the outdated research methodology, there is still a debate about the pros and cons of the usage of Qualitative Data Analysis (QDA) software in data analysis. This is due to the reason that QDA software is still not considered as an integral part of the analysis process. Several studies have proved that researchers feel closer to the data while using software instead of using paper. In this research, as mentioned in section 4.3, NVivo 11 Pro software was used for data analysis. The researcher started learning the software by self-learning for using it for the literature review. Before reaching the data analysis stage, the researcher attended a three-day course conducted by the researcher's university, which was pertinent to data analysis by using NVivo.

NVivo is among one of the best qualitative data analysis software. It has the capability to process audio files, videos, word documents, digital photos, PDFs, Excel spreadsheets, web pages, rich and plain text, and data from social media. The data can be coded into many codes, depending on the analysis. The codes then can be grouped into similar concepts, and subsequently, categories can be generated from the concepts (Ograjensek, 2016).

4.4.5.3 The key differences between content analysis and thematic analysis

According to Vaismoradi *et al*. (2013), there are three key differences between content analysis and thematic analysis. The first difference is the terminology of both methods. Table 4.2 explains their respective differences related to terminology.

Table 4.2: Difference in terminology between content analysis and thematic analysis (adapted from Vaismoradi *et al*., 2013)

Content analysis	Thematic analysis
Unit of analysis	Data corpus
Meaning unit	Data item
Condensed meaning unit	Data extract
Code	Code
Category/theme	Theme

The second difference is that in content analysis while analysing data qualitatively, it is possible to quantify it as well. In contrast, the thematic analysis does not allow quantification of the data. Mclntosh and Morse (2015) argued that the quantification of data facilitates patterns to emerge with greater clarity.

The third difference is that in content analysis, a researcher has to choose either manifest or latent analysis, whereas in thematic analysis, a researcher has to perform both simultaneously.

4.4.5.4 Choice of content analysis

Due to the ability of the content analysis to further allow the quantification of the data, researcher adopted a content analysis method. A method is defined as "techniques or procedures used to gather and analyse data." Content analysis is a research method (Cho and Lee, 2014, p. 2). It is a method for analysing visual, verbal, or written communication messages (Elo and Kyngas, 2008). The foundation of content analysis was laid by Paul F Lazarsfeld and Harold D Lasswell in the late 1920s in the USA (Marying, 2000). In advent, it was a quantitative research method and was defined as "a research technique for the objective, systematic, and quantitative description of the manifest content of communication" (Cho and Lee, 2014, p. 3). This approach was also known as a quantitative analysis of qualitative data (Hsieh and Shannon, 2005). During analysis, the data in the quantitative approach was broken down into quantifiable units – this often simplified and distorted meaning. Therefore, quantitative content analysis was criticised (Cho and Lee, 2014).

Hsieh and Shannon (2005, p. 1278) defined content analysis as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns." Content analysis deals with meanings, consequences, intentions and context; therefore, is more than just counting numbers (Cavanagh, 1997). It can be used to analyse a diverse range of communication materials, such as interviews, narrative responses, open-end survey questions, printed data (books, articles, manuals), focus groups, observations (Hsieh and Shannon, 2005), videotapes, documents and discourses (Marying, 2000). It is a method to classify oral or written data into a different and efficient number of categories that represent the same meanings (Moretti *et al.*, 2011 and Hsieh and Shannon, 2005). The data in these categories are either explicit or inferred communication (Hsieh and Shannon, 2005).

Content analysis delivers a condensed and broad description of the phenomenon. The outcome is in the form of concepts or categories describing the phenomenon. The objective of creating concepts or categories is to create a model, conceptual system, or a conceptual map (Elo and Kyngas, 2008).

The unique qualities of content analysis are its ability to provide flexibility: to adopt an inductive or deductive approach, or a combination of both approaches, for analysing data; and flexibility to choose between manifest and latent meaning of data (Cho and Lee, 2014). According to Vaismoradi *et al*. (2013), if conducting exploratory research when there is not much known about a phenomenon, content analysis can be a suitable approach for reporting common issues mentioned in data.

Inductive and deductive approaches

The key difference between inductive and deductive approach is the development of initial codes and categories. In the inductive approach, codes, categories, and themes are developed from the data. This approach is suitable when there is a paucity of existing knowledge regarding the phenomenon to be studied or when the phenomenon is fragmented (Elo and Kyngas, 2008). Data analyses frequently shift directions, and re-analyses are required as emerging results provide new insights (Kondracki *et al.*, 2002).

In contrast, the deductive approach is appropriate when there is an abundance of knowledge about the phenomenon to be studied. Usually, this approach is used when the research demands for testing the existing theory in a different context or for comparing categories at different time periods (Elo and Kyngas, 2008 and Kondracki *et al.*, 2002). Therefore, the deductive approach begins with predetermined words, codes, or categories derived from existing research or literature (Kondracki *et al.*, 2002 and Moretti *et al.*, 2011). In the inductive approach, data moves from specific to general in order to observe particular instances. Data is then merged into a larger whole or general statement. In contrast, in a deductive approach, data moves from general to specific (Elo and Kyngas, 2008). Hence, whether to choose an inductive or deductive approach solely depends on the purpose of the research.

The use of content analysis has been shown to produce symbolic content that is valid and reliable (Cavanagh, 1997). According to Erlingsson and Brysiewicz (2017), categories answer questions related to who, what, when, and where, and represent the manifest meaning of the data, whereas themes represent the latent meaning of the data and are used to answer questions investigating why, how, in what way or by what means. However, Heikkila and Ekman (2003) mentioned latent qualitative content analysis method could be used to answer questions related to 'what' as well. Content analysis does not involve identifying relationships between categories and theory developing, unlike in grounded theory. Instead, it involves developing categories from the data (Cho and Lee, 2014).

Types of qualitative content analysis

Hsieh and Shannon (2005) described three types of qualitative content analysis: conventional content analysis, directed content analysis, and summative content analysis. Conventional content analysis is used when there is limited literature about the phenomenon. Rather than using predeveloped categories, categories emerge from the data.

Directed content analysis is used when there is existing literature about the phenomenon, which is either incomplete or would benefit from further research. The objective of this approach is to validate or conceptually extend a theory or a theoretical framework. It involves deductive category development (Hsieh and Shannon, 2005).

Summative content analysis involves identifying and quantifying certain words or content in order to understand the contextual use of words and content. The purpose of quantification of words or content is not to infer meaning but to explore their usage instead. If the analysis is kept limited to just counting the frequency of words or content, then it will be a quantitative analysis of the data. However, summative content analysis goes beyond this to involve latent content analysis (Hsieh and Shannon, 2005).

There is no globally accepted way to perform content analysis (Cavanagh, 1997). However, some authors, such as Marying (2000), Marying (2014), Downe-Wamboldt (1992) and Elo and Kyngas (2008), have described the steps to conduct qualitative content analysis. From these steps, Elo and Kyngas' steps are chosen because these are corroborated by authors such as Vaismoradi *et al*. (2013) and are well described. Figure 4.6 shows the process developed by Elo and Kyngas (2008). It is clear from Figure 4.6 that Elo and Kyngas (2008) described both inductive and deductive approaches. Both approaches have similar phases: preparation, organising, and reporting. With this study being inductive in nature, an inductive approach was adopted.

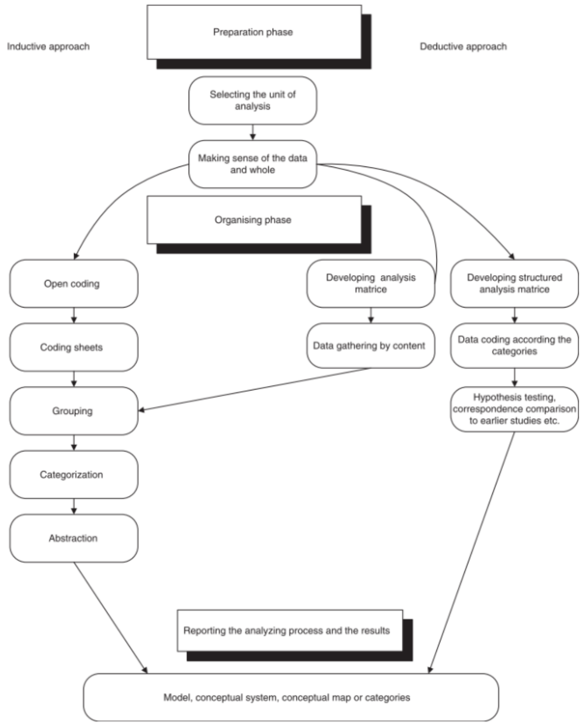

Figure 4.6: Qualitative content analysis process (Source: Elo and Kyngas, 2008)

4.4.5.4.1 Preparation

Unit of analysis of the study

A unit of analysis is defined as a "segment of text that is comprehensible by itself and contains one idea, episode, or piece of information" (Moretti *et al*., 2011, p. 421). Selecting the unit of analysis and in what details the analysis has to be performed are crucial initial steps towards analysing data. These steps help in reducing data to be analysed depending on the research questions (Cho and Lee, 2014 and Cavanagh, 1997). Depending on the research question, a unit of analysis can be in any form, such as a letter, word, sentence, part of page, number of participants in discussion, time (Elo and Kyngas, 2008), a person, organisation, program, an interview or diary in its entity, an amount of space allocated to topic, community, state and a nation, among others. When a unit of analysis is composed of more than one sentence and has several meanings, it makes the analysis process difficult and challenging. In contrast, a very short unit of analysis, such as a one-word analysis, may result in fragmentation (Graneheim and Lundman, 2004).

A different unit of analysis can have the same attributes but with a different meaning intensity. This variation in the intensity of meaning can provide useful insights that contribute to enhancing the researcher's understanding of the data (Downe-Wamboldt, 1992).

In this study, the unit of analysis is the individual research participants.

Being familiarising with the data

The objective of reading the data several times is to get familiarised with the data. It is a must for a researcher to get familiarised with the data for insights or theories to emerge (Elo and Kyngas, 2008). Accordingly, the researcher familiarised himself with the data by reading transcripts before starting to analyse them. This helped the researcher get an overview of the data of every transcript.

Latent and manifest analysis

Potter and Donnerstein (1999) have given extreme importance to the difference between latent and manifest content. The authors have called it the 'nature of content.' In a latent content analysis of the data, researchers focus on the underlying meaning of the text and on the tone or implied feeling. On the contrary, in a manifest content analysis, the focus is on the visible, surface, or obvious components of communication. In this approach, the researcher codes visible data (Downe-Wamboldt, 1992 and Graneheim and Lundman, 2004). Gender of a person in a movie, the appearance of a particular word in data, certain behaviours (such as scratching a head and blinking eyes) while communicating are examples of manifest content (Potter and Donnerstein, 1999). The latent content analysis further involves focusing on silence, laughter, sighs, and posture. There has been a debate on whether to conduct latent content analysis or not because it involves interpretation by the researcher. This solely depends on the research question of what to analyse (Elo and Kyngas, 2008). However, Graneheim and Lundman (2004) argued that both manifest analysis and latent analysis involves an interpretation of the data. This interpretation varies in depth and level of abstraction. In this study, manifest content analysis was adopted.

4.4.5.4.2 Organising

Open coding

Open coding means notes and headings are written in the text while reading it. The data is read again in order to create as many headings as possible to describe all aspects of the content (Elo and Kyngas, 2008).

Categories

Categories are themes or patterns that are directly expressed in the data or are derived from the data through analysis (Hsieh and Shannon, 2005). The objective of creating categories is to provide a way for describing the phenomenon under study, to increase understanding, and to generate knowledge (Cavanagh, 1997 and Downe-Wamboldt, 1992). It is a way to divide data into a few content-related categories. Categories encompasses data having similar meaning and connotations (Cho and Lee, 2014) because it is assumed that when words, phrases, etc. are classified into same categories, they depict the same meaning (Cavanagh, 1997). When data is added to a certain category, it distinguishes that from other data. Hence, for completely defining variables for content analysis, categories need to be created (USGAO, 1996).

The creation of categories depends on the research question, unit of analysis, literature review, data review, and relevant theories. However, this does not imply that all categories can be visualised by the researcher beforehand. In fact, imposing constraints like these on data can hinder the validity of the results (Downe-Wamboldt, 1992).

Categories must be exhaustive and exclusive (USGAO, 1996). An exhaustive list helps the researcher to define the data to its fullest extent (Cavanagh, 1997). Furthermore, if categories do not cover all possible classes of data, then variables can be missed or misclassified (USGAO, 1996). On the other hand, creating an exclusive list of categories has three main advantages. Firstly, it helps in understanding the data by increasing conceptual clarity (Cavanagh, 1997). If the data in categories overlap, it indicates that the data is wrongly classified (USGAO, 1996). Secondly, it increases certainty during data analysis by reducing the statistical problems of confusing variables (Cavanagh, 1997). If a unit of analysis can be rolled under two or more categories, then most statistical procedures that need variables to be mutually exclusive will be of no use to the researcher (Downe-Wamboldt, 1992). However, Downe-Wamboldt (1992) stated that the decision on whether to use mutually exclusive categories or not should be taken by the researcher on the basis of what is most appropriate in the context of the question under investigation. Last but not least, it facilitates higher certainty in the use of software to reduce data into categories (Cavanagh, 1997).

Categories can be nominal or ordinal. Nominal variables have no intrinsic order, but ordinal variables do (USGAO, 1996). Data collected often has multiple meanings. In this situation, a researcher has to rely on the data to determine the best way to categorise it (Cavanagh, 1997). Data which is difficult to categorise will provide insights for revising the categories (Downe-Wamboldt, 1992). Usually, adjustments are needed after the first analysis iteration (Erlingsson and Brysiewicz, 2017). Moving backwards and forwards between data and the output of content analysis enhances progressive refining and validating categories (Downe-Wamboldt, 1992). This process is known as the hermeneutic spiral or hermeneutic circle (Erlingsson and Brysiewicz, 2017).

Grouping

The generated categories are then grouped under higher-order categories. The objective of grouping categories is to decrease the number of categories by merging those that are similar or dissimilar into broader higher-order categories. Grouping data does not simply mean bringing together observations that are similar or related; in addition, it means that it should allow for the performance of a comparison with the data that is not classified under the same groups. An inductive content analysis solely depends on the researcher's interpretation of which categories are grouped together (Elo and Kyngas, 2008).

Abstraction

Abstraction means creating a generic description of the observations by generating categories. An abstraction process can keep on going as far as it is reasonable and viable (Elo and Kyngas, 2008).

4.4.5.4.3 Reporting

This means reporting the analysis process and results via a conceptual map or categories, models, conceptual systems, and a storyline (Vaismoradi *et al.*, 2013).

4.4.5.4.4 Trustworthiness

The criteria for trustworthiness differ for qualitative and quantitative research. The trustworthiness criteria for quantitative research includes the elements of reliability, validity, and generalisability (Graneheim and Lundman, 2004). Reliability is further composed of stability, reproducibility and accuracy (Potter and Donnerstein, 1999), described in Table 4.3.

Stability is also known as intra-coder reliability (Kondracki *et al.*, 2002). After some time, the already coded data is coded again by the coder. If the later coded data matches the previously coded data, then the coding is considered to be stable (Potter and Donnerstein, 1999) and is usually done after the completion of the analysis. Reproducibility (also known as inter-coder reliability) is required when the initial data is coded by multiple coders (Kondracki *et al.*, 2002). To increase reliability, Elo and Kyngas (2007) recommended showing a link between results and data. The authors explained the analysis process with as much emphasis and in as much detail as possible and further recommended to show tables and appendixes to show the link. The validity of content analysis can be established by submitting a sample of text to an independent panel of experts (Downe-Wamboldt, 1992).

Table 4.3: Reliability criteria (adapted from Potter and Donnerstein, 1999)

Criteria	**Definition**
Stability	the extent to which codes do not change over time
Reproducibility	the extent to which different coders code the same data similarly over time
Accuracy	the extent to which a process conforms to a known standard or delivers what it is designed to deliver

The trustworthiness of qualitative content analysis is composed of credibility, dependability and transferability (Graneheim and Lundman, 2004), described in Table 4.4. However, the authors acknowledged that still, many academics use the quantitative trustworthiness approach for the trustworthiness of qualitative content analysis. Moreover, Long and Johnson (2000) argued that dependability and reliability both have the same meaning, and nothing can be gained by arguing between these two. However, Graneheim and Lundman (2004) recommended using qualitative trustworthiness criteria for qualitative content analysis.

Table 4.4: Qualitative content analysis trustworthiness criteria (adapted from Graneheim and Lundman, 2004)

Criteria	Definition
Credibility	credibility deals with the focus of the research, and refers to how confidently gathered data and analysis process addressed that focus
Dependability	it involves ways for taking into account the factors of instability and factors of phenomenal and design induced changes.
Transferability	means degree to which findings can be transferred to other settings

Credibility – It begins by asking about the focus of the study, the selection of context, the selection of participants, and the approach adopted for data collection. Choosing research participants from diverse experiences enhances the probability of exploring research question from various different aspects. However, the amount of data required to answer a research question depends on the complexity of the phenomenon and the quality of the data (Graneheim and Lundman, 2004). In this study, the focus of the research was to explore elements related to managing stakeholders within BIM implemented projects. The selection of context was limited to the UK construction industry. The selection of participants and the data collection method are well described in section 4.4.4.1 and section 4.4.4.3, respectively.

Credibility is also incorporated to show explicitly the ways to judge similarity and difference between different categories (Graneheim and Lundman, 2004). The authors proposed two ways for this. One way is to show the quotes from research participants, and another way is to seek agreement from experts, colleagues, or participants. In this study, various quotes from diverse participants are mentioned and discussed. Categories developed were discussed with supervisors and a colleague.

Dependability – It means the extent to which data remains consistent with time, and the changes made in the researcher’s decisions while analysing data. When data is large and takes a long time to collect, there is a probability of inconsistency during data collection. It is important to ask questions about the same areas to all the research participants. Furthermore, interviewing and observing is an evolving process because researchers get new insights about the phenomenon, which can subsequently influence follow-up questions and/or narrow the focus for observation. Graneheim and Lundman (2004) recommended discussing this with a research team in order to tackle these issues. In this research, a semi-structured interview technique was adopted for collecting data. This assured that the researcher would cover all the questions in all the interviews.

Transferability – The authors should provide a clear description of context, sampling, characteristics of participants, data collection method, and data analysis method. Well-presented data, along with quotations, enhances transferability. In this study, data collection and data analysis processes are well defined in sections 4.4.4 and 4.4.5, respectively. It is recommended that findings are transferable to other countries that are lagging than UK in the BIM implementation. However, Graneheim and Lundman (2004) stated that authors could only give suggestions about transferability. It is ultimately the readers who decide whether findings can be replicated to other settings or not.

4.5 Research methods adopted

This section provides a brief summary of all the research methods adopted.

The paucity of the literature on the topic led to adopt an inductive approach. It further led to adopt a qualitative research methodology, which is an appropriate approach to adopt when the variables and theory base are not known. Purposive sampling was adopted because it is an appropriate sampling method to adopt when the focus is to enhance an in-depth understanding of the phenomenon rather than generalising the results. It was complemented with snowball sampling to target research participants with similar characteristics. For collecting data, semi-structured interviews were adopted because they allow researcher to remain open and flexible so that they can explore research participants experiences in more detail. Furthermore, data can be compared and quantified. Qualitative content analysis was adopted because it allows quantification of the data.

4.6 Summary of Chapter 4

In this study, a pilot study was conducted prior to the main study. The first five interviews were treated as a pilot, which informed the further data collection. Sampling, unit of analysis, data collection method, and data analysis methods have been discussed thoroughly. Semi-structured interviews were conducted for data collection. Content analysis was adopted for data collection. It is suggested that qualitative research was necessary for this study because of the paucity of the literature on the topic. Results from the main study are discussed in Chapter 5, Chapter 6, and Chapter 7.

Chapter 5 : RESULTS – THE ROLE OF BIM IN STAKEHOLDER MANAGEMENT

5.1 Introduction to Chapter 5

This chapter discusses the results from both the pilot study and the main study. A thorough analysis of the data collected from 23 interviewees from 18 different organisations in the construction industry is discussed in nine parts. Results are presented from the diverse sample, including but not limited to BIM managers, BIM coordinators, project managers, and CEOs on what they have found from their experience in the areas where BIM can assist in managing stakeholders.

The first section of this chapter presents empirical findings from the data analysis. Section two is composed of a discussion about three key areas: whom the construction industry perceives as their key stakeholders, the key uses of BIM in an organisation, and key drivers for implementing BIM. Sections three to seven of this chapter present key areas of BIM implementation: namely, BIM enhances the pre-planning process; BIM enhances collaboration; a better understanding of the project workflow; BIM improves communication; and BIM improves information flow. These are the key areas identified in the data analysis, where BIM can assist in stakeholder management by mitigating or reducing issues among construction project stakeholders. The eighth section of this chapter presents a summary that addresses objective two of this study.

During the data collection, the topic that BIM can assist in stakeholder management was raised in a general context, i.e., what role does BIM play in stakeholder management? The questions prepared in advance were:

- Who are your stakeholders in construction projects?
- What are the key roles BIM is playing in your organisation?
- Can you describe the key drivers that have influenced the need for implementing BIM initiatives in your project/organisation?
- How does BIM assist in stakeholder management?

These stimulated answers pertaining to the role BIM plays, in general, in the project environment. These were then diverted specifically to the context of stakeholder management. The data analysis strictly reflects the perceptions of the interview participants. There are no general assumptions made. Table 5.1 depicts the five main areas where BIM assists in improving compared to traditional projects. Furthermore, it also illustrates the number of interviewees and their relative percentages.

Table 5.1: The role of BIM in stakeholder management

Role of BIM	Percentage (N = 23)
Enhances pre-planning process	91%
Improves collaboration	91%
A better understanding of the project workflow	87%
Improves communication	87%
Improves information flow	83%

From the data in Table 5.1, it is explicit that the main role BIM plays in stakeholder management is to enhance the pre-planning process and to improve collaboration. It is followed by a better understanding of the project workflow, improvement in communication, and improvement in information flow. The other thing to note is that ‘enhances pre-planning process’ and ‘improves collaboration’ have an equal percentage. Furthermore, ‘a better understanding of the project workflow’ and ‘improves communication’ are corroborated by an equal number of interviewees.

In this chapter, detailed discussions on each of the points related to the role BIM plays in managing stakeholders (mentioned in Table 5.1) are as follows:

- ‘BIM enhances pre-planning process’ is discussed in section 5.3.
- ‘BIM improves collaboration’ is discussed in section 5.4.
- ‘BIM provides a better understanding of the project workflow’ is discussed in section 5.5.
- ‘BIM improves communication’ is discussed in section 5.6.
- ‘BIM improves information flow’ is discussed in section 5.7.

5.2 Key stakeholders, uses, and drivers of BIM

Key stakeholders

As discussed in Chapter 2 (sections 2.2 and 2.3), there is little consensus on whom the industry perceives as their stakeholders, so a question was asked to explore this. The results are presented in Table 5.2. When interviewees were asked who their stakeholders are, interviewees 2, 3, 4, and 5 said that it was a vague term.

Interviewee 2 perceived stakeholders as those who have financial input to the project. Thus, the client was emphasised as the key stakeholder. However, this interviewee further acknowledged that if it is a big project like High Speed 2 (HS2), then the public would be a stakeholder as well. The interviewee further elucidated this by giving an example of HS2, which their organisation was working on. Due to the nature of interviewee 2’s organisation, the organisation needed access to the land for doing site investigations. In this case, interviewee 2 said that landowners were not contributing financially to the project but would decide whether to provide access to their lands. Interviewee 2 concluded that the domain of stakeholders depends on the type of client and on the type of job. Interviewee 7 argued to define the term stakeholder specifically. According to interviewee 7, without its exact definition, it could be interpreted differently by every person. Interviewee 7 argued:

> "Stakeholders may be, in a lot of contexts, the wrong term to use because of that broader view in commerce. In the business community, stakeholders have a very broad definition, I think. So, I think as you said earlier when you are defining who is benefiting or who is involved in the BIM process, I think it needs to be a bit more specific rather than using the term stakeholder.
>
> It [stakeholders] is almost becoming a fashionable term that's used by many organisations in a different context. If you want to use the term stakeholder, I think you need to define what you see a stakeholder as being. Otherwise, if you leave it to the individual to decide, that could involve everyone".

It is obvious from Table 5.2 that interviewees treated clients, designers (architects, engineers) and contractors/sub-contractors as their key stakeholders on BIM-implemented projects. The client is the prime stakeholder, with 100% of the interviewees agreeing on that. Contractors and designers have taken the second and third place in terms of frequency of being mentioned, with 96% and 91%, respectively. Asset managers and the environmental agency are the least rated, at 4% and 9%, respectively.

The results are in alignment with the findings of Srinivasan and Dhivya (2020) and Jergeas *et al.* (2000). Jergeas *et al.* (2000) identified in their research that organisations usually considered stakeholders as those who can have a direct impact on the project, namely engineers, operators and contractors. Organisations limited stakeholder management to those who were directly affected or could directly affect the project. Srinivasan and Dhivya (2020) argued internal stakeholders, such as the client, engineers and contractors, are key stakeholders on construction projects because they are directly involved in the decision-making process. The interrelationship between them determines the overall performance of the project. The authors identified stakeholders' participation in decision making as the key factor influencing stakeholder management on construction projects.

The stakeholders as prioritised by interviewees are classified according to the power-interest matrix in Figure 5.1. It is explicit from Figure 5.1 that the classification is bit different from the classification presented in Figure 2.3. This is due to the reason that Figure 2.3 represents a general stance of stakeholders on a traditional project, whereas the classification in Figure 5.1 represents a general stance within BIM-implemented projects. After the client, designers and contractors are the key stakeholders in a BIM process, as they are the ones who have to generate the 3D models and implement and manage the whole BIM process. Most of the interviewees did not perceive the government or the environmental agency to be their key stakeholders. This could be due to the reason that they believe that they comply with government regulations and then only they get permission from the government to start the project. For instance, one of the interviewees, no. 6, replied:

> "Well, they (public) could do but that would be part of planning and the job doesn't go unless you have planning. So, the planning authority, local planning authority, we have to propose".

Asset managers indeed have little power to influence the design, but they are crucial stakeholders in a BIM process. They should be involved from the design stage so that they can guide and specify their information requirements throughout the project. Eventually, they have to use that information.

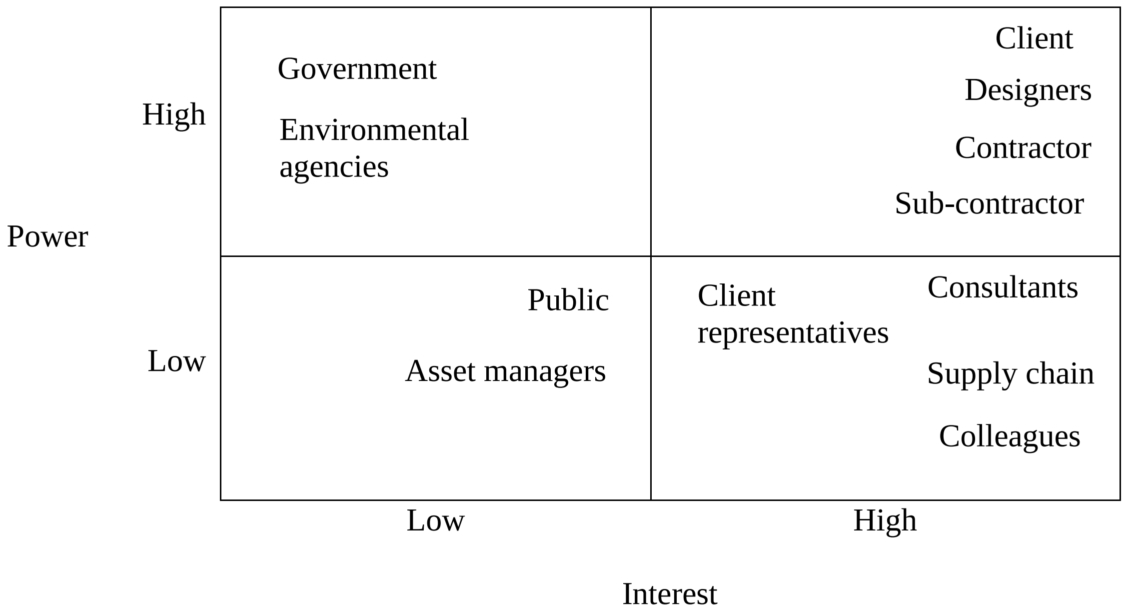

Figure 5.1: Classification of stakeholders within BIM-implemented projects

Table 5.2: Perception of interviewees regarding whom they treated as their stakeholders on BIM implemented projects

Interviewees No.	Client	Client representative	Designer (Architect, Engineers)	Contractor/Sub-contractor	Consultants	Supply chain	Colleagues	Public	Environmental agency	Government/ Local council	Asset managers
1	✓		✓	✓			✓				
2	✓		✓	✓	✓	✓	✓	✓	✓		
3	✓		✓	✓				✓		✓	✓
4	✓		✓	✓					✓		
5	✓	✓	✓	✓	✓	✓	✓				
6	✓		✓	✓							
7	✓		✓	✓	✓	✓	✓			✓	
8	✓		✓	✓				✓			
9	✓		✓	✓							
10	✓		✓	✓	✓	✓					
11	✓		✓								
12	✓	✓	✓	✓						✓	
13	✓		✓	✓							
14	✓			✓		✓					
15	✓		✓	✓				✓			
16	✓	✓	✓	✓	✓	✓					
17	✓	✓	✓	✓							
18	✓	✓	✓	✓							
19	✓		✓	✓				✓			
20	✓		✓	✓				✓			
21	✓			✓	✓						
22	✓		✓	✓							
23	✓	✓	✓	✓							

Key uses of BIM

Research participants were asked the question about the areas in which their organisations were using BIM on the projects, and their responses are compiled in Table 5.3. It is clear from Table 5.3 that BIM has mostly been used for design coordination and for creating 3D visualisations. This is followed by 4D, 5D and performing energy analysis, respectively.

Table 5.3: Key uses of BIM in an organisation

Key uses	Percentage (N = 23)
Design coordination (clash detection)	87%
3D (visualisations)	87%
4D (time)	65%
5D (material measurements)	52%
Energy analysis	35%

Key drivers for implementing BIM

Table 5.4 shows that organisations adopted BIM because the government has made it mandatory. Organisations cannot bid for government projects unless they prove their BIM competence. The second most cited reason was to stay competitive in the market. Client demand was identified as the third major reason. This was followed by BIM's capability for increasing efficiency by assisting in saving time and capital. Reducing re-work was suggested as the key reason for contributing to increasing efficiency.

Table 5.4: Key drivers for implementing BIM

Key drivers	Percentage (N = 23)
Government mandate	96%
To stay competitive	87%
Client demand	70%
To increase efficiency	65%

5.3 BIM enhances pre-planning process

In this study, 91 percent of the interview participants agreed that BIM assisted in pre-planning project activities. This is because BIM can assist in aligning project activities according to the time sequence in which they should be performed (also known as 4D). All the data is presented visually. Moreover, the ability to show site setup and design intent in a visual way further enhances this. The ability to show task sequences visually assists in understanding the complex tasks and their relationships with other tasks. Consequently, this provides opportunities to stakeholders to offer feedback. Furthermore, visual presentations are more engaging than presenting data in 2D. This factor further entices project stakeholders to provide feedback. Gathered feedback can then be considered to address the issues raised by concerned stakeholders. Relating to work planned, interviewee 1 noted that:

> "We have got the video of the whole BIM model, which is just based on the design that we showed the stakeholders. Basically, just to show them how are we going to set up the traffic management (all the signs) next year, August. So that they can know that we are planning to close this lane and this lane is going to be open. So, we showed to the police and the client and a lot of other stakeholders and got feedback from them, and we will change it before that. It's about telling stakeholders what you have pre-planned. If they don't agree with it, you can change it, but can't change easily, and get the same thoughts and things."

Another interviewee (No. 16) noted that:

> "What we've found is, it's really useful to sit down with our construction managers and actually talk them through that

program, the construction program, and then help them about their construction sequencing at a lot more detail than they probably would have before. They probably would have done that, maybe in the weeks coming up to something in the activity, but it allows them far better planning before a job kicks off to talk about, ‘Oh, there’s going to be a problem here on the roof. We'll need to start to get scaffolding in’, or whatever it is at the stage.

> It’s a very interesting process to see the digital engineers walking through the construction program with the construction manager and then talking about the logic of their build”.

One of the interviewees (No. 2) stated about site set-up:

> “[…] because one of the inefficiencies we come across usually on the site is when the first thing arrives, the foreman goes, ‘Put that here’, and when something else arrives, ‘Put that next to it’, and when something else arrives, ‘Ahhh, actually move the first one; I want to change how it’s gonna go’. You know we end moving things on a site set-up ten times. That’s what we are not determined to do. That’s inefficient wastage of time — absolutely. It’s because if we don’t have the tools to communicate, the people who are gonna be doing the work exactly how it’s been planned, whereas if you show them a video saying here’s how that all fits together, and if he says six weeks before we arrive on-site, and the foreman doesn’t agree, we can change it then, that’s not a problem. Adjust things digitally so that when we turn up on-site, all we do is implement the plan. That’s

> much more efficient moving things around digitally beforehand
> than actually doing it on-site".

Rokooei (2015) noted that BIM tools help project managers to visualise the construction project at any time, which enables them to have an explicit understanding of project stages. Visualisation can also help look at a sequence of activities relative to plant, temporary structures, and temporary supports, which can help detect workflow clashes (Smith, 2013).

Detecting clashes in advance and discussing with other team members about the sequence of construction can assist in mitigating many issues related to design and workflow in advance. It directly helps in saving time and money during construction and in delivering the project to the required standard.

5.4 BIM improves collaboration

Project managers receive a vast amount of information. This information must be checked for its reliability and its source of origin. As the project stakeholders are usually segmented and specialise in their respective areas, they tend to focus on their own interests to maximise their effectiveness. This consequently leads to inefficient solutions. This culture explicitly shows that the element of collaboration in the construction industry requires a rethinking of the ways to overcome the legal and informal boundaries for the whole life cycle of the project. The BIM process involves new and complex activities. As such, its effect on collaboration needs to be explored (Liu *et al.*, 2017).

Liu *et al.* (2017) noted in their research that the BIM literature discusses whether BIM enhances collaboration. Some researchers think it does, while others think otherwise. In a study conducted by the authors, most of the respondents stated that BIM provides an excellent platform for the construction industry to implement change and boost collaboration. However, the authors noted a lack of literature showing the influence of BIM on collaboration.

In this study, 91 percent of the interviewees noted that BIM helped improve collaboration among project stakeholders. This was because BIM servers facilitated stakeholders to access information, irrespective of their location. Moreover, the cost of disseminating information was low because of its online availability. One interviewee stated that "*it is making collaboration easier*," while another interviewee stated that "*the nature of BIM process forces collaboration*."

Interviewee No. 7 noted:

> “I wouldn't say it's increasing collaboration. I think it's making collaboration a lot easier. Even if you are talking on a telephone, you could say to someone, ‘Open up the BIM model, move to grid line X3 on the second floor where the beams are intersecting. Can you see the plate with three bolts?’ The person could be sitting in another country and have the model open on their viewer, and they could say, ‘No, my plate’s got four bolts.’ Right. ‘You’re in the wrong position. Turn the model around 90 degrees to the west.’ ‘Yes, right.’ ‘Ok, I see the plate with the three bolts.’ To try and have that discussion with a two-dimensional drawing can sometimes be a bit challenging.
>
> I’ve seen our design manager sending information to consultants where they’re not clear where they’ve kept the screenshot from a model, and they’ve sent the actual screenshot across. Even if

> someone can't find what it is you're talking about, you can send them a screenshot of what it is you're looking at. Yes, it's certainly making it easier to collaborate".

The other interviewee (No. 21) noted:

> "It's enhancing collaboration by essentially — the nature of the federated model forces collaboration rather than enhancing it and encouraging it. There's no way to avoid delivering a project without collaborating when it's a BIM-enabled project. There's nowhere to hide, essentially. If you're not pulling your weight or doing your job, then it's really clear when you're using BIM. So, it's less supporting collaboration, and more enforcing it".

It can be inferred from the aforementioned quotes that the nature of the BIM process both facilitates and forces collaboration on projects. This is because there is no way to work on a BIM project without collaboration, as the stakeholders have to interact and harmonise their communication. Also, the ease of accessing and working on the information from anywhere facilitates collaboration.

Popp *et al*. (2004) argued that sharing data, resources, overcoming organisational barriers, and sharing thinking processes are part of the collaboration process. Sharing thinking processes means considering numerous perspectives and discussing conflicting arguments. It enables stakeholders to understand explicit contextual complexity, and thus aids in providing the right meaning to the data, and consequently helping actors engage in the correct decision-making process. Interviewee 5 stated:

> "I think the biggest one is the collaboration to getting everybody to actually work together, and not separately in their different

> silos. That’s one of the biggest. . . definitely the biggest benefit, and then actually resolving everything before it becomes a problem and costs us significant amounts of money to make changes. That’s the biggest benefit from a construction company point of view”.

Interdisciplinary collaboration was traditionally based on 2D drawings and documents in the construction industry (Singh *et al.*, 2011). Traditionally, the information was exchanged in isolated files, and many opportunities for coordination were being missed, such as the experts from one discipline often ignoring the expertise of other disciplines. BIM is bringing a new way of exchanging information (Liu *et al.*, 2017). Various BIM tools allow the direct use and exchange of project information between disciplines. This provides opportunities for better collaboration and distributed project development (Singh *et al.*, 2011). Popp *et al.* (2004) argued that collaboration tools enable the formation of high-performance, agile teams from diverse organisations. Interviewee No. 12 noted:

> “There are opportunities that more stakeholders can be given access either during the planning process or directly if they are involved and can understand what’s happening and so on. So, the cost of disseminating information out to these remote or secondary — I don’t know what the right word is — stakeholders is low and relatively easy to use web technology and viewers so on”.

A BIM server is a collaboration platform that acts as a repository of information and allows users to import and export files for viewing, amending and retrieving the data. It enables various BIM tools (such as design, analysis, FM, and document management systems (DMSs), among others) to exchange information. The difference between a DMS and a BIM server is that a DMS provides a platform for collaboration by enabling an exchange of 2D drawings and documents while BIM servers allow for the integration and exchange of 3D project data along with their attributes (Singh *et al.*, 2011). Cloud-based model collaboration in BIM enables real-time clash detection and mitigates the need for a traditional constructability review and resolution process (Hardin and McCool, 2015).

Thus, BIM fosters collaboration by allowing stakeholders to access the same information remotely simultaneously. Furthermore, the cost of disseminating information in BIM is low, and the BIM process makes collaboration obligatory.

5.5 BIM provides a better understanding of the project workflow

BIM can explain the project tasks to the construction stakeholders. If plans are made explicit among the stakeholders, they will understand how the task should be executed. Often, not all stakeholders equally understand the intentions of project teams. So, when a task needs to be executed, stakeholders may perceive things differently. Consequently, BIM can assist relevant stakeholders in discussing their concerns more clearly in advance and provide feedback.

In this study, 87 percent of the interview participants agreed that they could understand the project workflow in a better way through the use of BIM. This was credited to 3D, 4D and the ability to detect clashes in advance. Emmit and Gorse (2003) corroborated this view, that when one party in the construction industry fails to convey its intentions to another party, it engenders disputes between both parties.

Interviewee No. 2 narrated a situation where 3D models helped immensely in presenting the project scenario clearly to the representatives of another organisation. It made them understand the project workflow in a better way, hence mitigating their concerns.

> "So, that's the tools that we use because you know when we are engaging with the utility company, and they come for meeting with a concern that we are going to damage their asset. That's what they are concerned about as they are a stakeholder, and without drawing things up in 3D to what we need to do is to give them confidence that we are not going to damage their asset, and to give them a cup of tea and say 'Don't worry, it will be fine' doesn't cut it, whereas we show them a 3D model and say 'Let's start, here is your asset and here's an inclusion zone we are putting around it and here's where we have designed the ground anchors to go and here is the zone of tolerance around where they could end up and that still doesn't clash with your exclusion zone – are you happy with that?' And they go, well that's better".

Further, the same interviewee narrated that:

> "It [BIM] increases, I think, their confidence that they understand our intentions, and sometimes they don't agree with our intentions, and that's absolutely fine. At least, if everybody understands our intentions, even if half of them wouldn't agree with it, then they can say alright let's discuss what your plans are, and we can come to an agreement".

According to Jergeas *et al.* (2000), 'setting common goals, objectives and project priorities' is a critical success factor for stakeholder management. These authors identified that this factor contributed to a misalignment between stakeholders. Different stakeholders could have different perceptions of what the project is about. Jergeas *et al.* (2000) suggested that the only way to manage stakeholders' expectations is to communicate the purpose of the project at the beginning of the project and gather feedback. This will bring hidden agendas, if any, to the forefront and help in correctly setting the project priorities. Consequently, it will align stakeholders with the project, which will immensely assist in making the project successful. Interviewee 10, corroborating this view, stated:

> "BIM is...if you are talking in terms of how to manage the stakeholders, if you follow the principle behind BIM correctly you will have stakeholder management completely because you will understand exactly where everyone is at any point in time on a project because if you follow the full level 2 compliance, which includes government soft landings, for example, at each stage of design, you have to answer certain plain language questions. So, that means you know the design that you have got is correct for what's going on, you know what's wanted from the customer's side. From the point of view of the designers, using the suitability codes and the status codes on the drawings, you will know exactly what stage of the design is at any one point in time. So, on a true BIM project, everyone knows what the major goals are and what the major benefits are for each person, yeah. So, everyone understands where everyone is on the project".

Another interviewee (No. 8) stated:

> “Also, we have from our construction colleagues, our project managers and their site team a much better understanding of the project because they are able to navigate through the models”.

Interviewee 11 was the CEO of a software company. The interviewee’s company developed software specifically focusing on visually generating the scope of work. It can assign roles to project team members relative to the time when they are required to be performed. It further assists in managing the information requirements at all the project stages, the level of information needed, assigning responsibilities to manage that information and updating progress, among others. As all this happens visually, it helps all stakeholders to understand their (and others’) responsibilities in a very engaging way and monitor the progress. Stakeholders can see the delegation of responsibilities and make mutual decisions. The team members can see who are lagging in their roles and can assist them.

Interviewee 17 highlighted an example of a non-BIM project and discussed how BIM could have mitigated issues.

> “[…] BIM wasn’t being used, and I went there to get some site experience. Some of the issues were so basic that you think if we did clash detection, where you’ve got like a fall suspended ceiling, you’re going to see services above that. We have corridors where the services have been installed lower than where the ceiling was going to be set up. The plumbers or electrical guys, they come in; they just don’t fit out what they thought they needed. They put it at the height to get around [a] different piece of kit. Then the ceiling installer came in and said, “Well, I can’t

> put my ceiling in at [the] level I should be because all the services are below it".
>
> That meant that that element of work stopped because we then had to decide what we're going to do. Do we get the plumber back in to move the pipes up? But then, if he does that, there's a whole host of issues back. You'd have to sort out loads of issues before you got there. Do we move the ceiling down? But then, we've to get client approval. We can't do that because a lot of the time, they're quite sensitive on the floor-to-ceiling heights. All of a sudden, it stops. You've got guys out there that they're getting paid, but they can't do anything. You've got wasted money. You've got wasted time. It all escalates. So, something as simple as that, if we were doing clash detection, we would have picked that up big".

From the findings, it can be inferred that 3D, 4D, and the clash detection aspects of the BIM process can provide immense amounts of information about any given situation. The provided information assists in a comprehensive understanding of the project issues. The project stakeholders can discuss their concerns based on the more detailed available information and can pre-emptively resolve any issues.

The critical point to note here, is that it is not the clash detection process (or 4D or 3D) which can help to manage stakeholders. It is the information that comes out from the clash detection process, based on which informed decisions can then be made.

5.6 BIM improves communication

Communication is highly essential for the execution of complex projects performed by teams. It is extremely pertinent to the construction industry, where stakeholders need to exchange information to execute projects successfully (Dubas and Paslawski, 2017). Communication helps stakeholders establish trust and foster empathy among themselves (Emmit and Gorse, 2003). Digital tools such as BIM can assist in improving communication with construction stakeholders (Dubas and Paslawski, 2017).

In this study, 87 percent of the interviewees agreed that BIM improved communication with other stakeholders. This is due to the reason that BIM can facilitate communication with non-technical or less technical stakeholders, and BIM objects can hold metadata, which can prevent miscommunication from happening.

Interviewee 1 narrated an anecdote from the motorway construction project they were working on. A person whose house was near the motorway approached them and objected to the position of the gantry. The objection was that the light from the gantry would glare into their window during the night. The project team put the exact location of the house, its fence and of the gantry into the model. They showed that if the fence of their house was three metres high, the light would not glare into their window.

There were also other ways to present the result to the stakeholders, such as by using simple maths or a theodolite. However, BIM provided a ready basis through visual representation, which was comprehensible to the stakeholders, and it addressed their concerns. Interviewee 14 corroborated this and noted:

> "So, when you communicate with stakeholders, you want to use as much rich media as possible. So, let's get back to my example. If you go to a stakeholder with a 2D plan that is really complicated, that person won't understand it. If you are communicating with richer media such as a 3D model, it is far easier to communicate. Therefore, you can capture feedback from them. So, in terms of the stakeholder management, it doesn't really matter who the stakeholder is. It could be a banker or a minister of the government. It doesn't really matter. It's about keeping it simple. Nobody has ever complained about something being too simple. When was the last time you had to say 'Oh God! That's way too simple to understand--way too simple?'. No one has ever said that".

Interview participant No. 4 noted:

> "There's a clear understanding. There's no misunderstanding. We find that in drawings, temporary works drawings, if you send that out as a line drawing, you won't get anything back until the day they're building it because no one's got the time to look at the drawing. They suddenly realize it's not going to do what they want to do.
>
> If you send that drawing out with a 3D model of that drawing up in the corner, they look at that, they know instantly that's going to work on that, and they will come back directly, and it's something we've found in our design office for anything that goes

> out with a 3D model associated with it. We will get comments on that straight away".

It can be inferred that 3D models are relatively easy to understand than 2D drawings, both for technical and non-technical persons. Hence, the time required to understand any particular situation also reduces. It makes stakeholders respond quickly because they can identify the issues easily.

Interviewee 5 narrated an incident from one of their projects when stakeholders came to the room straight away, picked 2D drawings from the boards and said they hate these drawings because they could not visualise from these.

Rokooei (2015) noted that the characteristic of a federated model to input, modify and analyse data enhances communication between different project participants and makes them coordinate, thus reducing the disputes between different project participants. BIM acts as a repository of information and thus enables all stakeholders to assess the same version of data, which consequently reduces the risk of poor communication. Furthermore, Love *et al.* (2011) postulated that it facilitates communication among project participants relative to spatial, logistical, material and performance specifications and requirements. Moreover, as all the data is in 3D, it facilitates the use of real-time visualisations as a tool to share information and communicate ideas among different stakeholders (Johansson *et al.*, 2015 and Wong and Zhou, 2015).

Interviewee 11 noted that there is considerable potential of miscommunication on construction projects due to disconnected data sources. Moreover, project stakeholders come together for one project, and then their teams are disbanded. This factor further contributes to miscommunication. The objects in BIM models can retain the data attached to them. This characteristic of BIM helps to avoid miscommunication among stakeholders by providing a common language for communication. The interviewee noted:

> "… but BIM gives a common language, and for us to say that, you know, there is an object that certainly can take data and have a path right the way through from a section to right the way through the in-life, you know, facility. That's a very valuable thing. So, what role does it play in stakeholder management? It integrates, and it helps to improve communication between people".

This quote suggests that metadata can play a huge role in preventing miscommunication on construction projects.

5.7 BIM improves information flow

According to the NBS National BIM Report (2015), for the last 40 years, the frequency of litigation due to late or incorrect information exchange has increased. Many organisations realised that exchanging native models can significantly enhance efficiency and productivity. If BIM level 2 is implemented as it should be (meaning all project parties are working in a common data environment), then BIM servers hold a vast amount of information related to a project. This information is readily available, correct, and will be up to date. It can help considerably in making the right decisions, hence assisting in managing stakeholders because it prevents many issues from arising. This study found that 83 percent of the interview participants agreed that BIM considerably improved information flow, which helped them make timely, correct decisions.

The interviewees highlighted four different areas in which BIM helped to improve information flow. These were adequacy (sufficient information), accuracy (correct information), clarity (easy to understand), and time (not delayed). Interviewee 7 noted that they were getting information on time due to BIM, so one of their projects was six weeks ahead of schedule, and another was heading to be 1–2 weeks ahead of schedule. The sole reason, according to this interviewee, was that they were getting accurate and complete information on time. Due to this, they were able to engage their supply chain quicker and to send supplies and actors to the site quicker.

This interviewee further argued that late information is the crucial reason for conflicts among project members (such as architects, engineers, QS) and the supply chain. The interviewee noted:

> "For the construction industry, information has always been a big driver of efficiency. I would say that one of the biggest reasons for conflict is information not being on time. If everyone got what they needed to get on time, that would remove a large number of conflicts. Because potentially, that's all people want. If they are asked to price a job, invariably that's based on time. So, they would derive their price from a time measurement. If anyone influences negatively on that time, that means they're not going to make money.
>
> That's where the conflict arises. The conflict is they can see the profitability being eroded because of someone else not delivering on time.

> And this is where, in legal terms, there is a claim for damages. The damages are the cost that they've incurred that they've not anticipated that were caused by a third party. That's when the conflict becomes legal; then they would instigate a claim against us because we are kind of in the centre, so we contract with the consultancy for an appointment; we contract with the subcontractors via a subcontractor agreement.
>
> The subcontractor has no legal relationship with the architect. If the architect delays through the issuing of information, then they would instigate a claim against us. We would then need to go and try and recover that cost from our architect. You just imagine, if you're working on a project that is a mess with all the claims going on, you could have a room full of people just dealing with litigation".

The other interviewee corroborated this view:

> "I think the other thing about stakeholder management is, I mean it is big subject, but I think the idea that BIM allows you to share information early or repeatedly means that, I mean maybe it's not the very well wide stakeholder community but in the design team or whatever you can share information early saying I think it's going to be like this, or this is what I am currently thinking and it's not an expensive thing to do. So, rather than waiting till the end of the stage of a project, [I can] say here is my design; tell me what's wrong with it. One of the key ideas is that you can share information early and often to the benefit of other stakeholders. It

can be done fairly continuously. So, on a paper-driven project, which is — I mean, I started on a paper-driven project, you can share information once every two months perhaps, but with the PAS 1192-2 method, people are sharing information on roughly a weekly basis". (Interviewee 12)

The ability to present 2D data in 3D reduces the probability of misinterpreting the data. Misinterpretation of data can lead to conflicts later in the project. Then, blame culture kicks in. Project parties start blaming each other, and no one accepts any fault. This was noted by interviewee 4, who stated:

> "When you look at engineering drawings, your interpretation of a line drawing will be different to mine every time. And so, when you're looking at third parties, if you're going to provide information in a context which can have different interpretations, it's not a clever idea. So, you need to think about how [you] can provide information [from] years of our understanding [so] what we're just saying [is] at the same place. That's where that helps, and really, it's just a different medium, isn't it? Providing information, very clear information".

Another interviewee No. 23 stated:

> "So, in non-BIM, I don't share with you, in non-BIM, but what I do share with you will always be 2D; you've got no guarantee of coordination, a risk to understanding but again it depends on the project".

Alreshidi *et al*. (2017) postulated that BIM is providing a new platform to manage the information flow between stakeholders during an ongoing project. It helps in mitigating information loss, which usually occurs while transporting information from the design team to the construction team and to the facility's owner and/or operator team, by enabling each party to reference back to all the information they create and/or use while working on a model (Smith, 2013).

Interviewee 13 noted that when it comes to stakeholder management, some team members end entirely at the technical route, which is not a stakeholder management aspect of BIM. They only focus on their job role. For instance, if they have to deliver a drawing, they will focus on producing that drawing in their way. They will not consider how their deliverables link to other team members. What they should do is, they should find what the other person needs to know, and which part of BIM provides them with that information. If they do not ask them, they could be going in the wrong direction. The interviewee further stated that stakeholder management is more about understanding the needs of stakeholders rather than just focusing on the technical domain of BIM. However, when using BIM for delivering the right information, its process should be maintained appropriately. The interviewee stated:

> "If you do use a BIM process, it should be better controlled, more understood, and there are gateways for checking that you have met stakeholder requirements, in which one of the key things is the checking. So, when you look at the BIM process, there are three gateways for actually checking that you have met a set of criteria rather than reaching to the end and then realising, in the end, you haven't done it".

Literature corroborates the views mentioned above. Porwal and Hewage (2013) stated that BIM holds a vast amount of electronic information related to a project as compared to 2D drawings and specifications. As this is electronic information, it can be easily extracted (partially or as a whole) and can be exchanged quickly and efficiently, and can be reused. Zhiliang (2012) argued that accumulated information could help in making decisions. The traditional approaches for information management have two related issues. The first issue is that every project generates several gigabytes of information, and usually, organisations have more than one project, which further increases the data requirements. This large amount of gathered information hinders the ability to extract the correct information quickly and makes it more difficult to produce valuable information from information handling. The second issue is that the existing information does not hold explicit relationships among various information items. However, BIM explicitly shows the relationships among various information items, which makes them easy to share during the life cycle of a construction project.

In their research, Demian and Walkers (2014) compared BIM with other platforms for information exchange and argued that BIM fostered comparatively more accurate, on-time, and appropriate information exchange between project stakeholders when compared to other platforms. Moreover, it also helped to generate information related to design details, programming, logistics, and coordination in advance, which helped immensely during the subsequent production phases. Interviewee 7 noted:

> “The other thing I think I’ve noticed is information. Because of that, we are able to make decisions quicker. So, in our procurement process, we would normally procure groundworks, steel structure, precast planks, and you'd go through a process and wouldn’t be able to consider the secondary steelwork for something like a roller shutter door, whereas now we can say to the structural engineer, ‘We want to put a roller shutter door in,’ because it's all done on a model. They can pick up where the

> kitchen is. They can see the position of where the steel has to go. It's very quick for them to give us that design a lot earlier. Normally, those sorts of things would have to wait until you are further on in the project. So, we are seeing, in a nutshell, it's accelerating everything. It means a lot of processes that are happening can happen a lot sooner."

It can be inferred from the above data that BIM assists immensely in information management if appropriately implemented. The managed information can serve as the basis for making informed decisions, hence, eradicating many issues among stakeholders. This will assist in delivering the project within the iron triangle of time, cost and quality.

5.8 Summary of Chapter 5

There are many dimensions in which BIM assists in stakeholder management. It is evident from this research that, to harness the potential of BIM for managing stakeholders, the teams have to be open-minded. Focusing only on the technical aspects will not yield a desirable result. Instead, it may contribute to increasing problems among stakeholders. This chapter has addressed the second objective of this research project, i.e., to explore how BIM can assist with stakeholder management. The key roles it can play in assisting stakeholder management are 'enhances pre-planning', 'improves collaboration', 'a better understanding of the project workflow', 'improves communication' and 'improves information flow.'

BIM enhances pre-planning because it can show the order of work planned, the site set up, and the design intent in a visual way. These help to provide feedback that eventually helps to address the concerns. Improving collaboration also plays a key role in managing stakeholders, as BIM facilitates online collaboration and the cost of disseminating information is low. BIM also plays a role in facilitating the understanding of the project workflow. The information generated by 3D visualisations, 4D simulations, and clash detection processes, helps in making informed decisions. This pre-emptively avoids issues from arising.

BIM improves communication, which consequently assists in managing stakeholders because communication is a key factor for managing stakeholders. It improves communication because 3D models are easier to understand when compared to 2D drawings. Moreover, BIM objects can retain metadata. This assists in eradicating miscommunication. The last factor identified in this research is that it improves information flow. The information is more accurate, adequate, easy to understand, and within time. Getting information late is one of the primary reasons for conflicts among project stakeholders. Hence, BIM assists in mitigating issues among stakeholders, which consequently assists in finishing projects within time, cost, and quality.

Chapter 6 : RESULTS – THE CHALLENGES OF MANAGING STAKEHOLDERS ON BIM IMPLEMENTED PROJECTS

6.1 Introduction to Chapter 6

This chapter discusses the results both from the pilot study and the main study on the challenges which organisations are currently facing for managing stakeholders within the BIM implemented projects in the UK construction industry. The discussion elucidates the key factors identified in this study.

A critical analysis of the data collected is presented in this chapter in seven sections. The first section presents the overview of this chapter along with the empirical findings, which are presented in Table 6.1. The sections two to six present the key themes: lack of understanding of BIM concept, resistance to change, lack of integration of BIM technology, lack of incentives, and lack of training and education. The seventh section presents the summary, which addresses the third objective of this study.

The innovation in IT takes place in a controlled environment, such as in laboratories, but its implementation is enormously difficult to control because it involves the complex interaction of humans dealing with technology (Peansupap and Walker, 2005). Tulenheimo (2015) argued that BIM, by nature, is closely related to information and communication technologies (ICT). Thus, BIM shares common challenges as with traditional ICT implementation. In this research, it is acknowledged that many of the challenges would be similar. However, they are explored in the context of stakeholder management on an on-going project.

During the semi-structured interviewees, the question related to challenges was asked (i.e., what are the key challenges of managing stakeholders within BIM-implemented projects?). This stimulated diverse responses that are categorised into five key themes and are presented in Table 6.1. Table 6.1 also depicts their percentage based on which they are placed in a descending order.

Table 6.1: Challenges UK organisations are currently facing for managing stakeholders within BIM implemented-projects

Key challenges	Percentage (N = 23)
Lack of understanding of the BIM concept	91%
Resistance of users to change	87%
Lack of integration of BIM technologies	87%
Lack of incentives	83%
Lack of training and education	78%

From Table 6.1, it is explicit that lack of understanding of the BIM concept among stakeholders is the key barrier for managing them effectively. It is closely followed by resistance to change and lack of integration of BIM technologies. Furthermore, both these barriers are corroborated by an equal number of interviewees. Lack of incentives is second last, and challenges related to lack of training and education is at the last. There is enormous literature on the challenges related to the implementation of BIM on projects. However, this research is different. This research has primarily focused on identifying the challenges of ongoing BIM-implemented projects related to stakeholder management.

Detailed discussions on each of the challenges about stakeholder management are as follows:

- Lack of understanding of the BIM concept is discussed in section 6.2.
- Resistance of users to change is discussed in section 6.3.
- Lack of integration of BIM technology is discussed in section 6.4.

- Lack of incentives is discussed in section 6.5.
- Lack of training and education is discussed in section 6.6.

6.2 Lack of understanding of the BIM concept

Khosrowshahi and Arayici (2012) identified in their research that different interviewees had different definitions of the BIM. This astonishing finding was from research conducted in 2012, whereas this study collected data in 2018. Still, the finding is similar, in that there is a huge lack of understanding among stakeholders about the concept of BIM because the deadline for the implementation of level 2 BIM in the UK construction industry was 2016. How the lack of understanding among stakeholders is creating issues among them is discussed in this section.

In this study, 91 percent of the interviewees noted that the lack of understanding of the BIM concept is an issue. Interviewees noted this at both an organisational level and a client level. Oraee *et al.* (2019) noted that each team member was having different perception about the understanding of requirements to deliver BIM collaboratively. At an organisational level, interviewee 10 noted:

> "I challenge you to define what BIM level 2 is? Actually no, let me rephrase that I challenge to find three people that have the same definition of what BIM level 2 is".

The same interviewee further stated:

> "But the thing is that you will still find between companies that our internal definition of BIM level 2 might be different to, say, Morgan and Sindall's definition, or Kier's definition, or Skanska's, or any one of those others – you know, contractors,

> they... we will all have a slightly different definition of what it is. Some organisations have individuals or a small team of people who understand what BIM is, and no one else in the company does, and other organisations understand a little bit, but no one has a full understanding of what's required".

Interviewee 12 stated:

> "I think, there is another challenge of people coming from old ways of working where they may identify the software they are using as being BIM and not understand the information exists outside of the tool they are using. Revit users have no understanding that there are other tools which might need that information that might use that information, and so on, so forth. So, that is a challenge to get people to separate the information from the tools which are needed or know the tools that are being used by different players".

Interviewee 16 stated that a project manager is a different person than the person who is an architect, an engineer or a technician. So, the project manager's knowledge would be different from another person's knowledge. They all will have different perceptions about the BIM. Furthermore, the interviewee stated that the knowledge of those who are at the top level in an organisation would be either excellent or completely at a low level. Another interviewee, number 17, noted:

> "That's a huge impact. The design consultants could also be a problem because, again, their understanding can be different. They can also say they can deliver BIM level two, but actually, when it comes to it, you find out that they've never done it before.

> They don't have the resource, so that's quite a challenge because what we try and do is assess the capability of our consultants before we go into contract, but they can still say what you want to hear, really".

One more interviewee, number 19, corroborated the view about consultants as:

> "We did invite a few guys from our supply chain, and we had an external BIM. . . A BIM consultant, I guess you can call him. He gave an overview of what BIM is, how it is beneficial, and he gave it to a lot of leaders and representatives from the supply chain. So, we do try and engage with them and try to encourage them and enhance their understanding of what BIM is. Unfortunately, he was from an architecture background. So, he was talking about layout and stuff, whereas this is obviously a road scheme. So, it was not that relevant, and I was brought in to show what we can do for the project".

Panuwatwanich and Peansupap (2013) identified in their research that misunderstanding of the BIM concept created problems between an organisation's business objectives and BIM implementation. These problems further impacted the client's perception of BIM, which, in turn, shaped their misinformed expectations about BIM projects. Interviewee 10 noted:

> "The biggest challenge for managing stakeholders on BIM projects at the moment is the lack of knowledge on the customer's side. They do not know what BIM is and they do not understand what it is supposed to do. So, that's the biggest challenge".

Interviewee 16 corroborated:

> "The majority of our key stakeholders also don't actually understand BIM level 2. They do not understand what the process is. They do not understand what the deliverables are. They do not understand what the roles and responsibilities are like the staff. They don't realize they should be producing Employer's Information Requirements, and these key customers often actually are very poor at providing even employers' requirements, let alone the information requirements that go along with it, as well".

One more interviewee, number 5, corroborated:

> "So, we have to negotiate with a client quite frequently because they ask for unreasonable things that they will never need, and you know, for instance there's a number of PAS documents I am sure you are familiar with, security PAS 1192 part 5. Quite recently, we have had a number of projects coming in with the highest level of security classification, and they are not, you know, they are not really secure projects. They do not require that. So, you have to go back, you have to discuss and agree on a resolution so you can move forward".

Interviewee number 3 stated that sometimes clients have their own BIM information manager or some other knowledgeable person advising them about the BIM. So, by the time it reaches the tender stage, the client already knows what they should be asking in the Employer's Information Requirements. In this instance, it makes it easy for contractors to proceed without issues. However, they sometimes are advised by their consultants or someone else to demand BIM at the tender stage. The interviewee stated that it creates issues with the client at such a time because they do not have Employer's Information Requirements, nor do they know how to generate them. Hence, contractors do not know what information they need to generate and deliver. Furthermore, they need information from EIR at the first place to start the BIM process. So, if BIM must be implemented, it should be at the very beginning of the project.

Interviewee 10 corroborated this:

> "We tend to pendulum between clients that don't know anything at all and don't ask for anything and actually are quite scared of the technology in BIM, and the clients who have maybe even hired a BIM consultant, who's told them that they need absolutely everything".

Another interviewee, number 4, stated:

> "The sweety shop syndrome, which means that they want everything. I have no idea what information I need, so I'm going to have all of it".

Tulenheimo (2015) identified that customers do not know what their needs are and what they want from a BIM project. Moreover, when they get a BIM model at the end of a project, they do not know how to use it. It decreases the importance of the as-built model. Tan *et al*. (2019) argued that the performance of BIM-implemented projects depends enormously on its stakeholders' understanding of the BIM concept. A misinterpretation of BIM's fundamental concepts, processes and applications will eventually destroy achieving all the potential benefits and can create serious risks to the project. In 2018, the very famous report called 'The Winfield Rock Report' stormed the UK construction industry. The authors of this report interviewed BIM experts in the UK construction industry and identified that none of the interviewees was having a similar understanding of BIM level 2. Everyone was interpreting it in their context.

6.3 Resistance of users to change

In this study, 87 percent of the interviewees noted that people's resistance to change is one of the major barriers for managing stakeholders. It is due to the reason that people are comfortable with the ways they have always worked because they have been working traditionally for decades. Whereas, to work in a BIM way requires a drastic change in their current modus operandi. Furthermore, construction projects are bound to time deadlines. Not finishing in the given time could bring serious financial blows to an organisation. Moreover, project managers can lose their jobs also. Decker (2010) argued that if people do not have the vision to change or are not open-minded to change, technology-related processes risk failing. The author further stated that during a change process in an organisation, the most important change to manage is the people. This was noted by interviewee number 22:

> "[…] project manager here is probably resistant to change because they are all managing the risks of a project. Managing [takes] time and effort, so they do not want to change too much from what they already know".

Another interviewee, number 4, corroborated this:

> "They've got the same problem; they've got cultural change. They have got people who have been in the position for a long time and are looking at particular systems and they don't want to change it because it's breaking down their empire that they've spent a career building. How do you manage that"?

One more interviewee, number 23, stated:

> "Even in some consultants, if it is new and they have never done it before, there is a natural resistance and that's the cultural thing".

Pliskin *et al*. (1993, p. 144) defined culture as "the set of important assumptions (often unstated) that members of a community share in common". Assumptions arise from diverse experiences shared by people. When all the assumptions come together, it forms a culture. This culture influences decision-making processes and specific choices and behaviours. Pliskin *et al*. (1993) mentioned 'performance orientation' as one of the dimensions of organisational culture. Under this dimension, an organisation specifies the nature of demands that are expected from employees; for instance, whether employees should be held accountable for their performance, whether performance appraisals should be formal, should performance expectations be explicitly defined, among others.

The quotes mentioned above explicitly correspond to the 'performance orientation' aspect of the organisational culture. It reflects that the apprehension of things may go wrong is a considerable barrier for managing stakeholders on BIM implemented projects. According to Peansupap and Walker (2005), when an innovation is introduced in an organisation, users have to learn that and change their current way of working. People usually resist change because of the habits they have developed over time. The resistance is often common when the innovation does not suit their traditional working practices. It is corroborated by Mathieson and Keil (1998) as well.

Oesterreich and Teuteberg (2019) identified in their research 'resistance to change' among one of the main barriers in BIM projects from the information systems (IS) perspective. This was due to the complex behaviour of individuals and groups towards negative consequences that could occur due to change. This factor was further reinforced by the uncertainty that would be created due to change. Stakeholders were even afraid of losing their jobs or reputations in an organisation. Panuwatwanich and Peansupap (2013) also identified resistance of employees as the most difficult thing related to BIM.

Pliskin *et al*. (1993) identified in their empirical research that the level of resistance for information systems in an organisation depends on the presumed and actual culture of that organisation. It means before implementing information systems, the organisation presumed the culture to be something, but when the organisation failed to implement the information systems due to the resistance from the staff, the organisation came to know that the actual culture of their organisation was something else. This was noted by interviewees as well. The interviewees said they believed that training of employees would be the greatest barrier, but they realised while implementing that it was not the case. In fact, the employees were not ready to change. The interviewee 2 noted:

> "It's not the hardware or training of software, it's the people, and it's that at some stage in people's careers for whatever reason people decide that they have sufficient knowledge to carry out their job for the rest of their careers. So, they have been learning new things up to a point, and then one day arrives, and they decide that's it now, I know everything; I will continue with this knowledge until I retire. So, when you come along with something new and say, 'I would like you to learn to do this instead', people who have not reached that point yet are quite open to it and say, 'Excellent, let's try this new thing', and you can explain [things to] them well".

Another interviewee, number 3, corroborated this:

> "What's the point of just saying that I am not going to learn something new. Well, computing is advancing so fast because when I started, in the beginning, we did not have any mobile phones, smartphones or laptops. The Vax computers were in the room somewhere, [and there was] that the CAD machine, big mainframe, [and] now it's on a laptop, and they probably won't have laptops, probably will have an iPad or Surface; you just draw a model on it".

Venkatachalam (2017) also identified resistance to change existing work practices and culture as a barrier. The author argued that in the construction industry, people are usually reluctant to learn new tools and workflows because they perceive these as a waste of time and barrier to their productivity. The author further argued that 'resistance to change' is a multifaceted concept. It can be interpreted in terms of people as it is behaviour oriented or in terms of process because workflow makes people behave in a particular way. Tulenheimo (2015) corroborated that resistance to change is a barrier.

Interviewee number 8 stated that 2D drawings are still the contractual output on a BIM project. The interviewee recommended to completely ban 2D drawings from construction projects so that the industry can move to the digital way of working. The interviewee stated that the only way is to force people to do this; otherwise, they will not change their minds. The interviewee stated an example of a project that the interviewee worked in the Netherlands. It was a road project. No one was allowed to print any drawings. Drawings were completely banned. Drawings were replaced by digital screens, which were touch sensitive. However, the interviewee acknowledged that it raised the budget of the project. Furthermore, it also needed to resolve legal and contractual issues for this to be implemented.

A similar scenario is noted by interviewee number 18. The interviewee noted that even if the project team does everything digitally, other stakeholders will still demand PDFs. Interviewee stated:

> "So, when you show them something that we have done on Share Point or a project we followed the BIM process on, they won't accept it. I think the major struggle is that key stakeholders say government agencies and civil servants will be reluctant to embrace digital technology and view models. We say, oh we have built a new flood alleviation scheme, have a look at our model on this link. I bet you they would not look at it. They will say, send us a drawing, and what's the point in that"?

This explicitly reflects that stakeholders are culturally bound to their ways of working. They do not want to change. It is corroborated by interviewee number 5:

> "But again, it is a culture change issue because people are just familiar with the way they have always communicated".

One more interviewee, number 9, corroborated this:

> "[…] difficult ones are the ones where the people need to do additional different work effectively using a digital process, and not the same people that see the immediate response that will benefit from it. So, when they want information, managers will quite often just phone the person who has got it and say, 'give me this information', and in these, a bit of turnaround for that person who receives the phone call does say, 'Well, I have put that information into the system; go find it'. Because I followed the process and it's there in the right place, don't phone me and ask

> me to dig it out for you and do your job as well. I have done my bit; go find it".

This quote clearly states that if someone is following a new process, but others are not, it may increase the work of a person who is following, which can make even that person avert the change.

> "I'm still a little bit old school, and sometimes if I'm checking drawings, I would prefer to go and print them.
>
> But even I'm finding that instead of sitting with a pen and marking things I've got an issue with, I'm now starting to use software to mark something on the screen and send the digital image. So yes, I mean all these things are just making sure that we're more productive; we work long days because it's a lot more to do". (Interviewee 7)

Interviewee 16 noted that in a virtual environment when they told their stakeholders to wear Oculus Rift headsets, approximately one-fourth of them got motion sickness. It showed how people could avoid technology because of its difficulty to use.

Arayici *et al.* (2011) noted in their empirical research that BIM adoption should be a bottom-up approach rather than a top-down approach. The authors argued that a bottom-up approach should be adopted to engage the staff in the adoption and to apply change management strategies successfully for ensuring employees' skills and understanding increases and how organisations build up their capacities and for mitigating potential resistance to change.

Organisational culture

Organisational culture is defined as normative or social glue that keeps an organisation together (Cheung *et al*., 2011). It is made up of social ideals, values, beliefs and assumptions that members of an organisation share together (Chartered Management Institute, 2015). Assumptions engender from diverse experiences shared by people (Pliskin *et al*., 1993). From this viewpoint, Schein (2004) argued that leadership underpins organisational culture because usually those basic assumptions are those of the leaders. Organisational culture can guide and shape behaviours of the members (i.e., how people should behave and interact), how tasks should be performed and how decision should be made. It facilitates the generation of commitment among organisation's members (Chartered Management Institute, 2015 and Cheung *et al*., 2011).

In construction industry, Wei and Miraglia (2017) investigated the effect of various cultural elements on knowledge transfer and concluded that cultural elements affected significantly project stakeholders in deciding the type of knowledge it was more important to share, transfer and leverage. Parker and Skitmore (2005) identified unsatisfaction with organisational culture as the key reason causing project management turnover, and Adenfelt and Lagerstrom (2006) identified organisational culture as the key enabler for enhancing knowledge management in transnational projects. Furthermore, Liu (1999) identified nine factors to describe the organisational culture, namely power orientation, rule and procedure orientation, people orientation, result orientation, innovation orientation, external vs internal focus, team orientation, customer orientation, and communication orientation. People orientation refers to the ability of managers in encouraging their employees for improving their skills in an amicable and trustworthy environment. Result orientation refers to the evaluation of how clearly goals are defined by the organisation. Communication orientation evaluates the effectiveness of communication channels between employees and managers of a firm. Cheung *et al*. (2011) identified 26 factors which influence organisational culture in the construction industry. The authors divided those factors into seven categories, namely reward orientation, innovation orientation, performance emphasis, coordination and integration, goal settings and accomplishment, team orientation, and members participation. 'Goal settings and accomplishment' was identified as the most prominent factor of all the seven factors. It corroborated the notion that organisational culture provides an identity to an organisation which engenders from the goals set, is showed in the approach and is polished by the actions. In brief, setting clear goals assists in developing appropriate strategies and action plans.

At project level, project managers should use leadership role to establish common project goals and objectives with contractor organisations rather than blaming on contractor organisations (Cheung *et al*., 2011). Different business objectives and leadership styles may engender different organisational culture (Ankrah and Langford, 2005). Only leadership can assist in developing a culture and nourish a culture that is open to change (Matinaro and Liu, 2017). Damanpour and Schneider (2006) argued that managers can influence outcomes by establishing an organisational culture which adapts change and innovation. Thus, transformational leadership and leadership competencies of project managers play the key role in creating an innovative culture (Tabassi *et al*., 2016). Therefore, managers should have strong soft skills for managing issues like organisational culture and people (Matinaro and Liu, 2017). Matinaro and Liu (2017) investigated that Finnish construction industry is result-oriented and pragmatic in nature. Therefore, it does not perceive innovation management as an essential part of it. Consequently, result-oriented and pragmatic skills are preferred more than soft skills of managing people and culture while recruiting managers. Therefore, recruitment practices need to be changed to recruit managers and employees who can implement open-minded approaches to tackle the mindset of 'unwillingness to change.' Experienced managers should also change their approaches and mindset and act like 'learning leaders' to establish an open, learning oriented and collaborative culture within organisation and its stakeholders.

Organisational culture lies in the organisational context of the TOE theory. Alshamaila and Papagiannidis (2013) identified that top management support and attitude towards change can significantly influence adoption of technology in an organisation. Top management plays a crucial role in articulating the vision of the organisation and by providing necessary resources required for the change. Okakpu *et al*. (2020) investigated that many project stakeholders were afraid of changing their working practice to BIM. Therefore, the authors argued that leadership was required to establish a positive team culture to mitigate the resistance to adopt BIM. Hochscheid and Halin (2020) argued that digital transition and change are risky procedures for an organisation as organisations mostly face legal barriers and internal resistance to change due to internal environment factors. The authors included top management support, social motivations, financial resources, communication behaviour, organisational readiness, willingness/intention, organisation size and organisation culture as internal environment factors.

In brief, it can be argued that leadership and clear goal settings are the key factors to bring a cultural change in an organisation. Leadership (top management support) is imperative for setting clear goals and pursuing them. It is essential for providing resources required to accomplish those goals.

6.4 Lack of integration of BIM technology

In this study, 87 percent of the interviewees noted that the lack of integration of BIM technology was a barrier for managing stakeholders. Panuwatwanich and Peansupap (2013) identified in their research that the incompatibility of BIM with the existing workflow was the major barrier for making project teams adopt BIM. The authors stated that the project managers identified the transition to BIM-based practices (from fragmented to integrated working practices), as the key barrier for making stakeholders adopt BIM. In this research, this factor is identified as the barrier for managing stakeholders effectively. Interviewee number 4 noted:

> "The real danger about that course is that people tend to look at the paper-based systems they have today, which they were using 10 years or even 20 years ago, and then trying to apply technology to mimic that, whereas, what you actually need to do is look at what are you trying to achieve".

Another interviewee, number 5, corroborated:

> "I still see examples of designers drawing stuff in 2D and model separately, which is such as a huge no-no. I found somebody the other day. . . all the 2D information should be taken from the model".

One of the interviewees, number 21, noted:

> "BIM is having a single source of correct information. It looks like those consultants normally have two separate teams—a team working in 2D and a team working in 3D. They are working in a

silo, and they are creating different information. That’s a risk anyway”.

Interviewee number 17 stated:

> “We’ve had instances where they will do the 2D drawings first in, let’s say, AutoCAD, and then they’ll get somebody else to model it. But the problem is that they are not linked in any way, and you can then be doing the clash detection on the models but how do you know you are solving clashes in the model, but if the drawings have been done separately anyway, how do we know that the clashes are being resolved from the drawings? Do you know what I mean? We have had that from some large architects. They'll do models and 2D drawings separately, and it's like that defeats the objective”.

Another quote from interviewee 23 stated:

> “All they have done is digitised what they have always done. And the reason the government wrote the construction strategy and why we wanted to have the BIM mandate was because we did not want people to do what they have done before. We wanted them to do something new because if we did what we did before, you get in the same mess all over again. So, this is slightly frustrating when you look at the stakeholder management, and if all you are doing is digitising what you have done before, and what you did before did not work, it's not going to get any better; if anything, it is going to get worse—yeah”. Because you have added a level of complexity which is already quite challenging. So, you do not

> actually take a stop and going and as part of that engagement piece, which is part of the BIM process and say, what it is you need. And it might not be what you have delivered for 20 or 30 years. I think that is the biggest challenge when you are doing that. It actually starts discovering things which you always assumed, and you were told which were not actually true."

The same interviewee further stated:

> "They do, but what we have seen or I see, there is. . . is quite lot of the time you will get an organisations who look at the requirements and they will sub-contract their BEP and they will sub-contract their modelling, but they will continue do their business as usual because they treat BIM as a deliverable, as a tool, not a process, not a cultural transformation and it is a step that if you want to say are we where we need to be with regards to using BIM properly on a project."

It is clear from the quotes above that most of the construction industry is still working in the silo on projects implementing BIM because they are treating BIM as a deliverable rather than a change in the process of delivering a project. In fact, at BIM level 2, 2D drawings should come out from 3D models. So, if the project staff is treating both as a different process, then technically, it will not be called a BIM level 2 project. This is explicitly specified in the PAS 1192-2:2013.

Tan *et al.* (2019), Lu and Korman (2010) and Elmualim and Gilder (2013) identified in their research that integrating BIM with the traditional process is one of the most difficult challenges within BIM-implemented projects.

6.5 Lack of incentives to adopt BIM

In this study, 83 percent of the interviewees agreed that lack of incentives was a major challenge for managing stakeholders within BIM-implemented projects. This was because of the difficulty in providing incentives to all involved. The number of stakeholders delivering a project could be huge depending on its type, size and complexity.

BIM adoption should be treated as social-technical in nature because it is equally about people and processes as it is about technology (Arayici *et al*., 2011). BIM implementation brought a radical change in the working practices of construction organisations, thus generating risk for diverse areas. It created an urgency for change management (Khosrowshahi and Arayici, 2012). Liu *et al.* (2017) argued in the context of the designers that BIM increases their liability. Hence, if economic benefits do not get shared with them, they are reluctant to follow the BIM process. One of the interviewees, no. 12, noted:

> "Well, I think the challenge is to make sure that everyone in the information web or systems get benefits".

Another interviewee, number 4, noted:

> "People need a process in IT, but they don't really like it. They will always do their own thing. IT depends on the process and people to do it. And the process depends on how the IT infrastructural people do it. So, you have got this unholy little area where, culturally, you've got to make the change for those who deliver it".

One more interviewee, number 2, stated:

> "I think the main challenge is a cultural thing, and part of the reason behind that is people not willing to learn new things, and the benefits don't always go to the person organisation that needs to make the change".

Another interviewee, number 21, corroborated this:

> "The subcontractors need to understand why they became part of the BIM project and what the benefits are to them, individually. Then, everybody in all those organisations across the board needs to be able to see the benefits for themselves, as well. If there is someone out there who cannot see a benefit of this process over what they were doing before, then they're not going to do it".

Liu *et al.* (2017) argued that the BIM usage should be complemented with an emphasis on sharing benefits arising due to the information flow from designers to contractors. Jergeas *et al.* (2000) argued that stakeholders would support the project only when they find the actions to be in their interest.

Another reason identified in data analysis is that internal stakeholders involved in delivering a project do not understand how their jobs are related to others in a BIM environment. In other words, they do not fully understand how their way of executing a task can affect the person who is going to have the output of their task as input for them. Oraee *et al.* (2019) identified that project teams were less knowledgeable about the roles of their colleagues within the team for generating shared knowledge. This hindered collaboration within BIM teams. One of the interviewees, number 13, noted:

> "Because when I have tried to go to the person producing the model and say—you know, when you produce the model—'Here

> is the coding to attach to everything; please, would you do that because it will be a help later on?' and they say, 'Yes, there is no problem', and the person doing the programme says, 'When you plan it, would you use these activity codes?', say 'Yes, there is no problem', and they don't. And they don't use it, and then they say well I didn't use it; it didn't make any difference to me. No, but it means now that somebody has to spend a week going through the model adding the coding, going to the program, and adding the coding before they can just plug it together. And then, the perception is that animation wasn't worth it because it took two weeks to do".

Another interviewee, number 9, corroborated:

> "Culturally, no one does anything for nothing. Even in our business, we're asking to do things in a different way. They are not going to do that because we're paying them. They will only do that if they get something out of it because they're comfortable.
>
> They know where they are. I just do this and this, and I guess I'm done, but now, you want me to do something completely different, which I feel very uncomfortable with now, and I might not do it right, and there might be repercussions. So, that does not matter whether it's an employee, a third party or an employer. So, what you have got to do is, look at things which are easy wins".

Ngwenyama and Nielsen (2014) identified in their research that technology implementation and change management are largely an organisational-influenced process

(OIP). Therefore, solely adopting technology with rational approaches is inadequate to achieve success. The authors found in their research that managers successfully implemented technology and managed change despite weak support from top management and that managers had less formal power and influence over the disciplines that needed to be changed.

Organisational influence processes (OIPs) are social actions formulated by a person or a group to achieve their objectives by influencing the behaviour of another group or an individual. OIPs have five main characteristics, namely type of influence, nature of influence, the direction of influence, the target of influence and influence tactics. "Influence tactics" are the fundamental building blocks of all influence processes. Influence tactics are the different ways by which an individual or a group engages their targets to influence them (Ngwenyama and Nielsen, 2014).

Yukl and Falbe (1990) mentioned eight different types of influence tactics, namely pressure tactics, upward appeals, exchange tactics, coalition tactics, ingratiating tactics, rational tactics, inspirational appeals and consultation tactics. Ngwenyama and Nielsen (2014) amended these. They kept six tactics similar and amended "upward appeals" and "exchange tactics." The authors merged "upward appeals" into "coalition tactics" and named it "alliance/coalition tactics." They further disintegrated "exchange tactics" into a new category called "rewards/recognition tactics," thus ending up with eight different types. However, they have not specified that they have amended the categories proposed by Yukl and Falbe (1990).

Ngwenyama and Nielsen (2014) identified in their empirical research that "rewards/recognition" tactics played the most crucial role in influencing the behaviour of targeted stakeholders. It was followed by "rational persuasion" (rational tactics). Other tactics were lagging hugely. The astonishing finding was that the "coercion/pressure" tactics played zero role in influencing the behaviour of targeted stakeholders.

Yukl and Tracey (1992) argued that hard tactics such as coercion and manipulation could lead to resistance, while soft tactics such as rational persuasion, inspirational appeal and consultation can lead to cooperation from other stakeholders.

Petty and Singleton (1992) conducted empirical research on an electric utility company. The company was divided into two divisions for the research. One division was provided with incentives to bring change, while another division was controlled. It was found that the division which was incentivised for bringing change performed better on 11 objectives out of 12. Jallow *et al.* (2019) identified that their organisation started award system, as an incentive, to entice people for changing their working practises. Their organisation started choosing BIM Warrior every two-month based on the engagement of the employees in a BIM process. The BIM Warrior would get a trophy and a financial prize. This strategy worked extremely well for the organisation, and organisation experienced a significant increase in the number of employees adopting BIM.

In brief, it can be concluded that providing incentives in the form of rewards is a key factor to drive cultural change.

6.6 Lack of training and education

In this study, 78 percent of the interviewees agreed that the training and education of the employees was a major challenge for managing stakeholders. This was because construction organisations (depending on their size) may have a huge number of employees. Moreover, within an organisation, there are different disciplines. Upgrading the hardware and buying software licenses involve a huge cost. One of the interviewees, number 4, stated:

> “We've got 3,000 employees. How do I keep 3,000 employees up to speed with what we are doing and where are we going, what's it going to change from? No, it is not easy. It is such a huge step. It needs a lot of money as well as involvement to train the culture of 3,000 people”.

Another interviewee, number 6, stated:

> “We have issues when the smaller contractors do not have that capability, and that's where we have an issue because there's still a big uplift in cost to any project when you go to contractors, and you ask them to get the software, especially if they have a design package in their order and if they do not have that software; then, that's a cost that gets put onto the job. And you won't necessarily see that cost reality until later on down the line”.

One interviewee, number 20, noted:

> “A lot of initial hard outlay for a company of our size, for all our computers is to be able to run the BIM model. It is a horrendous amount of investment. It is guaranteed we probably wouldn’t get all our computers upgraded to look at BIM models, for the first ones have to be redone. This is a massive logistical issue within a company of our size to get that up and running or updated”.

Another interviewee, number 22, corroborated:

> “Making sure everyone’s got the technology to cope with what we’re dealing with here. The lower ends are struggling to see the value of the investment.
>
> We do try to bring people on. There is a time and a cost element to that. So, who pays for that? There are hidden costs everywhere in regard to the time you take people out of what they’re supposed to be doing. [There’s] lost time, too, and then facilitating that has a cost. If you are going to get any real benefit, you need to revisit that to see if there are people actually implementing what they’ve been taught. It has to happen because if you don’t, BIM won’t get any traction within the industry”.

Liu *et al.* (2017) identified in their research that designers have to upgrade their hardware and train their staff. When they do not get a financial incentive from the client for this, it discourages them. The time consumes for building complex models further enhances this factor. Moreover, BIM has a new way of collaboration. All team members have to undertake required training for changing their current working practices so that they can become capable of participating and collaborating in a new type of collaboration. Tulenheimo (2015) and Panuwatwanich and Peansupap (2013) corroborated education and training of employees as a barrier due to the costs associated with them. One of the interviewees, number 11, corroborated this:

> “It changes everything in the workflow, not only have the contents created been changed, but also its uses. I spent three years as a vice president and had a client where we were implementing BIM for FM, but it was for an 800-member staff that was not technology savvy and, therefore, it was very

challenging. Not only do you need to have a better workflow to get a better output, but you also have to train the teams, and not only the ones who are creating the content but also those who are receiving the content. So, it is a really big challenge and a big change".

On construction projects, different organisations work together. It is highly unlikely that all the project stakeholders have the same level of skills. Interviewee number 5 noted:

> "So, yeah, another project this is with regard to them signing up to a contract to say they can deliver x, y and z. One of those elements was asset information. But they are not capable. They don't have the training. It is not our position to actually offer them technical training. It is not part of our contract, you know. It's like asking an architect to design a building. I will train you on how to design it, exactly the same in my opinion. But we have to had spent time with them, training them on how to actually add information into their model and how to export it properly. Otherwise, we do not meet our deliverables because they are not just capable. Very frustrating".

Another interviewee, number 16, corroborated:

> "We provide COBie data. Without training, that's going to get just forgotten. There's a lot of work to collect it, to collect it from ourselves managing the process from a supply chain, collect it before having to change their processes and to put it all together, and train people. All this will get quite significant. The cost associated with it as well will be quite significant. If it is not being

> used by the stake team, it makes a bit of a mockery of the process".

Two interviewees (number 2 and number 4) suggested a way to overcome this issue within an organisation and on projects where multiple organisations work together. Usually, on construction projects, multiple organisations work together. Interviewees advised promoting knowledge sharing. Interviewees favoured encouraging knowledge-sharing both at the organisation level and even on consortium projects.

Interviewees stated that sometimes the internal staff does not share their knowledge with colleagues because of the fear of competition from them. At the consortium level, sometimes, two equal rivals work together. Hence, they do not want to transfer their knowledge. Interviewees corroborated that if Company A is more knowledgeable and skilled than Company B (assuming they are working on the same project), and they are arch-rivals as well, Company A would take action to hide their knowledge. It is due to the reason that they believe that they may be competing with each other for some other project in the future. Interviewees believe Company A should share its knowledge with Company B so that they can deliver the project collaboratively. Interviewees believe companies should not be afraid of the competition. Interviewees strongly believed that the time Company B would take to excel that knowledge and skills, in that time, Company A would be learning something new. Hence, they can always stay ahead of the competition.

Furthermore, interviewees strongly believed that organisations should train their supply chain if their supply chain consists of SMEs because SMEs usually do not have the budget to train their staff appropriately. Interviewees agreed it would cost an organisation in the first instance, but it will save them when the organisation works with the same supply chain on the next project. Liu *et al*. (2017) noted that on BIM projects, organisations should train other organisations. This way, they can take the most advantage of BIM technologies.

6.7 Summary of Chapter 6

Data analysis resulted in the identification of five key barriers, namely lack of understanding of BIM concept, resistance of users to change, lack of integration of BIM technologies, lack of incentives and lack of training and education. It is evident from the research that the lack of understanding of BIM is still a major hindrance for managing stakeholders. This is because misconception about the fundamentals of BIM makes clients put unnecessary demands from the project. Moreover, due to this, employees do not understand how their roles are linked with others in the BIM environment. Behaviourally, they are resistant to change as well. It is because project stakeholders become accustomed to their usual working practice. Hence, they do not want to divert from what they already know. Moreover, construction projects are bounded by time. So, the apprehension that things may go wrong further enhances this factor.

One of the astonishing findings was the incoherence of the BIM process and the traditional process. The BIM team works separately from the 2D team. In some cases, organisations are first drawing in 2D, then they hire someone to model it. A lack of incentives was another major challenge identified. BIM requires changing people's current working practices. People are not ready to change unless they get some personal benefit from that change. The last challenge is related to the cost of training the staff. It is a challenge for both large and small organisations. Large organisations have much more staff to train, which involves a huge investment, whereas small organisations usually do not have enough budget to train staff. Leadership, setting clear goals and providing incentives are identified as key factors for addressing cultural issues in an organisation.

Chapter 7 : RESULTS – THE KEY TECHNIQUES FOR MANAGING STAKEHOLDERS ON BIM IMPLEMENTED PROJECTS

7.1 Introduction to Chapter 7

This chapter discusses the results both from the pilot and the main study about the techniques organisations are using for managing stakeholders within BIM-implemented projects, and the outcomes of managing stakeholders effectively. This chapter is divided into seven sections. Section one introduces the chapter. Section two, three, four, five and six discuss the key findings in detail, i.e., learning experience, meetings, online collaboration, and creating a sharing and learning environment, and key outcomes of managing stakeholders, respectively. The seventh section presents the summary of the chapter.

It is clear from Table 7.1 that learning experience is the most important technique for managing stakeholders within BIM implemented projects. It is followed by meetings, online collaboration, and creating a sharing and learning environment.

Table 7.1: Key techniques for managing stakeholders

Key techniques	Percentage (N = 23)
Learning experience	87%
Meetings	83%
Online collaboration	78%
Creating a sharing and learning environment	78%

Diffusion is defined by Rogers (1983, p. 6) as "the process by which an innovation is communicated through certain channels over time among the members of a social system.” So, it is a type of communication in which the messages are specially related to a new idea. According to Rogers (1983), it is usually difficult to adopt a new idea even when it has clear advantages. Often it takes many years for organisations to adopt some innovations fully. Therefore, a common issue for organisations or individuals is to find ways to expedite the diffusion of an innovation.

7.2 Learning experience

If specific tools, methods and techniques are not considered while integrating complex practices, potential issues can arise which can prevent the successful implementation and can cause limitations. Therefore, training and education is a crucial factor because implementing new practices require a level of knowledge prior to the implementation in systematic routines and working practices (Mellado and Lou, 2020). For instance, BIM has its own complexities in terms of its processes, which makes it different from traditional construction practices.

An individual’s total learning experience is composed of both education and training (Masadeh, 2012 and Nelson, 1991). Therefore, it is crucial to understand the difference between these two. Generally, education teaches problem-solving approaches while focusing on the ability to think abstractly, whereas training provides skills for implementing problem-solving approaches while focusing on the ability to work concretely (Nelson, 1991). Education involves an understanding of abstract theory, while training involves developing the necessary skills to accomplish a task (Nelson and Cheney, 1987). Education helps individuals to choose their activity, while training helps them to improve their performance in it (Nelson, 1991). Masadeh (2012) distinguishes training and learning by arguing that training particularly is associated with on-the-job skills required for a particular job. In contrast, education is a general, less specialised approach for enhancing knowledge, usually related to a formal academic background. The author further argued that, with increasing complexities in organisations, both are necessary for improving the potential of employees.

Nelson and Cheney (1987) used the terms ‘education’ and ‘training’ to refer to formal efforts to get the required Information Systems (IS) knowledge. In ‘IS’ knowledge, the authors included IS concepts, technical skills, organisational skills and knowledge about specific IS products. Oesterreich and Teuteberg (2019) argued BIM has a similar nature to IS systems. Therefore, this research will use the terms ‘education’ and ‘training’ to get knowledge about BIM concepts, technical skills, organisational skills and knowledge about specific BIM tools. However, Nelson and Cheney (1987) made ‘training’ as their primary focus rather than ‘education.’ The reason is they have researched in the context of computer’s adoption by individuals in organisations. Now, that era was the advent of computers. To adopt computers, individuals do not need to receive much education about how computers work. Instead, they need to get training on how to use them to accomplish their everyday organisational tasks. It could be the prime reason authors emphasised more on training than education.

BIM is a process. Therefore, this research equally emphasises both education and training. Education about the BIM process is fundamental in managing stakeholders. It is evident from the findings that ‘lack of understanding of the BIM concept’ is the most critical challenge. To overcome this challenge, education is essential. It should be followed by on-the-job training to implement the knowledge gained from education. It is further evident from the findings that ‘lack of integration of BIM technologies’ is also a key challenge. To overcome this, training is required.

In this study, 87 percent of the interviewees agreed that education and training of project teams is a must to manage them successfully.

7.2.1 Education

Concerning education, interviewee number 5 noted:

> "But you also have to educate the team internally because they need to understand what the deliverables are going forward".

Another interviewee, number 17, noted:

> "We'll try and help them (client), and in that way, we're trying to educate them as well. Obviously, there is a responsibility on the client as well with us. In PAS 1192, it says that the client has responsibilities that they need to do first before we can respond to that. There's also training for even just using apps or modelling software".

The same interviewee further stated:

> "So, again, it's about education. It's about saying, 'Look, these are the models, this is the asset information, this is how the two links together,' and showing them (client) how it all works, rather than just walking away".

7.2.2 Training

Related to training, interviewee number 4 noted:

> "Yes, we train them (supply chain) in all the 3D modelling products. We train, and then they use a common data environment

> (CDE); they're using ours. And we have worked with some of the more significant ones in terms of the approach of how to manage data. So, it's aligned with us and aligned with the industry. That's a win for everyone".

Further, interviewee number 11 corroborated:

> "However, definitely, the more collaborative approaches combined with BIM are incredibly powerful, but again, it—you know—really is the training and the team; you can't just mandate something and expect everything to be better".

Interviewee number 17 noted:

> "We will hold training sessions. At the start of a project, we will have training sessions with the client, our design team, our supply chain, and also our internal team because they're not always the best in a common data environment".

The quotes mentioned above clearly indicate that the interviewees have used the words 'education' and 'training' collectively with a meaning similar to that of Nelson and Cheney (1987). It is explicit from the quotes mentioned above that education and training both are necessary to manage stakeholders within BIM implemented projects; education is required to make them understand the various constituents of BIM process, and training is necessary to deliver those appropriately.

Jallow *et al.* (2019) identified that training employees significantly increased the use of common data environment (CDE) in their organisation. In September 2017, only seven persons used CDE for information. This was increased to 631 employees using CDE in October 2018.

Peansupap and Walker (2005) noted training as a primary ICT diffusion factor because it makes users understand how to use and adapt the software efficiently. Compeau and Higgins (1995) identified an organisation's support for training its employees as a crucial factor for successfully implementing computer usage in an organisation. Nelson and Cheney (1987) identified that computer-related training helped end-users to develop the required ability, and the greater the computer-related ability, the greater the rate of acceptance of IS products and technologies was among end-users. The authors further postulated that IS related training and education begot the acceptance and usage of IS technologies throughout the organisations. Nelson (1991) argued that for organisations to stay competitive, they should treat employees as their assets whose value can be increased by education and training. Moreover, well-trained end-users assist in the implementation of institutional strategies.

Nelson (1991) and Akins and Griffin (1999) argued that individuals should be trained in developing only skills relevant to their job. It is because it is difficult for an individual to learn all the aspects of business knowledge. It is corroborated by one of the interviewees, number 21, who noted that:

> "There's nothing more disengaging than getting 40 people in a meeting room for a full-day session when 80% of it doesn't relate to them."

Another interviewee, number 22, corroborated:

> "The way that you get people to embrace that is by going in very gently, so you have to do bespoke training with individuals. If you do not go into your project and explain all the processes and procedures of BIM to someone—a quantity surveyor doesn't

> need to know about the CIC BIM Protocol, but he does need to know how to do a quantity take-off from the model. . .”

Peansupap and Walker (2005) argued that organisations should provide employees enough time for learning because they are usually extremely busy or are distracted by their work duties. People are generally reluctant to learn if they do not get time to practice and reflect that learning. Construction organisation workers, especially, can feel they have limited time to learn and use new IT tools. Hence, organisations should provide them enough time to learn and practice IT systems (Akins and Griffin, 1999).

7.3 Meetings (face-to-face)

In this study, 83 percent of the interviewees preferred meetings (face-to-face communication) as a key technique to manage stakeholders. The findings suggested doing as much as communication as possible; if possible, face-to-face communication is preferable to resolve issues. Furthermore, reducing emails is also emphasised.

Rogelberg *et al.* (2010) defined meetings as purposeful work-related interactions taking place between a minimum of two people and having more structure than a simple chat but less than a lecture. It is a sociotechnical process that uses a set of resources (i.e., people and technology) to change the individuals’/groups’ current problem state to a desired future state through a series of action steps (Bostrom *et al.*, 1993). Rogelberg *et al.* (2007) stated that meetings can be a crucial source for providing leaders with a platform where they can disseminate their vision, develop strategic plans, and find solutions to challenges and opportunities affecting their organisations. Meetings can serve as a good platform for gathering ideas, increasing employee involvement, and brainstorming. In organisations, meetings play a crucial role in enhancing employees’ socialisation, relationship-building, and shaping an organisation’s culture.

In meetings, attendees make work-related decisions, share information, and discuss and delegate tasks. Events that elicit affective reactions at work such as events related to achieving goals, planning, recognition (receiving praise), and acts of management all commonly take place in meetings (Rogelberg *et al.*, 2010). However, meetings should be carefully planned; otherwise, they may end up causing attendees to be dissatisfied (Rogelberg *et al.*, 2007).

Dohen *et al.* (2010) argued that spoken conversation develops a complex communicative act among the interlocutors, which is composed of linguistic, emotional, expressive, cognitive, and social dimensions. Face-to-face communication is a key form of communication and is much more than mere speaking. It involves nonverbal communication to a large extent. Speakers, along with hearing each other, can also see facial and body gestures. Gazing at each other while speaking maintains mutual attention and allows for taking turns in speaking.

Ferreira and Ramos (2014) argued that in this modern era where technology has overcome the barriers of time and space, communicating face-to-face is still a better way than all types of computer-related communication. Communicating face-to-face sends a message before a word is even said. In addition to what a person says, people get a message from the tone, emotion, voice inflexion and body language. Paul *et al.* (2016) corroborated that face-to-face communication has benefits over virtual communications. Interviewee number 23 noted:

> "So, if you wanna look again at management practices you will never start with a Skype meeting. You will do a face-to-face. And once you have understood people's personality what they are like,

> you then get a better idea of tech meetings like emails and text messages rather than misreading tech".

Winger (2005) argued 'productivity' involves face-to-face communication as a key element despite the development of cheaper and more flexible electronic ways of communicating. The author described two factors which contribute to productivity. First, physical closeness activates all the senses (sight, smell, touch and sound) and makes them play their role. All these can play a crucial role in providing clues in some discussions. The second factor is speed. Information communicated face-to-face is instantly received and elicit an immediate response. It is highly effective when the problem to be sorted requires tacit knowledge from interlocutors. In business, it is common to have issues that need the exchange of tacit knowledge for their solutions to be developed. One of the interviewees, number 3, said:

> "You know it's more than 90% common sense having a rational talk with somebody rather than dictating this is our project; this is how we are gonna build it".

One of the interviewees, number 12, stated that the best way to resolve an issue is to invite them for a cup of tea. The interviewee narrated an incident where it took them two days to resolve an issue. It was a road infrastructure project. The interviewee booked two hotel rooms for two days, for the interviewee and the other party with whom they had a conflict. The interviewee invited the other party, and they discussed the issue in the hotel and came to a mutual agreement. Interviewee number 19 noted:

> "So, you need to talk or get people to talk and share information".

Another interviewee No 18 corroborated:

> "Because we don't want to write pages and pages of what we actually mean. We want to write concisely and then enter into a dialogue. I think the risk is we do not enter into that dialogue, like you and me now; you could have sent me this document, I could have answered a bunch of questions. But we wouldn't necessarily arrive at an understanding".

Bostrom *et al.* (1993) mentioned two types of outcomes from meetings, i.e., task-related outcomes and relational outcomes. Task-related outcomes mean individuals meeting to accomplish some tasks such as developing a plan, making a decision to share information, to solve a problem, to resolve a dispute and to negotiate a contract, etc. Liu *et al.* (2017) argued that the nature of BIM demands frequent meetings among project stakeholders. When designers and contractors collaborate intensely on BIM projects, they openly share information that makes one party understand the expectations of the other party, anticipate their actions and create a desire to offer help. It generates trust among project stakeholders and reinforces their relationship. Weber (2008) identified that trust as a crucial ingredient of teamwork. It plays a vital role in the development of effective teamwork processes and the effective performance of the team. Laan *et al.* (2012) argued that inter-organisational trust is extremely important for the construction industry because organisations often work with others for different projects. Trust becomes a critical issue when things go wrong. Different teams can gather information about each other through repetitive meetings.

> "We do it mainly through meetings, and then view the model at the meetings. So, I think that's another benefit of the 3D model; everyone can sit in the same room and get a perspective of what's being discussed". (Interviewee 7)

Another interviewee, number 8, noted:

> "So, I hold regular workshops where we're all sitting together and discussing issues".

Liu *et al.* (2017) argued that past non-BIM experience could only assist in successfully accomplishing traditional projects. It will not necessarily assist in developing the collaboration that is required for accomplishing BIM-implemented projects. Therefore, project stakeholders should organise more formal meetings than traditional ways of collaboration to enhance their understanding of BIM activities. Alreshidi *et al*. (2017) identified in their research that project stakeholders organised regular face-to-face BIM meetings to discuss their progress and to receive explicit updates on interim milestones and goals for organising and tracking project objectives. In case where the project team was located remotely, project stakeholders used Skype for face-to-face interactions.

A relational outcome means that a meeting is a relationship between different people. This type of meeting generates emotions, which in turn creates feelings, which affects the development and quality of the relationship between attendees. These meetings aim to encourage effective collaboration. Negative energy in these types of meetings is not avoided but is redirected towards a positive direction (Bostrom *et al.*, 1993). These types of meetings should be promoted in BIM-implemented projects. Interviewee number 21 noted:

> "Even under the guise of providing free BIM training for the client, you can say, 'As a nice thing to do, why doesn't the whole client team come in and we'll do a two-hour session on BIM? We'll talk about what it actually is, and we'll run you through your model. You can have a look at how it's all set up and how it

> works and what we will deliver to you at the end of the project.' People come along because it is interesting, and the model looks quite cool. And then actually that session develops into a Q&A sort of environment. You learn things about the client that you might not necessarily have known, and they learn, and they trust you more".

Interviewee number 8 noted:

> "We have stakeholder engagements, with a series of engagement meetings; we try to understand what the school wants in the sense of how it operates as a facility, what the circulation is, what its demands are, and how it manages the school".

Interviewee Number 14 stated:

> "We have supply-chain meetings, forums, and we talk about where we are going and where they are going. We bring the supply chain and the designers together in that forum. We've got a common understanding of where we are going, what we are trying to do, and how that is aligning with the rest of the business and with the employers, which is exactly the same".

Young (2013) identified the client and project sponsors as the most crucial stakeholders. The author recommended having face-to-face meetings at least once a week (even if it is possible for only 20 minutes) to build a good relationship with the project sponsors.

Interviewee 2 mentioned that in BIM implemented projects, the first step they take is to organise a BIM meeting between the project teams. There, they make project teams discuss with one another, from the very basics to their understanding of BIM in the context of their project. They call this meeting a "BIM Awareness Session." It is followed by a "BIM Goals Session." In this meeting, they discuss (particularly to that project) the key risks involved in that project; processes to reduce those risks; if that project requires specific kind of BIM tools; workforce's skills related to those tools, for instance, if those tools require special training of staff; if special hardware be required; if those tools will affect the selection of their supply chain, among others.

Use of emails

Emails are vulnerable to misinterpretation. Moreover, people often do not check their emails. The data analysis highlighted that people should encourage informal talk among them rather than sending emails frequently. Interviewee number 10 noted:

> "Key techniques are basically its communication via meetings and conversations; that's the biggest thing that has happened. Face-to-face talking, removes emails is what I would say because it sounds strange what hmm the problems with emails is that everyone gets thousands of them every day and they never look at them and the thing is I know the number of my colleagues will . . . if I look at their email inboxes, they have 700 emails they have been copied into, and the reality is some of those emails been sent by some of who sits opposite them. So, rather than turning around to them and saying, 'Oh, by the way, you know you got this to deal with,' they will send them an email and speak to them".

Interviewee 7 noted:

> "Often, on e-mails and telephone calls, you have miscommunication, whereas physically, everyone can physically

> see exactly in an interactive manner what's the problem is. It helps for quicker solutions".

Interviewee 23 corroborated:

> "So, from that point of view, giving people – communication is one thing, but understanding each other is actually, for me, the result of communication. So, I can send you lots and lots of communication, and whether you understand it and whether you read it back to me is completely different. So, people think of writing emails as if they are communicating. They are not. They are broadcasting. Yeah, true. Because quite often, you see a lot of so-called communication by email is trying to achieve understanding. So, I will tell you something, and you will tell it back to me. If we believe it, we are talking about the same thing, then we have understood, and we have communicated. We can move on".

Guzzo *et al.* (1993) described 'group potency' as the collective belief among the members of a group that they can be effective. Lira *et al.* (2008) compared the effect of face-to-face communication and computer-mediated communication (CMC) to group potency. The authors divided the subjects into two groups, i.e., face-to-face communication group and CMC group. The authors identified in their research that group potency increased in face-to-face communication groups with time. The reason is that CMC lacks social context cues about the group members. Face-to-face communication provides more information than electronic information. Lightfoot (2006) argued that emails do not contain as much context as spoken communication and are vulnerable to misinterpretation. Liu *et al.* (2017) also argued to encourage informal communication among project stakeholders in a BIM environment.

It is evident from the quotes mentioned above that face-to-face communication is a better way for conflict resolution and to get a better understanding of the conversation. However, considering the segregated nature of the construction industry, it is acknowledged that it is not always possible to arrange face-to-face talks. Lee and Panteli (2011) noted that face-to-face meetings could be difficult to arrange (especially when team members are fragmentarily located), can be expensive and can be time-consuming. Furthermore, emails act as a repository of exchanged communication that can be referred to when required. The authors identified in their research that project participants used emails as proof when accusing other participants of causing problems for the project.

Lee and Panteli (2011) identified in their research that when the discussions are related to complex processes or products, emails should be complemented with face-to-face meetings and other computer-mediated communication methods to improve communication effectiveness. If only email is chosen as a communication medium for complex processes, it may lead to conflicts among project stakeholders. Group emails should include only those project participants who need to know that information. Furthermore, the authors recommended that different communication media should be chosen for different stages of the task according to the sensitivities involved.

It is evident that meetings can play a crucial role in managing stakeholders. Meetings can assist in developing solutions to the problems and in developing effective working relationships. One of the interviewees (number 21) argued that in BIM implemented projects, the most frequent meetings should be the BIM meetings. This study concludes that both formal and informal communication should be encouraged on the project. When informal communication involves sensitive information, it can be backed up with email summarising critical points of discussion.

7.4 Online collaboration

Online collaboration is a method for group members to work together within the group and with external groups with whom they share the same objectives, in which members use online tools to communicate and share data irrespective of their location (Samanakoopt *et al*., 2015). Online tools can facilitate collaboration because they can facilitate larger data sharing, facilitating peer reviews and enhancing communication between stakeholders (Baumber *et al*., 2018). Online collaborative teams provide an excellent platform, which can bring together individuals of different backgrounds and expertise to build collective knowledge and coordinate team members to work autonomously and interdependently toward a common goal. The intellectual power of virtual teams lies in their diverse expertise and ability to integrate diverse experiences to generate shared knowledge. Virtual teams enable people to develop their own knowledge. The more effective virtual team members share their knowledge, the better they can perform their tasks (Wu and Deng, 2019).

Within BIM-implemented projects, a common data environment (CDE) provides an online platform for collaboration by enabling to share not only geometric information but also registers, schedules, contracts, reports and model information. It gathers all project stakeholders' information into a virtual space. This shared information is accessible to all project team members (Comiskey, 2017). In this study, 78 percent of the interviewees agreed that they are using online collaboration tools for sharing information, and hence, reducing disputes among them. Interviewee 2 noted:

> “[A] common data environment is a fantastic place for data housing. The key issue we face on a project is to find the right information when we need it quickly. I think CDE comes in handy at that time. Information is right and up to date. We can send messages to concerned persons straight away if there are any concerns. It makes life easier”.

Project stakeholders also share screenshots of BIM models to discuss concerns with other stakeholders. It assists both the parties (person who has concern and the person with whom he/she has concern) to understand the issue easily. This was not possible in 2D drawings before. Interviewee 3 noted:

> “I often see my colleagues sharing screenshots of models for any concerns. Yeah, they often do that. Just a little tiny thing makes life so much easier. What I have seen is they often get quick replies back”.

Alreshidi *et al.* (2017) identified that BIM practitioners shared BIM model screenshots with other team members to resolve the issues. BIM practitioners used emails to communicate. However, the author further identified that some practitioners recommended having communication via common data platforms rather than emails to keep a record of the communication. It tracks who, when and why a decision was made.

7.5 The sharing and learning environment

In this study, 78 percent of the interviewees agreed that organisations should create an environment where employees should share their knowledge and benefits of BIM.

Sharing and learning environment is essential to diffuse innovation in an organisation. When employees collaborate to share their experiences, knowledge, vision and skills, organisational learning takes place (Peansupap and Walker, 2005). Kululanga *et al.* (2001) defined organisational learning as a systematic promotion of a learning culture in an organisation, in a way that all employees of an organisation individually and together continuously endeavour to improve their performance. Therefore, organisational learning and continuous improvement are inextricably linked. By developing a culture of organisational learning, organisations can explore what they must do now and in the future in order to cope with the changing environment.

Organisational learning is a critical factor for the implementation of IT/ITC when IT/ITC development is frequently subject to change (Attewell, 1992). Stata (1989) argued that for organisational learning to take place, an organisation should change their workforce from a 'doing' workforce to a 'thinking' workforce. A 'doing' workforce means employees will complete their tasks for the sake of completing them. They will just follow the procedures and will not usually ask about their relevance to the organisation's business processes. Thus, they will perform tasks unthinkably and will not contribute to the improvement of an organisation. On the contrary, a "thinking" workforce will ask the value of their actions to the organisation's business processes. It is true in the context of BIM because there is no one BIM tool that can fulfil all the requirements of the project. Moreover, BIM tools would change according to project requirements. So, this is a constant learning process. Interviewee 4 corroborated:

> "I said, right at the beginning, that we don't whitewash a process on every job because our jobs are all very different. A marine job would be different from a service job. It would be different from a road job. It would be different from a railway job. So, we need

> to think carefully about how we are going to use the tools to support and provide information in the lean working we need, how we're going to provide the information to the employers and the third parties and how we are going to engage the supply chain to provide the information to enable us to do that. So, there isn't a single process for the whole business. We have to look at lots of different requirements, and this plug and play element of how we do that.
>
> Anyone that says, 'Well, I don't worry, I'm doing BIM, I use this product,' is really limiting themselves".

The interviewee further gave an example of a software called Chain Link, which his/her organisation was using. The interviewee stated that it is a good software if someone has to present his/her project programme on a single A3 piece of paper. However, that works well only with infrastructure projects, such as roads, and not in building projects.

Tacit knowledge developed from experience is an invaluable organisational asset (Peansupap and Walker, 2005). Sharing tacit knowledge related to IT/ICT within an organisation can boost its usage tremendously (Gibson and Smilor, 1991). Traditional mentoring and peer mentoring are among the best ways to transfer knowledge to novice users and colleagues because personal change can be best influenced by colleagues, family and friends (Peansupap and Walker, 2005).

Kram (1985) defined mentoring as a developmental and supportive relationship between a senior, more experienced employee and a junior, less experienced employee, and also among colleagues. There are several definitions of mentoring. However, these definitions are almost similar in meaning (Bozeman and Feeney, 2007). The mentor-protégé relationship is a union that enhances the performance and competence of protégés by the exchange of formal and informal knowledge (Hoffmeister *et al*., 2011). Clawson (1985) identified in his research that mentoring is composed of several roles, such as a teacher, role model, coach, developer of talent and a leader.

Marsh (2017) researched three construction organisations that implemented mentoring programmes and identified that all three had massive success in achieving their goals. The key reason was that the top management of all three organisations was fully involved in supporting and monitoring the mentoring programmes, both at a group and regional level. Cost savings and improvements in business processes were evident in all three.

> "You need to actually sit down and discuss that with them and start to tease out what it is". (Interviewee 13)

Another interviewee noted:

> "Help them in their tasks, find out their worries, guide them. . . usually, I have seen people are too shy to ask. Make them feel comfortable so that they can come to you". (Interviewee 23)

One of the interviewees noted:

> "Raising awareness and holding their hand and being there, you know you wanna be there all throughout the project, right"?

> "Techniques to engaging stakeholders is definitely talking with people; it's sharing, helping, and training. For us, as the supply chain. . . we are not stopping anyone at engaging with us and having a contract with us, because they are not doing any 3D modelling, or they do not understand what BIM is. What we do

> is, they are required to provide something; we put an arm around them and help them deliver that". (Interviewee 3)

Rogers (1983) described five attributes of innovation, i.e., relative advantage, compatibility, complexity, trialability and observability. Relative advantage can be measured in economic terms, but factors such as convenience, satisfaction and social prestige are also important. According to the author, it does not matter much to individuals whether an innovation has a huge objective advantage. What matters to stakeholders is whether an individual perceives innovation as advantageous or not. The more the perceived relative advantage, the faster its rate of adoption will be. Thompson *et al.* (1991) corroborated this as they identified that the relationship between perceived usefulness and utilisation was stronger than the relationship between effect and utilisation. One of the interviewees corroborated this that stakeholders should be taught about the benefits of BIM. The interviewee noted:

> "It's trying to push forward the benefits basically within actual techniques. The benefits you will get from this are, and it keeps showing, and it keeps showing." (Interviewee 6)

Another interviewee corroborated that:

> "A lot of . . . what I do see here though is people are engaging with it and they are seeing the benefits of it and they are sharing across the business which is really good." (Interviewee 5)

Compeau and Higgins (1995) argued that people would use computers if they see the benefits associated with them. Liu *et al.* (2017) also agreed that the implementation of BIM needs a positive attitude among its users; otherwise, it is difficult to implement.

Baldwin *et al.* (1997) noted that in 1980 Motorola Corporation decided to build its university (Motorola Training and Education Centre) for training its employees. It was not meant to replace the company's already existing practice of training its employees under the human resource department. The fundamental aim of Motorola University was to address imminent business needs. It took Motorola 10 years to develop the famous Six Sigma standard of manufacturing excellence after learning from their mistakes. The first fundamental learning they identified was that employees were not ready to change even after training. Employees could not see why the organisation required the change. Ultimately, Motorola had to convince them and had to explicitly state to them that unwillingness to change would be considered as poor performance. Motorola developed a shared responsibility for change across the whole organisation.

7.6 Key outcomes of managing stakeholders

Interviewees were asked the benefits an organisation can reap by managing stakeholders effectively. Most of the interviewees mentioned that managing stakeholders effectively reduces conflicts and decreases the probability of issues that can arise because they were not anticipated. This all can lead to a significant increase in capital and time and can even jeopardise the quality of work. Table 7.2 shows the findings in ascending order.

Table 7.2: Key benefits of managing stakeholders on BIM projects

Key benefits	Percentage (N = 23)
Improved cost savings	83% (19)
Time savings	83% (19)
Repeat business	78% (18)
Improved quality	70% (16)

7.7 Summary of Chapter 7

Chapter 7 has covered the use of technologies within BIM-implemented projects. Adopting new technologies is evolution. It may take years for an organisation to adopt a new technology fully. Organisations often face challenges from their stakeholders to make new working methods a regular working routine. This chapter has addressed the objective four, i.e., to explore the key techniques for managing stakeholders. The key techniques identified were learning experience, meetings, online collaboration, and creating a sharing and learning environment. In relation to the objective five, improved cost savings, time savings, repeat business and improved quality were identified as key benefits of managing stakeholders within BIM-implemented projects.

Chapter 8 : THE DEVELOPMENT OF A FRAMEWORK FOR AIDING STAKEHOLDER MANAGEMENT

8.1 Introduction to Chapter 8

This chapter discusses a developed framework to facilitate stakeholder management on BIM-implemented projects in the UK construction industry. For this, it draws from the literature and analyses the data collected as reported in chapters 2, 3, 5, 6 and 7. This chapter is divided into six parts. The first part introduces the chapter. The second part discusses why a framework is required, and the third part discusses the rationale for the descriptive framework. The fourth part describes the framework developed, which is composed of the role of BIM in stakeholder management, the challenges in managing stakeholders, the techniques for managing stakeholders and the outcomes of managing stakeholders. The fifth part discusses a conceptual framework developed, and sixth part the validation of this framework. The last part presents a summary of the chapter.

Framework defined

Parsons *et al*. (1999) defined a framework as a system which can be extended, specialised or customised to have more appropriate, more specific or slightly different capabilities. Yusof and Aspinwall (2000) defined a framework as an explicit picture of the leadership goals for an organisation, which should incorporate the key characteristics of the business's operations; it should represent the activities to be carried out and the ultimate vision of the new style of management. Dafikpaku (2011) defined a framework as a system which serves as a guide, outline or overview of interlinked activities for facilitating an approach to achieving a particular goal. It is also a set of basic assumptions and fundamental principles having intellectual origin where actions and discussions can proceed. A ‘model’ answers questions related to ‘what is’, whereas a framework answers questions related to ‘how-to’ and provides a way forward (Yusof and Aspinwall, 2000). Sound implementation of a framework should state what the organisation does, what it is trying to achieve, how it will achieve it, and ensure that each step is built on a previous step (Soni and Kodali, 2013). For this study, the definition proposed by Dafikapu (2011) has been adopted, which interprets a framework as a system composed of guiding principles, ideas, or relevant entities that support a discipline. To effectively manage stakeholders, a set of guiding principles is required to take appropriate actions and perform relevant activities on BIM-implemented projects.

8.2 Why a framework is required

The development of a framework should be the first step of any initiative to manage stakeholders effectively. It lays the essential groundwork because it supplies guiding principles in plan implementation. In simple words, it guarantees that project managers do not ignore or underestimate the critical components in managing stakeholders. Hence, it helps in formulating the required strategies proactively. Arora (2002) argued that without proper guidance, organisations may focus excessively on the use of information technology and will not bring a corresponding change to the human and culture of an organisation. If project managers focus their strategies for managing stakeholders as they were doing on traditional projects, they may ignore the unique challenges which they would encounter within the BIM implemented projects. Meanwhile, these challenges can lead to conflicts among stakeholders, which consequently can affect the time, cost and quality of a project negatively. Sometimes, even project managers manage stakeholders without aligning them with the overall project strategies and objectives, eventually finding themselves to be less successful and failing to achieve their intended goals. Most of these problems may arise due to the absence of a framework to guide the management process. Essentially, a stakeholder management framework is required to support the stakeholder management processes and to align this process with the project's goal and objectives. Furthermore, the reasons why a stakeholder management framework is required include (Holsapple and Joshi, 2002):

- To provide a holistic view of stakeholder management on BIM implemented projects. It can provide a context of all the work in the field. It provides academics and practitioners with a common set of well-defined terms and concepts for research and practice in stakeholder management on BIM implemented projects.
- It can help project stakeholders understand what stakeholder management is, what stakeholder management activities are involved and how those will affect project activities within BIM-implemented projects. It helps to determine the scope of actions required.
- It enables readers to look at it, and hence, consider all its facets from a broader perspective. Furthermore, it provides opportunities for readers to reflect on and conceptualise stakeholder management in an integrative manner.
- It facilitates the communication of stakeholder management across all project stakeholders. A framework provides common vocabulary and language for people. It assists managers to communicate their stakeholder management vision to their teams, and it helps to raise the issues related to stakeholder management at a senior level.
- As an assessment tool, it provides a way for managers to see whether they have covered all the critical points related to stakeholder management on BIM implemented projects. Otherwise, some issues may be overlooked.
- Managing stakeholders is not new; what is new and exciting is the development of a framework that allows practitioners and academics to talk about /study it and continuously improve it.

- Last but not least, it facilitates the management of the implementation process by making it easier to understand how big a problem is, and that it is essential to understand it in a global dimension. Hence, it identifies all resources, individuals and influences involved in the process.

8.3 The case for a descriptive framework

Different authors have used different approaches to develop frameworks. Some authors depict them in the form of diagrams and graphical representations, while others describe various steps to be followed (Yusof and Aspinwall, 2000). Based on these approaches, frameworks can be classified as system, step and hybrid frameworks. The frameworks based on systems approach are descriptive in nature, whereas frameworks based upon step approach are prescriptive in nature. The hybrid approach contains the characteristics of both the approaches (Wong and Aspinwall, 2004). This study has adopted the systems approach (also known as systems thinking) for developing a descriptive framework due to the following reasons:

- Descriptive frameworks describe a phenomenon in the form of graphical representations with an aim to provide a systematic and holistic perspective of the phenomenon (Wong and Aspinwall, 2004 and Mele *et al*., 2010).
- A descriptive framework helps to organise concepts and thoroughly understand them in a unified manner. It explains a phenomenon in the form of key factors, constructs or variables and their relationships (Holsapple and Joshi, 2002).
- Descriptive frameworks identify attributes that are critical for the success or failure of a phenomenon and help understand them in a better way (Heisig, 2009 and Montano *et al.*, 2001).

- A systems thinking approach considers the problem in its entirety; therefore, the environment of the system influences problem-solving because it influences the system, but it is not a part of the system (Montano *et al.,* 2001).
- Mastering the systems thinking approach requires one to consider that there are emergent properties of systems that do not exist when the system is disintegrated into smaller parts (Montano *et al.,* 2001). This characteristic is extremely pertinent when stakeholder management is placed in the systems thinking context. For instance, individuals, their interests, their needs, project objectives, culture and technological infrastructure must all be considered for effective stakeholder management initiatives on BIM implemented projects.
- System thinking is, fundamentally, an approach for intellectually engaging change and complexity (Chen and Stroup, 1993). This approach is also used for dealing with issues related to human behaviour (Patton and McMahon, 2006). As BIM has fundamentally changed the traditional way of working and project stakeholders are finding it a complex process, the systems thinking approach was appropriate for developing a framework.
- Description framework is important for stakeholder management because it provides an overseeing framework for ensuring that the same general requirements should be addressed during stakeholder management initiatives across BIM projects.

8.4 The framework developed for managing stakeholders within BIM implemented projects

The stakeholder management framework was developed following a thorough review of the literature on stakeholder management, BIM and analysis of the empirical data obtained from 23 interviews conducted across 18 different organisations in the UK construction industry. All but one of the 23 interview participants indicated that they need a framework for managing stakeholders on BIM implemented projects which can provide them guidance. The only interviewee who said a framework is not required argued that stakeholders are dynamic because each project is different. So, according to him, guidance would be a better approach than a framework. However, a descriptive framework provides guidance. Hence, the empirical study supports the need for developing a framework for the issues which project participants can face and techniques they can use for managing stakeholders effectively on BIM implemented projects.

The framework developed for stakeholder management (see Figure 8.2) consists of three stages: input, process and output. The input stage includes the key drivers. The process stage is composed of key role, key challenges and key techniques, and the output stage incorporates key benefits.

Stage one: input

This stage acts as an input to the systems thinking process and depicts the reasons for implementing BIM in the UK construction industry. There can be one or more reasons for an organisation to implement BIM on a given project. The reasons were discussed in Chapter 5 (section 5.2), and include:

(1) Government mandate

(2) To stay competitive

(3) Client demand

(4) To increase efficiency

The input stage is where a user begins to use the framework. The framework needs time and cost to implement. Furthermore, it also needs top management support (leadership) to proactively encourage and support BIM implementation. It also needs to conduct a BIM assessment of the stakeholders, i.e., to assess their capability to work within a BIM environment.

Stage two: process

This stage has three parts: the role of BIM in stakeholder management, the key challenges which project managers face while managing stakeholders and the key techniques for managing stakeholders. The first part, the role of BIM in stakeholder management, further specifies five factors which are discussed elaborately in Chapter 5 (sections 5.3–5.7). The second part, which specifies key challenges which organisations can face while managing stakeholders within BIM-implemented projects, is discussed in detail in Chapter 6. The third part discusses key techniques which organisations can use for managing stakeholders, as discussed in detail in Chapter 7. Leadership (top management) support and clear project goals are discussed in section 6.3, and rewards orientation is discussed in section 6.5 of Chapter 6. Stage 2 of the framework suggests actions that project managers and other participants should take in order to manage their stakeholders more effectively.

Stage three: output

This stage discusses the benefits of managing stakeholders. The range of benefits was discussed in detail in Chapter 7 (section 7.6). If stages 1 and 2 of the framework are implemented effectively, then the benefits will accrue in stage 3. The framework is presented in Figure 8.2.

8.5 Conceptual framework

Figure 8.1 shows a conceptual framework developed from critical literature review and data analysis. This framework was used for validation. Based on the changes suggested by interviewees in the conceptual framework, final framework (post validation) was developed, which is shown in Figure 8.2.

It is explicit from the comparison of Figure 8.1 and Figure 8.2 that the conceptual framework went through many changes to emerge as a final framework. For instance, the final framework is more systematic. It clearly states the three stages, i.e., input, process and output. The first stage (which is input) is labelled differently. In the second stage, the title 'role BIM plays' is changed to 'the roles of BIM.' Furthermore, wording is improved under the same title. Under the title 'key challenges', the wording of 'training and education issues' is changed to 'lack of training and education', which represents the framework in a better way than the previous one. Similarly, 'resistance to change' is changed to 'resistance of users to change.' The contents of the title 'key techniques' are considerably improved in Figure 8.2. The wording of the elements is improved, and three elements are added, i.e., leadership support, clear project goals and rewards orientation to address the issue of 'resistance to change.' In the stage three, the element 'repeat business' is added after the validation.

Pre validation: A framework for managing stakeholders in the BIM implemented projects

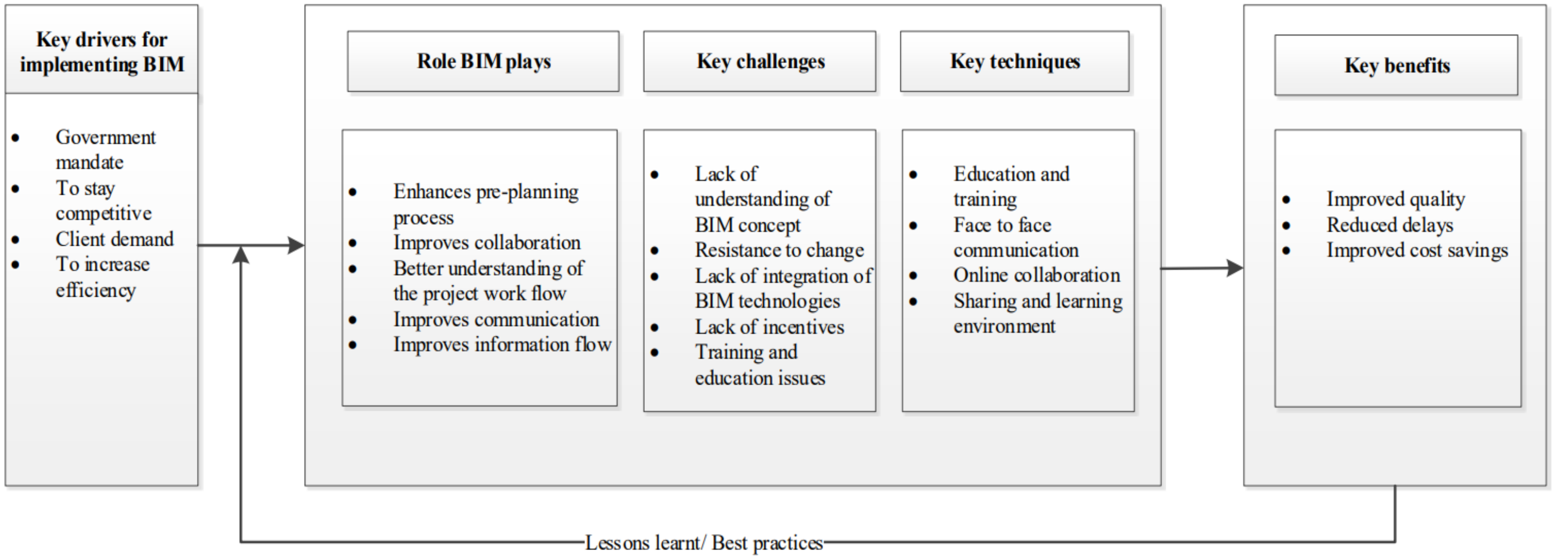

Figure 8.1: Conceptual framework for stakeholder management within BIM-implemented projects in the construction industry

Post validation: A framework for managing stakeholders within BIM implemented projects

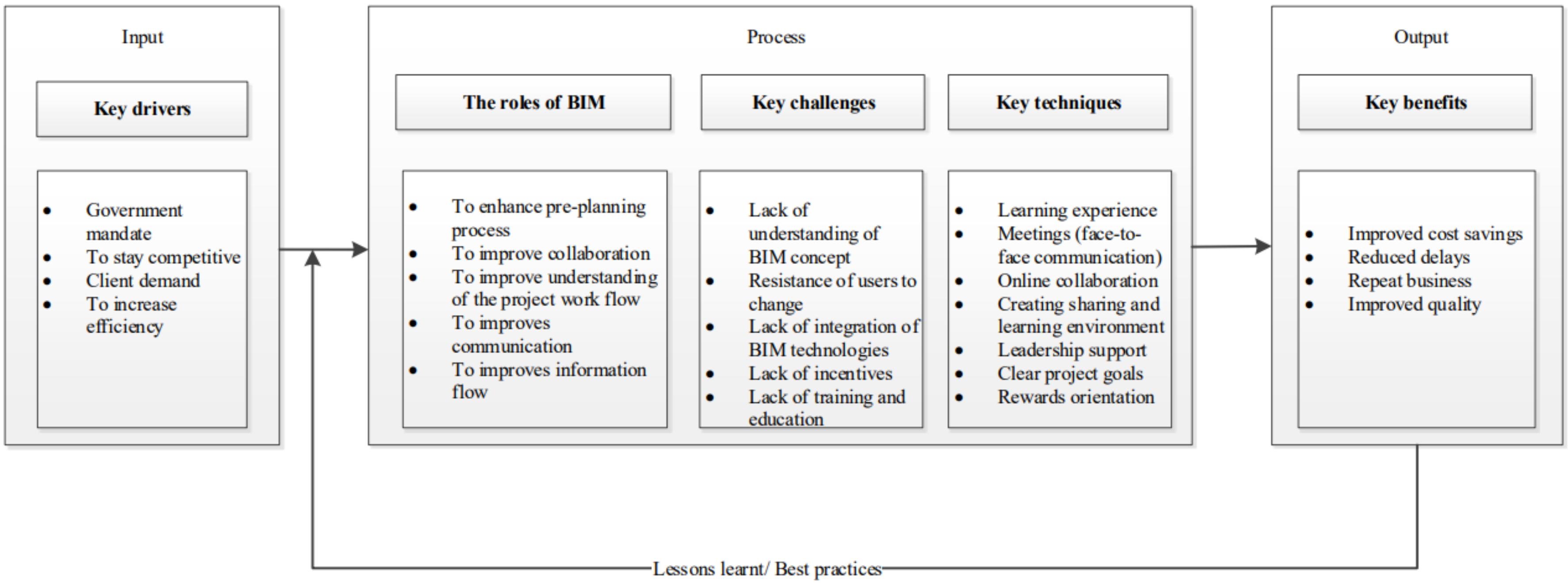

Figure 8.2: Framework for stakeholder management within BIM-implemented projects in the construction industry

8.6 Validation of the stakeholder management framework within BIM-implemented projects

The framework is not focused on stakeholder management in a particular type of sector in the construction industry. It can be applied to a diverse range of projects that are underpinned by BIM methodology. The elements of the framework have been described in their respective chapters. The framework required validation to enhance its acceptability and generalisability. In this regard, quotes from the empirical data are used to explain elements and are by no means exhaustive (Holsapple and Joshi, 2002).

According to Graneheim and Lundman (2004), participants' recognition of the findings can be treated as the aspect of credibility. Thus, the opinions of some of the research participants about the framework were sought. A qualitative approach was adopted for validating the framework as previously explained in Chapter 4.

A template of semi-structured questions was emailed to all the 23 persons who took part in the interviews during the data collection. Of those, 11 emails (48%) were reverted to the researcher. It could be that some of the intended recipients had moved to other organisations. Therefore, the researcher opted to email new potential participants to increase the number of responses. A total of six responses was ultimately obtained. Five of these were new participants (not part of the original data collection), while one was a previous participant. The purposive and snowball sampling techniques were thus effectively used (as previously done) in both the pilot and main data collection. Table 8.1 shows the profile of the participants who took part in the validation process. The template of questions used for validating framework is attached in Appendix F.

Table 8.1: Profile of participants in the validation interviews

Participant number	Job title	Years of experience	Duration of interview
1	BIM manager (new)	30	40 mins
2	BIM manager (snowball)	29	20 mins
3	Project manager (new)	17	15 mins
4	Project manager (snowball)	10	20 mins
5	Project manager (new)	12	15 mins
6	BIM coordinator (previous)	3	20 mins

All the interviews were conducted in July 2019. The average interview time was 22 minutes. As discussed in Chapter 4, the ethical approval applied to the validation interviews as well, and the permission of the supervisors was sought and obtained before the interviews commenced.

8.6.1 Improving the framework

All the participants were okay with the agreed framework but proposed some subtle changes. One of the participants (number 2) proposed that the study should investigate special software and hardware to aid with the management of fragmented stakeholders and the communication between them. The same participant further stated that each sector of the industry has a different set of stakeholders; therefore, using a case study approach, the study should further investigate a particular sector such as the National Health Service (NHS).

Participant number 3 suggested making some changes, such as using proper titles for the sections and using better vocabulary. The changes recommended by this interviewee were incorporated into the framework. The suggestion to investigate a particular industry could not be incorporated into this research because of the limited time available. However, the researcher acknowledges that this study can be examined further at a later date by exploring challenges that are particular to some sectors. This suggestion informs one of the recommendations of this present study.

8.6.2 Requirements for implementing the framework

The question "What resources implications are needed to implement this framework?" was asked. All the participants agreed that it would require finance and time to implement the framework because it involves educating and training stakeholders. One of the participants also suggested that it will involve the stakeholder BIM assessment for implementing this. This means assessing the capability of each stakeholder to determine what type of education and training they require to perform their jobs.

8.7 Summary of Chapter 8

This chapter has discussed the framework developed for stakeholder management within BIM-implemented projects in the UK construction industry. The rationale for adopting a descriptive framework was explained as well as how the framework was developed. The framework has three stages: input, process and output. The validation of the framework with six practitioners in the construction industry was explained.

Chapter 9 : CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction to Chapter 9

The aim of this study was to facilitate stakeholder management within BIM-implemented projects in the UK construction industry. This chapter reflects on the research process and objectives of this study. Moreover, it summarises the key findings and main conclusions of the study. Furthermore, recommendations are made for practitioners and academics (for future work).

9.2 Reflective review of the research process

The study began with a critical review of the literature, which revealed that there is a paucity of the literature related to stakeholder management within BIM-implemented projects. It was further found that most of the literature was focused on the technical capabilities of BIM, such as its potential for detecting clashes and for performing energy analysis, among others. There was less literature related to project management and BIM, and there was no literature specifically related to stakeholder management and BIM, considering stakeholder management is a key part of project management.

Construction industry is mostly a project-based industry where different disciplines have to work together to accomplish a project. Depending on the project’s size, type and complexity, sometimes different organisations have to work together to accomplish a project. This brings diverse stakeholders together on a single project. They all have their own interests and needs. Inappropriately managing them often leads to conflicts among them. Consequently, this can delay the project considerably and/or increase the allocated budget exponentially. Sometimes, unanticipated circumstances also lead to conflicts. This is specifically true in the case of BIM-implemented projects because BIM requires a fundamental shift in the way the construction industry has been working for decades. Thus, it was important to investigate the challenges the industry was facing within BIM implemented projects. Hence, stakeholder management within BIM-implemented projects was chosen as the object of the study.

The aim of this research is to explore how BIM enhances stakeholder management in the UK construction industry and any associated challenges therein, for which the following objectives were identified:

1. To explore stakeholder management and BIM concepts in the context of the construction industry.
2. To explore how BIM can assist with stakeholder management.
3. To explore the key challenges that construction organisations face while managing stakeholders within BIM-implemented projects.
4. To explore the key techniques organisations are using for managing stakeholders effectively.
5. To study the key benefits of managing stakeholders effectively within BIM-implemented projects.
6. To develop and validate a framework for managing stakeholders effectively within BIM-implemented projects.

The following research questions were posed for the study:

- How does BIM assist in stakeholder management?
- What are the key challenges of managing stakeholders within BIM-implemented projects?
- What are the key techniques used to manage stakeholders within BIM-implemented projects?

- What are the key benefits of managing stakeholders within BIM-implemented projects?

Figure 9.1 depicts the research process. Following a systematic approach, literature on the general areas of stakeholder management was explored, which included stakeholder management processes, stakeholder management tools and critical success factors for stakeholder management. Furthermore, critical literature review on the BIM process, its benefits, and barriers was also conducted.

During data collection, five pilot interviews were conducted. The main study further led to 18 more interviews for a total to 23 interviews. Data were analysed simultaneously, and data collection was stopped when the saturation point was reached. The professionals interviewed during data collection were BIM managers, BIM coordinators, CEOs and project managers.

A qualitative approach was adopted for this study due to the lack of variables in literature. Semi-structured interviews were used for data collection both for the pilot study and the main study. Content analysis was used to analyse data. The analysis of primary and secondary data led to the development of a three-stage descriptive framework. The framework was validated using semi-structured interviews.

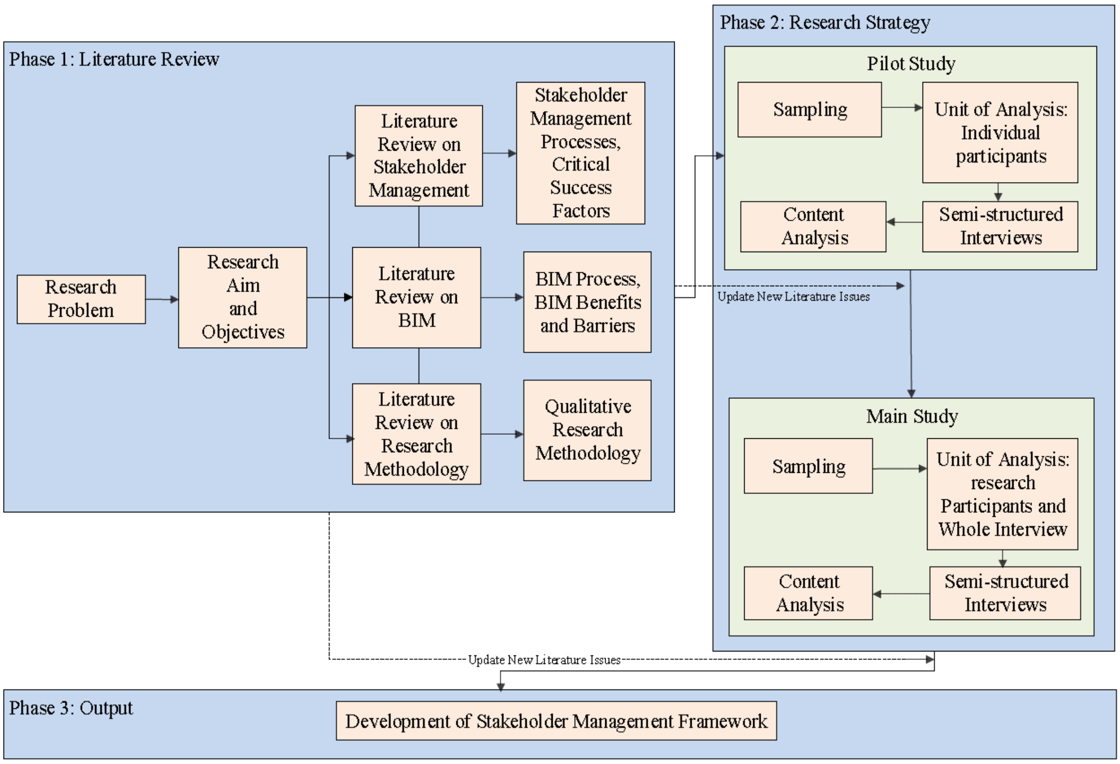

Figure 9.1: The research process

9.3 Key findings

This section summarises the key findings from the data analysis. The interview question "What are the key roles BIM is playing in your organisation?" revealed five key roles:

- Design coordination (clash detection)
- 3D (visualisations)
- 4D
- 5D (material measurements)
- Energy analysis

The interview question "Can you describe the key drivers that have influenced the need to implement BIM initiatives in your project/organisation?" revealed four key drivers:

- Government mandate

- Staying competitive
- Client demand
- Increasing efficiency

The interview question “How does BIM assist in stakeholder management?” revealed five key roles that it plays in stakeholder management:

- Enhance the pre-planning process
- Improves collaboration
- Improves understanding of the project workflow
- Improves communication
- Improves information flow

The interview question “What are the key challenges for managing stakeholders within BIM-implemented projects?” disclosed five key challenges:

- Lack of understanding of BIM concept
- Resistance to change
- Lack of integration of BIM technology
- Lack of incentives
- Lack of education and training

The interview question “What are the key techniques used to manage stakeholders within BIM-implemented projects?” disclosed four key techniques:

- Learning experience
- Meetings
- Online collaboration
- Creating sharing and learning environment

The interview question “What are key benefits of managing stakeholders within BIM-implemented projects?” disclosed three benefits. These are:

- Improved cost savings
- Time savings
- Repeat business
- Improved quality

9.4 Conclusions of the study

It is concluded that BIM has the potential to assist in stakeholder management in several ways. Pre-planning activities in a visual way assist in understanding complex tasks and identifying their relationship with other tasks. This enables stakeholders to provide feedback. This feedback can be incorporated into the decision-making process. Traditionally, collaboration was based on 2D drawings, and the experts of different disciplines were finding it difficult to collaborate because of the lack of a common platform. BIM provides that platform by acting as a repository of information where files can be amended, exchanged and stored. Moreover, being cloud-based, the participants can collaborate from anywhere. Explaining tasks to be performed in a visual way helps the project participant to understand them holistically. BIM software enables the assignment of roles and responsibilities to various project participants and helps to monitor their progress. In this manner, it assists in understanding a project workflow in a better way. Communication helps stakeholders establish trust and fosters empathy among them. 3D models are easier to understand than 2D drawings. Moreover, BIM objects hold metadata, which prevents miscommunication from happening. Furthermore, BIM enables all stakeholders to assess the same version of the data. Consequently, this reduces the risk of poor communication. Incorrect or late information is among the key reasons for conflicts on construction projects. If all the parties work in the same common data environment, they can get adequate, clear and correct information in time. It can help in making informed decisions in time, and hence, eradicating many issues among stakeholders.

Relating to challenges for managing stakeholders on BIM implemented projects, it is concluded that project managers have to face additional challenges on BIM implemented projects for managing stakeholders. These challenges are due to the change in project participants' traditional way of delivering projects. For some of the project participants, the concept is still relatively new. Not all the staff in organisations understand the concept of BIM. Furthermore, their level of understanding varies. Clients are the least knowledgeable persons among all stakeholders. They neither have detailed EIR nor do they know how to generate them. Construction projects are bound to time. Not finishing within the given time can be disastrous for an organisation. The apprehension that things may go wrong prevents employees from changing and adopting new working practices. Furthermore, they are accustomed to working traditionally because they have done so for decades. Project managers are facing challenges to having project teams work cohesively. The 2D teams and 3D teams work in silo. This increases the probability of generating different information. It can lead to conflicts among project participants. Project participants adopt change if they find that it will benefit them personally. If they do not see the benefits of doing things in a new way instead of the old way, they are reluctant to change. Larger organisations have more staff to educate and train, which increases their budgets, whereas smaller organisations do not have larges budgets to train their staff.

In relation to the techniques for managing stakeholders within BIM-implemented projects, it has been concluded that organisations are educating and training their staff. They are educating them so that project teams can learn what data they have to generate.

Training is provided for software and about using the common data environment. Organisations should provide enough time for their staff to learn to use and practise using IT systems. Academia should incorporate BIM related modules in its curriculum to overcome the issue of lack of education in the industry. Face-to-face interaction is preferred (wherever possible) over computer-mediated communication. Informal talk is preferred over sending emails for everything. Organisations usually conduct meetings for discussing BIM models. Meetings help generate trust among project teams because one party can understand the expectations of another party easily. At the outset of the project, meetings should be arranged among project participants for identifying the challenges they can encounter. Meetings should be arranged with the client to understand their requirements for the project and for them to explain their roles and responsibilities during the project. Organisational learning should be promoted among the staff. This is because no one BIM tool can fit all types of projects. This is a constant learning process. Mentoring should be encouraged and supported by top management.

9.5 Achievement of the research aim and objectives

The aim of this research was to explore how BIM enhances stakeholder management in the UK construction industry and any associated challenges therein. Table 9.1 maps the research objectives, research questions and their accomplishments in various chapters of the thesis.

Table 9.1: Mapping objectives with research questions and sections of the thesis

Research Objective	Research question where applicable	How research objectives (and research questions) were met	Accomplished fully in (Findings)
To explore stakeholder management and BIM concepts in the context of construction industry.		Literature review	Chapter 2 and Chapter 3
To explore how BIM can assist with stakeholder management	How does BIM assist in stakeholder management?	Primary data collection (semi-structured interviews)	Chapter 5
To investigate the key challenges that construction organisations face while managing stakeholders within BIM-implemented projects.	What are the key challenges of managing stakeholders within BIM-implemented projects?	Primary data collection (semi-structured interviews)	Chapter 6
To explore the key techniques organisations are using for managing stakeholders effectively.	What are the key techniques used to manage stakeholders within BIM-implemented projects?	Primary data collection (semi-structured interviews)	Chapter 7
To study the key benefits of managing stakeholders effectively within BIM-implemented projects.	What are the key benefits of managing stakeholders within BIM-implemented projects?	Primary data collection (semi-structured interviews)	Chapter 7
To develop and validate a framework for managing stakeholders effectively within BIM-implemented projects.		Framework validated by conducting semi-structured interviews	Chapter 8

Table 9.1 depicts that the first research objective was met by reviewing literature critically with findings discussed in Chapter 2 and Chapter 3. The objectives pertaining to the role of BIM, challenges, techniques and benefits were met through primary data collection. The primary data was collected using semi-structured interviews. The last objective pertaining to the development of a framework was met from the findings identified from

literature review and primary data. The framework was validated using semi-structured interviews. Having addressed all the research objectives and questions, the study has inadvertently addressed the research aim.

9.6 Recommendations

While this research has made many contributions in the area of stakeholder management within BIM-implemented projects, the following recommendations are worthy of note and have been divided into two groups: practitioners (including the client) and academics (possibilities of future work).

9.6.1 Recommendations for practitioners

These recommendations are being made to practitioners in the construction industry:

- Every construction project has a unique set of stakeholders. Therefore, project managers should conduct a BIM assessment of all key stakeholders and develop a bespoke stakeholder management plan based on that.
- Top management should proactively support stakeholder management plan because the lack of knowledge and understanding of BIM among project participants on an ongoing project may lead to conflicts.
- There is a need for the top management to enhance its understanding of the BIM.
- The client is a key stakeholder on any project, whether it is a traditional project or a BIM-implemented project. The key difference between a traditional project and a BIM-implemented project is that the client has the most important role in the BIM-implemented project. Actually, the client is the one who has to drive the whole BIM process from the beginning till handover. This enhances client value exponentially in a BIM-implemented project as compared to a traditional project.

Astonishingly, the client is the one who has the least understanding of the BIM process. This not only creates disputes on an on-going project but also renders the BIM process useless. When a project finishes, the BIM model and other data handed over to the client by the contractor will most likely be useless. They will not assist in running and managing that asset effectively. Consequently, the money spent by a client on the BIM process will go waste as well, due to EIR being the fundamental aspect of the BIM process. Therefore, it is of paramount importance for clients to be well knowledgeable about the BIM process. Furthermore, they should also be aware of their roles and responsibilities in the process.

- The UK government is a key driver of BIM. The various divisions of government act as a client on public projects. So, the government should proactively raise awareness among its divisions about their role and responsibilities in the process.
- Larger organisations should help smaller organisations on BIM-implemented projects because smaller organisations usually do not have enough budget to train their staff.
- The term 'Building Information Modelling' in itself is a controversial term. Hearing it fails to convey a clear meaning, and a novice person cannot understand what he or she is supposed to do on a project. Even when someone explains BIM to them, people find it difficult to understand because the term does not generate a clear image in the mind of the listener about the topic, so everyone interprets differently. Consequently, this leads to more ambiguities rather than solving them. Moreover, the word 'building' in its noun form covers only buildings and neglects other infrastructure such as roads, rails, water and power. In the verb form, it covers only up to the construction stage of an asset and ignores the operational and demolition stage of an asset, considering construction stage is only a small

part of the lifecycle of an asset. The word ‘modelling’ only focuses on creating the information. It neglects the management aspect of the information. The created information needs to be shared, used, secured and ultimately disposed of.

- The term BIM should be replaced with DIM – Digital Information Modelling and Management, which is very simple and easy to understand term and even novice internal stakeholder can understand what it means; when the process is explained to them, they understand it because of the clarity of the concept in their mind. Clearly the term ‘DIM’ means a process of modelling the digital information of an asset and then managing it throughout the lifecycle because the process of BIM is all about the digital information of an asset.

9.6.2 Recommendations to academics for future work

The study has opened up new ideas for future research, which are being recommended to academics:

- The data was collected in the UK only. So, this research is geographically limited only to the UK construction industry. Similar research can be performed in other countries as well, especially the developing countries.
- The variables provided by this research can be investigated further on a larger scale by adopting questionnaires.
- The case study approach can be adopted to further investigate this topic pertinent to a particular industry, such as NHS (National Health Service) and the education sector. Findings can then be compared.
- Research should be carried out to develop a framework which can assist clients in developing an EIR.

9.7 Dissemination

Some of the findings of the study have been presented at two conferences, namely:

- Singh, S., Chinyio, E. and Suresh, S. (2017) The Potential of BIM for Stakeholder Management in Infrastructure Projects. *13th International Postgraduate Research Conference*. University of Salford, Salford, 14-15th September, pp.552-563.
- Singh, S., Chinyio, E. and Suresh, S. (2018) The Implementation of Stakeholder Management and Building Information Modelling (BIM) in UK Construction Projects In: Gorse, C and Neilson, C J (Eds) *Proceeding of the 34th Annual ARCOM Conference*, 3-5 September 2018, Belfast, UK. Association of Researchers in Construction Management, pp.776-785.

9.8 Summary of Chapter 9

This chapter has presented a review of the research process, detailing the aim and objectives, and has summarised the key findings. Furthermore, the conclusions drawn from the study were presented. Next, the achievement of the study’s aim and objectives were presented. This chapter is ended by highlighting the dissemination done and making recommendations to practitioners and academics.

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APPENDIX

APPENDIX A: INVITATION LETTER TO PARTICIPATE IN A RESEARCH INTERVIEW

Invitation to participate in a research interview

Date: ……..……………

Dear …………………………………………………

Stakeholder management within BIM-implemented projects: Request for a research interview

I am currently carrying out research at the University of Wolverhampton on "stakeholder management within BIM implemented projects in the UK construction industry" under the supervision of Dr Ezekiel Chinyio and Dr Subashini Suresh. I would like to invite you to participate in a semi-structured interview relating to the above research based on your experience in the construction industry.

The interview will investigate the key uses, drivers, challenges and techniques used for managing stakeholders in BIM implemented projects. The interview would last around 30-45 minutes. Please note that your responses will be treated as highly confidential and transcripts will not contain references to any personal details (including yourself) or organisations.

Please see the attached interview questions. Should you be willing to participate, please email me your available dates and times for the interview. The summary of the results of this study will be available at the conclusion of the research. Should you wish to obtain a copy of these, please let me know. Thank you very much for your consideration of this invitation. Your participation is highly valued as it will contribute to improving stakeholder management on BIM implemented projects.

I look forward to hearing from you.

Yours sincerely,
Sukhtaj Singh

PhD Researcher
Faculty of Science and Engineering
University of Wolverhampton
WV1 1LY

Mob: [number redacted]

Email: [e-mail address redacted]
Website: wlv.ac.uk

Kind request – please forward this invitation letter to your colleagues or other known persons who can contribute to the success of this research. Your participation is much appreciated.

APPENDIX B: INFORMATION SHEET FOR INTERVIEW PARTICIPANTS

Information Sheet for Interview Participants

Research Project Title: Stakeholder management within BIM implemented projects in the UK construction industry

Project context: The APM Body of Knowledge (2012, p. 116) defined stakeholder management as "the systematic identification, analysis, planning and implementation of actions designed to engage with stakeholders." The inadequate management of stakeholders may lead to project delays, cost overruns and in worse case scenarios scuttle the project.

The global use of Building Information Modelling (BIM) in the construction industry has witnessed a dramatic increase in the last few years due to its ability to foster collaborations and communication among different project disciplines. While the management of stakeholders in the construction industry has been researched widely, the added dimension of BIM has not been studied yet. Moreover, the challenges which project managers are facing while managing stakeholders in BIM implemented projects are unreported. Hence, this study seeks to bridge this gap in knowledge. The knowledge gathered from you will ultimately help to develop a framework for managing stakeholders in BIM-implemented construction projects.

Purpose of the interview:
(a) To identify whom the UK construction industry treat as their stakeholders.
(b) To explore how BIM can assist with stakeholder management.
(c) To investigate the key challenges that construction organisations face while managing stakeholders within BIM-implemented projects.
(d) To explore the key techniques organisations are using for managing stakeholders effectively.
(e) To study the key benefits of managing stakeholders effectively within BIM-implemented projects.

Duration and data storage:

The interview will last around 30-45 minutes. Please note that interviews will be audio-recorded then transcribed onto a computer system. You may review, edit or erase the transcripts and audio recording of your interview, at any time, if you wish to do so. All recordings will then be destroyed at the end of the research. Your responses will be treated in strict confidence and computer transcripts will not contain references to any persons (including yourself) or organisations. Such references will be replaced by codes known only to me, and all data will be stored securely.

APPENDIX C: CONSENT FORM

Consent Statement

- I agree to participate in the above research project and give my consent freely.
- I understand that the project will be conducted as described in the 'Information Sheet', a copy of which I have retained.
- I understand that I can withdraw from the project at any time and do not have to give a reason for withdrawing.
- I consent to participate in an interview with the researcher.
- I understand that my personal information will remain confidential with the researcher.
- I understand that my organization will not be identified either directly or indirectly.
- I have had the opportunity to have questions about the research answered to my satisfaction.

Print Name: ________________________________

Signature: ___________________________ Date: _________________

Contact Address: ____

Phone Number: ___________________

Email Address: ___________________

APPENDIX D: INTERVIEW QUESTIONS

Interview Questions

Date	
Time of interview	
Name of interviewee	
Position of Interviewee	
Years of experience	
Qualification of interviewee	
Name of organisation	
Organisation's sector	
Organisation's total employee size	

This section will focus on general questions related to BIM	
	• Please kindly tell me a little about what your current job role is in the project/organisation? • Who are your stakeholders in construction projects?
	• How long your organisation has used BIM? • Your organisation's BIM maturity level is? • Describe your personal use and knowledge of BIM. • What are the key roles BIM is playing in your organisation?
	• Can you describe the key drivers that have influenced the need for implementing BIM initiatives in your project/organisation?
Next section will focus on the questions related to the merged concept of stakeholders and BIM	
O2	• How does BIM assist in stakeholder management?
O5	• What are the key benefits of managing stakeholders within-BIM implemented projects?
O3	• What are the key challenges of managing stakeholders within BIM-implemented projects?
O4	• What are the key techniques used to manage stakeholders within BIM-implemented projects?
	Overall: • How has BIM changed, or not changed your stakeholder management practices? • What are the key unresolved or outstanding issues, if any, pertaining stakeholder management – with and without BIM? • Does the construction industry need a framework for managing stakeholders on BIM implemented projects? If yes; what should be its contents or outlook? • Any final free comments or suggestions on the research?

	End of interview and vote of thanks

Table matching research questions with the literature from where they arose and the research objectives they addressed.

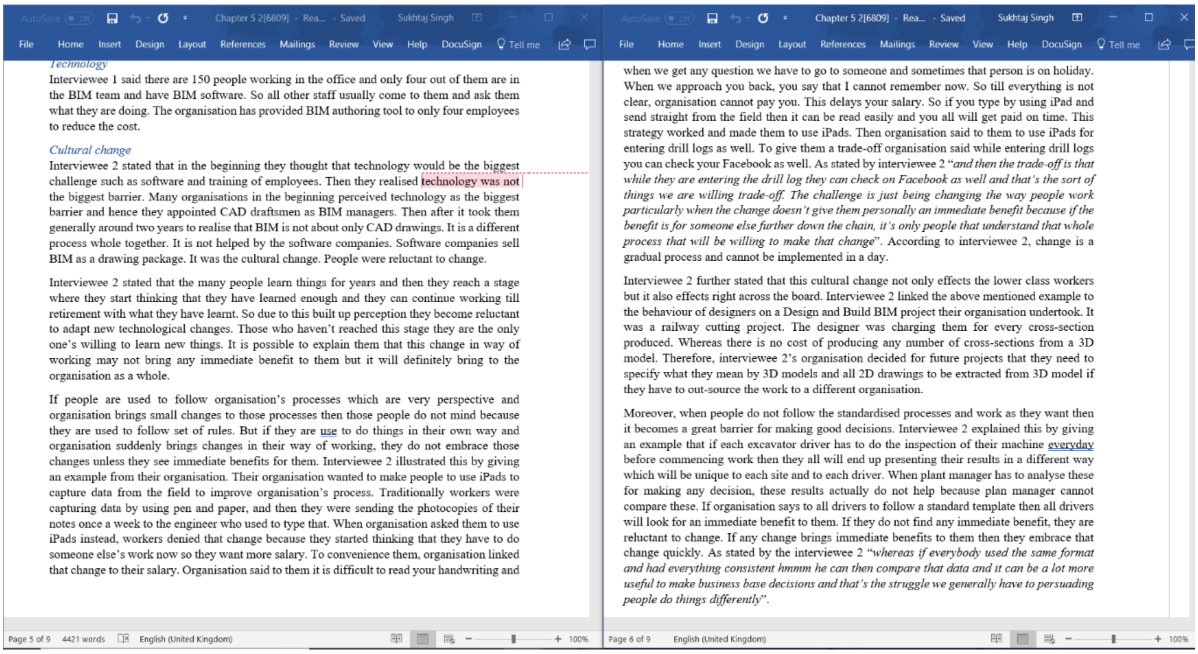
Interview questions	**Key literature from which the constructs arose**	**Objectives addressed**
Please kindly tell me a little about what your current job role is in the project/organisation?	General question to develop a rapport for interview/for developing interviewees profile.	
Who are your stakeholders in construction projects?	Chapter 2 – Freeman and Reed (1983), Olander (2007) and Jespen and Eskerod (2009)	Objective 1
How long your organisation has used BIM?	General question to develop a rapport for interview/for developing interviewees profile.	
Your organisation's BIM maturity level is?	For developing interviewees profile.	
Describe your personal use and knowledge of BIM.	General question to develop a rapport for interview.	
What are the key roles BIM is playing in your organisation?	An introductory question to enhance understanding and data analysis.	
Can you describe the key drivers that have influenced the need for implementing BIM initiatives in your project/organisation?	An introductory question to enhance understanding and data analysis.	
How does BIM assist in stakeholder management?	Liu *et al.* (2017), Rokooei *et al.* (2015) and Johansson *et al.* (2015)	Objective 2
What are the key benefits of managing stakeholders within-BIM implemented projects?	Tantalo and Priem (2016), Karlsen (2002) and Chinyio and Akintoye (2008)	Objective 5
What are the key challenges of managing stakeholders within BIM-implemented projects?	While developing this question, I thought interviewees would answer this question in terms of CSFs mentioned in Table 2.2 on page 38.	Objective 3
What are the key techniques used to manage stakeholders within BIM-implemented projects?	I expected interviewees to talk about Stakeholder management tools – Olander (2007), Newcombe (2003) and Walker *et al.* (2008)	Objective 4
How has BIM changed, or not changed your stakeholder management practices?	Alreshidi *et al.* (2017), Bryde *et al.* (2013) and Fazli *et al.* (2014)	
What are the key unresolved or outstanding	Question asked to identify further research areas.	

issues, if any, pertaining stakeholder management – with and without BIM?		
Does the construction industry need a framework for managing stakeholders on BIM implemented projects? If yes; what should be its contents or outlook?	Question asked to know about the overview of what should be included in a framework.	

APPENDIX E: SCREENSHOTS OF DATA ANALYSIS PROCESS AND EXPLANATION

This appendix shows screenshots taken during data analysis process of Microsoft Word and NVivo software which were used for analysing data. Basically, NVivo was used for all data analysis but Microsoft Word was just used in the beginning because it was allowing data to read easily. For this to happen, data was coded in NVivo first and then exported to Microsoft Word.

The explanation of all screenshots is provided in the end of this appendix.



Technology
Interviewee 1 said there are 150 people working in the office and only four out of them are in the BIM team and have BIM software. So all other staff usually come to them and ask them what they are doing. The organisation has provided BIM authoring tool to only four employees to reduce the cost.

Cultural change
Interviewee 2 stated that in the beginning they thought that technology would be the biggest challenge such as software and training of employees. Then they realised technology was not the biggest barrier. Many organisations in the beginning perceived technology as the biggest barrier and hence they appointed CAD draftsmen as BIM managers. Then after it took them generally around two years to realise that BIM is not about only CAD drawings. It is a different process whole together. It is not helped by the software companies. Software companies sell BIM as a drawing package. It was the cultural change. People were reluctant to change.

Interviewee 2 stated that the many people learn things for years and then they reach a stage where they start thinking that they have learned enough and they can continue working till retirement with what they have learnt. So due to this built up perception they become reluctant to adapt new technological changes. Those who haven't reached this stage they are the only one's willing to learn new things. It is possible to explain them that this change in way of working may not bring any immediate benefit to them but it will definitely bring to the organisation as a whole.

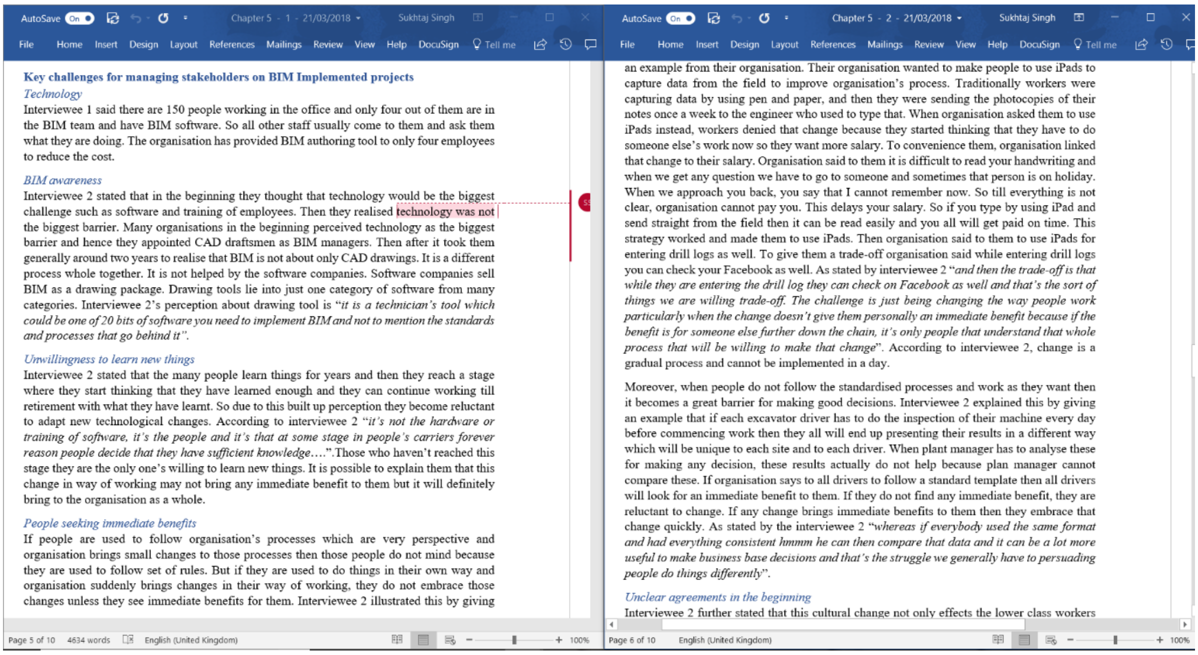
If people are used to follow organisation's processes which are very perspective and organisation brings small changes to those processes then those people do not mind because they are used to follow set of rules. But if they are use to do things in their own way and organisation suddenly brings changes in their way of working, they do not embrace those changes unless they see immediate benefits for them. Interviewee 2 illustrated this by giving an example from their organisation. Their organisation wanted to make people to use iPads to capture data from the field to improve organisation's process. Traditionally workers were capturing data by using pen and paper, and then they were sending the photocopies of their notes once a week to the engineer who used to type that. When organisation asked them to use iPads instead, workers denied that change because they started thinking that they have to do someone else's work now so they want more salary. To convenience them, organisation linked that change to their salary. Organisation said to them it is difficult to read your handwriting and

when we get any question we have to go to someone and sometimes that person is on holiday. When we approach you back, you say that I cannot remember now. So till everything is not clear, organisation cannot pay you. This delays your salary. So if you type by using iPad and send straight from the field then it can be read easily and you all will get paid on time. This strategy worked and made them to use iPads. Then organisation said to them to use iPads for entering drill logs as well. To give them a trade-off organisation said while entering drill logs you can check your Facebook as well. As stated by interviewee 2 "*and then the trade-off is that while they are entering the drill log they can check on Facebook as well and that's the sort of things we are willing trade-off. The challenge is just being changing the way people work particularly when the change doesn't give them personally an immediate benefit because if the benefit is for someone else further down the chain, it's only people that understand that whole process that will be willing to make that change*". According to interviewee 2, change is a gradual process and cannot be implemented in a day.

Interviewee 2 further stated that this cultural change not only effects the lower class workers but it also effects right across the board. Interviewee 2 linked the above mentioned example to the behaviour of designers on a Design and Build BIM project their organisation undertook. It was a railway cutting project. The designer was charging them for every cross-section produced. Whereas there is no cost of producing any number of cross-sections from a 3D model. Therefore, interviewee 2's organisation decided for future projects that they need to specify what they mean by 3D models and all 2D drawings to be extracted from 3D model if they have to out-source the work to a different organisation.

Moreover, when people do not follow the standardised processes and work as they want then it becomes a great barrier for making good decisions. Interviewee 2 explained this by giving an example that if each excavator driver has to do the inspection of their machine everyday before commencing work then they all will end up presenting their results in a different way which will be unique to each site and to each driver. When plant manager has to analyse these for making any decision, these results actually do not help because plan manager cannot compare these. If organisation says to all drivers to follow a standard template then all drivers will look for an immediate benefit to them. If they do not find any immediate benefit, they are reluctant to change. If any change brings immediate benefits to them then they embrace that change quickly. As stated by the interviewee 2 "*whereas if everybody used the same format and had everything consistent hmmm he can then compare that data and it can be a lot more useful to make business base decisions and that's the struggle we generally have to persuading people do things differently*".

Screenshot 1



Key challenges for managing stakeholders on BIM Implemented projects

Technology

Interviewee 1 said there are 150 people working in the office and only four out of them are in the BIM team and have BIM software. So all other staff usually come to them and ask them what they are doing. The organisation has provided BIM authoring tool to only four employees to reduce the cost.

BIM awareness

Interviewee 2 stated that in the beginning they thought that technology would be the biggest challenge such as software and training of employees. Then they realised technology was not the biggest barrier. Many organisations in the beginning perceived technology as the biggest barrier and hence they appointed CAD draftsmen as BIM managers. Then after it took them generally around two years to realise that BIM is not about only CAD drawings. It is a different process whole together. It is not helped by the software companies. Software companies sell BIM as a drawing package. Drawing tools lie into just one category of software from many categories. Interviewee 2's perception about drawing tool is "*it is a technician's tool which could be one of 20 bits of software you need to implement BIM and not to mention the standards and processes that go behind it*".

Unwillingness to learn new things

Interviewee 2 stated that the many people learn things for years and then they reach a stage where they start thinking that they have learned enough and they can continue working till retirement with what they have learnt. So due to this built up perception they become reluctant to adapt new technological changes. According to interviewee 2 "*it's not the hardware or training of software, it's the people and it's that at some stage in people's carriers forever reason people decide that they have sufficient knowledge….*".Those who haven't reached this stage they are the only one's willing to learn new things. It is possible to explain them that this change in way of working may not bring any immediate benefit to them but it will definitely bring to the organisation as a whole.

People seeking immediate benefits

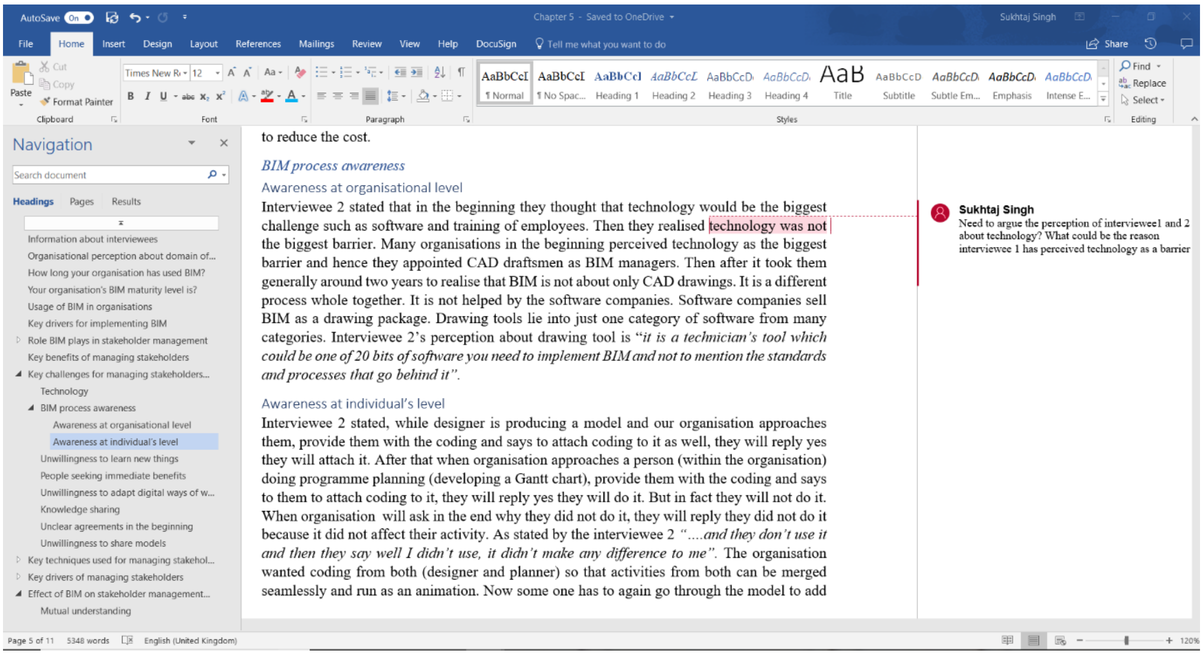
If people are used to follow organisation's processes which are very perspective and organisation brings small changes to those processes then those people do not mind because they are used to follow set of rules. But if they are used to do things in their own way and organisation suddenly brings changes in their way of working, they do not embrace those changes unless they see immediate benefits for them. Interviewee 2 illustrated this by giving an example from their organisation. Their organisation wanted to make people to use iPads to capture data from the field to improve organisation's process. Traditionally workers were capturing data by using pen and paper, and then they were sending the photocopies of their notes once a week to the engineer who used to type that. When organisation asked them to use iPads instead, workers denied that change because they started thinking that they have to do someone else's work now so they want more salary. To convenience them, organisation linked that change to their salary. Organisation said to them it is difficult to read your handwriting and when we get any question we have to go to someone and sometimes that person is on holiday. When we approach you back, you say that I cannot remember now. So till everything is not clear, organisation cannot pay you. This delays your salary. So if you type by using iPad and send straight from the field then it can be read easily and you all will get paid on time. This strategy worked and made them to use iPads. Then organisation said to them to use iPads for entering drill logs as well. To give them a trade-off organisation said while entering drill logs you can check your Facebook as well. As stated by interviewee 2 "*and then the trade-off is that while they are entering the drill log they can check on Facebook as well and that's the sort of things we are willing trade-off. The challenge is just being changing the way people work particularly when the change doesn't give them personally an immediate benefit because if the benefit is for someone else further down the chain, it's only people that understand that whole process that will be willing to make that change*". According to interviewee 2, change is a gradual process and cannot be implemented in a day.

Moreover, when people do not follow the standardised processes and work as they want then it becomes a great barrier for making good decisions. Interviewee 2 explained this by giving an example that if each excavator driver has to do the inspection of their machine every day before commencing work then they all will end up presenting their results in a different way which will be unique to each site and to each driver. When plant manager has to analyse these for making any decision, these results actually do not help because plan manager cannot compare these. If organisation says to all drivers to follow a standard template then all drivers will look for an immediate benefit to them. If they do not find any immediate benefit, they are reluctant to change. If any change brings immediate benefits to them then they embrace that change quickly. As stated by the interviewee 2 "*whereas if everybody used the same format and had everything consistent hmmm he can then compare that data and it can be a lot more useful to make business base decisions and that's the struggle we generally have to persuading people do things differently*".

Unclear agreements in the beginning

Interviewee 2 further stated that this cultural change not only effects the lower class workers

Screenshot 2



to reduce the cost.

BIM process awareness

Awareness at organisational level

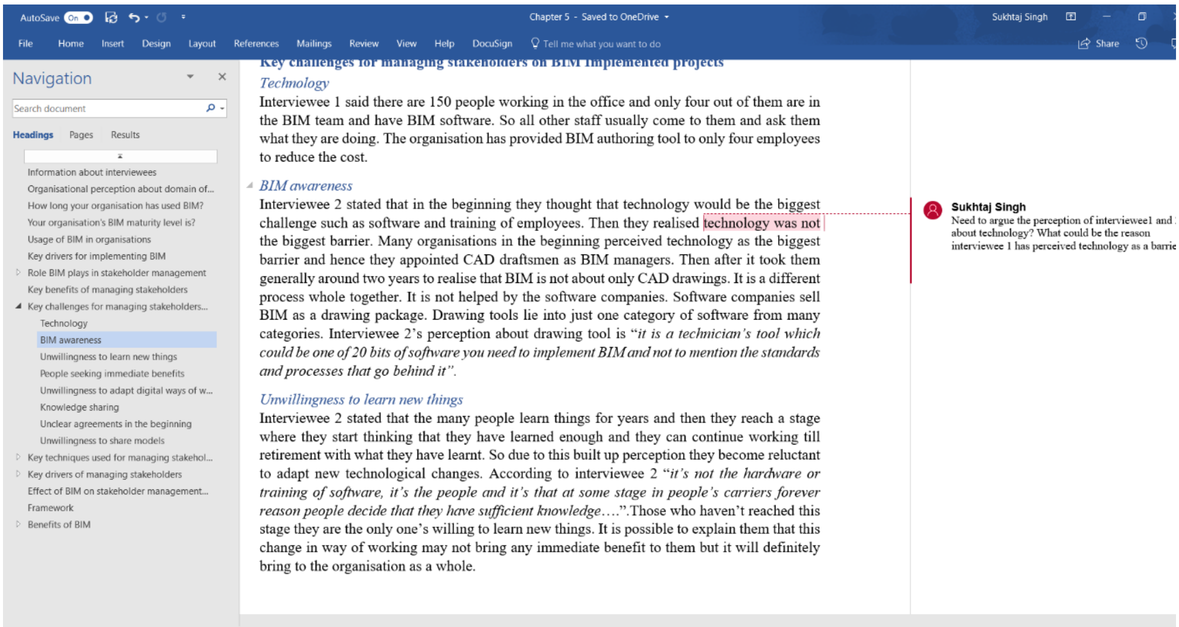
Interviewee 2 stated that in the beginning they thought that technology would be the biggest challenge such as software and training of employees. Then they realised technology was not the biggest barrier. Many organisations in the beginning perceived technology as the biggest barrier and hence they appointed CAD draftsmen as BIM managers. Then after it took them generally around two years to realise that BIM is not about only CAD drawings. It is a different process whole together. It is not helped by the software companies. Software companies sell BIM as a drawing package. Drawing tools lie into just one category of software from many categories. Interviewee 2's perception about drawing tool is "*it is a technician's tool which could be one of 20 bits of software you need to implement BIM and not to mention the standards and processes that go behind it*".

Awareness at individual's level

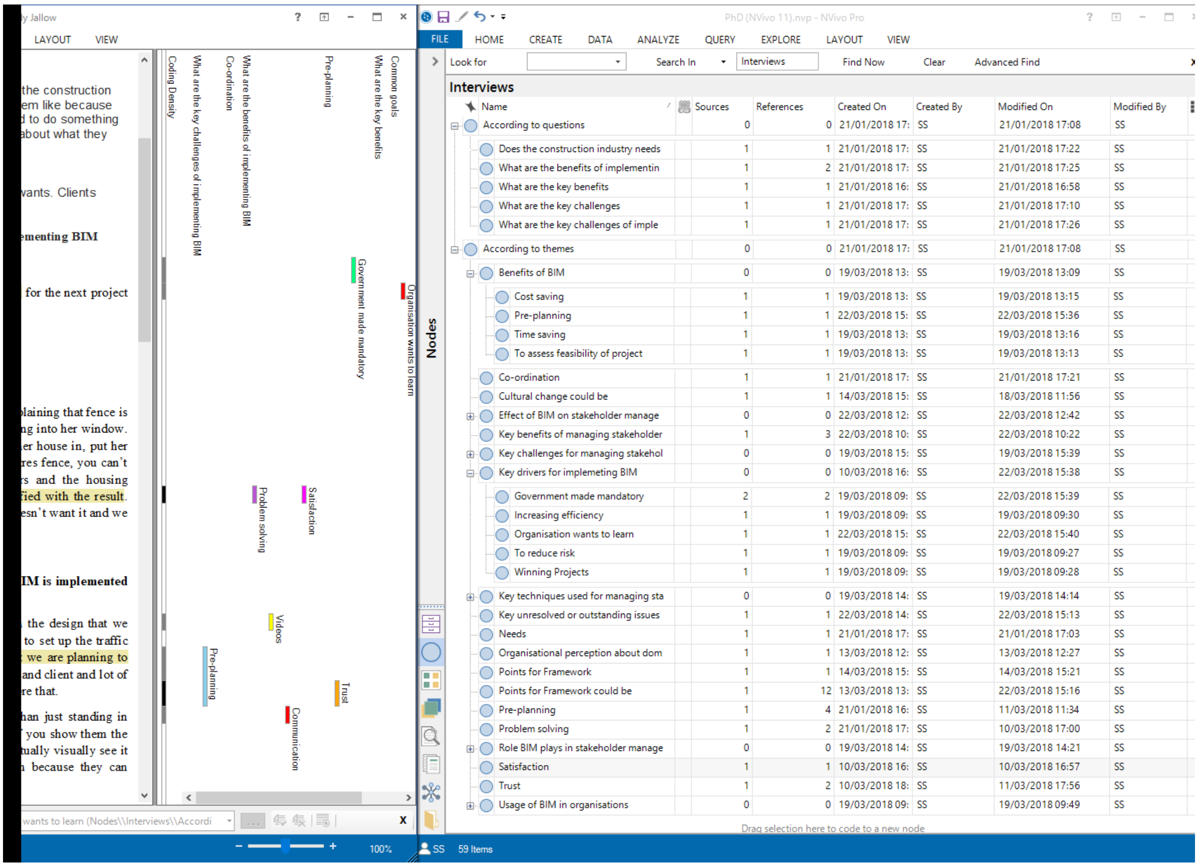
Interviewee 2 stated, while designer is producing a model and our organisation approaches them, provide them with the coding and says to attach coding to it as well, they will reply yes they will attach it. After that when organisation approaches a person (within the organisation) doing programme planning (developing a Gantt chart), provide them with the coding and says to them to attach coding to it, they will reply yes they will do it. But in fact they will not do it. When organisation will ask in the end why they did not do it, they will reply they did not do it because it did not affect their activity. As stated by the interviewee 2 "*….and they don't use it and then they say well I didn't use, it didn't make any difference to me*". The organisation wanted coding from both (designer and planner) so that activities from both can be merged seamlessly and run as an animation. Now some one has to again go through the model to add

Sukhtaj Singh
Need to argue the perception of interviewee1 and 2 about technology? What could be the reason interviewee 1 has perceived technology as a barrier

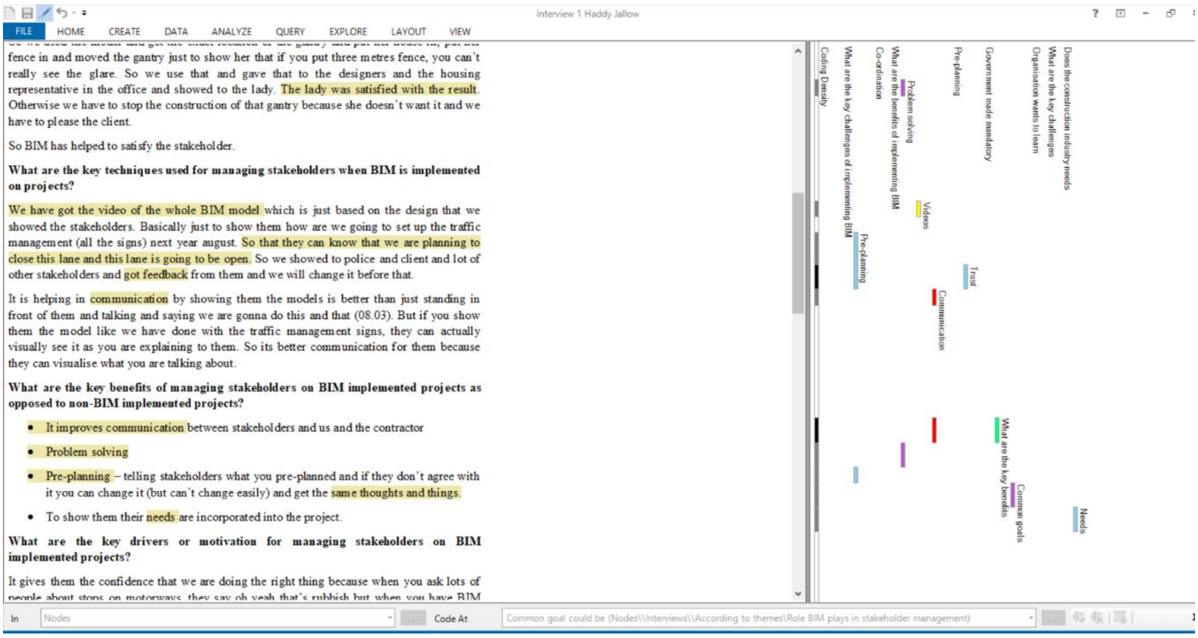
Screenshot 3



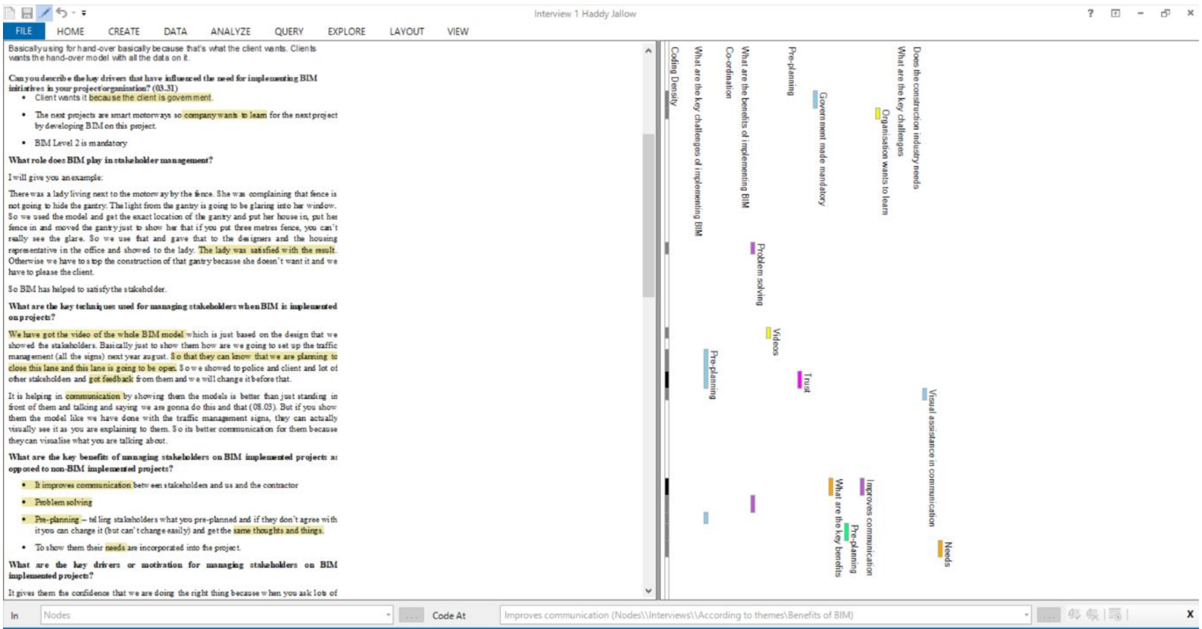
Screenshot 4



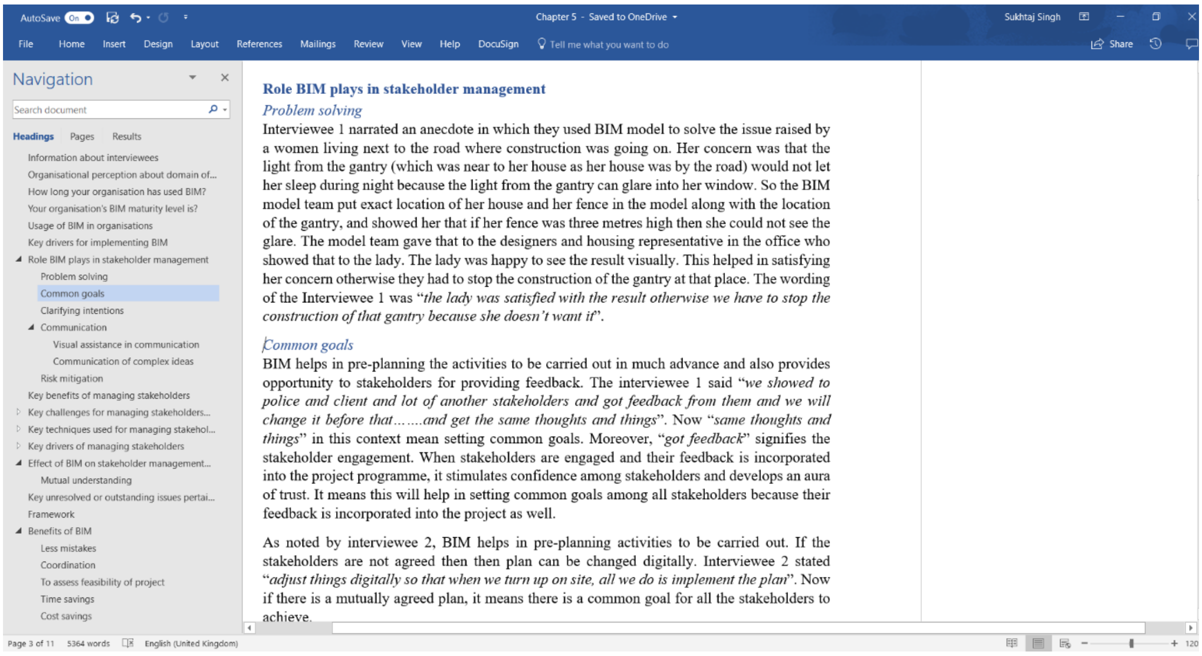
Screenshot 5



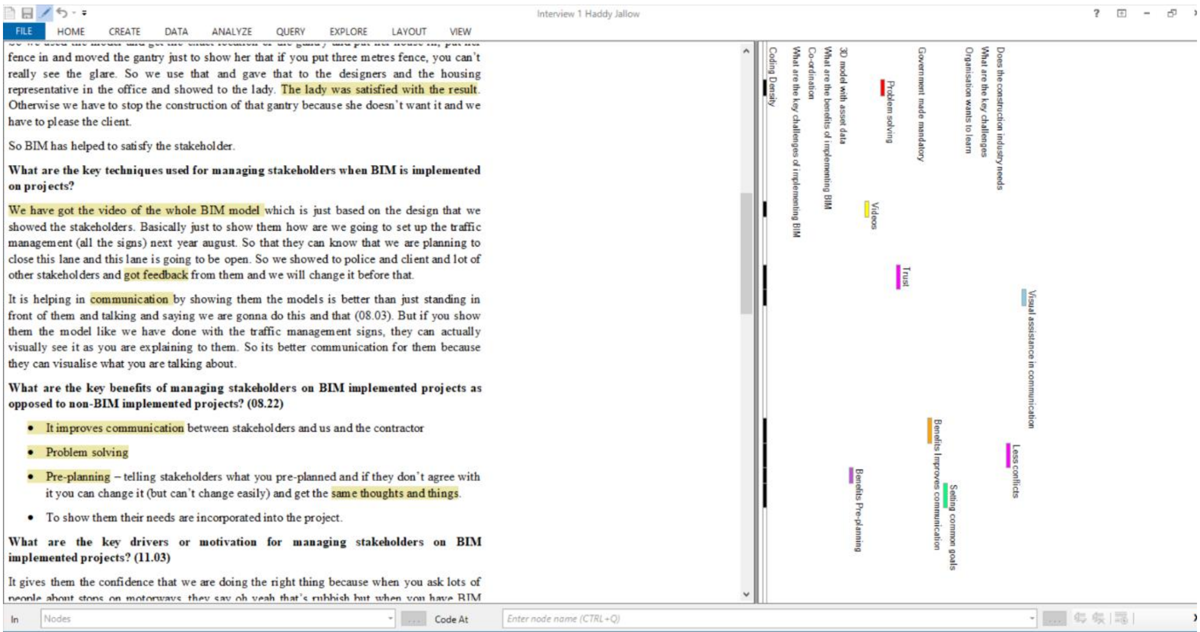
Screenshot 6



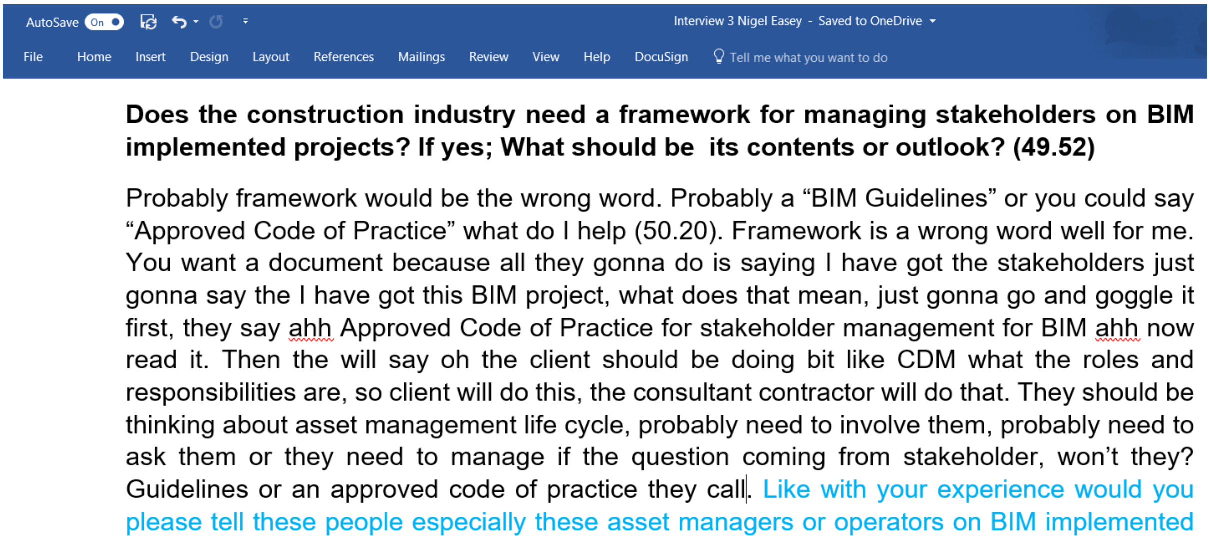
Screenshot 7



Screenshot 8



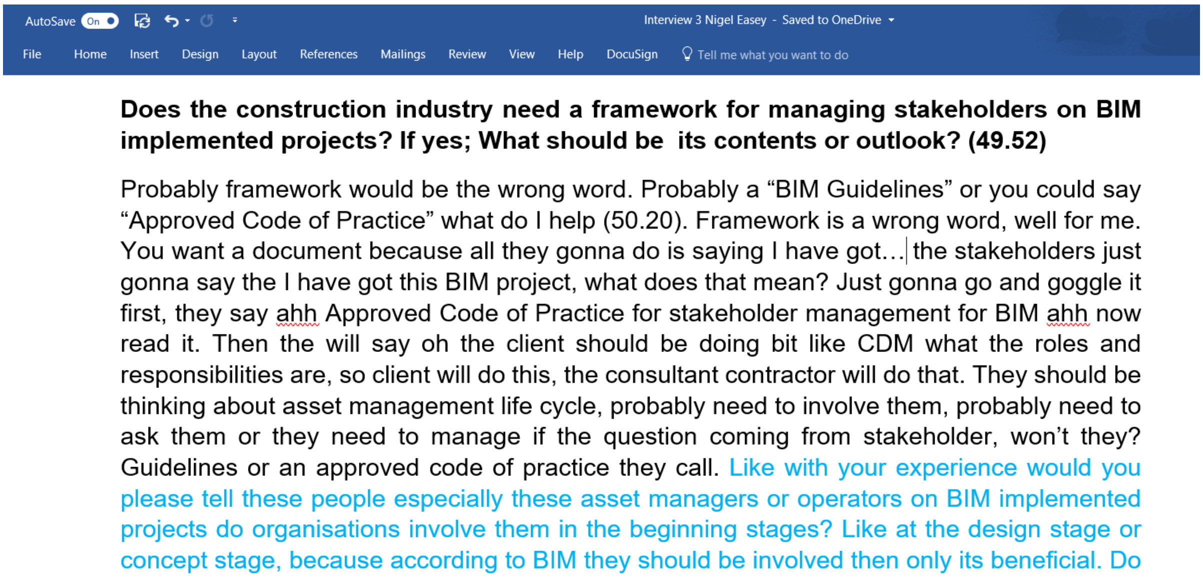
Screenshot 9


AutoSave On Interview 3 Nigel Easey - Saved to OneDrive
File Home Insert Design Layout References Mailings Review View Help DocuSign Tell me what you want to do

Does the construction industry need a framework for managing stakeholders on BIM implemented projects? If yes; What should be its contents or outlook? (49.52)

Probably framework would be the wrong word. Probably a "BIM Guidelines" or you could say "Approved Code of Practice" what do I help (50.20). Framework is a wrong word well for me. You want a document because all they gonna do is saying I have got the stakeholders just gonna say the I have got this BIM project, what does that mean, just gonna go and goggle it first, they say ahh Approved Code of Practice for stakeholder management for BIM ahh now read it. Then the will say oh the client should be doing bit like CDM what the roles and responsibilities are, so client will do this, the consultant contractor will do that. They should be thinking about asset management life cycle, probably need to involve them, probably need to ask them or they need to manage if the question coming from stakeholder, won't they? Guidelines or an approved code of practice they call. Like with your experience would you please tell these people especially these asset managers or operators on BIM implemented

Screenshot 10


AutoSave On Interview 3 Nigel Easey - Saved to OneDrive
File Home Insert Design Layout References Mailings Review View Help DocuSign Tell me what you want to do

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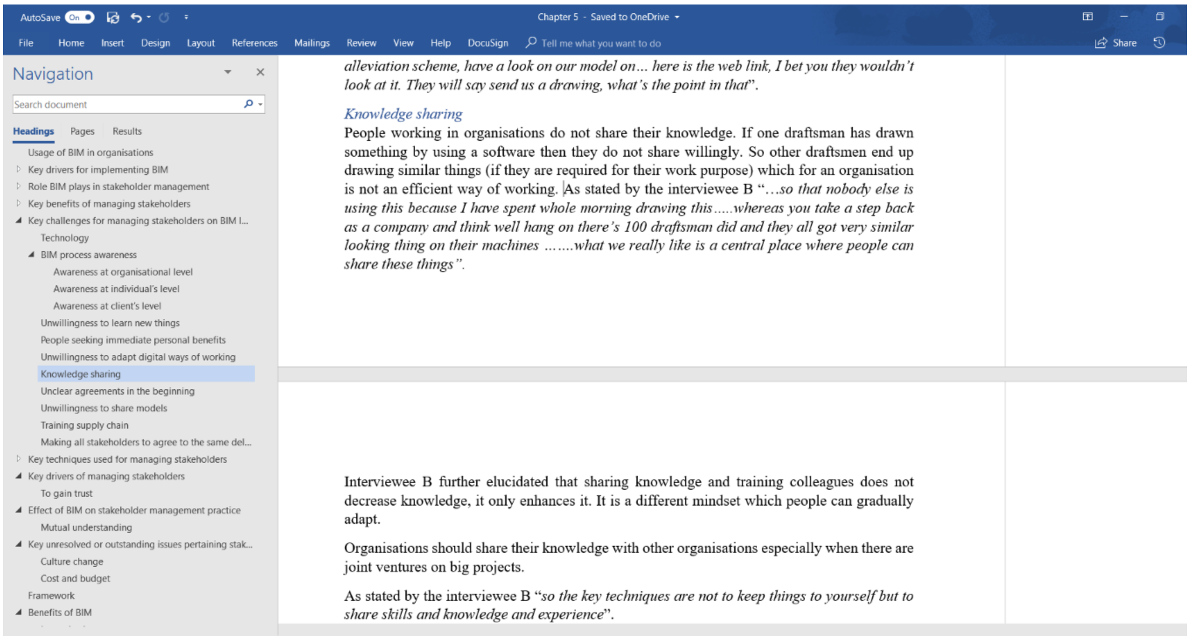
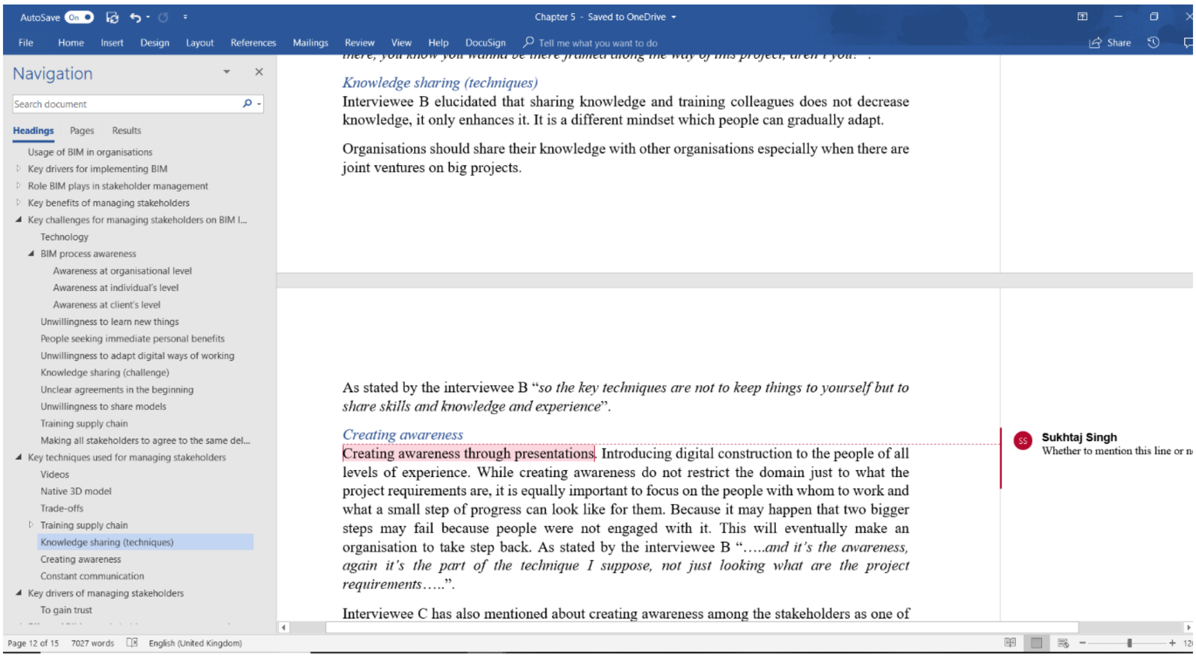
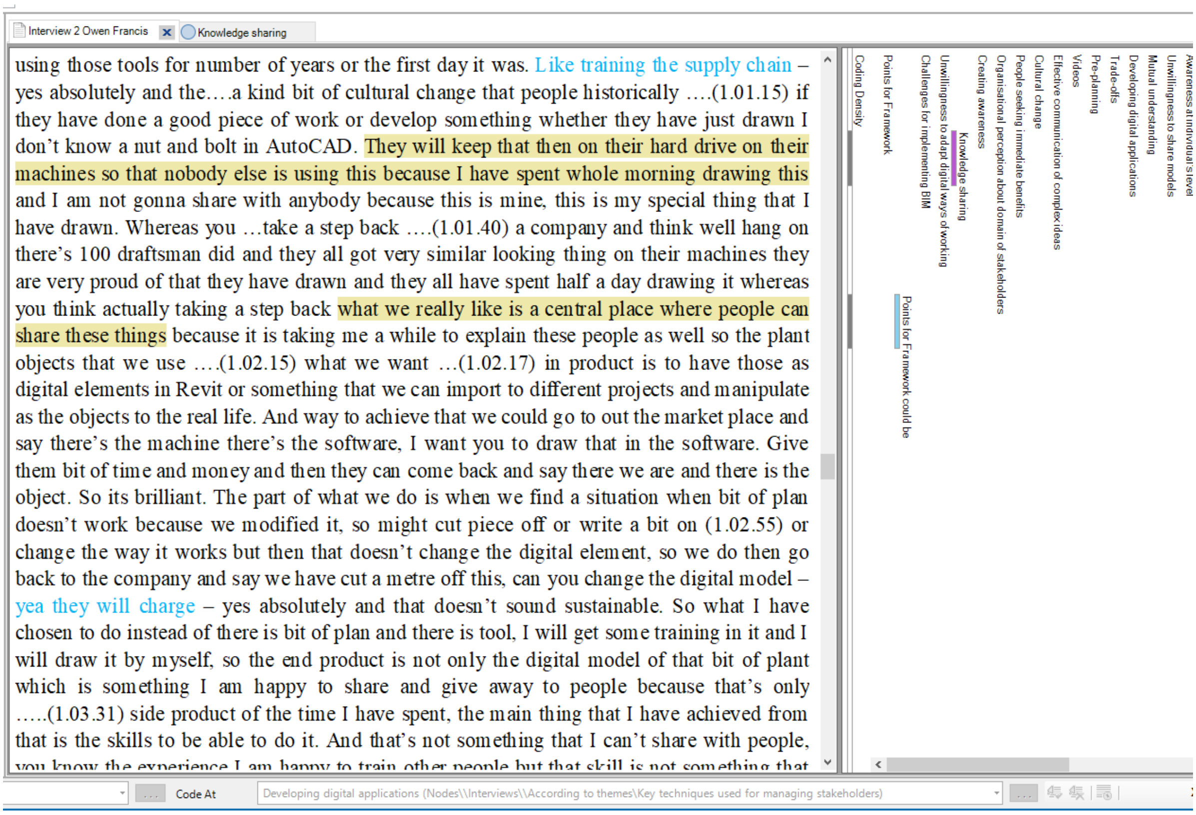
Screenshot 11



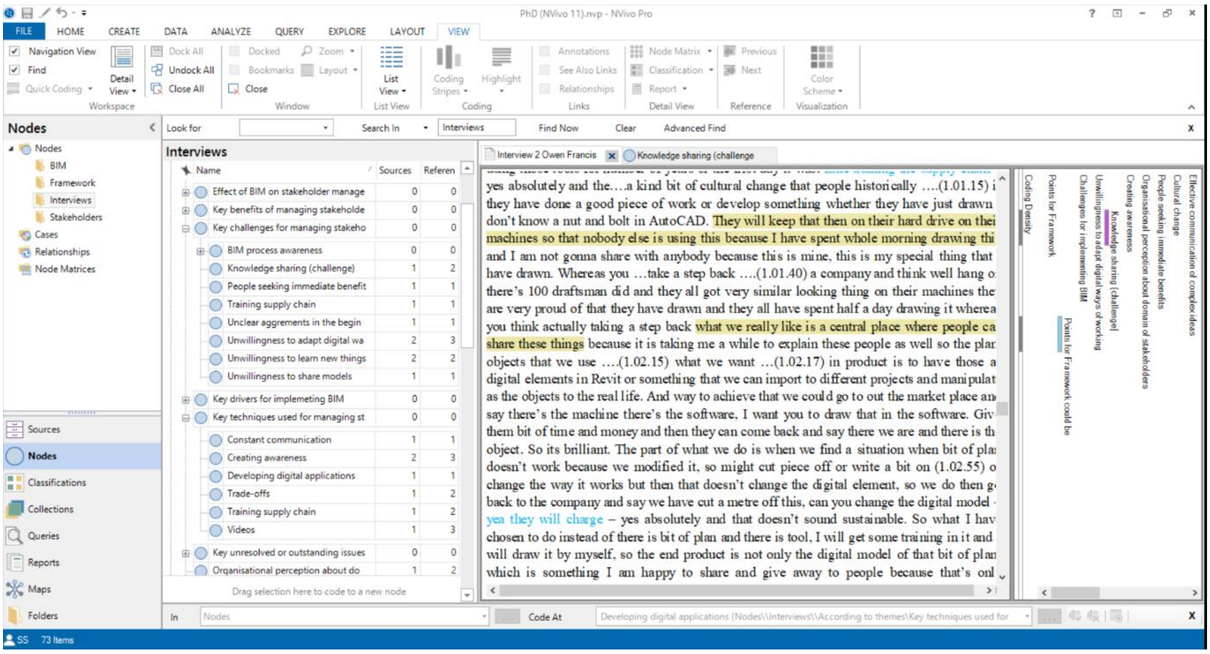
Screenshot 12



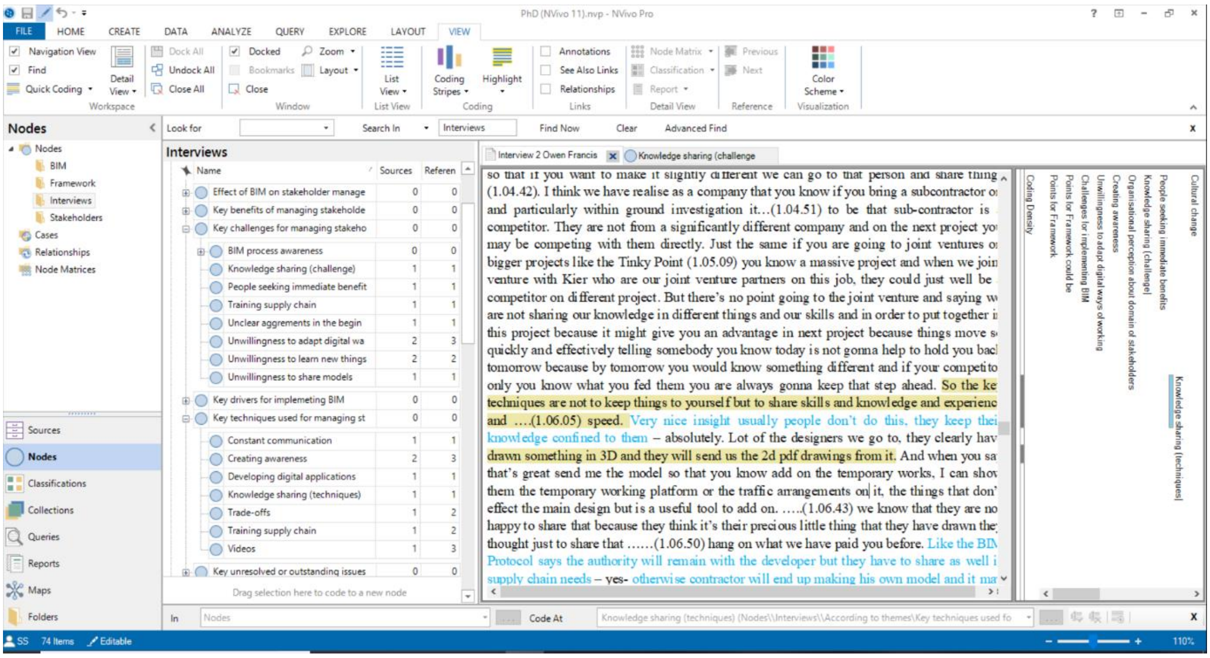
Screenshot 13



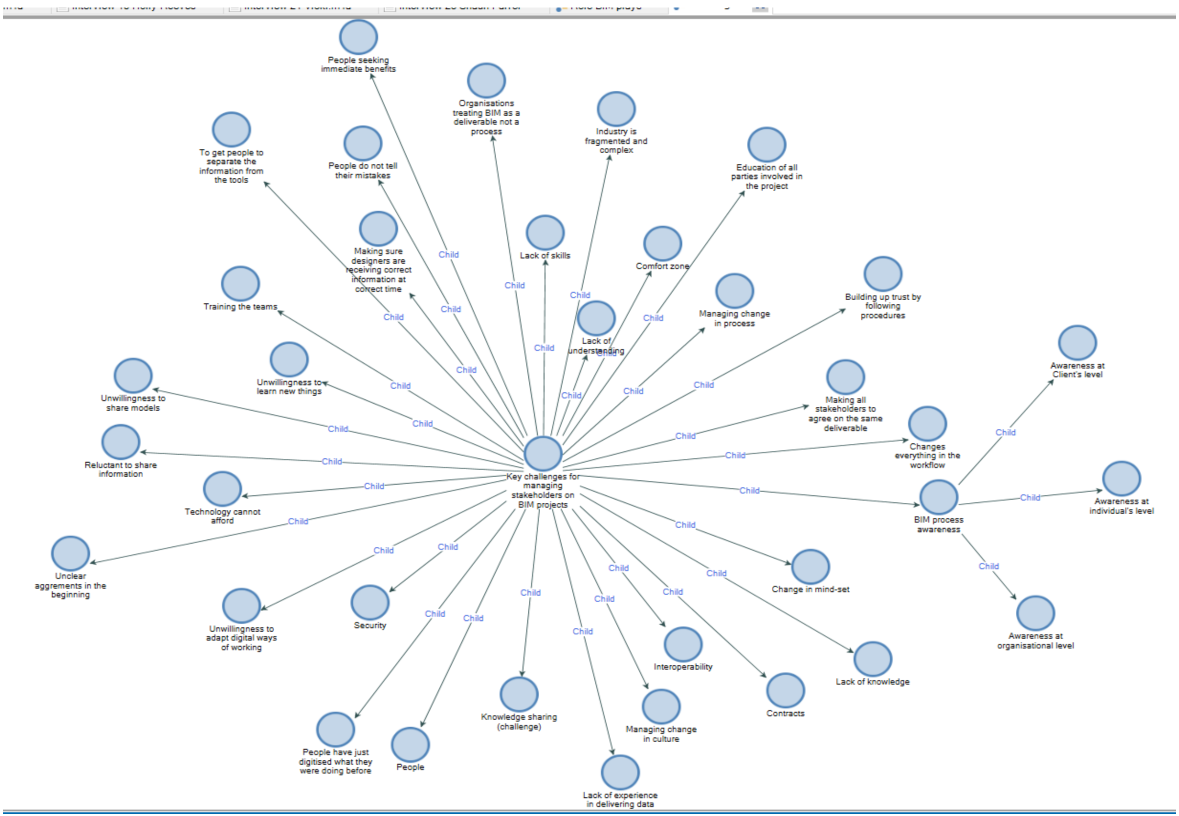
Screenshot 14



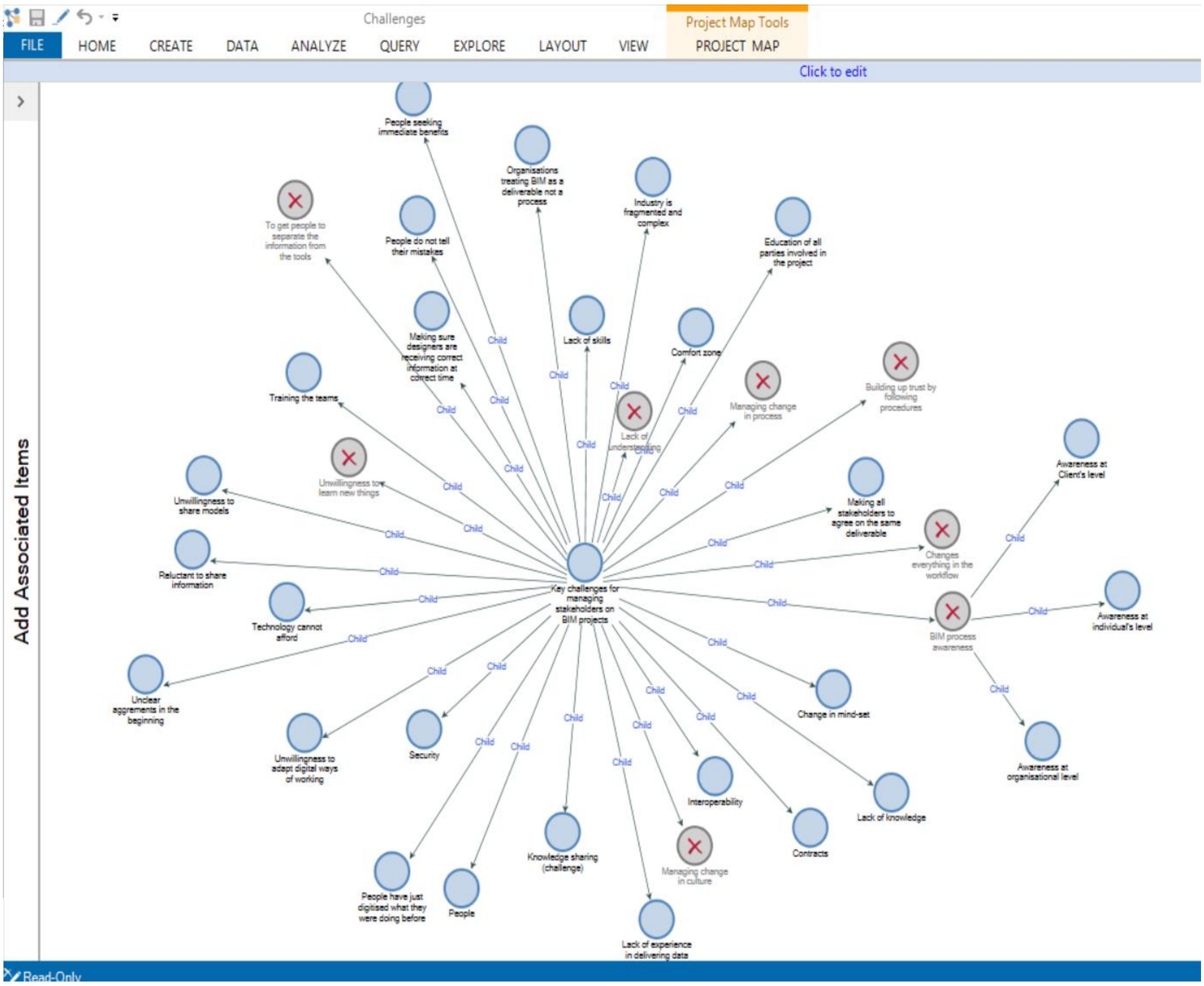
Screenshot 15



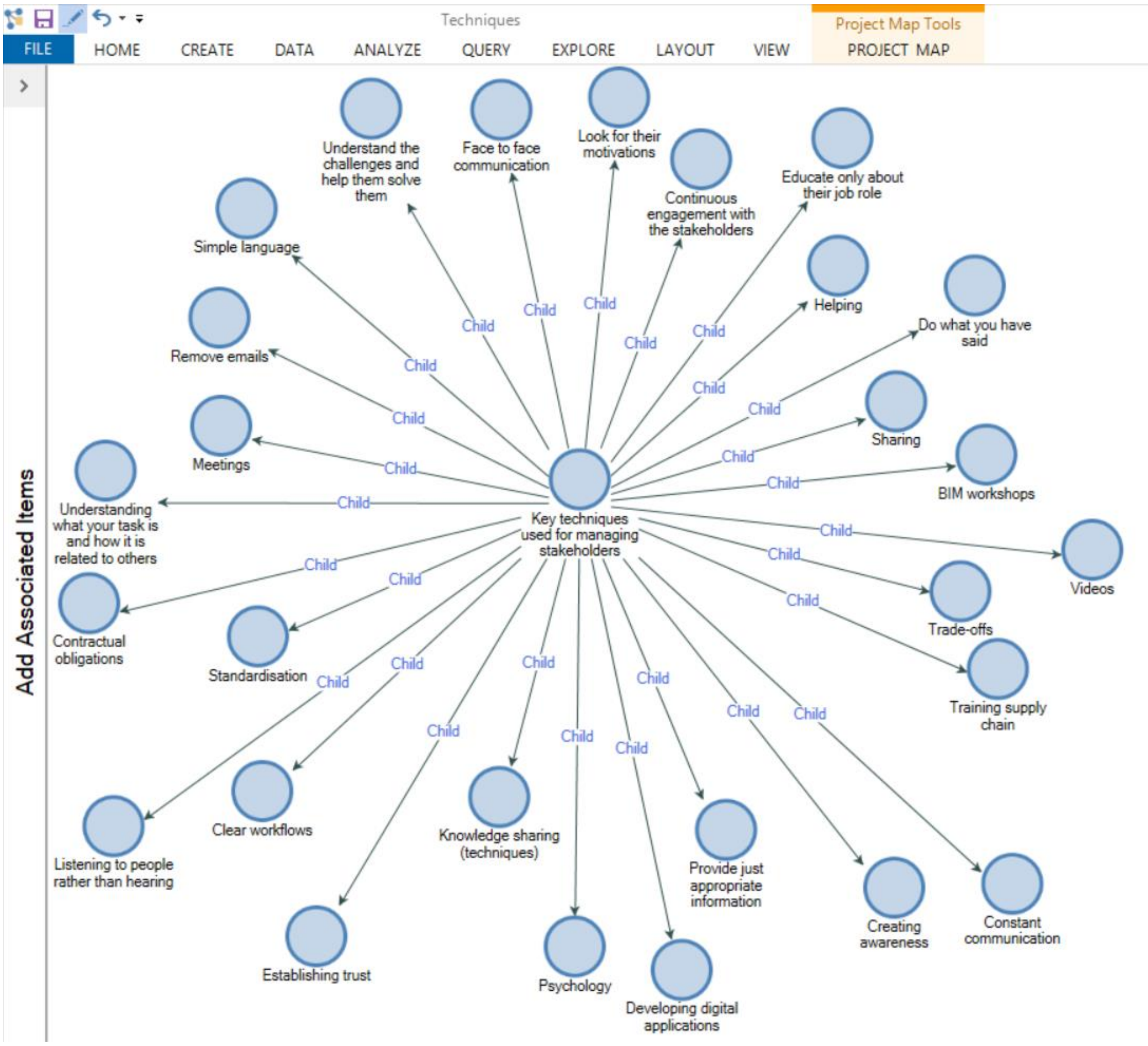
Screenshot 16



Screenshot 17



Screenshot 19



Screenshot 20

Explanation

Screenshot 1 and 2

The theme “cultural change” in snapshot 1 is divided into “BIM awareness”, “unwillingness to learn new things” and “people seeking immediate benefits” whereas “cultural change” is a main theme now in snapshot 2.

Screenshot 3 and 4

Before the title was BIM awareness but then when I reached “how BIM has changed or not changed your stakeholder management practices” then from this I realised that in this it is talked about the knowledge at individual’s level then I decided to change the title to

"BIM process awareness" and make sub-titles of "Awareness at organisational level" and "Awareness at individual's level".

Screenshot 5, 6, 7, 8 and 9

I forgot to take snapshot before changing nodes in NVivo. Anyway snapshot 5 is taken after changes. There was a single node only before entitled "Key drivers for implementing BIM".

Then it was sub-divided into "Government made mandatory" and "Organisation wants to learn" which is shown in the screenshot.

The node "satisfaction" which is visible in snapshot 5 is deleted in screenshot 6.

The node "communication" in snapshot 6 is divided into "visual assistance in communication" and "improves communication".

In screenshot 7 "common goals" is changed to "pre-planning". Now there are two different nodes with a similar name "pre-planning" as can be seen in snapshot 7.

Screenshot 8 shows "common goals" is changed to "pre-planning". Moreover, "common goals" is a main theme now.

Screenshot 7 and 9 are considerably different though they are for same coding.

In screenshot 7 "problem solving" from the text was coded at "what are the key benefits" node. This node was deleted and text "problem solving" was assigned to a new node called "less conflicts".

In screenshot 9, the node "needs" is deleted which was in snapshot 7.

In screenshot 9, the node "pre-planning" is deleted which is in snapshot 7.

The text "same thoughts and things" was coded at node "pre-planning" in screenshot 7 which is changed to a new node "setting common goals" in screenshot 9.

Screenshot 10 and 11

Difference in punctuation

Screenshot 12 and 13

The bottom half of the content under node “knowledge sharing” is cut and moved to a newly generated node “knowledge sharing (technique)”. Even the name is changed to “knowledge sharing (challenges). In bracket the word challenge is written just to differentiate it from a newly created node which shares same name as “knowledge sharing (technique)”. Basically, to avoid confusion in NVivo while coding.

Screenshot 14 and 15

Both these snapshots are linked to snapshot 12 and 13. These are basically showing the name of the code changed in NVivo from “knowledge sharing” to “knowledge sharing (challenges)”. Moreover, snapshot 15 shows that there is no node called “knowledge sharing (techniques)” under the node of key techniques. This can be seen in snapshot 16.

Screenshot 16

Moreover, the sentence which is coded at “knowledge sharing (techniques)” now, was coded at “knowledge sharing” before.

Snapshot 17

Shows the initial nodes (related to challenges) in NVivo before sorting out.

Screenshot 18

Shows the initial codes (related to role BIM plays) before sorting out.

Screenshot 19

Shows how the coding is changing (related to challenges).

Screenshot 20

Shows the initial coding of techniques.

APPENDIX F: INTERVIEW QUESTIONS FOR FRAMEWORK VALIDATION

Interview guide for validating a strategic framework for managing stakeholders in BIM implemented projects in the UK construction industry

Purpose of the interview questions:
The interview questions seek to validate the developed framework for managing stakeholders in BIM implemented projects in the UK construction industry.

Details of Respondent:

- Profession: …………………………………………………………
- Position / Area of expertise: ………………………………………………
- Experience: …………………………………………………………
- Date: ……………………………………………………….……………….

Evaluation of the proposed framework:

Please respond as follows:

1. Is the proposed framework easily understood?

2. What is your opinion on the level of completeness of the proposed framework?

3. What is your understanding of the logic/flow/sequence of the proposed framework?

4. What is your opinion on relevance of the issues covered within the developed strategic framework?

5. Would you recommend the framework for use by construction organisations in the BIM implemented projects in the UK?

6. What changes, if any, would a company require in order to implement the framework?

7. What resources implications are needed to implement this framework?

8. Do you have further comments/suggestions regarding any areas that need to be improved/included/deleted within the proposed framework?