Achieving Design Quality in Building Projects

An evolving understanding of critical success factors and stakeholder attributes

By

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Declaration

The author declares that the work contained in this thesis is his own work and has not been submitted for a degree at any other university.

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Abstract

Good building design can provide a myriad of benefits. There is ample evidence suggesting an association between design attributes and various outcomes for users and other stakeholders of built environments. Despite is importance, design quality is found to be overlooked in building projects in favour of other objectives such as time and cost. Recent initiatives have attempted to highlight the value of design quality, however, their focus have been mainly on post project completion and building evaluation. 'How' design quality - with its complex nature –is achieved during the projects has seen little empirical attempt. The research in this thesis, therefore, aimed to improve the understanding of design quality achievement in building projects by exploring the critical success factors (CSFs) and stakeholder attributes.

A multi-phase, mixed methods approach was developed to fulfil this aim. In the first phase, the theory and methods offered in 'project success' and 'stakeholder management' assisted in devising a developmental process to a) identify, validate and evaluate the CSFs, and to b) explore stakeholder attributes using three major analysis models. A preliminary interview study, then, explored the viewpoints of 11 architects on the topic and verified the research aim and directions. A matrix-based model was also used to map the bi-directionality between design quality and its stakeholders. The second phase, consisting of a qualitative study followed by a quantitative one, first identified 36 potential CSFs from the perspective of 10 experts and then validated 28 of them through a questionnaire survey of 129 individuals with architecture and client backgrounds. 'Brief', 'communications' and 'leadership' were revealed as the most important CSFs. Using principal Component Analysis to assess the interrelationships between the CSFs in 126 building projects extracted 7 components that could meaningfully represent the CSFs. Moreover, Regression Analysis was employed to establish the causal relationship between these components and the design quality success criteria of functionality, build quality and impact. It was found that the components collectively contribute to the achievement of design quality in real projects but differently to each of its success criteria. Also, by applying the second stakeholder model, it was found that clients and architects had the highest level of power, proximity and urgency with regard to design quality decisions while users and facility managers were low in these attributes. In phase 3, Social Network Analysis was used to model and visualise the stakeholder relationships with regard to design quality in a case project (third stakeholder model). 21 members of the stakeholder groups were approached and their involvement, influence and communication effectiveness were assessed.

Apart from the evolving understanding obtained through the above process, the research contributed by developing conceptual frameworks for a) design quality CSFs, b) design quality related stakeholder relationships, and c) success criteria of building projects. Moreover, for the first time, the dynamism of stakeholder communications in a construction project was visualised for different stages. Based on the knowledge emerged, the research also proposed a holistic evaluation of design quality achievement to enhance the current DQI tool.

1 Chapter One

Introduction

This chapter introduces the research project undertaken. It provides an overview of the research background with the key points influential in its inception. It presents the research opportunity emerged from this background with a description of the research problem and motivation, aim and objectives, and the scope. The structure of the thesis is outlined lastly.

1.1 Background to the research

Built environments, as the output of building projects, have significant impact on people's lives. There is increasing evidence that buildings, if designed properly, could improve quality of life. Ample research - e.g. Ulrich et al. (2008) and Huisman et al. (2012) - indicates the association between design attributes and various types of outcomes for building users and other stakeholders. This emphasises the important role that the design and its quality have and thus, the attention that should be given when a new building is being designed.

Building projects pursue a set of objectives. It is widely recognised that time, cost and quality – aka 'iron triangle' (Atkinson, 1999) – are the major objectives set for building projects. Scholars such as Gann et al. (2003) argue that among these, the quality, particularly that of the completed building, has been overlooked and relegated to a secondary goal in favour of cost and time performance. This subordinate position of design quality manifests itself also in the academic realm with relatively limited publications in comparison with other project objectives.

In recent years with the recognition of the social and economic value of good design, the building industry has been criticised for its underachievement. This has called for more attention to be given to design quality in projects. Industry reports - e.g. Egan (2002) - as well as academic studies - e.g. Walker et al. (2009) - urged for more focus on building quality. These coincided with the concern voiced by the architecture community that the lately popularised contractor-led procurements and process-based Key Performance Indicators (KPIs) would result in even further inferior priority given to building quality. As a result,

multiple initiatives have taken place since late 1990s promoting and providing knowledge in favour of design quality. An examination into publications relevant to design quality shows two areas where the majority of works have been concentrated on, i.e., design outcomes and building evaluation.

As mentioned earlier, it has been explored for years that building design could provide positive outcomes – or negative if it fails. These outcomes could belong to various stakeholder groups, from building users to facility providers like the designer and contractor. It has been studied, for instance, that good design could enhance learning in educational spaces (Higgins et al., 2005) or reduce recovery duration in healthcare environments (Ulrich, 1984). Good design could also lower the high costs of late changes and those associated with the operational phase, thus benefiting financially the client and other providers. The design of a built environment has a variety of attributes which could lead to different types of outcomes. As a case in point, aesthetics and use of colour could be related to user delight or stress reduction, and mechanical performance of a building could lead to energy conservation and cost saving. There are many publications looking into this design-outcome relationship for different attributes, outcomes and stakeholder groups (e.g. Codinhoto et al., 2009).

The evaluation of building quality has been the other highlighted area in the publications. There have been attempts to encourage industry practitioners to embrace building assessment tools especially after construction and during occupancy stage. These advocated for structured methods instead of rudimentary or award-oriented approaches. Such an activity not only could benefit the specific building under evaluation in error-finding and improved usage but also in providing feedback and lessons learned for future projects. Among several tools developed, the Design Quality Indicator (DQI) gained recognition and has been employed in several building projects since its debut in 2003.

It is noteworthy that inherent in both the above (i.e. design-outcome relationship and building evaluation) is an endeavour to better understand the concept of design quality

and the appreciation of its complex nature. The definition of design quality, the classification of design attributes, its intricate relationship with stakeholder outcomes and how to assess whether a design has a good or bad quality have been the subject of debate among scholars as well as practitioners.

Another notable point is that both these exercised areas of design quality research mainly address the post-project considerations, that is, how the completed building impacts on stakeholders and how its quality should be evaluated. Although their contribution to the subject theory and practice is invaluable, their attention to the project process and how the design quality is developed or should be developed by the stakeholders has been on the sidelines. This is, however, sensible to assume prior to investigate 'how' design quality should be achieved, it is imperative to understand 'what' should be achieved and 'why' – the key questions of the abovementioned two areas of design quality research conducted so far.

Having acknowledged the need for a 'design quality focused' research and the motivation to look into the 'how is design quality achieved' question, two unexplored areas were identified which were valuable and feasible to pursue. Reviewing adjacent topics including 'project success' and 'stakeholder management' in building projects were instrumental in this regard. These areas are described and justified briefly in the followings.

As stated earlier, in the quest for design quality achievement in building projects, the 'how' question succeeds the 'what' question. Prior research provided a good understanding on design quality outcome 'criteria'. The epitome of this is the classification given by the DQI tool, i.e., functionality, build quality, and impact (Gann et al., 2003). – which can be considered as 'the what' of design quality achievement. To answer the 'how' question, the project and construction management literature offers the 'critical success factors' (CSFs) approach, by which a number of areas of activity with high importance in achieving an objective are identified. CSFs studies are prevalent in the management realm. For construction projects, a variety of CSFs studies exist for various contexts mostly concerning

the overall project success. However, careful examination shows there are few CSFs studies with a specific focus on design quality as a key project objective of building projects. While this gap exists, one can find a rich body of literature offering a variety of rigorous methods for systematic identification and evaluation of CSFs. The identified gap and the existence of appropriate methods point out to a valuable opportunity for research.

Another aspect with respect to the design quality achievement process is related to the stakeholders. It was stated earlier that design quality could generate various types of outcomes for stakeholders and that is 'why' its achievement is crucial. Stakeholders of design quality span a large spectrum of groups or individuals who can affect or are affected by its achievement. There are often many stakeholders in building projects whose requirements and interactions influence the design decisions during project process. In fact, the stakeholders 'for whom' the building is built are the ones expected to get involved in its design and delivery. Stakeholders could differ from one another in terms of degree of influence and interaction in a project and also between different projects, yet the management of stakeholders and their attributes has large impact on 'how' the design quality is achieved. Stakeholder management is prominent in construction project management. There are various studies investigating stakeholder attributes and relationships using different analysis models. However, these have not yet been exercised with a focus on design quality. An understanding of stakeholders and analysis of their attributes is especially valuable for design quality considering its wide-ranging impact on them. This gap is seen as important in this research and could be filled by employing analysis models offered in stakeholder management literature.

Figure 1-1 summarises the main points outlined above justifying the research need. In Chapter 2, these will be expanded on in further detail by reviewing the existing literature of 'design quality', 'project success' and 'stakeholder management' disciplines.

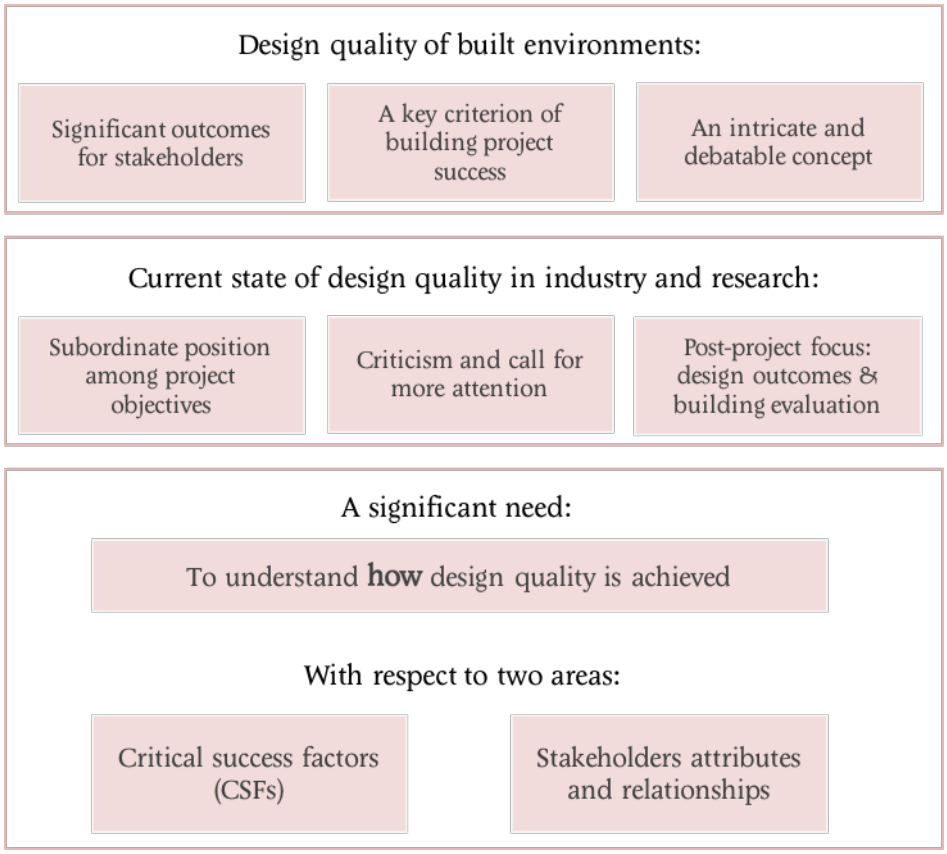


Figure 1-1: Main points contributing to the need for the research

1.2 Research opportunity

Based on the background (section 1.1), design quality as an important objective of building projects and as a complex phenomenon needs further research that could lead to its enhanced understanding and realisation in projects. It would be valuable if such research looks into the development process as opposed to the currently more-emphasised post-project perspective. In doing so, an in-depth understanding of the critical success factors as well as the attributes and relationships of stakeholders during the project process is merited.

Project and construction management literature put emphasis on CSFs and stakeholder analysis. While these two have been employed for project success in general and in cases for other specific project objectives, the design quality has not been a focus thus far. This research, therefore, intends to implement the tested models and techniques offered in the

literature to carry out a 'design quality focused' research with the aim of providing an in-depth understanding into design quality achievement in building projects. The overall aim, thus, is set as the following:

> **(Overall aim)** To improve the understanding of how design quality is achieved in building projects;

Which is a response to the research problem stated below:

> **(Research problem)** The design quality of built environments could bring about various types of outcomes for building stakeholders and is significant to project success. However, being characterised as a complex concept, it has seen limited attention from the construction industry. While there is call for more attention, the research on design quality achievement is currently bounded mainly to why it matters and to assess whether or not it is achieved. A natural successor to these should be an understanding of **how** it is achieved in projects. Despite existing approaches and similar attempts for other project outcomes such as cost, such attempt to understand how design quality is achieved is currently lacking and needed.

In addition to this problem identified from the review of the literature, there was a practice-derived motivation to the research as well. In the early stages of the research, the researcher had the opportunity to attend and observe a number of DQI workshops where several stakeholders from different project parties could gather together, interact and assess the building design quality and its attributes using a questionnaire. While the virtue of it became evident, it also led to speculations of potential ways to more holistically assess the achievement of design quality in projects with which the existing tool could be complemented.

To meet the stated overall aim, two primary objectives were defined:

> **(Primary objective A)** To explore and improve the understanding of the critical success factors (CSFs) for design quality achievement in building projects.
>
> **(Primary Objective B)** To explore and improve the understanding of the attributes and relationships of design quality stakeholders in building projects.

The sought-for 'understanding' in the research aim was intended to be an in-depth one, so that it could provide insight into design quality achievement and valuably extend the current knowledge. For this purpose, the 'exploration' element in the primary objectives needed to be detailed and extensive. Therefore, a multi-phase research process was designed employing a variety of research methods and theoretical models through which an incremental and evolving understanding could be gained with respect to each primary objective. Moreover, these objectives – each suggesting a strand of enquiry – were subdivided by a number of more specific, task-oriented objectives. There were also defined a few preliminary objectives assisting in the formulation of research sensibility and direction. The rationale and further details on this hierarchy of objectives as well as the research process are given in Chapter 2 (section 2.5) and Chapter 3 respectively. Table 1-1, though, lists these objectives for easy reference.

In terms of the research scope, an overlap between three academic fields of 'design quality', 'project success' and 'stakeholder management' forms the research area. In terms of the project success criteria, the research is only concerned with 'design quality' and excludes other project objectives such as time, cost and process quality. Although largely related to design quality and sometimes interchangeably used, the concept of 'value' and its criteria is not included. Only building projects where multiple stakeholders exist are considered and civil or infrastructure construction projects are excluded. The geographical context of the project is the UK. These are further elaborated in the next chapter.

Overall Aim	To improve the understanding of how design quality is achieved in building projects.		
Preliminary Objective 1	To identify key gaps in previous research on design quality and suitable methods to address them	*Phase one*	*Literature review*
Preliminary Objective 2	To explore architects' perspectives on design quality in real-world building projects	*Phase one*	*Study 1*
Primary Objective A	To explore and improve the understanding of the CSFs for design quality achievement in building projects.	*Research strand A*	
Specific Objective a1	To identify potential CSFs for design quality achievement from the viewpoint of area experts	*Phase two*	*Study 2*
Specific Objective a2	To rank and validate the identified potential CSFs based on their relative importance	*Phase two*	*Study 3*
Specific Objective a3	To determine if there is any significant difference in perception between different stakeholders regarding the importance of the potential CSFs.	*Phase two*	*Study 3*
Specific Objective a4	To explore the inter-relationships between the validated CSFs and to identify the underlying components.	*Phase two*	*Study 3*
Specific Objective a5	To assess the relative impact of the derived CSFs components on the achievement of design quality success criteria, i.e., functionality, build quality and impact.	*Phase two*	*Study 3*
Primary Objective B	To explore and improve the understanding of the attributes and relationships of design quality stakeholders in building projects.	*Research strand B*	
Specific Objective b1	To devise and apply a stakeholder analysis model based on stakeholder definition to map the two-way relationship between design quality and its stakeholders	*Phase one*	*Study 1*
Specific Objective b2	To compare key stakeholders in terms of their power, proximity and urgency and to identify any significant association between these attributes.	*Phase two*	*Study 3*
Specific Objective b3	To model and visualise the networks of relationships between design quality stakeholders in a building project.	*Phase three*	*Study 4*

Table 1-1: List of preliminary, primary and specific objectives of the research

1.3 Structure of the thesis

The structure of the thesis follows the logical steps of establishing the research objectives and fulfilling them through a sequence of empirical studies. The thesis consists of eight further chapters, a synopsis of each is given here. The overall organisation of the thesis is exhibited in figure 1-2.

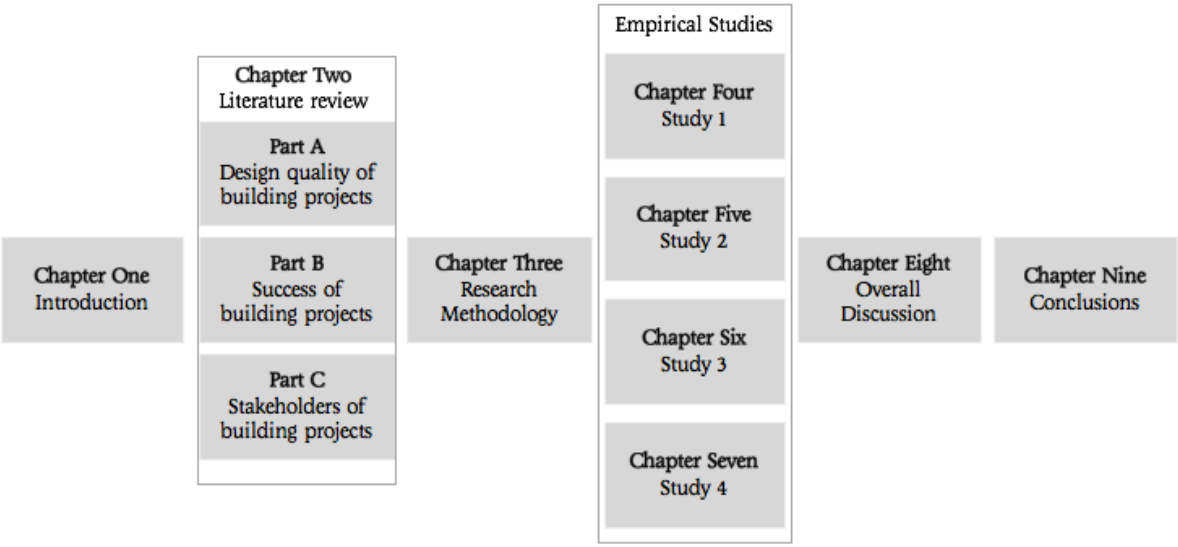


Figure 1-2: Overall structure of the thesis

Chapter 2: A review of design quality, success and stakeholders in building projects

The second chapter begins by reviewing the concept of design quality and its application in the construction industry (Part A). The following two sections (Part B and Part C) explore the theory and methods available in project success and stakeholder management realms. In the last section (Part D), the opportunity for research is established by bridging the identified objectives and the methods available to address them.

Chapter 3: Research methodology

This chapter describes and justifies the research approach devised and the various methods employed in the course of the research process. It introduces the research approach as

multi-phase and mixed methods and illustrates the process undertaken. It also provides a description of the sampling techniques, units of analysis, data quality and ethical considerations.

Chapter 4: Exploring architects' viewpoint on design quality: a preliminary study

Chapter four describes the first empirical study of the research project. A series of interviews were conducted with expert architects with the aim of exploring the topic in practice and examining the suitability of the set research avenues. The interview instrument is described and the qualitative findings are discussed. The study explores the two-way relationship between design quality and stakeholders and further corroborates the suitability of the research direction.

Chapter 5: Exploring expert opinion on the CSFs for design quality achievement

This chapters presents the second empirical study. Through capturing the opinions of a number of area experts, a set of 36 potential CSFs for design quality achievement was obtained and described individually in three categories of product-, people- and process-related factors.

Chapter 6: An industry survey for CSFs Validation and Evaluation in Building Projects

This chapter reports on a questionnaire survey conducted based on the identified factors in study wo. Industry professionals were approached to elicit their opinions on the criticality of the factors and also on the extent to which each factor was present in a case project in which they were involved. Several descriptive and inferential statistics were used to rank and validate the CSFs, to explore difference in perceptions of the respondent groups, to identify underlying components and to establish the relative impact of each on design quality outcome criteria. A stakeholder model, derived from the literature, was also utilised to explore the power, proximity and urgency of key stakeholder groups and the associations between them.

Chapter 7: A Case study to model design quality stakeholder relationships

An in-depth case study of a building project is the subject of this chapter. Social Network Analysis (SNA) was used to explore various relational attributes of stakeholder groups present in a case project. The findings include the change in design-related communications over project stages, involvement of stakeholder groups in different design communication topics and the influence each has on design related decisions and activities.

Chapter 8: Overall Discussion

This chapter brings together and reflects on the overarching themes, contributions and learnings from various parts of the research and discusses them in the context of each subject strand as well as for the design quality concept. A holistic design quality evaluation package is proposed based on the research findings to enhance the current DQI tool. An assessment of the research process and the methodological approaches used is given in the end.

Chapter 9: Conclusions

This concluding chapter synthesises the main findings with respect to the research objectives. It also outlines the research contributions to different subject areas and also a number of recommendations for further research.

2 Chapter Two

A review of design quality, success and stakeholders in building projects

2.1 Introduction

This chapter reviews the significant literature on the research area. Part A discusses the background and theory of building design quality and examines its current research and practice. Part B and Part C, then, review the domains of 'project success' and 'stakeholder management' and the applicability of their concepts and approaches for studying design quality achievement. Finally, in Part D, the gaps identified and the research avenues offered are brought together to establish the research opportunity.

2.2 Part A: Design quality of building projects

The construction industry is a major contributor to the UK economy with an annual output of £92 billion - 6.4% of GDP (Rhodes, 2015). It involves several small and large organisations from various disciplines and professions providing spaces for many other sectors like healthcare and education.

The construction industry is intrinsically project oriented. A project is defined as '*a temporary endeavour undertaken to create a unique product, service, or result*' (PMI, 2013) or '*a temporary coalition of stakeholders having to create something together*' (Jepsen and Eskerod, 2009). In light of these definitions, a building project includes a number of stakeholders interacting with each other to create a unique built environment with a set of objectives. Building projects are often characterised with high complexity and uncertainty involving various groups from clients and designers to engineers and builders at multiple project stages. This lays great emphasis on the appropriate management of these projects in order to achieve their objectives.

The success of projects is often determined based on their time, cost and quality objectives – or the 'iron triangle' as coined by Atkinson (1999). In terms of the quality objective, the construction industry is criticised for its poor performance and its lag behind other industries such as manufacturing (Egan, 1998; Arditi and Gunadyn, 1997). Moreover, most

of the quality delivery methods used have not been adequately concerned about the quality of the product and customer satisfaction as they have with the process improvement and efficiency (Gann et al. 2003; Walker et al. 2009). In this part, the current literature of design quality in building projects is presented with regard to its background in the industry, significance for stakeholders, conceptual characteristics and evaluation methods.

2.2.1 Design quality background

Built environments have long witnessed a quality discourse. Figure 2-1 depicts the historical development of the notion of design quality in the UK construction industry.

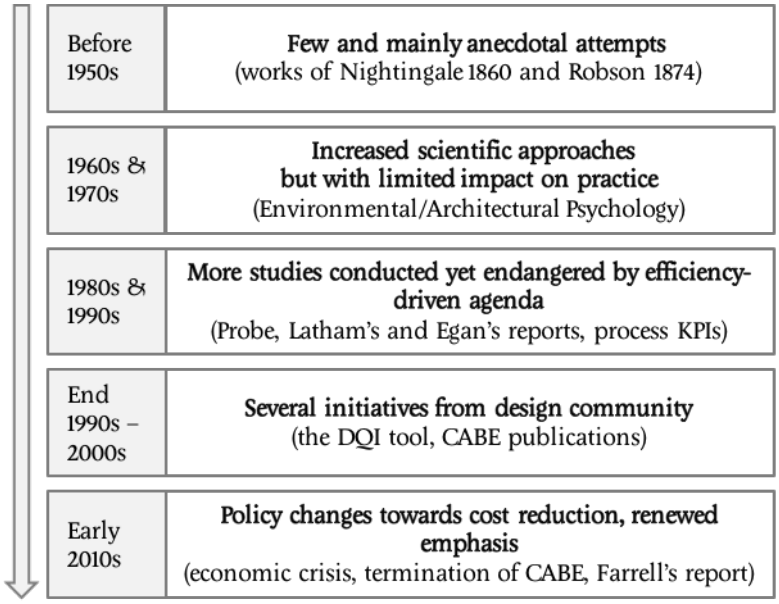


Figure 2-1: Historical development of design quality notion in construction industry (multiple references)

Discussions about the importance of built environments and their impact on people's lives and activities date back to at least 400BC with Hippocrates (Codinhoto et al., 2009). In late 19th century, Florence Nightingale - founder of modern nursing - and Edward Robson - famous English architect - pointed to the therapeutic benefits of sunlight in healthcare and educational buildings respectively. Winston Churchill also expressed a similar sentiment

in 1943 about the design of the parliament's debating chamber when he famously said: *'We shape our buildings, thereafter they shape us'* (Macmillan, 2006).

More scientific approaches to the person-environment relationship began in the second half of the 20th century through the developments in environmental psychology, participatory planning and post-occupancy evaluations (Dewulf and van Meel, 2004). However, these academic works, as reported by Philip (1996) and Dean (1989), had limited impact on the practice due to the complexity of such relationships, miscommunication with design community and also architects' disinterest. A more noticeable impact, however, emerged later in 1980s and 1990s with the attention given to building-related illnesses (e.g. sick building syndrome) and a rising interest in creating 'healthy' spaces. Studies like the 'Probe' (Post Occupancy Review of Building Engineering) series in the UK were initiated in this period to benchmark and improve the indoor climate and energy performance especially for offices (Dewulf and van Meel, 2004; Leaman and Bordass, 1999).

Even with this relative progress, the design-for-people aspiration was overshadowed by the newly process-improving culture that the construction industry became occupied with towards the end of the century. With the industry reports of Latham (1994) and Egan (1998) criticising the UK's construction industry for its under-achievement and inefficiency and their call for a radical change, several initiatives supported by the industry and the government were established to improve process related issues like cost, time, waste, and safety. Of note was the development of key performance indicators (KPIs) by the Constructing Excellence organisation (then, Movement for Innovation (M4I)) that allowed performance measurement and benchmarking across the industry (Prasad, 2004: 176)

According to Gann et al. (2003), these indicators were mostly concerned with the production process: time, cost and freedom from defect and waste. The quality of the output of this process, i.e., the building itself, was noticeably missing. The danger would be, by removing the product from the equation, project success would entail only completion on time, to budget and with an acceptable safety and client satisfaction (Prasad, 2004). Eley (2004)

reported the same observation: the case projects presented in '*Construction Best Practice Programme*' in 2002 all deemed as successful if handled only the construction process appropriately. Design quality was ignored to be considered a success criterion and at best was implied in specific quality of things like finishes or in relation to functionality. Gann et al. (2003) urged that a heavy focus on process performance improvement would put design quality in an inferior position and could lead to a new era of low-quality buildings.

The concern over a jeopardised building quality triggered a number of new initiatives from the UK design community. One was a series of publications emphasising the monetary as well as non-monetary value of design quality. These included '*Value of Architecture*' essays (Worpole, 1999; Leo, 2000) and '*Designing Better Buildings*' book (Macmillan, 2004) supported by the Royal Institute of British Architects (RIBA). The Royal Academy of Engineering also published a paper titled '*The Long Term Cost of Owning and Using Buildings*' (Evans et al., 1998) suggesting a '1:5:200' ratio between capital cost, lifetime facilities cost and lifetime operating cost. This aimed to promote viewing buildings as means rather than ends and therefore, the value of investing in well-designed buildings (Saxon, 2005).

Another key initiative was the development of the Design Quality Indicator (DQI) by the Construction Industry Council (CIC) in the UK with the aim of assessing the design quality in buildings (Gann et al., 2003). The DQI incorporates a number of design quality indicators and could extend project evaluation beyond purely process-focused KPIs to also include product attributes. The tool was advocated to be adopted across the industry in 'Accelerating Change' (Egan, 2002), an update to Egan's 1998 report. According to Macmillan (2006), this updated report, unlike the original one that had no mention of the building quality, asserted that value for stakeholders could be heightened through high quality buildings.

In reviving the interest in the quality of building design, another major development was the establishment of a new body called the Commission for Architecture and the Built

Environment (CABE) in 1999 as the successor to the Royal Fine Art Commission in the UK. Its purpose was to promote and improve design quality of buildings and spaces. It set a design review programme to give expert advice on building projects and also endeavoured to collate evidence on the value of good design in various sectors. The CABE managed to publish a large number of studies, reports and guidelines covering a wide range of topics on design quality (CABE 2009 and 2002).

By virtue of these initiatives, a widespread recognition on the value of design quality was received across the industry. As Macmillan (2006) mentioned, The Office of Government Commerce allocated a whole section to design quality in its 'Achieving Excellence in Construction Procurement Guide' series (OGC, 2007). A Treasury Taskforce (2007) published its technical note to assist the public sector on how to achieve design quality in PFI projects in response to the low-quality achievements reported in these projects (CABE, 2005b). Another industry report published by Saxon (2005) urging the need for value optimisation rather than cost minimisation and also toolsets to elicit different types of values in stakeholders. The DQI tool since its inception has been employed in more than 1400 projects and has added a healthcare- and school-specific versions as well (DQI, 2015). Giddings et al. (2013) associated the period between 1997 to 2011 with an 'unprecedented attention' to design quality in built environments.

In late 2000s, however, the policy changes due to the economic crisis gave a greater place to cost reduction, standardised design and systematic construction techniques at the expense of the quality and value agenda. The Building School for Future (BFS) – which advocated design quality in one of the biggest government programmes to improve school buildings (Cardellino et al., 2009) – was cancelled and in NHS projects, replication of proven design solutions replaced responding to stakeholder expectations (Thomson et al., 2013). The CABE was also terminated and merged into the Design Council in 2011.

Nonetheless, after a decade-plus since the Egan report, its agenda still resonates in the industry despite the drawbacks. As cited by Wolstenholme et al. (2009), in Egan's view *'we*

could have had a revolution and what we've achieved is a bit of improvement'. Another industry report by Baldry (2012) pointed to the fact that a fundamental change can be seen in the industry where the focus and language has centred around the performance outcome and the benefits that accrue to stakeholders of built environments. Last but not least is the recently published industry report of architecture and built environment by Farrell (2014) that attempted to rekindle the value of design quality as an invaluable determinant of building project success. Despite the impeding happenings, it is now acknowledged more than ever that design quality matters. This significance is to a great extent owing to the outcomes it can provide for building users and other stakeholder groups. This will be further examined in the next section.

2.2.2 Design quality and outcomes

Good design can provide a myriad of benefits. There is ample evidence suggesting a link between design quality and outcomes in built environments. A rapidly growing body of literature in recent years has examined how a range of building design attributes could impact on a vast set of outcomes for different stakeholder groups and in various building types. The use of evidence arising from credible research in design decisions in order to achieve the best possible outcomes is a process called 'evidence-based design' (EBD) (Goetz et al., 2010).

The movement towards EBD is especially prominent with regard to healthcare buildings. The physical environment is more and more seen as part of the holistic treatment of patients (Huisman et al., 2012). A seminal work by Ulrich (1984) found positive effects of a view of nature in shorter post-surgery recovery through comparing two groups of patients, one with views of nature and the other views onto a brick wall. Since then, the number of healthcare EBD publications has rapidly increased in scope and size (Lawson, 2010); some are concerned with a specific design attribute or outcome (e.g. Choi et al., 2012; Brooks, 2011)

and others aiming to propose comprehensive frameworks encompassing various attributes and outcome types (e.g. Huisman et al., 2012; Rechel et al., 2009).

Ulrich et al. (2008) reviewed an extensive literature of healthcare EBD and found relationships between 11 design characteristics/interventions of hospitals and 16 patient and staff related outcomes. Strong evidence, for example, was seen between 'improved patient sleep' and 'single-bed rooms' and between 'decreased staff injuries' and 'ceiling lifts'. Another multi-attribute study based on a literature review was conducted by Codinhoto et al. (2009). They proposed a framework linking different design attributes to health outcomes (Figure 2-2). Other examples include Rechel et al. (2009) with focus on performance and well-being of healthcare staff and Huisman et al. (2012) who looked into numerous outcomes for three stakeholder groups of patients, staff, and patients' families.

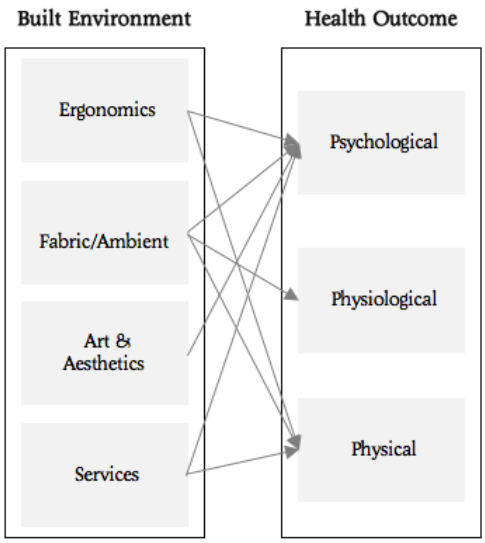


Figure 2-2: Framework linking built environment attributes to health outcomes (Codinhoto et al., 2009)

The beneficial effects of good design have also been reported in learning environments. Two key investigations conducted by PwC (2001, 2003) found a measurable association between capital investment in school design and improved staff morale, pupil motivation and effective learning time. Higgins et al. (2005) conducted a comprehensive literature

review of about 200 sources with the aspects of physical environment impacting on teachers as well as learners in five categories of attainment, engagement, affect, attendance and well-being. They particularly found a strong evidence base on the effect of air quality, temperature, lighting and acoustics on learning outcomes. Another study with focus on the higher education sector was CABE (2005a) indicating that well-designed buildings on a campus have impact on recruitment, retention and performance of both students and staff. The growing interest in the role of building quality and related evidence suggesting outcomes for users are present for other sectors as well like workplace (CABE, 2005b) and residential.

According to CABE (2006a), although some wrongly believe that high-quality design would always add too much to the development cost, it could, on the contrary, lead to economic outcomes as well. Lawson (2010) asserted that an EBD approach could provide time and cost savings for the facility providers and client organisation in addition to the user outcomes. Based on a theoretical evaluation of a 300-bed hospital, Berry et al. (2004) found that with only 5% additional capital cost, major benefits could be gained including an operational saving which returns the extra investment in a year. The famously proposed ratio of 1 (construction cost): 5 (twenty-year building operation cost): 200 (twenty-year business staffing cost) by Evans et al. (1998), although argued by Ive (2006) to be imprecise and exaggerated, denotes that the project initial cost is over-emphasised and decision-makers ought to increase short-term costs for long-term gains. This ratio was later expanded by adding 'design cost' and 'business income' to the two ends making it 0.1:1:5:200:≥250, reinforcing the value of investing in initial design (Thomson et al., 2003).

Therefore, the building design quality can impact on a variety of outcomes and benefit different stakeholder groups. While acknowledging this point, Macmillan (2006) summarised numerous outcomes valued by various stakeholders in different categories, as the result of a series of expert workshops (Table 2-1).

Stakeholder categories	*Examples of outcomes*
Finance (e.g. financiers, developers, PFI consortia)	profitability, return on investment, awards
Design and construction (e.g. architects, contractors, engineers)	profitability, repeat business, prestige
Occupant organisation (e.g. project directors, general workforce, facilities managers)	productivity & profitability, staff health and well-being, reduced energy & maintenance costs
public Realm (e.g. local authority, local community)	impact on property values, local health, civic pride
Visitors to building (e.g. hospital patients, hotel guests, students)	Hospital recovery rates, educational attainment levels, retail footfall

Table 2-1: Stakeholders and the outcomes they value (Macmillan, 2006)

The area of EBD and the integration of evidence into design decisions is not without limitations and challenges. Firstly, the multi-faceted relationship between design attributes and outcomes is reported to be a complex one with indirect effects, confounding variables, different level of analysis and too many cause-and-effect relationships to be empirically tested. The quality of evidence is also criticised with many anecdotal or few randomised controlled trials. The paucity, poor availability and lack of clarity are also reported to make practitioners reluctant to integrate evidence into the practice. The tendency towards compliance to guidelines and minimum standards and also the belief in 'architecture determinism' have been mentioned as other obstacles (Codinhoto et al., 2009; Ulrich et al., 2008; Salonen et al., 2013; Lawson, 2010; Macmillan, 2006). Despite these challenges, the advancement in EBD has established the impact of quality of built environments on the quality of life and thus the critical role of design quality in building projects.

2.2.3 Design quality definition

Despite its recognised significance both in the industry and academia, the definition of design quality and what accounts for 'good design' lack consensus (Dewulf and van Meel, 2004) and has been subject to a long-standing theoretical debate (Volker, 2010). The terms

'design' and 'quality' are both abstract and profound taken separately or together (Leaman and Bordass, 2004) and there is no unanimous interpretation of either.

The Oxford Dictionary (2015) defines quality as *'the standard of something as measured against other things of a similar kind; the degree of excellence of something'*. A widely used definition of quality, according to van Voordt (2009), is the extent to which a product fulfils the requirements set for it. He added that quality of design, in debates and reflections on architecture, is primarily interpreted as architectural quality. Beim and Jensen (2007) stated that unlike the industrial concept of quality that is chiefly based on technical and functional matters, quality in architecture also embraces aesthetics and ethical issues. In construction projects, quality can be associated with the process as well as the product (as buildings can be seen as product). Thomson et al. (2003) argued that the conventional methods of delivering quality are chiefly about the former with a focus on maintaining consistency and minimising deficiencies in manufacturing output and less with the appropriateness of the attributes of the building. They defined the product quality as '*an assessment of how well the qualities meet the customer's needs*'. Product qualities in their opinion refer to building attributes or associated terms such as features, characteristics, traits or properties.

According to Volker (2010), these product qualities (or attributes) can be categorised into tangible and intangible categories, with degrees of overlap. Tangibles are the hard or objective attributes that are measurable and quantifiable – e.g. measurement of sound in decibels. Intangible attributes are, on the other hand, the soft, subjective characteristics that are a matter of perception and judgement and hence, not easily measurable in technical terms – e.g. people's perception of texture or colour. Macmillan (2006) argued that intangible attributes, although of utmost importance, have received a relatively lower attention due to the hurdle of measurement.

Design quality is frequently treated as a multifaceted concept (Cardellino et al., 2009) encompassing a variety of attributes. While many classifications are proposed, the oldest

known operationalisation of design quality is by the Roman architect Vitruvius who suggested three principal areas of 'utilitas', 'firmitas' and 'venustas' (Vitruvius and Morgan, 1960). The modern-day translation of these are 'commodity', 'firmness' and 'delight' (Prasad, 2004). According to Volker (2010), other seemingly different lists of design attributes are in essence a version of the Vitruvius classification, supporting its credibility to the present date. Prasad (2004) argued that true excellence is achieved only when the three quality fields work together synergistically, and if otherwise, only basic quality is achieved. Volker (2010) also stressed the holistic notion of design quality and added that the totality could be seen as a quality of its own.

CABE, across its several publications (i.e., CABE, 2006a & 2006b & 2006c & 2009a & 2010), argued that in opposite to the wrongly-held belief that design quality is entirely subjective, its assessment is in fact to a large extent an objective process and it is possible to distinguish between good and bad design. CABE claimed that it is, in fact, taste and fashion that change and vary and are a matter of personal opinion. Design quality, which can happen in many styles and appeal to some tastes and not others, could be assessed based on the three enduring principles given above: fit for purpose (commodity), built to last (firmness) and lift the spirits (delight). It, however, acknowledged that design quality cannot be reduced to a formula and that creativity in design transcends rigid codes and prescriptions.

A separate yet related concept to quality in the built environment is 'value' which according to Volker (2010) is equally important in discussions. These two terms are sometimes used interchangeably with the value being the preferred one in the industry. Thomson et al. (2003), however, urged the need to distinguish between quality and value and also their associated terms of 'qualities' and 'values' as one is not the plural of the other. In the context of construction projects, while 'qualities' are the product attributes inherent in the built object and may be desirable or not, 'values' refer to the core beliefs, morals and ideals of individuals and organisations having a stake in the project. These values could be partly unique and partly shared (Mills and Austin, 2014). The values are inherently subjective and influence an individual's value judgement when assessing a product.

By ignoring the subjective nature of value judgement, an objective view has been commonplace in the industry's value delivery methods like value management or value engineering. Loe (2010) stated that these are sometimes interpreted as cutting cost approaches with a negative connotation. Thomson et al. (2003) recommended a broader definition that accommodates both subjective and objective interpretations, in such, value reflects a relationship between the benefits (what you get) and sacrifices (what you give) when an assessment of the product qualities happens based on held values. Taking a value perspective to design quality, Volker (2010) gave her own definition of the term design quality as *'an overall value judgement by an individual person based on the interaction between this person and an object in the built environment'*.

2.2.4 Design quality evaluation

What the concept of design quality is and why it matters for the built environments were reviewed from different perspectives in the prior sections. Whether or not a building project yields an appropriate design quality in the constructed building is another facet of design quality research and practice. Product appraisal is an important topic in many sectors. Building evaluation, in particular, is seen as complex, compared to the manufacturing sector for example, due to issues such as presence of diverse stakeholder groups with different expectations and difficult-to-measure attributes (Leaman et al. 2010).

Building evaluation is often conducted in form of post occupancy evaluation (POE). POE is one of the oldest and most common assessment methods for buildings. Although characterised with its 'mutability' (Hadjiri and Crozier, 2009), it can be broadly defined as '*a process of systematically evaluating the performance of buildings after they have been built and occupied for some time'* (Preiser, 2002). The POE is seen as a project's logical final step (Zimmerman and Martin, 2001) closing the loop between design and use (Whyte and Gann, 2001) to create *virtuous cycles* of improvement (Leaman and Bordass, 2001).

These have been traditionally concerned with the technical performance of the building and more quantifiable attributes. However, recently a more holistic and project lifecycle view to building evaluation has been called for with the addition of non-technical, user-oriented elements. Preiser and Vischer (2005) proposed a 'building performance evaluation' framework with six phases - where POE is just one of them – to allow for feedback being provided throughout the process. Leaman et al. (2010) also emphasised on the importance of feedback and defined multiple levels for it with respect to building evaluation (figure 2-3); These range from benefiting the ongoing project and feeding forward to future ones to the consolidation of a knowledge base for dissemination across the industry. Despite the benefits, building evaluation and POEs have yet to become mainstream in the industry. Some of the barriers are given as cost and time constraints as well as disinterest in outcome sharing (Hadjiri and Crozier, 2009).

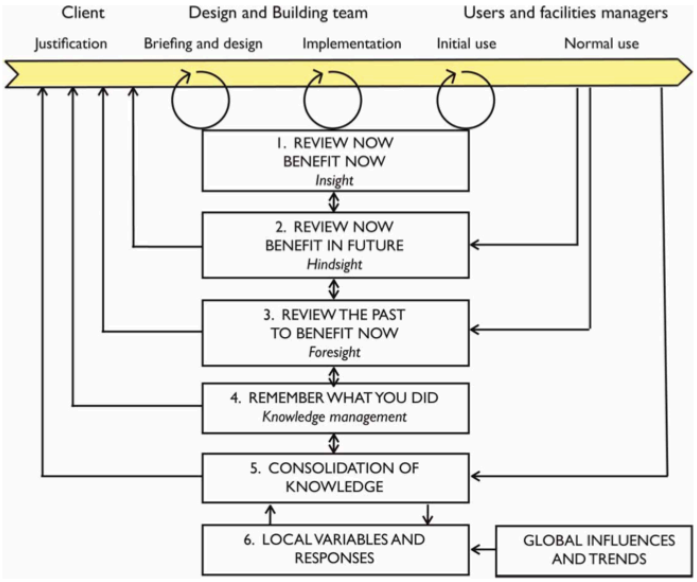


Figure 2-3 Different types of feedbacks in building projects (Leaman et al. 2010)

Various techniques and tools are reported for the assessment of buildings; expert walkthrough, occupant survey, visual records and physical measurement, to name some (Bordass and Leaman, 2005). Fronczek-Munter (2013), while mentioning that over 150 methods exist, attempted to group some of these based on their focus on Vitruvian trilogy (figure 2-4). For instance, the BREEAM (Building Research Establishment Environmental

Assessment Methodology) energy performance tool is mapped onto the firmness area. Although, it seems to be inaccurate in places (for instance, the DQI can assess all three areas), this depiction shows the applicability of the trilogy to building assessment.

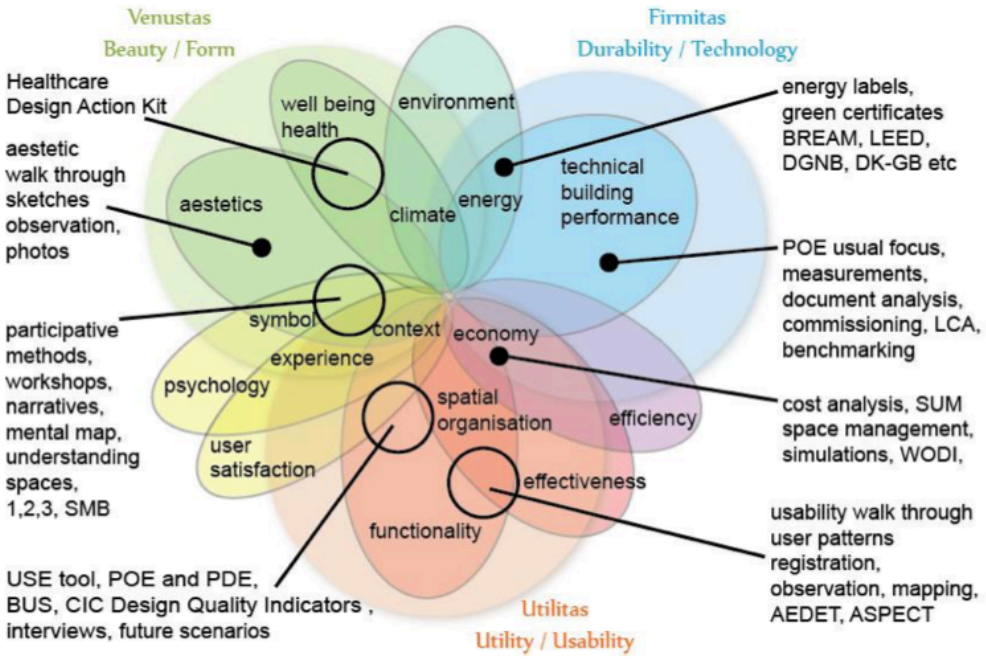


Figure 2-4: Different building evaluation methods mapped on Vitruvius quality fields (Fronczek-Munter, 2013)

2.2.4.1 Design Quality Indicator (DQI)

One of the building evaluation tools that has a holistic approach is the Design Quality Indicator (DQI). According to DQI (2015), it is *'for evaluating the design and construction of new buildings and the refurbishment of the existing buildings'*. As mentioned in section 2.2.1, the DQI was introduced as an extension of the UK 'Rethinking Construction' agenda for the assessment of the project's end-product.

The development process of the DQI tool is well documented (Gann et al., 2003; Whyte and Gann, 2003; Prasad, 2004; Dickson, 2004 and Whyte et al., 2004). Sponsored by the Construction Industry Council (CIC) – the umbrella organisation representing UK construction professional institutions – a research team at the University of Sussex was appointed to develop the tool. The team benefited from working closely with an industry

Steering Group of 15 representing different professional, industrial and government interests as well as a Reference Group of a larger number of members (i.e., 35) to engage more stakeholder groups like client and building owners.

The tool initially aimed to measure design quality and to facilitate benchmarking across the industry. It was aimed for the tool to not get passed the vital intangible attributes. It was also intended to have a transparent and visual result representation with an easily understood framework usable for lay and professional people at different phases of building lifecycle and across a wide range of building types. The development process went through a series of iterative steps. Refinements and piloting occurred in several projects. Previously existing tools as well as design attributes classification lists were studied by the team and different forms of conceptual models, respondent questions and result visualisation/analysis were examined.

The outcome was a toolkit consisting of three elements, i.e., a conceptual framework, a data-gathering tool and a weighting mechanism (Figure 2-5). The conceptual framework embraced the Vitruvius trilogy as the 'indicators' while renaming them 'functionality', 'build quality' and 'impact'. 10 sub-indicators applicable to buildings were defined under these three categories. The interaction between the indicators are also embedded in the framework with more overlap as an indication of higher quality. As the achievement of design quality is influenced by a number of 'constraints' or 'enablers' including time, finance, human and natural resources, the design quality is bounded in a so called 'resource envelope'.

The data-gathering tool is in the form of a self-completion questionnaire with approximately 100 questions across the subsections with the respondent using a 1-6 Likert scale to answer. A simple weighting mechanism was also devised to find out the importance that each respondent allocates to different areas based on their intent. The results were set to be visually presented on spider diagrams. It was also designed to be used at four major phases of a building project, i.e., 'the brief', 'mid-design', ready for occupation', and 'in-use'.

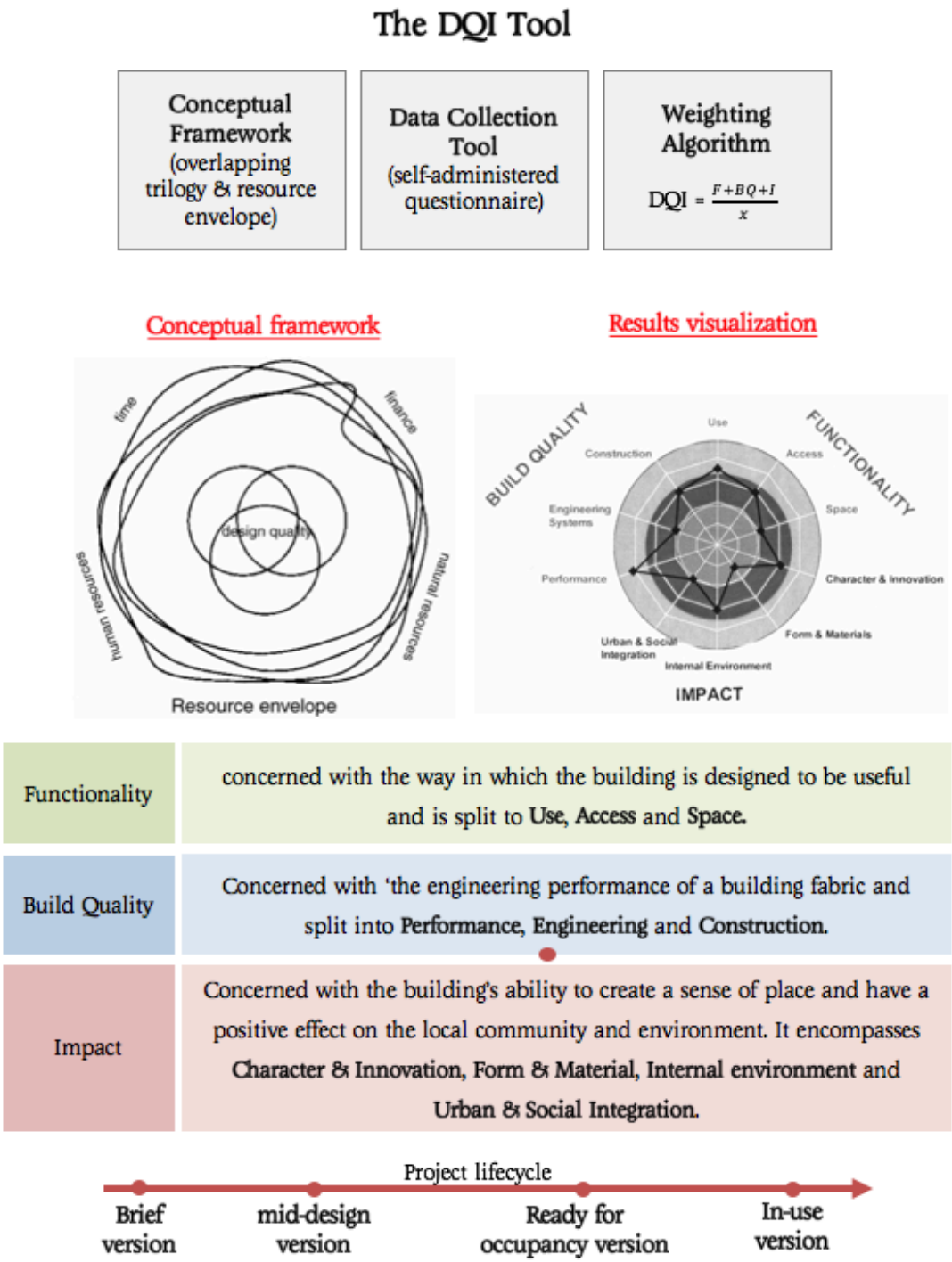


Figure 2-5: The DQI tool (Gann et al., 2003; Volker, 2010, DQI, 2015)

The DQI tool, its purpose and methodology raised both admiration and criticism, as one would expect due to elusive and debatable nature of design quality measurement. Gann and Whyte (2003), two members of the DQI development team, distinguished between three approaches to understanding and assessing design quality, i.e., the 'judgment-based

approach' (which leaves design to the expert judgement of professionals), the rational or 'manage and measure' approach (which supports systematic ways for improvement through defining parameters, measurement and control), and lastly, the 'rational-adaptive' approach which sits in between and while accepts the difficulty of measurement and uncertainty in future, advocates for developing tools that aid thinking about the impact of design and observing a diverse range of viewpoints. The DQI tool is created in line with this last approach.

However, there are also criticism and downsides reported. Markus (2003) listed a few of the methodological issues with the tool, including a lack of appropriate techniques to convert subjective responses to objective data, allocation of equal weights to different respondents, and the weak treatment of the data regarding those respondents having no knowledge on some questions. Dewulf and van Meel (2004) also while admiring the deliberate subjective and user-oriented approach of the tool, warned that this could also be the 'achilles' heel' of the tool making it unscientific and over-simplified. They, however, corroborated the real benefit of the tool, as also acknowledged by the developers to be 'a tool for thinking', facilitating a dialogue between stakeholders rather than controlling it. Slaughter (2004) saw this shift from a set measure of relative quality to a negotiating tool among the parties and recommended the tool could be used to elicit stakeholders' shared or divergent interests and thus reaching a consensus through compromises and reconciliation.

2.3 Part B: Success of building projects

Due to its significance, achieving quality in building design could be viewed as an essential determinant of project success. Success is viewed as the ultimate goal of every construction project (Ng et al., 2012) and thus, the topic of 'project success' has seen an ample interest in project and construction management. Several authors have attempted to define success criteria and to identify its contributing success factors in various contexts and applications.

In this section, the literature of project success is reviewed to first, gain an understanding of its state-of-the-art and second, to find out how its rich body of models and methods could be best applied to explore the concept of design quality and to better understand its achievement in building projects.

2.3.1 The criteria for project success

Despite its importance and a large body of research, the concept of project success is reported to remain elusive with no consensus on a list of universally agreed success criteria (Ahadzie et al., 2008; Jha and Iyer, 2007; Ika, 2009). However, by virtue of extensive theoretical as well as empirical research endeavours, the understanding of the concept and its criteria has evolved and expanded over recent decades.

Project success generally entails the level of attainment of project goals and objectives (De Wit, 1988). Traditionally, this implied project completion within the pre-determined time (duration), cost (budget) and quality (specification) – or as said earlier the 'iron triangle' (Atkinson, 1999). These are the most commonly postulated criteria for project success (Han et al., 2012) and are also used in many recent publications (e.g. Kog and Loh, 2012; Berssaneti and Carvalho, 2015). Despite the wide acknowledgement, criticism was raised on their inadequacy (Al-Tmeemy et al., 2011, Toor and Ogunlana, 2010). As discussed by Ika (2009), examples of projects exist where while the triad of time/cost/quality is satisfied, they were eventually deemed as failure or vice versa. Muller and Turner (2007) argued that project

success is project-specific and could change over time and one should consider the perception of various stakeholders about it. In the same vein, Baker et al. (1988) suggested that there is no 'absolute' success but only the 'perceived' one. According to reviews conducted by Jugdev and Muller (2005) as well as Ika (2009) on the historical evolution of the concept, many scholars have attempted to provide a more holistic picture of success criteria and also frameworks depicting its components.

De Wit (1988) argued that a distinction should be drawn between 'project management success' and 'project success', as the two, although related and often mixed up, may be very different. In his view, 'project management success' is part of 'project success' and is measured against the traditional time, cost and quality criteria. Whereas, the 'project success' is measured against the overall objectives of the project that also include stakeholder satisfaction of the end outcome. This distinction is well appreciated by others like Cooke-Davis (2002). A similar model was proposed by Lim and Mohamed (1999), who classified project success according to two viewpoints, i.e., micro and macro. The micro viewpoint is concerned with the project 'completion' and is usually gauged by the completion of project construction stage. However, the macro viewpoint considers both 'completion' as well as 'satisfaction' as necessary for project success and thus, lends into the project operational phase as well.

The described frameworks consider the traditional criteria only as basic and part of a larger model of project success, but do not clearly define the other dimensions of the project success. This has been done firstly by Baccarini (1999). In his view, project success consists of 'project management success' and 'product success', where the latter *'deals with the effects of the project's final product'*. In other words, the first is focused on the project 'process' and has a short-term implication as opposed to the longer-term, 'product' oriented nature of the second (Baccarini, 1999). In this framework, 'project management success' is seen as subordinate to 'product success' yet could impact on its achievement, as found in a later study by Collins and Bacarrini (2004).

In the following years, similar classifications were also proposed. For instance, Nelson (2005) categorised project success into 'process' and 'outcome' related criteria. Project 'efficiency' and 'effectiveness' were put forward by both Deacon (2011) and Takim and Adnan (2008). Al-Tmeemy et al. (2011) also added a new component called 'market success' to Baccarini's (1999) framework. Table 2-2 gives a summary of some of the project success frameworks, their components and constituent criteria proposed by the scholars. Although inconsistencies exist between these frameworks, they clearly signify the importance of distinguishing between the components and move towards more focus on the product-related criteria.

Author	*Project success criteria classification*
De Wit (1998)	**'Project management success'** is part of the overall '**project success**'.
Lim and Mohamed (1999)	**'Macro viewpoint'** (time, satisfaction, utility and operation); '**Micro viewpoint'** (time, cost, quality, performance and safety)
Baccarini (1999)	**'Project management success'** (time, cost, quality, project management process, stakeholders satisfaction); **'Product success'** (owner's strategy, user satisfaction, profitability, market share
Chan and Chan (2004)	**Objective measures** (e.g. time, cost, safety & environment) **Subjective measures** (e.g. quality, functionality, & satisfaction of different project participants)
Nelson (2005)	**Process-related** criteria (time, cost, product) and **outcome-related** criteria (learning, value, use)
Al-Tmeemy et al. (2011)	**Project management success** (adherence to quality targets, adherence to schedule, adherence to budget), **product success** (customer satisfaction, functional requirements, technical requirements), and **market success** (revenue and profit, market share, reputation, competitive advantage)

Table 2-2: Examples of project success frameworks and their associated dimensions and criteria

2.3.2 The critical success factors in projects

In discussing project success, a similarly important concept besides the success criteria is the 'critical success factors' (CSFs). The idea of defining managerial *'critical elements'* in a clear and meaningful way was first proposed by Daniel (1961), based on which Rockart (1979)

later coined the term 'critical success factors' and defined it as *'a limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation'*. He stresses that these particular areas of activity should be constantly and carefully managed. The concept of CSFs since then has become popular and been applied to several disciplines and applications. It was firstly employed into the area of project management by Pinto and Slevin (1987) and later, in construction by Savindo et al. (1992). Accordingly, similar definitions were provided by the scholars in these fields (table 2-3).

Authors	*Definition of CSFs*
Pinto and Slevin (1987)	'Factors which, if addressed, significantly improve project implementation chances'
Zhang (2005)	'A number of factors combine to determine the success or failure of a project in terms of its objectives (i.e., cost, time and quality).'
Toor and Ogunlana (2009)	'Certain element which significantly contributes to and is crucially vital for the success of a project.'

Table 2-3: Examples of CSFs definition in project and construction management

Several authors urged the need to clearly distinguish between the concepts of 'success criteria' and CSFs (Cooke-Davies, 2002; Belassi and Tukel, 1996; Todorovic et al. 2015). According to Oxford English Dictionary, criteria are *'a set of principles or standards by which something may be judged or decided'* whereas factors are *'a set of circumstances, facts, or influences that contributes to a result'*. Therefore, one could conclude that the success of projects is determined against a set of success criteria while the key contributors to the achievement of these criteria are in fact the CSFs. In other words, as Westerveld (2003) stated, success criteria are the 'what' and CSFs the 'how' of project success. He further emphasized that there is a link between the two and criticised the scarcity of research on their relationships. Ika (2009) also pointed out the fact that in order to gain a complete understanding of project success, both concepts are needed together. In doing so, Turner (1999) believed there is no point in identifying CSFs prior to have corresponding success criteria in hand.

Similar to the success criteria, the understanding about CSFs has also evolved over the last few decades. Didenkon and Konovets (2008) as well as Davis (2013) have looked into the CSFs lists produced by researchers over years in the field of construction. According to their reviews, initially, the focus was mainly on factors of planning and control techniques. The factor lists were produced intuitively and based on previous experience. Later, it became known that merely the standard tools could not result in desirable project success and there is a need for a systematic approach. Human factors started to emerge in the CSFs lists with the first attention being given to the project managers and their competency. With more attention to procurement methods in the industry, the selection of proficient contractors became important as well. Then, other project participant saw importance: client, users, subcontractors. More recently, apart from the traits of different stakeholders, the relationship between them was deemed as critical for project success. An interesting observation is that similar to the development of success criteria from the focus on project management success into project success and the importance of stakeholder satisfaction, the focus on only efficiency-oriented factors shifted to include stakeholders' characteristics, their relationship and management.

Today there is an extensive body of literature on the CSFs for construction projects. CSFs are identified for general project success (Chen et al., 2012; Jha and Iyer, 2007), specific success criteria (Hwang et al., 2013; Iyer and Jha, 2006), procurement methods (Chan et al., 2010; Zhang, 2005), different project stages (Tang et al., 2013; Ng et al., 2012), different managerial areas (Yang et al., 2010; Shen and Liu, 2003) and many other aspects.

However, to date, there is no study dedicated to the identification of CSFs for design quality – i.e. 'the how question – in building projects despite the availability of the DQI classification as 'the what' to design quality achievement. Although, such a study is lacking, the existing CSFs literature has employed a rich body of methods that could be utilised for the aim of this research (section 1.2). Some studies are merely an attempt to the identification of CSFs while many others have performed further evaluations such as CSFs

ranking, categorization and their relative contributions to success criteria. Table 2-4 exhibits some of the recent studies.

Authors	*Application*	*Number of CSFs*	*Survey respondents (No.)*	*Study elements (& methods used)*
Phua (2004)	Multi-firm construction projects in Hong Kong	18	Contracting and consulting firms (398)	Identification (interviews); Categorisation (factor analysis); differing respondent opinions, relative contribution to success criteria (regression)
Li et al. (2005)	PPP/PFI construction projects in UK	18	Public sector and private sector (61)	Identification (literature); Mean value ranking (mean value), categorisation (factor analysis)
Iyer and Jha (2006) & Jha and Iyer (2007)	Construction projects in India	55	Industry professionals (112)	Identification (literature, case studies & interviews); categorisation (factor analysis); relative contribution to success criteria (regression)
Koutsikouri et al. (2008)	multi-disciplinary design projects in UK (design phase)	31	Employees in an engineering consultancy firm	Identification and categorisation (Semi-structured interviews, workshops and survey)
Tabish and Jha (2011)	Public construction projects in India	36	Industry professional (105)	Identification (literature); differing respondent opinions (ANOVA), categorisation (Factor Analysis), relative contribution to success criteria (regression)
Kog and Loh (2012)	Different components of construction projects	67	civil engineers, M&E engineers, architects, quantity surveyors (27)	Identification (literature); ranking (Analytical Hierarchy Process)
Hwang et al. (2013)	Schedule performance of public housing projects in Singapore	18	Contractors, consultant & private owners (36)	Identification (literature) ranking and categorisation (by the researchers)
Toor and Ogunlana (2008)	Large-scale construction projects in Thailand	39	Project managers and line managers (76)	Identification (literature review); differing respondent opinions (ANOVA), categorisation (factor analysis)

Table 2-4: Examples of recent studies on CSFs in construction

The first element in these studies is the identification of CSFs. Careful examination of the studies in the field of project success shows two general methods employed by the researchers to identify CSFs. Many including Toor and Ogunlana (2008) relied on a review of previous literature to develop their lists of CSFs; some like Yang et al. (2009) followed up

this literature review by a handful of pilot interviews for refinement. A limitation to this approach is that the literature could become outdated and as a result, the studies which incorporate this method could merely reproduce old lists. A second method, in contrast, involves collection of primary data. Examples are Phua (2004) and Koutsikouri et al. (2008) who employed interviews and focus groups to collect first-handed data from primary data sources. Phua (2004) recommended the use of this second method in cases where prior research on a specific topic is scarce. One could consider a lack of validation as a drawback of this method. This, however, could be compensated for with a follow-up validation study, similar to what Iyer and Jha (2006) and Jha and Iyer (2007) did.

Categorisation is another common elements of the CSFs studies. This, also, is either carried out based on the researcher's own opinion (e.g. Gudiene et al. (2013)) or more rigorously by statistical methods, such as factor analysis, based on empirical data (e.g. Tabish and Jha (2011)). Prioritisation is also performed through mean value method (e.g. Li et al. (2005)) or by pairwise comparison methods like the Analytical Hierarchy Process (e.g. Kog and Loh (2012)). Two other less practiced elements in CSFs studies are to identify differences in opinions between different groups of respondents and to determine the relative contribution of CSFs to the achievement of success criteria. Both of these are applied using statistical techniques, such as ANOVA and regression). As it will be discussed in section 2.5, all of these elements are employed in the current research, due to its aim to be in-depth and comprehensive.

2.4 Part C: Stakeholders of building projects

From the previous sections, it has become clear that the concept of design quality is highly linked to the project stakeholders. In Part A, it was discussed that the quality of design could impact on various stakeholder groups by providing different types of social and economic outcomes. It was also shown that building evaluation tools, especially the DQI, rely on the perception of and dialogue between these stakeholders to assess the quality achieved in the constructed building. Part B, furthermore, showed that the evolving understanding about project success is expanding towards the role of stakeholders with respect to both success criteria and CSFs. This was especially evident with the inclusion of stakeholder traits, relationships and management in recent CSFs lists. As a result, in pursuing the aim of better understanding design quality achievement, it is necessary to explore and analyse the stakeholders present during project process for whom the design quality has implications.

Therefore, in Part C, the current literature of stakeholder theory and management, especially with respect to construction projects is reviewed. Various stakeholder analysis models are evaluated for their applicability in the empirical studies of this research.

2.4.1 Stakeholder theory and management

Stakeholder management concerns the relationship between an organisation and its stakeholders (Chinyio and Olomolaiye, 2010). In a project context, McElroy and Mills (2003) defined it as *'the continuing development of relationships with stakeholders for the purpose of achieving a successful project outcome'*. According to PMI (2013), stakeholder management is one of the key areas of project management. It has attracted several scholars investigating its theory from different aspects. Moreover, many stakeholder management processes and analysis models have been developed for use in real-world practice (Yang et al., 2009; Smudde and Courtright, 2011).

The stakeholder theory evolved since half a century ago. Elias et al. (2002), in their attempt to map this evolution, identified three key stages, i.e., 'classical stakeholder literature', 'strategic management: a stakeholder approach' and 'dynamics of stakeholders'. The first stage began when the term stakeholder was firstly defined in the management domain in 1963 by the Stanford Research Institute as '*those groups without whose support the organisation would cease to exist*' (Freeman, 1984). This stage was associated with the term being incorporated in areas of corporate planning, system theory, corporate social responsibility and organisational theory (Elias et al., 2002).

The second stage began with the landmark work of Freeman (1984) who defined stakeholder theory as a key part of strategic management of organisations. Despite the classical definition that was based on survival of the firm, Freeman defined stakeholders as *'any group or individual who can affect or is affected by the firm's objectives'*. He proposed a systematic management approach that takes into account an organisation's external environment. His work received wide acknowledgement and was succeeded by an extensive research into the stakeholder concept. Donaldson and Preston (1995) later identified three perspectives to stakeholder theory, namely, descriptive, instrumental and normative. According to them, the descriptive (or empirical) view attempts to identify the stakeholders and explore how they interact with each other. The instrumental perspective examines the connections that could exist between stakeholder approaches and corporate objectives such as profitability. The normative perspective is concerned with the philosophical and moral aspects of stakeholder management. These perspectives reflect the researcher's intention in relation to stakeholder theory. They address the questions 'what happens?', 'what happens if?' and 'what should happen?', respectively (Jones, 1995).

Descriptive approaches are valuable in exploring new areas of stakeholder relationships and in assessing the alignment between research theories and observed reality (Amaeshi, 2010). Yang et al. (2009) examined the literature of stakeholder management and found the 'descriptive' research, compared to the other two perspectives, is growing and accounts for half of the papers published between 1979 and 2008. This appears sensible as an

instrumental or normative research requires a degree of stakeholder description in advance. An instrumental research is interested in the consequences that certain stakeholder practices have. It is often regarded being pre-occupied with a firm's self-interests, and thus, uneven balance of power and one-way communication between a focal firm and the other stakeholders (Crane and Livesey, 2003). Normative perspective is largely prescriptive and seeks to satisfy the moral rights of individuals (Amaeshi, 2010). According to Donaldson and Preston (1995), in this perspective, all stakeholders' interests are of *'intrinsic value'* and should be treated as an end rather than means to some other ends. They concluded that these three perspectives, although distinct, are interrelated and mutually supportive.

The third stage, according to Elias et al. (2002), was concerned with the recognition of 'dynamism' of the concept and the fact that the mix of stakeholders as well as their stakes could change over time. The models developed by Mitchell et al. (1997) and Rowley (1997) – explained in the next section – are regarded as notable works of this stage (Yang et al. 2009). This dynamic view to stakeholders was marked as important by recent scholars such as Myllykangas et al. (2010) as well. However, others like Elias et al. (2002) and Neville et al. (2011) were of the opinion that there is an inadequate attention to this point in current theoretical and empirical research. The interest in stakeholder theory grew further in popularity in the new century with studies in multiple contexts and applications.

Definition of Stakeholder:

The proliferation of stakeholder research resulted in the emergence of many, somewhat divergent definitions of the term (Fassin, 2010). Friedman and Miles (2006), for instance, listed 55 definitions they identified in the literature between 1963 and 2003. According to Leung and Olomolaiye (2010), two categories of stakeholder definition exist: narrow and broad. In narrow definition, those maintaining some type of right, claim or ownership in the organisation are considered as stakeholders whereas broad definitions, such as Freeman's, view a stakeholder as anyone who can exert influence even without an economic relationship with the organisation. Kaler (2002) came up with a similar distinction:

'claimant' and 'influencer' definitions. Table 2-5 exhibits a few examples of these two viewpoints.

Authors	*Definitions of 'stakeholder'*	
Gray, Owen and Adams, (1996: 45)	'Any group or individual that can be influenced by, or can itself influence, the activities of the organisation'	Broad view
PMI (2013)	'Individuals, groups, or organisations who may affect, be affected by, or perceive themselves to be affected by a decision, activity, or outcome of a project'	
McElroy and Mills (2000)	'Individuals or a group of people who have a vested interest in the success of a project and the environment within which the project operates.'	Narrow View
Bourne and Walker (2005)	'Individuals or groups who have an interest or some aspects of rights or ownership in a project'	

Table 2-5: Definition of 'stakeholder' from broad and narrow perspectives

Stakeholder Management:

The construction industry in general and building projects in particular tend to be characterised as multi-stakeholder environments. Although traditionally only the client was considered in practice (Newcombe, 2003), in fact the stakeholders of construction projects span vastly to include among others, the user group, design team, facility managers, authorities, contractor, suppliers and even neighbouring entities (Chinyio and Olomlaiye, 2010). These stakeholders could have different types of stakes, attitudes and interactions with the project (Nash et al., 2010). This requires an effective stakeholder management.

Cleland and Ireland (2002) stressed the need for a formal stakeholder management process However, Karlsen (2002) from a survey of project managers found out that in real-world projects, there were no systematic strategies or methods for stakeholder management and it has been only implemented randomly. However, several authors have proposed their own stakeholder management process models, which although inconsistent with each other (Mok et al., 2015), often are a synthesis of a number of activities. Table 2-6 have listed some of these models. As it can be seen and according to several authors (Freeman, 1984; Jepsen

and Eskerod, 2009; Missonier and Loufrani-Fedida, 2014), stakeholder analysis is an important stage in stakeholder management process. Yang et al. (2011b) argued that stakeholder analysis includes stakeholder identification, classification and assessment of their attributes and relationships. They also believed that planning for stakeholder engagement, although sometimes could contribute to the analysis stage, should derive from the outcome of stakeholder analysis.

Authors	*Stakeholder Management Process*
Cleland (1986)	Stakeholder identification, classification, analysis and strategy development
Karlsen (2002)	Defining objectives, resources and operational details, identifying stakeholders, evaluating their interests and impacts, reporting evaluation results; formulating stakeholder management strategies, and monitoring effectiveness.
Walker et al. (2008)	Identifying stakeholders, prioritising stakeholders, visualising stakeholders, engaging stakeholders, monitoring effectiveness of communication.
Bourne and Weaver (2010)	Identifying stakeholders, prioritising stakeholders, visualising stakeholders, engaging with stakeholders, monitoring

Table 2-6: Examples of stakeholder management process models

2.4.2 Stakeholder analysis models

As mentioned above, stakeholder analysis is an important component of stakeholder management. A number of models have been proposed in the literature for analysing stakeholders, which often come with visualisation and graphical representation. Considering the complexity of stakeholder environment in building projects, these could aid better understanding of stakeholders and their attributes (Fasin, 2010; Bourne and Weaver, 2010).

A simple yet popular technique for stakeholder mapping and analysis is the power/interest matrix (figure 2-6: a) proposed by Johnson and Scholes (1999). According to Olander (2005), interest and power are respectively concerned with "*how interested is each stakeholder group to impress its expectations on the project decision?*" and *'do they mean to do so? Do they have the power to do so?'*. Mapping the stakeholders based on the power they hold and interest they have aids the project manager in better understanding their attitudes towards the project and could define the type of relationships/engagement needed towards

them (Olander, 2005; Newcombe 2003). For example, stakeholders with low power and high interest should be kept informed while those with high power and low interest require to be kept satisfied (Newcombe, 2003).

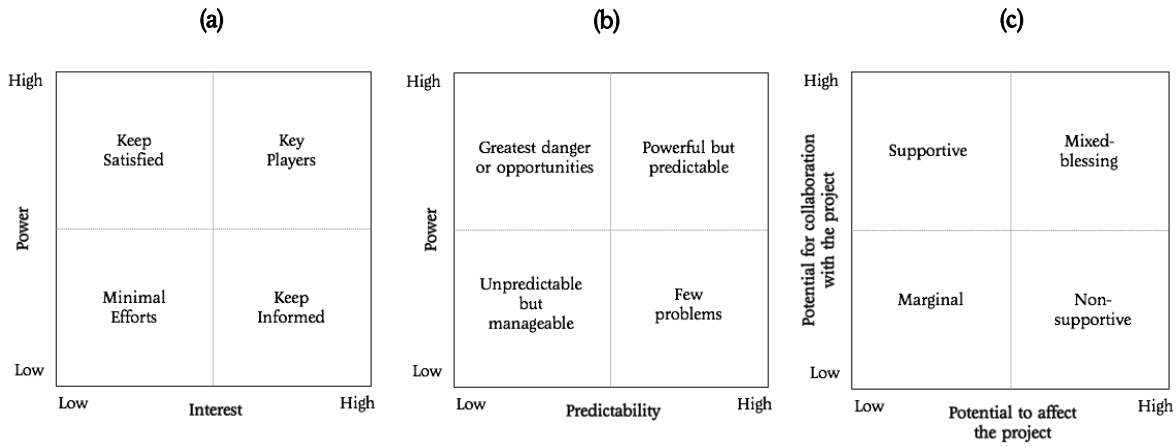


Figure 2-6: stakeholder analysis matrix models: (a) power/interest (Johnson and Scholes, 1999), (b) power/predictability (Newcombe, 2003), and (c) potential for collaboration with/affect the project (Karlsen, 2002)

A similar matrix proposed by Newcombe (2003), i.e., power/predictability (figure 2-6, b), replaced stakeholder interest with how predictable a stakeholder attitude towards the project is. An assessment then could be done accordingly on the level a stakeholder is a danger and manageable. For example, low power but high predictability shows few problems yet the most difficult stakeholders to manage are those with high power and low predictability. Another matrix-based mapping technique was proposed by Karlsen (2002). In his matrix (figure 2-6, c), the axes are labelled as 'potential to affect the project' and 'potential for collaboration with the project'.

Careful examination of these matrix techniques and the specific language used shows their tendency towards a narrow, instrumental perspective where a focal firm assesses how other stakeholders support or influence its goals and objectives. This is while the Freeman's (1984) stakeholder definition, which is regarded as the most adopted in the literature (Mainardes et al., 2011; Nash et al., 2010), inherently encompasses two variables of 'affect' and 'is affected' in a symmetrical manner (Friedman and Miles, 2006). However, according to Money et al. (2012), this two-way relationship has not yet been explored empirically. In this view, the

firm itself is a stakeholder. Reflecting on the power/interest model, Olander (2007) raised the point that evaluating the magnitude of power on a scale is problematic and instead the impact a stakeholder has on the project decisions as result of its power should be assessed. Likewise, in his view, interest in essence refers to the probability of a stakeholder having an impact.

The 'stakeholder Salience' model developed by Mitchell et al. (1997) is another key analysis model. It has gone beyond the simplistic two-dimensional matrix techniques and incorporates three stakeholder attributes, namely, power, legitimacy and urgency. A stakeholder may possess one or more of these attributes based on which is positioned into one of the seven stakeholder groups the authors defined (figure 2-7). For example, a 'definitive stakeholder' possesses all three attributes whereas those with urgency and legitimacy are considered as 'dependent stakeholders'. This would then define a stakeholder's saliency, or in other words, the priority and level of attention that should be given to its needs.

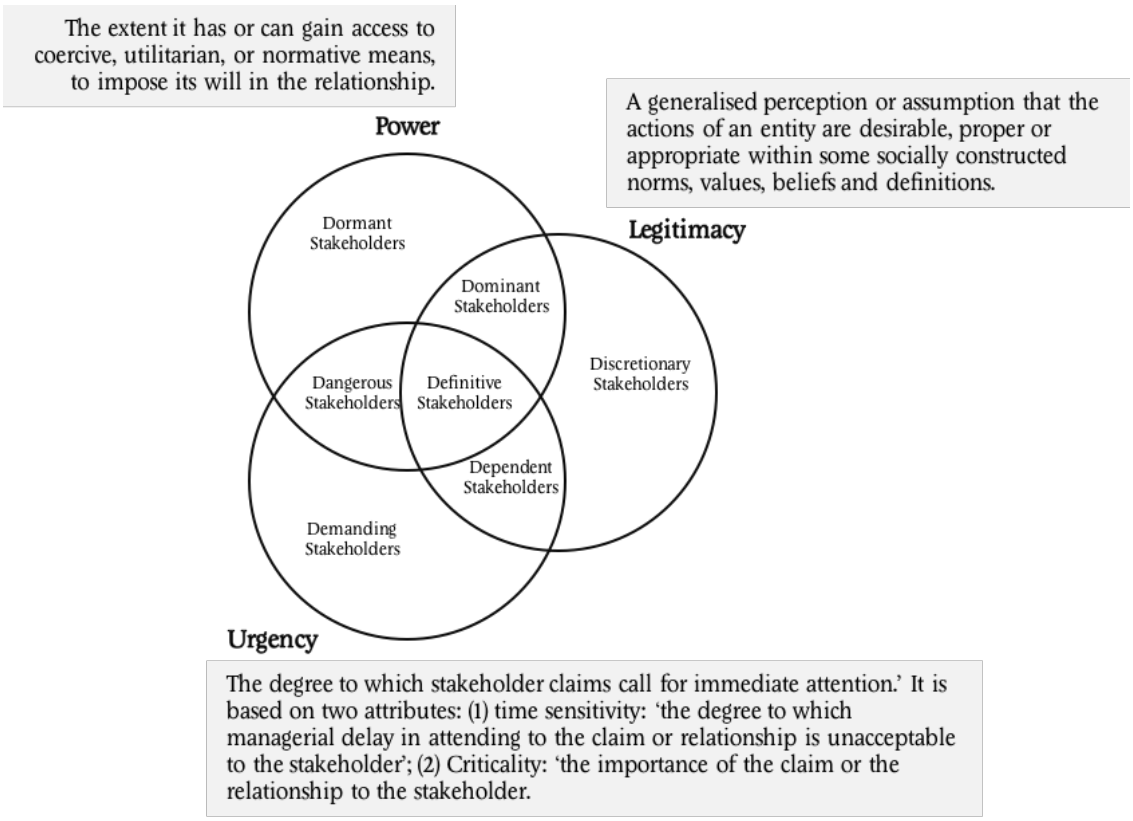


Figure 2-7: Stakeholder Salience Model (Mitchell et al., 1997)

The stakeholder salient model received wide recognition and has been used by many authors (e.g., Aaltonen et al., 2008). However, criticism was also raised. Driscoll and Starik (2004) questioned the exhaustiveness of the model's attributes and suggested analysing the 'proximity' of stakeholders as well. Neville et al. (2011) also found 'legitimacy' inappropriate. Yang et al. (2011) also found in their interview study with industry practitioners that they viewed legitimacy as imprecise and difficult to operationalise. The model was also criticised for lack of attention to stakeholder relationships (Frooman 1999; Rowley 1997). Again, the salient model tends to favour an instrumental perspective to stakeholder theory as it put emphasis on the prioritisation of stakeholders and therefore, the belief that some have more important stakes than others.

'Stakeholder circle™' (Bourne, 2005; Walker et al., 2008) is another analysis method which is commercialised as a tool with supporting software. It attempts to identify, visualise and prioritise stakeholders based on which engagement and communication strategies could be devised. The tool emphasises the graphical representation of the stakeholder environment where differences between stakeholders, for instance in terms of influence, distance from the project and homogeneity, are illustrated using different patterns, concentric lines or block size. An example of such visualisation is given in figure 2.8. A highlighted feature of this method is the adaptation of Mitchell et al.'s (1997) attributes in the context of projects, but with the replacement of the problematic 'legitimacy' with 'proximity' (table 2-7).

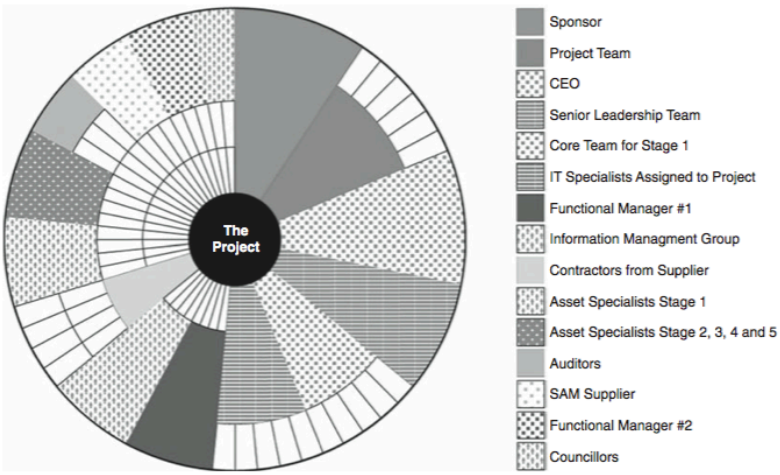


Figure 2-8: 'Stakeholder circle™' visualisation (Bourne and Weaver, 2010)

Power	Power to kill the project (from high capacity to formally instruct change (4) to relatively low levels of power (1)
Proximity	Closeness to the project (from 'directly involved in the work' (4) to 'relatively remote from the work (1))
Urgency	How important is this project to the stakeholder and how prepared are they to act to achieve their own outcomes (positive or negative)? Urgency is a combination of 'value' and 'action'. Value: how much stake does the person have in the work or its outcomes? (very high (5) to very low (1)) Action: a measure of the likelihood that the stakeholders will take action, positive or negative to influence the work or its outcomes. (very high (5) to very low (1))

Table 2-7: 'Stakeholder circle™' attributes and measurement scales (Bourne and Weaver, 2010)

As mentioned above, one of the shortcomings of Mitchell's (1997) model – and other conventional methods - is the lack of attention to stakeholder relationships and the assumption that only dyadic, mostly contractual ties exist between a focal organisation (or a project manager) and individual stakeholders (Pryke, 2006). However, the project stakeholder environment is more intricate in reality and involves multiple networks of intertwining relationships between the stakeholders. Based on this, Rowley (1999) urged the necessity of moving beyond dyadic ties and individual attributes and taking a relational perspective to stakeholder theory and analysis. He applied Social Network Analysis (SNA) for the first time in the field of stakeholder management and examined how a firm's reaction to stakeholder needs is affected by the stakeholders' network characteristics (Missonier and Loufrani-Fedida, 2014). Other scholars also acknowledged Rowley's (1999) network theory as a superior approach.

SNA is both a theory and an analytic method (McCarty et al., 2001) to construct, view and analyse patterns of 'social networks' which are defined as *'a finite set or sets of actors (nodes) and the relations (ties) between them'* (Wasserman and Faust, 1994). SNA is originally introduced by Moreno (1960) based on graph theory. Nodes represent actors such as individuals or firms and ties could exist between the actors as some form of relations such as communication or influence. Social networks are shown by 'sociograms' (figure 2-9). A

social network perspective argues that actors' actions (attitudes and behaviour) are explainable based on their network positions (Nohria and Eccles, 1992) and contexts such as projects should be managed as social collaborations (Chinowsky et al., 2008). Two main advantages of the SNA are its quantitative evaluation and visualisation capability that could provide a novel insight into the overall network structure as well as the characteristics of individual actors. It benefits from a set of evaluation measures like density and centrality. Moreover, as Frooman (1999) pointed out, the network approach, beyond its descriptive accuracy, appreciates a normative perspective to stakeholder theory since it does not consider a central point for a focal firm. Instead, it sees it as a stakeholder among others in a network of relationships.

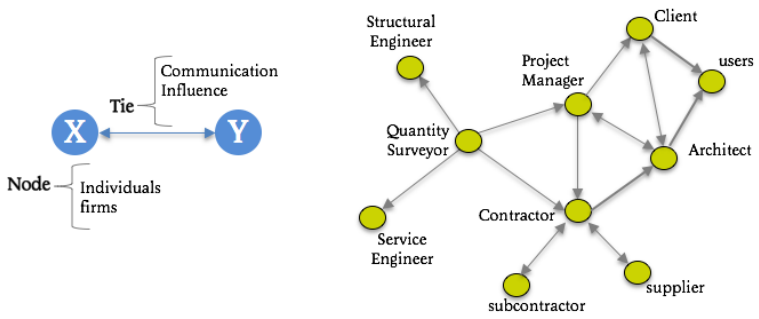


Figure 2-9: An illustrative example of a construction project sociogram

Due to its value and distinctive lens to social structures, SNA has been used in many disciplines and applications; from online social networks such as Facebook and Twitter to areas such as terrorist networks (Ressler, 2006), supply chain management (Silva et al., 2008) and inter-firm relations (Beckman et al., 2004). The approach is also employed in the field of engineering project management. Chinowsky and Taylor (2012) reviewed the publications in this field from 1997 to 2011 and found a sharp increase in attention in recent years.

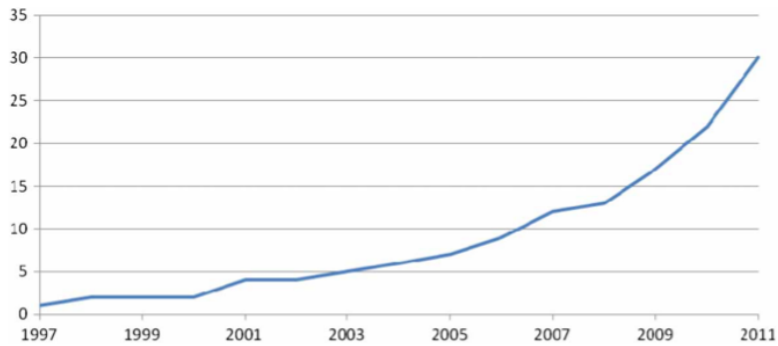


Figure 2-10: Cumulative number of journal papers per year with the use of SNA (Chinowsky and Taylor, 2012)

More recently, the scholars in the construction field have also applied SNA to explore stakeholder networks, despite in limited scope (El-sheikh and Pryke, 2010). Ruan et al. (2013) found only eleven papers from 2002 to 2012 that have employed the SNA method. According to Yang et al. (2011b), it is in its 'infancy' in construction. According to Pryke (2012), there is a great potential for the method in construction projects due to particularly complex and multi-stakeholder nature of the construction projects. Table 2-5 has outlined the main SNA studies in the field of constructions.

Authors	*Context*	*Relations*	*Network measures*	*Project stage*	*Method*
Yang et al. (2011b)	A small school building project	Information exchange; influence	Density, cohesion, status centrality	Construction stage	Email questionnaire
Pryke (2012)	Four construction projects	Information exchange (frequency, importance & nature)	Density, degree centrality	Construction stage	Face-to-face questionnaire
El-Sheikh and Pryke (2010)	Two construction projects	Information exchange for areas of time, cost and quality	Density, degree centrality	Construction stage	Structured questionnaire
Chinowsky et al. (2008)	One construction project	Mechanics (e.g. information exchange) & dynamics (e.g. trust)	Density, distance	Construction stage	Online questionnaire
Alsamadani et al. (2012)	Safety communicatio n in 9 small project teams	Frequency and mode of communicatio ns	Density, centrality, betweenness	Construction stage	Face-to-face questionnaire

Table 2-8: Some SNA studies in construction projects

For example, Chinowsky et al. (2008) developed a model of various relations in two categories of 'mechanics' (items that are exchanged) and 'dynamics' (performance motivator items) and assessed them in a construction project. El-Sheikh and Pryke (2004) interestingly assessed the information exchange networks with respect to three topic of time, cost and scope as project success criteria in two case studies. However, no attempt exists to assess the stakeholder network with regard to design quality related relationships. This is while

design development was found to account for the majority of communications in construction projects a complex and challenging one (Pryke, 2012). Another similarity between these studies is that all of them are only looked at the 'construction stage' in a snapshot observation. Both Mok et al. (2015) and Chinowsky and Taylor (2012) have seen this as a significant gap and recommended the examination of projects throughout their lifecycle process. The latter authors argued that the value of a dynamic analysis is in providing an enhanced understanding of changes in stakeholder network patterns. Another recommendation given by them was to apply the SNA into detailed areas of construction.

2.5 Part D: Establishing the research opportunity

The reason for conducting a literature review was two-fold. The first was to provide background knowledge required to contextualise the research project. For doing so, in the prior sections, the state-of-the-art of three academic fields of 'building design quality', 'project success', and 'stakeholder management' were reviewed. This involved the identification and evaluation of relevant theories and concepts, trends and alternative viewpoints as well as models and methods devised by the scholars. Based on this foundation of 'what is known', the second reason was to identify knowledge gaps and to define substantive objectives merited to pursue in this research project. This would allow situating the research area in its wider context, specifying its stance with regard to the differing perspectives and deciding on a synthesis of appropriate methods to adopt for the aim of this research. This concluding section incorporates this second purpose via which it tackles the research 'preliminary objective 1' outlined in table 1-1.

In Part A, the body of literature on building design quality, while organised in four categories of background, outcome, definition and evaluation, was reviewed. The first section showed a gradual evolution in research and practice towards more attention being allocated to design quality, albeit with obstacles. The significance of design quality driving this trend is in fact rooted in the impact and outcome it generates. As shown in the second theme, there exists a wealth of evidence suggesting that the design of healthcare, educational and other types of built environments can affect a vast range of stakeholders socially, economically or health-wise. Thus, quality in design can deliver benefits and should be highly sought-after. Even though the value of design has become clear, the definition and determinants of design quality remained elusive and an area for academic debate. Amid the objective/subjective viewpoints, tangible/intangible attributes and quality/value relationship discussed, the classification offered as part of the DQI tool has been advocated by many as suitable decomposition of the concept where higher achievement in design attributes yields higher quality of design. The assessment of whether or not design quality

is obtained out of a building project was the fourth theme reviewed in Part A with an elaboration of the DQI tool.

An examination of the above, i.e., what is known and where the current research is focused on, together with what could be an appropriate next step, would suggest a number of key questions defining five areas of design quality research (Figure 2-11). The existing research and publications which discuss design quality are mainly around the top three questions. The first segment of the last question, i.e., 'for whom', has been also addressed through the research looking into the various outcomes concerning particular stakeholder groups. However, how design quality could be achieved, having known its significance and being equipped with tools to examine it, is currently left untapped. Little research could be found at the time which attempted to identify the critical factors in achieving design quality in building projects. It is, nonetheless, to some extent unsurprising. The attention to the role of design quality, as it deserves, is still recent and the amount of focussed research compared to other project objectives is relatively poor. Moreover, as pointed out by Turner (1999) [section 2.3.2], there is no point in identifying the CSFs ('the how') without previously setting out the success criteria ('the what'). The DQI classification of design quality attributes used for building evaluation, is in fact the success criteria based on which CSFs could be strived for in this research.

Five Areas of Design Quality Research

1. What is design quality?	Theoretical & conceptual attempts towards definition, characteristics and constituents
2. Why does design quality matter?	Relationship between building design & various outcomes, EBD based research
3. Whether or not design quality is achieved?	Building evaluation tools and techniques, POEs, DQI tool etc.
4. How is design quality achieved?	Identification and evaluation of CSFs for design quality success
5. For whom/by whom design quality is achieved?	Identification and evaluation of the stakeholders of design quality

Figure 2-11: Key areas of design quality research

Besides an analysis of the CSFs, in order to better understand how design quality is achieved, addressing the second part of the fifth question in figure 2-11, i.e., 'by whom', is also imperative. This involves an examination of the stakeholders through interaction and support of whom, the project could achieve its objectives. A better understanding of stakeholders, their attributes and relationships could be seen as even more needed compared to other project objectives such as time and cost, as the design quality could affect a wider range of stakeholders for long after the project completion.

Another way to portray the research gap delineated above is to look at a depiction of project lifecycle (Figure 2-12). The current research can be seen to mainly occur for post-project completion when the building is already constructed and in use. The large amount of POEs and evaluation attempts and also the research on the impact of building outcomes for stakeholders, i.e., EBD, are positioned in post-project completion research. However, the pre-completion period or in other words, the design quality development throughout the project process has seen less attention.

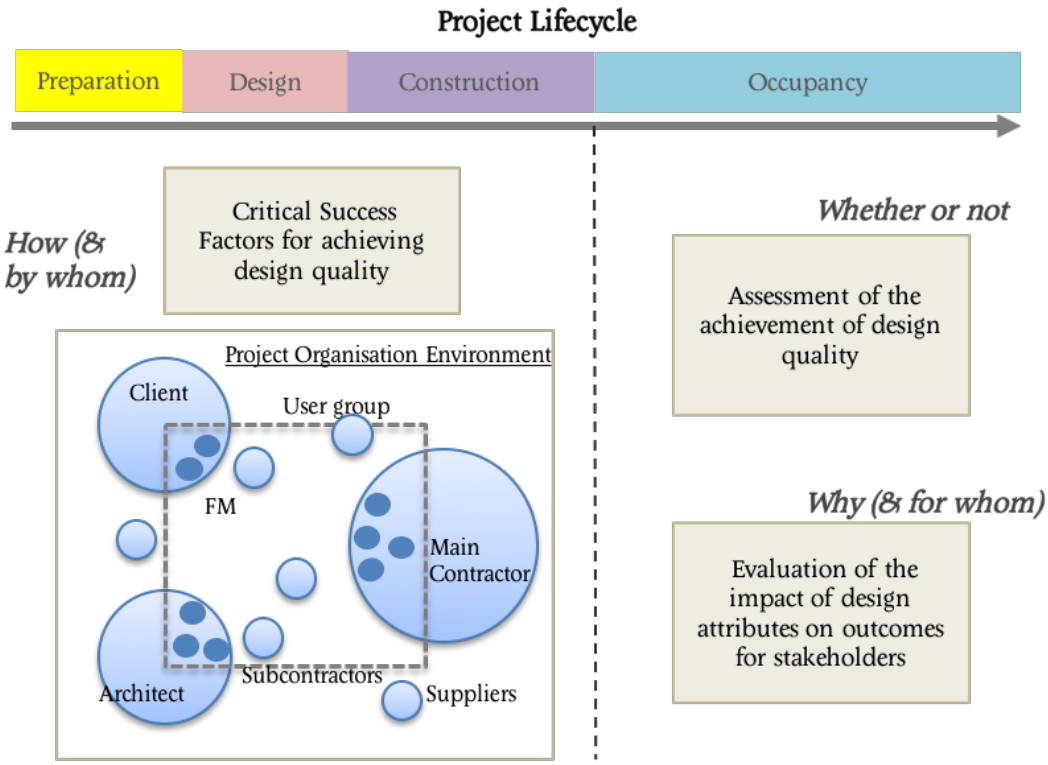


Figure 2-12: Design quality research areas from a project lifecycle perspective
['project organisation environment' part is adapted from (Pryke and Smith, 2006)]

Inclusion of the project process into the overall research on design quality could provide a better understanding of the concept and therefore, better management of it in building projects. 'Design quality management' could be seen as an element of the overall project management body of knowledge which has been so far overshadowed by the generic quality management that - as discussed in Part A - mostly refers to the process quality. Moreover, from a practical point of view, the current DQI tool could be enhanced and completed if the evaluation of design quality achievement also includes an assessment of the CSFs and analysis of stakeholders in the project. As a result, a more comprehensive appraisal of design quality achievement could be obtained.

Aim and Objectives:

The significance of the design quality, the intricate nature of it, and the scarcity of research on it, all, indicate to a pressing need and the justification to conduct further research on it. This new research could look at the 'how' question, the area with less given attention, whilst be built upon what is currently known, i.e., design quality success criteria (i.e. DQI classification) and the stakeholders affected by it. Hence, the current research sets out its overall aim as:

> **(overall aim)** To improve the understanding of how design quality is achieved in building projects.

This better understanding could provide a more holistic design quality evaluation which in turn, could result in an improvement of quality in constructed buildings with more benefits accrued to the stakeholders.

As discussed, to tackle this overall aim, it was decided to employ the concepts of critical success factors – from the 'Project Success' discipline - and stakeholder analysis – from the 'Stakeholder Management' discipline, which both sit in the realm of project management. In order to do so, a 'design quality focussed' approach is required in each, where the

concepts and methods are tailored. Figure 2-13 depicts the interplay of these disciplines in order to fulfil the aim of this research.

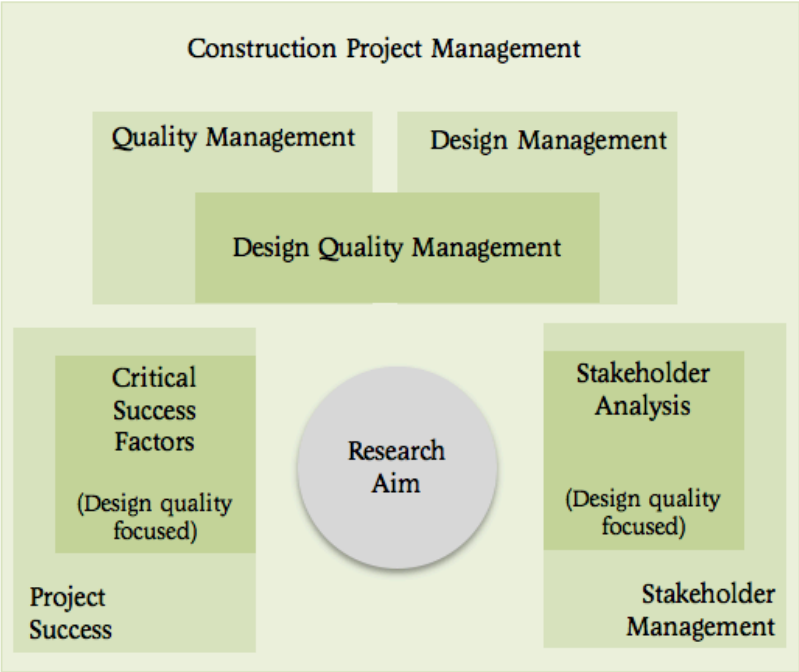


Figure 2-13: Research position with respect to related topics and disciplines

In part B, the literature of 'Project Success' in two sections were examined. Regarding the first category, i.e. success criteria, the learning was two-fold. First, the definition of the success criteria - as the areas based on which the success of project is judged - suggested that the design attributes of the DQI could be defined as the 'success criteria for design quality achievement' and be used for the purpose of this research. Second, a trend was identified with respect to the project success frameworks towards distinguishing between 'project management success' and 'product success'; the prior is concerned with time, cost and to a large extent the 'process' quality and the latter the quality in the final product with implications for stakeholders. The project success theory evolved around the fact that mere success in terms of project management objectives is insufficient to label a project as an overall success. The success also depends on the achievement of product criteria. This is in line with the focal point of design quality scholars that quality is not solely that of the process but also that embedded in the constructed building.

The evolving understanding of CSFs was also investigated in the second section of Part B. As it was shown, this also indicated to a growing attention to the role of stakeholders over time and thus the identification of more CSFs related to stakeholders' competence, relationship and appropriate management in the CSFs studies.

An examination of the current literature on project success in construction, despite the above trends, revealed no attempt to identify and evaluate a comprehensive list of critical success factors for design quality achievement, i.e., product success. Even though studies exist on generic project success and in some cases other project objectives, there is no study with a design quality focus and its specific success criteria (i.e. DQI classification). Based on the above, the first primary objective of this research was defined as:

> **(primary objective A)** To explore and improve the understanding of the CSFs for design quality achievement in building projects.

To fulfil this objective, the project success body of literature provides a rich range of methods and procedures - as uncovered in section 2.3.2 - that can be utilised for the current research. In deciding on these, two points were considered, a) the fact that this would be the first attempt to investigate CSFs for design quality; and b) a rigorous approach is desired to ensure an in-depth understanding. These would suggest a multi-step procedure where the CSFs identified and evaluated at different layers. Accordingly, and based on the norm in this class of research (section 2.3.2; table 2-4), the following specific objectives were defined:

> **(Specific objective a1)** To identify potential CSFs for design quality achievement from the viewpoint of area experts

> **(Specific objective a2)** To rank and validate the identified potential CSFs based on their relative importance

(Specific objective a3) To determine if there is any significant difference in perception between different stakeholders regarding the importance of the identified factors.

(Specific objective a4) To explore the interrelationships between the validated CSFs and to identify the underlying components.

(Specific objective a5) To assess the relative impact of the derived CSFs components on the achievement of design quality success criteria, i.e., functionality, build quality and impact.

It is noted that design quality classification by the DQI is used as the success criteria (the what) in this research. Through the objectives a1 and a2, the CSFs (the how) to design quality achievement will be developed and the objective a4 yields a number of components as a grouping of the identified CSFs (the how).

It would be obvious that the above require the employment of various data collection and analysis methods, qualitative and quantitative, with the involvement of different types of participants. This will be elaborated in the next chapter.

The second primary objective is set as the following:

(primary objective B) To explore and improve the understanding of the attributes and relationships of design quality stakeholders in building projects.

On this account, the literature of stakeholder management was reviewed in Part C. Several pertinent learning points were reached. As discussed in 2.4.1, the numerous definitions by scholars for the term 'stakeholder' generally sit into two categories of narrow and broad with the former focusing on those vital to the firm's success while the latter embraces any group or individual who can affect or is affected. The design quality body of knowledge

puts great emphasis on the impact a building has on all its stakeholders. Therefore, a broad approach is more plausible and Freeman's (1984) widely recognised definition a suitable choice for this research. Furthermore, Frooman's (1999) argument that stakeholders should be defined for an 'issue' rather than for a 'firm' is also taken on board. In his view, every individual or group with a stake in an issue is qualified as a stakeholder of it. This issue-centric perspective suggests that a firm itself should be seen as a stakeholder, together with the external stakeholders or customers. His observation showed the majority of given definitions had a firm-centric view to stakeholders. In the context of building projects, this means all the participating firms and relevant groups are the stakeholders of the project objectives. Assuming the contractor firm, for instance, at the centre and others as its stakeholders provokes a fallacious picture. Based on the above, the stakeholders of design quality – as the subject issue here – is defined as:

> 'Any individual or group who can affect or is affected by the achievement of design quality in the completed building'.

It should be noted that besides its broad, issue-centric stance, the research demonstrates a normative approach to stakeholder theory to value equally every stakeholder who falls in the above definition. As mentioned earlier in section 2.4.2, the existing matrix techniques as well as the salient model (Mitchell et al., 1997) are more instrumental. Therefore, this research, as shown in the following chapters, employs normative techniques such as a matrix technique based on Freeman's (1984) definition in study one and a network methodology in study four.

The importance of stakeholders necessitates appropriate stakeholder management. As discussed in Part C, several processes are proposed by the scholars recurrent in all is the the importance of stakeholder analysis. Stakeholder analysis, with the use of informative visualisation, could considerably enhance the understanding of who the stakeholders are, what attributes they possess and how they interact with each other. As this accords with the second primary objective of this research, different models for stakeholder analysis were

reviewed in section 2.4.2. These models could be generally classified into three groups; a) two-axis matrix models. b) multi-attribute models; c) the network-based models. For this research, it is intended to employ a model from each of these categories. This would allow benefiting from the complete offering of the stakeholder analysis literature to achieve an in-depth understanding of design quality stakeholders.

The interest/power matrix and the other models in the first category appear to be concerned with 'instrumental' paradigm, which is at the advantage of organisations rather than stakeholders. This research, therefore, takes the definition defined above for design quality stakeholders to devise a simple matrix model. It would allow an analysis involving both post- and pre-project completion depicted in figure 2-11 suitable to commence the stakeholder analysis with. Accordingly, the first specific objectives under the primary objective B is defined as:

> **(Specific objective b1)** To devise and apply a stakeholder analysis model based on stakeholder definition to map the two-way relationship between design quality and its stakeholders

From the second group of analysis models, the attributes of power, urgency and proximity are chosen as suitable to explore. Proximity is preferred over legitimacy in Mitchell's Salient model due to the shortcomings discussed in section 2.4.2. Instead of merely determining whether a stakeholder possesses these or not, it would provide a richer understanding if the extent of possession is investigated (similar to the approach of Stakeholder circle™) and the stakeholders being compared to each other based on that. In addition, it would be useful to explore if there is any significant association between these attributes, something that has not yet been addressed in the stakeholder analysis research. The associated specific objective therefore is:

(Specific objective b2) To compare key stakeholders in terms of their power, proximity and urgency and to identify any significant association between these attributes.

The analysis of design quality stakeholders' network of relationship would be the third analysis model for the purpose of this research. As reviewed in section 2.4.2, there are only a small number of studies which have applied the SNA to the field of construction project and there is a call for further research in more detailed aspects of the projects and the change patterns throughout the project lifecycle. Current studies have yet to go beyond a snapshot analysis of construction stage and also the examination of stakeholder relational attributes with regard to design quality objective of building projects. Therefore, the third specific objective is:

(Specific objective b3) To model and visualise the networks of relationships between design quality stakeholders in a building project.

The first preliminary objective to identify gaps in design quality research and to find available methods appropriate for addressing them was pursued and addressed in this chapter. This would allow a 'design quality focused' research from the perspective of project success and stakeholder management currently lacking in the literature. To complement this literature-based approach and to bolster confidence in the intended research focus and direction, an initial investigation into the views of area experts (i.e. architects here) would be beneficial. Thus a second preliminary objective was set as the following:

(Preliminary objective 2) To explore architects' perspectives on design quality in real-world building projects

In the next chapter, the research process and methodological considerations in order to address the identified objectives will be described.

3 Chapter Three

Research Methodology

3.1 Introduction

This chapter presents the approach taken in pursuit of the research aim and objectives established in the previous chapter. It describes and justifies the research underpinnings, overall research design and the data quality and pragmatic considerations.

3.2 Research underpinnings

There are four key elements for developing a research study according to Crotty (1998). These, as adapted by Creswell and Clark (2011), are 'paradigm worldview', 'theoretical lens', 'methodological approach' and 'methods of data collection'. In this section, the choices made with respect to the first three elements in the current research project are discussed. These, in fact, define the foundation for the research design. The methods employed for data collection as well as data analysis are numerous and will be given in the next section as part of the overall research design.

Theoretical foundation:

A theoretical foundation is a standpoint taken by the researcher that provides direction for the research study and guides defining and pursuing the research aim and objectives. It could be theories from the social sciences and be presented in form of a literature review (Creswell and Clark, 2011) – as is the case in this research.

This research is informed mainly by the theories and associated concepts given in 'project success' and 'stakeholder management' disciplines, along with that in 'design quality' and 'social network analysis'. These theories and concepts were discussed as part of the literature review in Chapter Two.

With regards to the 'project success', the concepts of 'success criteria' and 'CSFs' and the interrelationship between them were central in defining the primary objective A and its

associated specific objectives. In addition, the theoretical frameworks suggesting the distinction between 'project management success' and 'product success' were instrumental in positioning the focus of the research, i.e. achievement of design quality, based on the the latter category.

In articulating the set of objectives under the second primary objective and in guiding the methods and variables required to pursue them, multiple theories and concepts of 'stakeholder management' were referred to. As it was explained in section 2.4.2, these were Freeman's (1984) stakeholder theory, Mitchell's (1997) stakeholder salience theory, and Rowley's (1997) stakeholder network theory and the concepts embedded in them. Particularly for the specific objective b3, the theories and concepts of the SNA were of relevance and employed in data collection and analysis methods. The theory advocates for a relational approach to stakeholder analysis instead of the conventional individual-based approach and take advantage of network concepts like centrality and density.

Finally, there were the theories and concepts pertinent to 'design quality' area. The key to research scoping was the differentiation between the concepts of 'design quality' and 'process quality'. The interdependence yet distinction between the concepts of value, values, quality and qualities discussed in section 2.2.3 was also illuminating in this regard. Most importantly though was the conceptual framework of the DQI providing a set of suitable success criteria for design quality achievement (or in other words, building success).

Methodological approach:

'Mixed methods research' was selected as suitable methodological approach for this research. Various definitions exist for mixed methods research highlighting different aspects of it. Johnson et al. (2007), by examining nineteen definitions given by renowned researchers, proposed a 'composite' one as the following:

'Mixed methods research is a type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purposes of breadth and depth of understanding and corroboration.' (p.123)

According to Creswell and Clark (2011), notable in this definition is to view mixed methods as a methodology – not merely a method. Teddlie and Tashakkori (2011) referred to the inherent *'methodological eclecticism'* in this definition which stands for *'selecting and then synergistically integrating the most appropriate techniques from a myriad QUAL (qualitative), QUAN (quantitative), and mixed methods in order to more thoroughly investigate a phenomenon of interest'*. Greene (2007) viewed mixed methods research beyond the combination of qualitative and quantitative elements and more as *'multiple ways of making sense of the social world'*. Creswell and Clark (2007) also pointed to the fact that this method combination could occur in either a single or a series of studies.

A mixed methods research could compensate for the weaknesses exist in each single method if taken individually and provides benefits such as triangulation that could lead to more rigor (Shenton, 2004). In other words, the sum is greater and the outcome '*superior'* (Johnson and Onwuegbuzie, 2004). Adopting such an approach could provide the capability of tackling both the exploratory and confirmatory elements of the research objectives. This is, in fact, in line with the research aspiration for an in-depth multi-faceted understanding of the research problem. On the other hand, increased time and cost as well as skill in conducting both types of qualitative and quantitative research are envisaged as some challenges for mixed methods approach (Johnson and Onwuegbuzie, 2004).

A mixed methods methodology is therefore appropriate as the general approach for this research. The research approach includes multiple individual studies in three phases which integrate elements of qualitative and quantitative data in either concurrent or sequential forms. This choice is rooted in the research aim defined earlier to provide a comprehensive

account of the design quality concept and its stakeholders, and the appropriateness of a multi-phase mixed methods approach in providing depth and breadth. Moreover, such approach provides the opportunity to employ the most suitable study design for each individual research objective which all together contribute to the overall aim of the research for an evolving understanding of design quality achievement and its stakeholders. The literature on mixed methods research allows for different designs (e.g. concurrent or sequential) with different justifications for integrating qualitative and quantitative elements (e.g. greater validity).

Synthesis of varying perspectives of study participants (e.g. different stakeholder groups of a building project in study four) lead to a more comprehensive insight into the phenomenon under study and different building sectors (e.g. healthcare and higher education in study three) into a better comparison of the industry in relation to design quality. Furthermore, approaching multiple professionals (e.g. architects, clients and contractors in study two) would lead to a superior complementary understanding. The specific benefits and structure of mixed methods approach in this research are presented in the next section. Also, the philosophical assumptions taken to support this methodology and also the criteria for judging the research quality is discussed in the following.

Philosophical assumptions:

According to Creswell and Clark (2011), the paradigm worldview surrounding a research study consists of a set of beliefs and assumptions about knowledge that guide the enquiry. Worldviews differ in terms of broad philosophical elements such as ontology (nature of reality) and epistemology (how we gain knowledge of what we know). The researcher should be aware of these assumptions and state them clearly. Two prevailing worldviews are 'post-positivism' and 'constructivism'. The former is often associated with quantitative research and views reality as singular and the latter is often associated with qualitative research and the perspective that reality is multiple and one should look for multiple perspectives from participants (Creswell and Clark, 2011).

Unlike these, the mixed methods research has been a point of debate in terms of its best fitted worldview. According to Creswell and Clark (2011), pragmatism is a typical choice of paradigm for mixed methods research. It presents a pluralistic view that is oriented towards 'what works' and therefore, the use of different approaches based on what is required and what appropriately addresses the research questions or objectives. This view suggests a single overarching worldview. However, Creswell and Clark (2011) themselves advocated multiple worldviews in mixed methods research, in that, the selection of the worldview depends on the study design rather than on how the researcher attempts to know the social world.

In this second view, which is taken in this research, different methods used in the mixed-methods approach have their own related paradigms. This means the qualitative part has a 'constructivist' and the quantitative part a 'post-positivist' worldview. Since the choice of the worldview informs the criteria for the evaluation of the research, here, the quantitative parts are evaluated based on quantitative criteria (e.g. validity, reliability) and the qualitative parts based on qualitative criteria (e.g. dependability, credibility). The use of different criteria - that is further explained in section 3.4 – is also supported by the findings of Bryman et al. (2008). In a survey of researchers active in mixed methods studies, two thirds were of the opinion that different criteria should be used to judge the quality of the qualitative and quantitative components of a mixed methods study.

3.3 Research design

This section outlines the overall research process and the data collection/analysis methods used in each study. It also presents the sampling techniques and the units of analysis for each of these studies.

3.3.1 Overall research process

The research employs a three-phase research process presented in the following.

3.3.1.1 Phase one

Figure 3-1 shows the main parts and the associated objectives of the first research phase. As stated in Chapter One, a practical motivation of the research was to explore the DQI tool and possibilities for its improvement. Following an informal observation of a series of DQI workshops for two building projects, the research firstly looked at the literature around the tool and as a result, the area of design quality. The literature review led to a better understanding of the topic and also speculations on possible gaps and merited avenues for empirical research.

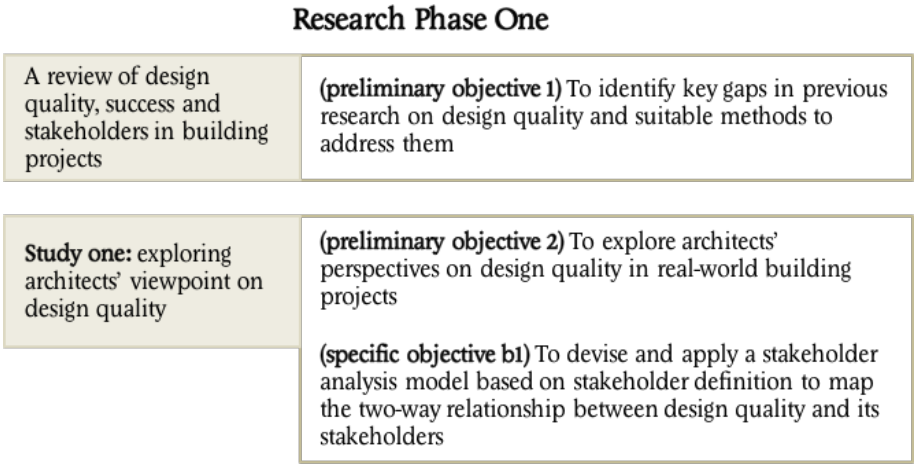


Figure 3-1: Research phase one

With the realisation that the topic of design quality sits under the umbrella of construction project management and is viewed as one of the key project outcomes, a number of adjoining areas were surveyed in order to obtain an understanding of the larger context and to assist in defining significant gaps and appropriate research direction. The main

areas looked into were evidence-based design (EBD), stakeholder management, project success, and multi-criteria decision-making.

Due to the complexity identified in the design quality concept and the limited amount of publications on the topic in construction project management, it was decided to conduct an exploratory interview study with a number of area experts (i.e. architects). Getting in touch with the real-world practice could positively contribute to better specifying and verifying the research objectives. It could also provide valuable insights into the perception and experience of those dealing with design quality in building projects. This interview enquiry formed the first empirical study of this research and facilitated the formulation of the research focus and direction. The study also embodied the first stakeholder analysis model associated with the objective b1.

The design of Study One was mainly qualitative in its data collection and analysis. Semi-structured interviews and thematic analysis were used accordingly. There was, however, a numerical element embedded in the stakeholder analysis model used during the interviews. Thus, the design can be considered mixed methods where a greater emphasis was placed on the qualitative component. Bryman (2006) offered a list of reasons for conducting mixed methods. 'Completeness' – aiming to provide a comprehensive account for the area of enquiry - and 'explanation' – aiming to explain the quantitative data with qualitative discussions - could be viewed as the primary reasons for employing a mixed-method approach in this study.

Subsequent to Study One, the area of project success with a further focus on suitable CSFs methods and the area of stakeholder management with a further focus on suitable stakeholder analysis models were reviewed with scrutiny. As a result of the activities in phase one, the research focus and direction were determined.

3.3.1.2 Phase two

The second phase of the research process encompassed two empirical studies and was concerned with addressing the objectives outlines in figure 3-2. Study Two and Study Three, together, formed a sequential mixed methods design where the first one was qualitative and the second one quantitative in data collection and analysis. The reasons, by consulting the Bryman's (2006) list, were mainly 'instrument development' and 'triangulation and greater validity'.

Research Phase Two

Study two: Exploring expert opinion on CSFs for design quality achievement	**(specific objective a1)** To identify potential CSFs for design quality achievement from the viewpoint of area experts
Study three: An industry survey for CSFs Validation and Evaluation in Building Projects	**(specific objective a2)** To rank and validate the identified potential CSFs based on their relative importance **(specific objective a3)** To determine if there is any significant difference in perception between different stakeholders regarding the importance of the identified factors. **(specific objective a4)** To explore the interrelationships between the validated CSFs and to identify the underlying components. **(specific objective a5)** To assess the relative impact of the derived CSFs components on the achievement of design quality success criteria, i.e., functionality, build quality and impact. **(specific objective b2)** To compare key stakeholders in terms of their design quality related power, proximity and urgency and to identify any significant association between these attributes.

Figure 3-2: Research phase two

Study Two aimed to identify the CSFs for design quality achievement from the viewpoint of a number of area experts. Structured interviews and thematic analysis were used to collect and collate a list of CSFs. The derived list would then be used in the instrument development of the subsequent study. Having identified inductively, these factors still needed further validation and therefore, preferred to be named 'potential' CSFs at this stage.

To follow-up the second study, Study Three was devised to validate and further evaluate the potential CSFs. A questionnaire with closed-ended questions was developed based on the previously identified factors and sent to a large sample of industry professionals (from architecture firms and client organisations). It was aimed for the participants to share their opinion on the criticality of the factors as well as their level of agreement on the presence of these factors in a recent building project. A final section of the questionnaire was allocated to the second stakeholder analysis model (objective b2). Descriptive, correlational and inferential statistical techniques were used for data analysis.

3.3.1.3 Phase three

Two of the three stakeholder models and their associated objectives were addressed in the first two phases. Phase three, as shown in figure 3-3, included the fourth empirical study and the modelling and visualisation of stakeholder networks in a real-world building project. It was in the form of a case study with interviewing the design quality stakeholders of a building project. A conceptual framework was developed through literature review and the data collection and analysis were done in accordance with Social Network Analysis. The study was mainly quantitative but the respondents also provided supporting comments to their numerical responses during the interviews. Therefore, 'context' and 'explanation' – from Bryman's (2006) list - could be deemed as the main reasons for the mixed methods approach of this study.

Research Phase Three

Study four: A case study to model design quality stakeholder relationships	**(specific objective b3)** To model and visualise the networks of relationships between design quality stakeholders in a building project.

Figure 3-3: Research phase three

Figure 3-4 provides a summary of the main characteristics of the empirical studies.

	Phase 1	Phase 2		Phase 3
	Study One	Study Two	Study Three	Study Four
Research objectives addressed	Preliminary 2 – Specific b1	Specific a1	Specific a2, A3, A4, A5, b2	Specific b3
Data Collection Method	Semi-structured interviews Open-ended questions	Structured interviews Open-ended questions	Questionnaire Survey Closed-ended questions	Case Study: structured interviews Closed-ended questions
Data Analysis Method	Thematic analysis	Thematic analysis	Descriptive and inferential statistics	Social Network Analysis
Study Participants	Area experts (architects)	Area experts	Industry professionals (architects & clients)	Building's stakeholders
Mixed methods characteristics	Qualitative dominance For 'completeness' & 'explanation' Concurrent timing	Qualitative first and then quantitative with equal emphasis For 'instrument development' and 'triangulation & greater validity' Sequential timing		Quantitative dominance For 'context' & 'explanation' Concurrent timing

Figure 3-4: Characteristics of the conducted empirical studies

3.3.2 Sampling and unit of analysis

Guided by the research objectives and the research design, appropriate approaches for sampling and units of analysis were considered for each study.

Both Study One and Study Two were designed to employ qualitative interviews with area experts. The target population for Study One was 'highly experienced architects involved in design quality related decision-makings and stakeholder management of healthcare projects'. This for the second study was expanded to also include individuals from other sectors and groups, like contractor or client. Therefore, these studies could be considered as expert elicitation or *'elite interviewing'* involving those who are '*especially knowledgeable*'

about the research area (Gillham, 2005). This type of target population is not easily accessible but could be considerably helpful (Gillham, 2005). Therefore, a non-probability sampling strategy with elements of 'convenience' and 'purposive' techniques was deemed as suitable. Convenience sampling would allow recruitment based on accessibility of subjects and helps reducing practical issues associated with probability techniques (Yin, 2011). Purposive sampling would ensure selection is done based on the required characteristics of the population. Since these studies were of exploratory nature, the sample size was not strictly defined yet the concept of data 'saturation' that is often associated with qualitative analysis was used (Marshall, 1996).

Study Three, which employed a questionnaire survey, also used a non-probability sampling technique to approach the target population. These were 'industry professionals' with relatively high working experience who were also involved in a recent multi-stakeholder building project with good knowledge of its process and outcome. Unlike the previous study, the sample size was important to satisfy the requirements of the intended statistical tests and generalisability of findings. Statistical significance at 5% (i.e., 95% confidence level) was considered and a number of rules of thumbs and statistical techniques were also consulted for the adequacy of the sample size, according to recommendations by Hair et al. (2014) and Field (2009). These will be elaborated in Chapter 6.

Study Four differed from the previous studies with respect to the sampling approach. The SNA approach used in this study, unlike the conventional methods, would require the whole target population or at least a good approximation of it (Prell, 2012). The target population was the design quality stakeholders in the case building project, which would contain several groups. As it will be explained in Chapter 7, a good approximation of the population was achieved, despite considerable practical difficulties. The case project, itself, which was a higher education building, was selected based on the researcher' accessibility.

In terms of the unit of analysis, the first two studies considered individuals with their subjective perception on the interview questions. Again, the perception of the participants

was the unit of analysis in Study Three, section one. However, for the second section, the units were the case projects (even though the questions were also based on the opinion of the participants). Study Four considered the participants in the capacity of their associated stakeholder group. Therefore, the best possible representatives were approached.

3.4 Data quality and ethical considerations

In order to ensure the quality of the findings, the empirical studies in this research incorporated a number of considerations. Quantitative research is often assessed in terms of quality criteria of validity, reliability and generalisability (Bryman et al., 2008). Some suggest using these for qualitative research as well, whereas others like Guba (1981) propose other criteria like credibility, dependability and transferability. According to Shenton (2004), these are the equivalent of validity, reliability and generalisability respectively. In this research, for instance, the use of mixed methods approach assisted the validity and triangulation regarding the identified CSFs in Phase 2. Pilot interviews and questionnaire pre-test were also crucial for ensuring validity and appropriateness of the data collection instruments across the studies. In terms of the reliability, in study 3, Cronbach Alpha was tested for internal consistency of scales. Generalisability for the findings of this study is also assessed based on factors like sample representativeness. These criteria will be assessed for each study in their corresponding chapters.

In terms of the ethical considerations, the research abided by the guidelines provided by the University of Warwick. Ethical approval (Ref:235-07-2012) was obtained from the Biomedical and Scientific Research Ethics Committee (BSREC) of the university. Participant information sheets were provided for all participants and informed consents were obtained from them (Appendix E). Permission was received from the participants wherever audio-recording took place. Anonymity and confidentiality were preserved at all stages of the research process.

3.5 Chapter summary

This chapter presented an overview of the research underpinnings, design and considerations. In the next four chapters, the empirical studies conducted in this research will be delineated.

4 Chapter Four

Exploring architects' viewpoint on design quality and its stakeholders: a preliminary study (study 1)

4.1 Introduction

As stated in the previous chapter, the first research phase besides the literature review incorporated an empirical investigation that could assist in formulating the research focus and ensuring its value and sensibility. For this purpose, an interview study with a number of architects, as the appropriate area experts, was conducted to explore their perception and experience with regard to design quality in the industry. The first stakeholder analysis model was also utilised in the interviews. This chapter reports on this preliminary study.

4.2 Objectives

The objectives of this study were defined as follows:

(preliminary objective 1) To explore architects' perspectives on design quality in real-world building projects

(specific objective b1) To devise and apply a stakeholder analysis model based on stakeholder definition to map the two-way relationship between design quality and its stakeholders

4.3 Study design

The study was mainly for exploratory purposes, which is advocated for early research stages and when a better understanding is sought for about a complex phenomenon (Denzin and Lincoln, 2005; Robson, 2011). An exploratory approach could inform the next stages of the research project by assessing its value and feasibility and guiding the path to more conclusive studies (Kumar, 2014).

4.3.1 Data collection

In-depth semi-structured interviews were considered appropriate as the data collection method. According to Rubin and Rubin (2011), in-depth interviewing is suitable for

exploring complex matters. A semi-structured design with its flexibility is also recommended for interviewing experts who will not *'submit tamely to a series of prepared questions'* (Gillham, 2005).

Based on the literature and study objectives, an interview guide was developed covering four topic areas and ordered to ensure suitable flow of concepts (Table 4-1). To maintain consistency, the main questions remained unchanged across all the interviews, however, the flexible design allowed for probes and follow-up questions as well as emerging discussions. A copy of the interview guide with the inclusion of probes and follow-up questions are given in appendix A.

Topic Areas	Main Questions
1. Design Quality Concept	How do you define the concept of design quality? What do you consider as good design?
2. Design Quality in Project Process	How is design quality ensured in projects considering various objectives? How are related decisions made?
3. Design quality Stakeholders	Who are the stakeholders of design quality? To what extent they can affect and are affected by design quality?
4. Design quality Stakeholders in Project Process	How are design quality stakeholders managed in projects? How are their requirements are integrated into related decisions? What tools are used?

Table 4-1: Interview topic areas and main questions

Enquiry about design quality stakeholders, i.e., topic area '3' (table 4-1), was facilitated by employing a matrix-based stakeholder analysis model devised based on Freeman's (1984) definition of the term 'stakeholder' (discussed in section 2.4 and 2.5). In light of his definition, design quality stakeholders are 'any individual or group who can affect or is affected by the design quality of the completed building'. Of note is a two-way relationship between design quality and its stakeholders inherent in this definition, in that both could affect each other. Figure 4-1 depicts this matrix. The aim was for the participants to map the stakeholders they identify based on the extent they can affect design quality and the

extent they are affected by it. A simple numerical scale of 0 to 5 and their verbal equivalents (i.e., very low to very high) were also provided for the interviewees to use whichever they preferred.

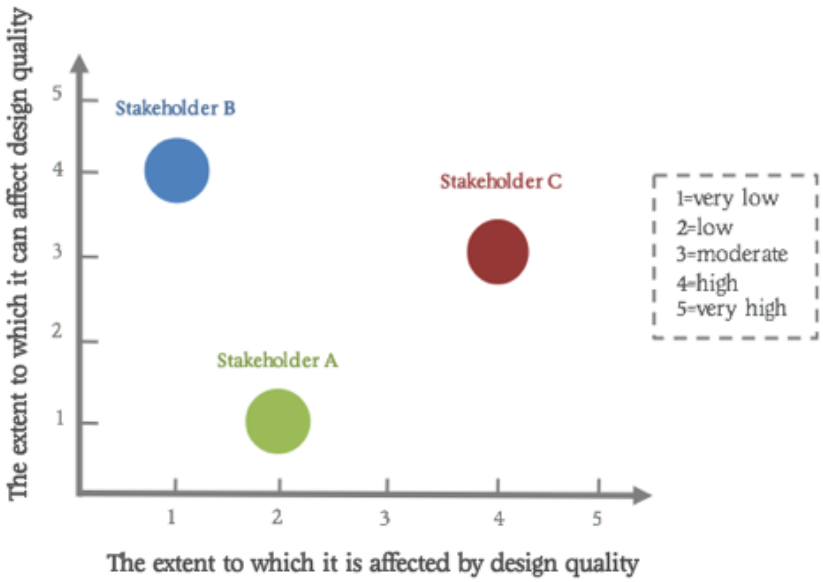


Figure 4-1: Stakeholder analysis matrix devised based on Freeman's (1984) definition

Although the topic could be relevant for various building types where design quality is an important output, it was decided to orientate the questions to the healthcare sector where the role of design quality is prominent and multiple stakeholders often exist (van Hoof et al., 2015; Lawson, 2010). Moreover, the matrix exercise could be better used when the study is constrained to a specific sector.

Sample:

Experienced architects involved in design quality decision-makings and management of stakeholders were considered as an appropriate target population. The architects were chosen because they deemed to be the key group who were relevant and knowledgeable about the state of design quality in the current industry and also about the its management and approaches to its improvement. Since the study was exploratory, the sample size was not strictly set and instead the concept of 'data saturation' that is often associated with qualitative analysis and suggests the continuation of data collection until no new major theme is added to the dataset, was used (Marshall, 1996). Non-probability Sampling with

elements of convenience and purposive techniques was used for recruitment as discussed in section 3.3.2. The RIBA directory of architecture firms specialised in healthcare sector was consulted and forty potential participants were approach with an invitation letter detailing the study intent and content.

Procedure:

The interview procedure was devised beforehand. Each topic was allocated fifteen minutes, making the interview duration with pre and post arrangements a total of seventy minutes. Prior to the questions, the participants were encouraged to re-read the information sheet – originally sent a week earlier – and asked to sign the consent form (copy in Appendix E). The study objectives were explained and the intended definition of 'design quality stakeholder' was presented. Sticky labels were provided enabling probable re-positioning. Permission was sought from the participants on the consent form to audio-record the interviews in order to aid data analysis. At the end of the interviews, the participants were thanked for their time.

4.3.2 Data analysis

A thematic analysis process by Spencer et al. (2013) was employed for qualitative data analysis. They suggested starting with 'data management' and towards 'abstraction and interpretation' in a number of steps, at each a level of abstraction in analysis is attained incrementally. However, these occur almost simultaneously, iteratively and with overlaps, as is the case with most qualitative analyses.

The interview recordings were transcribed verbatim after each interview. These were read a few times to allow for data familiarisation. This step included labelling passages and generating an initial thematic framework based on the interview questions and related points made by the interviewees. Using MS Excel, a matrix-based format – with rows as themes and columns for each interviewee – used for organising the data material and constant comparison. Data reduction, ordering and collating were performed in a number of iterations until manageable and meaningful segments were dissected for each theme.

By taking a more interpretive manner in the next step, the generated matrix was reviewed with scrutiny in order to '*go beyond the surface of the data*' (Braun and Clarke, 2006) and to identify higher-level themes by integrating relevant sub-themes. The data were then re-organised based on these underlying themes in advance of reporting. For theme identification, study objectives, theoretical interests and emerging issues from empirical data were put into consideration as suggested by Attride-Stirling (2001). The matrices were also examined in two manners. First, each matrix was analysed individually and then repeating stakeholders were compared across the matrices.

4.4 Findings and discussion

This section presents and discusses the study findings. Eleven individuals from eight architecture firms took part in single or group face-to-face interviews (Table 4-2). These included participants with senior positions and extensive experience (over 10 years). The matrix exercise was not completed in two interviews – Int3 and Int5 – due to time limitations, however, both interviews still contained rich comments on the stakeholder related questions. The first interview served as pilot but was included in the study as no subsequent modifications were made to the questions.

Participants	*Position*	*Experience*	*Interview*	*Matrix*
P1-1	Director	Over 20 years	Int1	Mat1
P1-2	Partner	Over 20 years	Int2	Mat2
P1-3	Director	10-20 years		
P1-4	Partner	10-20 years	Int3	-
P1-5	Senior Architect	10-20 years		
P1-6	Partner	10-20 years	Int4	Mat3
P1-7	Director	Over 20 years	Int5	-
P1-8	Director	10-20 years	Int6	Mat4
P1-9	Director	10-20 years	Int7	Mat5
P1-10	Director	10-20 years		
P1-11	Director	10-20 years	Int8	Mat6

Table 4-2: Profile of the participants in study one

The thematic analysis yielded three overarching themes with which the findings are sectioned and presented here (Figure 4-2). The first theme 'design quality characteristics' is mainly mapped onto the topic area 1 and partially onto 2. It revolves around the characteristics of design quality or 'product' of the building project. Topic area 3 and the findings from the matrix exercise formed the second salient theme, i.e., 'two-way relationship between design quality and stakeholders'. This implies the 'product-people' interplay. 'Stakeholder relationship regarding design quality' emerged as the third theme based on the data pertinent mainly to topic area 4 and also 2. It highlights the 'product' related interactions between the 'people' during the 'process'. It should be noted that these themes are not mutually exclusive and there exists degrees of overlap between them. In the following, each of these themes and related sub-themes are described and discussed.

Theme One	Theme Two	Theme Three
Design quality characteristics	Two-way relationship between design quality & stakeholders	Stakeholder relationship regarding design quality
product	product - people	people in process about product
topic area 1 & 2	topic area 3	topic area 4 & 2

Figure 4-2: Salient themes and the main topic areas they mapped onto

4.4.1 Theme one: design quality characteristics

Sub-Themes for Theme One
Difficult & tricky to define
Subjective & based on individual perceptions & experiences
Sector & Project-specific
Multi-faceted & multi-attribute
Dynamic and changing over time and across regions
Matching the brief versus exceeding expectations

Need for optimisation due to potential conflicts between: • Project objectives (time, cost and quality) • Design objectives (various design attributes) • Design objectives & regulations

Table 4-3: Sub-themes under the Theme One

The first noticeable point regarding the concept of design quality was actually the difficulty in defining it. This was evident during the interviews where most participants had to take some moments expressing, changing or expanding their definitions. Comments like *'a very tricky question'* [P1-4] and '*it is a difficult question'* [P1-6] were examples. P1-1, while finding the question interesting, also referred to a recent conversation he had with a contractor who said to '*really struggle to understand what is meant by quality of design'.* In a similar vein, Dewult and van Meel (2004) also referred to the absence of consensus on and the difficulty in defining design quality.

This defining issue does not reflect any lack of knowledge of the participants –who had many years of experience and were positioned at senior levels in their practices – but is, in fact, rooted in other characteristics of this concept. The definition can vary from one individual to another as P1-7 said *'it depends on which side of the fence you are sitting'* or when P1-6 mentioned '*it depends from the viewpoint of which stakeholder you look at'*. Design quality – according to P1-1 is defined based on '*individual perceptions*' and '*varies by people'* and because of that is very much a subjective matter. In this regard, P1-4 linked design quality to individual experience and said '*it is all about the benchmarking process, you always assess the quality of space based upon previous experiences*'. Likewise, van Voordt (2009) saw the reason behind differing opinions on a building's quality to be personal preferences and different interests and backgrounds. Nasar (1994) also linked people's perception of a building's features to the previous experience they had with that particular class of building.

Besides this subjectivity, there is another facet to the nature of design quality, which is being project-specific. Although the focus was on the healthcare sector, the diversity in healthcare settings and projects' circumstances prevent one from giving a universal

definition even for healthcare environments. This point was specially observed when the participants tried to distinguish between good and bad buildings by emphasising key attributes. P1-9 found build quality and longevity as important while P1-11 referred to natural light and ventilation as primary areas for good design. It is interesting to note that P1-9 was involved in spaces for patients with dementia and P1-11 in primary health centres. This issue could in fact extend beyond only healthcare sector.

Apart from these characteristics, the responses provided two more dimensions to design quality, which further clarify its nature. Firstly, the design quality is multi-attribute and all the participants agreed on that either directly in their definitions, e.g., '*it is a synthesis bringing together many different aspects*' [P1-6] and '*it is a complex, multi-layered, and multi-disciplinary experience*' [P1-4] or indirectly when naming different attributes for building design, like accessibility, privacy and patient pathway. It was interesting to see that four participants – i.e., P1-2, P1-3, P1-6 & P1-7 – directly referred to the 'DQI' tool classification, i.e., functionality, impact and build quality, where P1-2 even believed that all diverse architectural styles talk about these three elements but interpret them differently. The same point was made by Volker (2010), as mentioned in section 2.2.3.

Another characteristic noted in the literature is the dynamism of design quality definition (Slaughter, 2004). According to P1-2, it changes over time and varies across different cultures. This point was corroborated by P1-8 with experience in international projects who referred to the differences in design quality perception in other regions, for instance where male and female patients need to be split.

Probing the responses further hinted on how the architects give meaning to design quality by linking it to a number of considerations for its fulfilment during projects. The first of these was the role of briefs. In the same way as P1-8 who said '*design quality is matching the client's brief*', P1-5 and P1-11 also pointed out similar comments. However, P1-7 gave an emphasis on the need to exceed initial expectations in order to delight the client by providing better quality than what was asked in the first place. P1-4 also brought up a

necessary 'push' of the quality attributes by the designers. It is also worthy to mention that P1-11 found briefs to be *generally very poor* especially in healthcare where '*they are often written by managers and not designers*' causing '*an immediate disconnect*' with the client's wants. P1-7 while echoed this, added that the briefs often change during projects. In the literature, inexperienced clients with lack of required knowledge are mentioned as a barrier to effective briefing in construction projects (Kelly and Duerk, 2002).

A challenge towards design quality achievement is the potential conflict between various project objectives and the existence of resource constraints, hence the need for optimisation, prioritisation and compromise. P1-11 referred to this by describing the design journey as '*delivering as much quality as possible with minimum compromise within the time and budget constraints*'. P1-7 showed discontent over the fact that '*it is usually the quality that is chopped*' although what '*lives on*' and wins people's praise over time is this very quality in buildings. On tension between quality and cost many participants referred to the need to have a lifecycle costing approach in line with Saxon (2005). P1-1 said '*the construction cost is important but not as important as the lifecycle cost*' and found the latter key in '*maintaining design integrity*' and '*ending up with satisfied users*'. P1-7, P1-10, P1-11 and P1-12 argued similar points.

Tension was also mentioned to exist between design objectives and regulations especially for healthcare environments. P1-4 and P1-5 argued that although the aesthetics is highly important, the architects are limited about what they can do to maintain patient dignity or minimise infection. Although compliance to these is essential, P1-1 and P1-4 believed by sticking to only guidance (like HBN and HTM[1] in healthcare), one could not get *'terribly satisfied'* end-users and the architects need to '*a lot of time challenge*' them.

Another important point raised was the need for optimisation between design objectives or design attributes. All participants were on the same opinion that they need to prioritise

[1] Health Building Notes and Health Technical Memoranda

different design objectives and often have to compromise; P1-2 by saying *'of course, architecture is about the best compromise'* pointed out that the prioritisation should be based on '*what a building is for, it is a hospital and not an art gallery or cultural building'*.

4.4.2 Theme two: two-way relationship between design quality and stakeholders

This section presents the findings about design quality stakeholders and the matrix exercise. Together with aiding stakeholder identification, the use of the matrix especially helped the participants to convey their perspectives about the position of stakeholders in comparison with each other. As mentioned in section 4.3.2, the analysis of the matrices was performed in two manners, i.e., in-case and cross-case. To avoid repetition, the findings are presented here based on the latter and for seven stakeholder groups as sub-themes (table 4-4).

Sub-Themes for Theme Three			
Patients & visitors/families	Clinicians & non-clinical staff	Facilities managers	Architects
Builder contractor	Client body	Government/Regulators	

Table 4-4: sub-themes under the Theme Three

Design quality in healthcare buildings represents a large number of stakeholder groups: *'we may have 15 to 20 different stakeholders'* [P1-6], *'there are too many stakeholders usually'* [P1-8]. Figure 4-3 shows how the participants mapped the stakeholders they identified for healthcare settings. Photograph of one of the filled matrices is given in appendix A. 17 stakeholders of healthcare environments were collectively identified on the matrices and positioned based on how much they could affect or were affected by design quality, in the participants' perceptions. In the followings, the results are discussed for the different stakeholder groups.

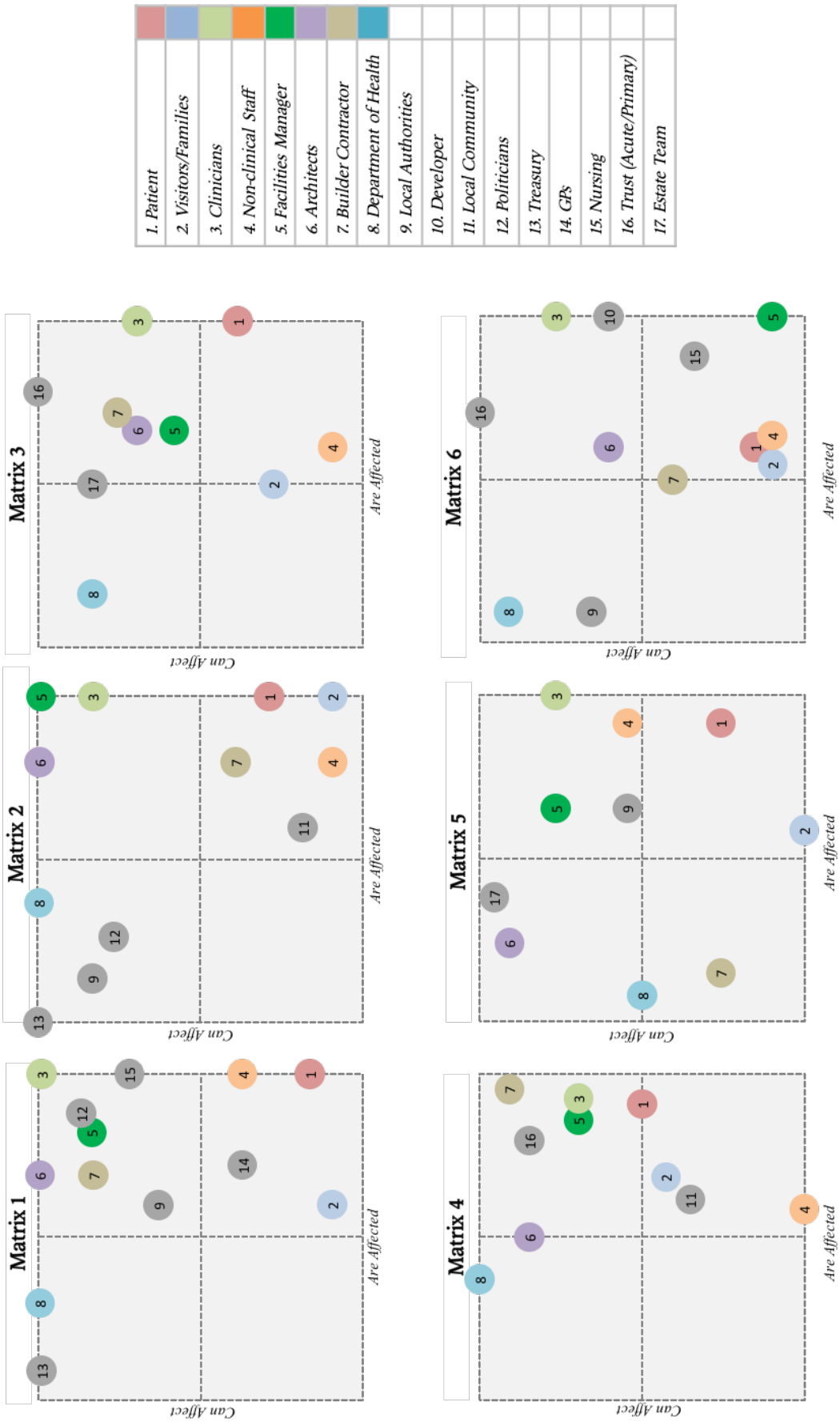
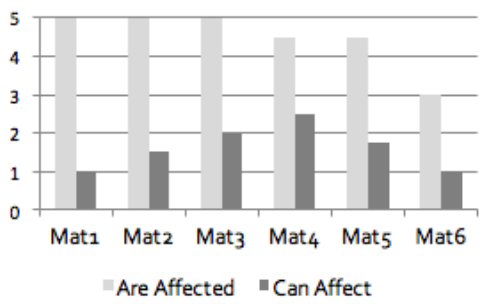


Figure 4-3: Results from the stakeholder matrix model

4.4.2.1 Patients and visitors/families

The position of the 'patients' on the matrices clearly implies that they are highly affected by design quality but left with limited influence on related decisions in the participants' viewpoint (figure 4-4). They are repeatedly located at the lower right corner. The built environment can affect the patients in different ways from medically related aspects to general wellbeing way-finding and reduced infection (Ulrich et al., 2010; Huisman et al., 2012). On the other hand, their input, if any, according to P1-1 and P1-10, is mostly on aesthetics and are relayed by a liaison. Lawson (2010) similarly indicated that many stakeholders in healthcare projects have little or no voice in the briefing process. Mat6 (matrix 6) shows a relatively moderate impact of the building on the patients. According to P1-11, who was referring to primary healthcare centres, this is because the patients stay a short time in these spaces so the environment does not affect them that much. This suggests that the design quality impact upon patients and other stakeholders likewise, can vary by building type.

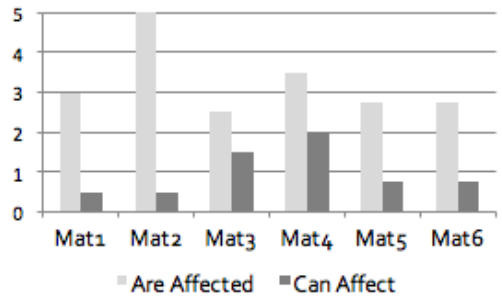


'The patients are the most important stakeholders by distance, they are the reason we build the facility, but generally they don't get asked, they are ignored' [P1-1]

Figure 4-4: Matrix results for stakeholder 'Patients'

Visitors and patients' families are affected less than patients according to the participants but still there is a marked discrepancy between how much they can affect design quality and how much they are affected by them (figure 4-5). With the exception of the Mat2, this group is located at the lower centre of the matrix space. In Mat2, the interviewees considered the visitors/families to be highly affected by design quality especially in children hospitals

where parents or siblings often stay and sleep with the children. Huisman et al. (2012) mentioned that visitors may play an important role in patient's recovery.

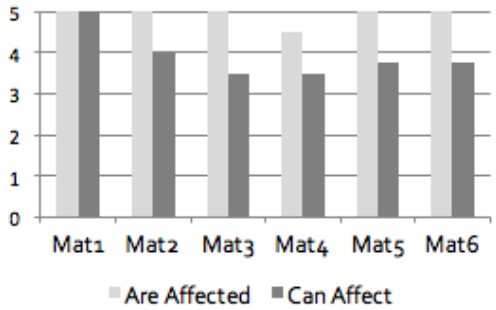


'By design you give them a boost and a nice environment to be in a positive mind frame to visit their sick relatives' [P1-3].

Figure 4-5: Matrix results for stakeholder 'Visitors/Families'

4.4.2.2 Clinicians and non-clinical staff

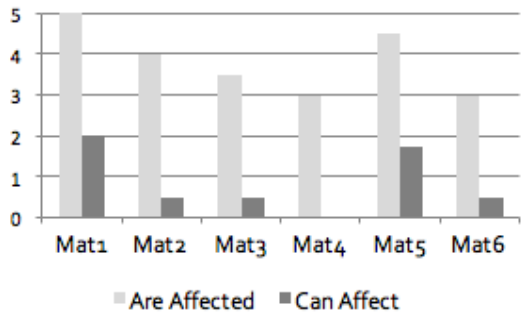
The next major stakeholder group are the people working as the staff in healthcare buildings. These include doctors, surgeons, nurses, GPs, Physiotherapist, receptionists, cleaners, hospital managers etc. The clinicians, among these, were considered by all the participants to be affected highly by the design quality and also with high influence on related decisions (figure 4-6). They are located on the top right corner of all the matrices. Compared with the patients, these are considered to be equally or sometimes even more affected. Unlike the patients, the participants found them to be involved in design quality decision-makings and more regularly present in the stakeholder workshops. Even P1-2 believed this high power is '*at the expense of other people'.*



'The design team should engage the senior clinician who understands the clinical service so the design supports it' [P1-1].

Figure 4-6: Matrix results for stakeholder 'Clinicians'

Unlike the clinicians, the non-clinical staff, e.g., receptionists, cannot affect the decisions proportionate to the level they are affected by from the viewpoint of the participants (Figure 4-7). Similar to the 'patients' and 'visitors/families', they are not very much involved in the decisions. However, as P1-2 said, they should be more engaged.

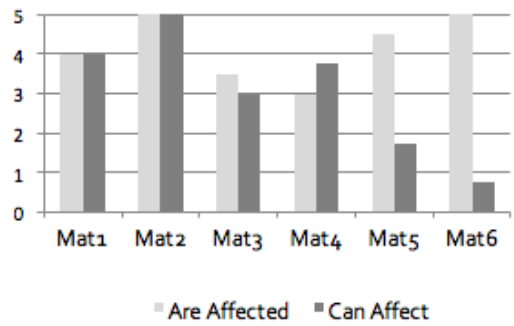


'They should have more influence, they should be more involved, because they make everything work, the building has considerable impact on them' [P1-2].

Figure 4-7: Matrix results for stakeholder 'Non-clinical staff'

4.4.2.3 Facilities Managers

Facilities Managers (FMs) are another stakeholder group responsible for right operation of the building when in use. The results from the matrices show that design quality impacts highly upon FMs despite somewhat less than that on patients and clinicians. However, how much they can affect varies across the matrices. Although P1-2 believed they, in general, ought to be much more important than they are, in some projects their presence in decisions is required contractually.



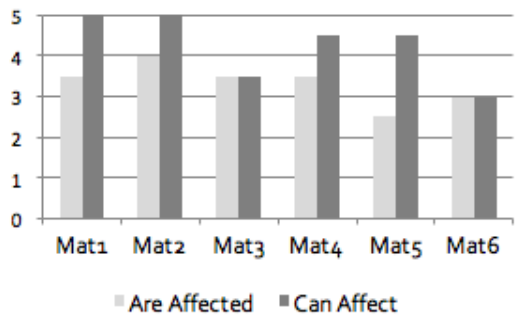
'Everything is being decided before they ever come on picture, if the building is overheating because there is not enough ventilation these are the guys constantly paying the price for that' [P1-11].

Figure 4-8: Matrix results for stakeholder 'Facilities Managers'

4.4.2.4 Architects

Architects or the design team from architecture firms are a key stakeholder group of design quality. The participants considered a fairy high power for this group in influencing design decisions (figure 4-9). P1-6 stated that the way the architects usually affect the design is not by making the final decisions but by providing alternative solutions; *'People make choices and select options but we influence the options'*. While the influence of clinicians is mostly on the specialist equipment and services and the influence of patients on the aesthetics side, P1-2 believed the architects can influence all aspects of design.

In terms of how the architects are affected is on a different level to the way users are affected, that is '*in a commercial sense*', according to P1-11. Whether the architects deliver a high quality design or not can affect their reputation to become engaged by the client again and also in terms of the lessons they learn for future projects.



'We are not affected in a clinical level, but we are affected greatly in terms of ourselves as business' [P1-3].

Figure 4-9: Matrix results for stakeholder 'Architects'

4.4.2.5 Builder Contractors

The results from the matrices for builder contractors show inconsistency in opinions, similar to the FMs. The Mat5 and Mat6 indicate that this group is affected modestly by the design quality, whereas the other matrices tell a different story. The variance can be seen for both the extent to which they are affected as well as their ability to affect the design quality. *'It varies enormously depending on the project,* P1-2 said. For large projects they have more power and are more affected compared to small extensions or refurbishments,

according to P1-6. In more recent procurements systems - referring to the PFIs - P1-8 believed '*they now have a far more influence, they become the client'.* In contrast, P1-2, P1-11 and P1-12 perceived moderately low influence from contractors on design decisions, based on their experience. *'They don't get a huge amount of input in the decisions',* said P1-11. Some showed dissatisfaction with contractors' high influence. P1-8 referred to the '*intense conversation'* they have with contractors sometimes. P1-11 went further by saying:

> *'They will build whatever is on a piece of paper and it doesn't matter if it doesn't work because it is not their responsibility, this is our responsibility. They benefit from the success of our scheme.'* [P1-11]

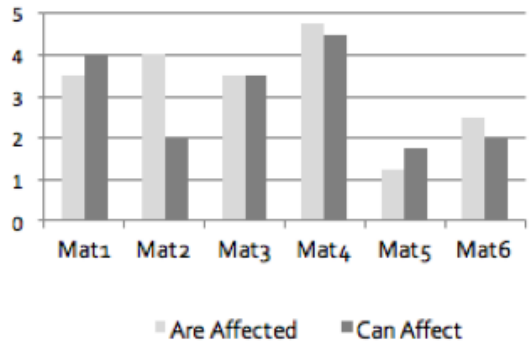


Figure 4-10: Matrix results for stakeholder 'Builder Contractor'

4.4.2.6 Client Body

The client could denote different groups or individuals in different projects. They could themselves be users or a hospital board. In our matrix exercise, groups like the NHS Trust, NHS Estate Team, and developer are categorised as the client body. This point was also reflective in some of the comments like *'it's not just a person in a hospital'* [P1-1] or '*the client in a healthcare building is not one person it is always maybe about 15 people'* [P1-6]. This point has been also raised by the Sengonzi et al. (2009) that especially for organisations like the NHS, the client is not a single point of contact but comprised of several interest groups. The client was considered as the '*ultimate decision makers'* [P1-4] with very high

influence on design quality and similarly with high responsibility in terms of what it becomes in the building.

> *'They just dictate the whole of the project, rather than really one of the separate attributes, they influence lot of the attributes. They make decisions about the overall project'* [P1-6].

4.4.2.7 Government/Regulators

The 'department of health' was identified in all matrices and was consistently positioned in the top left quartile. P1-10 described them with '*high and considerable influence on design decisions*'. Setting programs of investment and commissioning design guides are examples of how they affect design quality in projects, as brought up by P1-2 and P1-8. Although this group is not equivalently affected according to the matrices, the quality of buildings also affects them, as they are *'responsible for the nation's health'* [P1-2].

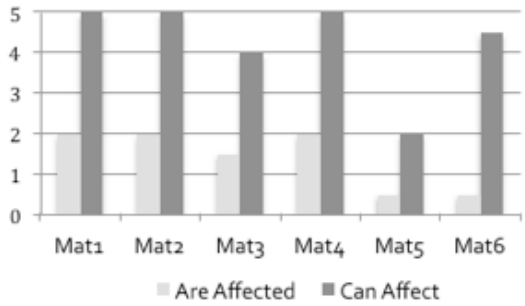


Figure 4-11: Matrix results for stakeholder: Department of Health

Politicians and the treasury were identified in two matrices with high influence yet considered to be increasingly remote by the others. Local authorities, unlike the politicians, were seen to have more influence on design quality decisions recently especially for community health centres. In most matrices, they are considered to be fairly equal in terms of both axes. Par1-11 pointed out that *it is literally us going to meet them.*

4.4.3 Theme three: stakeholder relationship regarding design quality

Sub-Themes for Theme Three
Importance of appropriate stakeholder interactions & engagement
Challenges exist for stakeholder interactions: • Difficult, time consuming • Conflict of interest among stakeholders • Messy communications • Language barrier
Need for Competent and skilful architects
Use of facilitating tools: • Post Occupancy Evaluation (POE) • Design Quality Indicator (DQI)

Table 4-5: Sub-themes under the Theme Three

With the complexity of design quality and its relationship with several stakeholder groups, an appropriate strategy for stakeholder management during the project process becomes paramount. In this regard, the participants highlighted the role of interactions and engagement.

> '*The more dialogue and interaction we have with the end-users, the more confident we become that the quality of design is appropriate.'* [P1-4]

Participants referred to a series of formal communications, workshops and meetings as well as informal conversations as various channels of they have with other groups. This point was recurrent in the responses.

> *'It is lot more about communications, and workshops and meetings and discussions; we get to speak to same format, less formalised way, more personal interactions.'* [P1-6]

There was a lot of emphasis on engagement of stakeholders especially that of the user group in the process in order to achieve design quality.

> *'It is important to get the stakeholders involved at the outset and throughout the process... If you do not do it, you will end up with a design that fails.'* [P1-1]

> *'It has to be all considered so all users have their sort of input into the final design then that creates a strong design'* [P1-9]

However, the participants found the interaction process not challenge-free. They described the engagement process as '*difficult and formidable'* [P1-1] and the communications '*quite messy'* [P1-6]. They also referred to *'conflict of interests'* between different groups [P1-4] and the presence of a '*language barrier'* [P1-2].

Evidence in the dataset on conflict of interest was evident. For example, clinicians sometimes consider their own wants more than that of the patients, as mentioned by P1-1 and P1-8. Contractors sometimes show low interest in design quality but just in the cost factors, according to P1-8 and P1-11. P1-3 even said the facility managers could wrongly influence aesthetics elements, which can be considered as irrelevant to their needs.

> *'Some people are concerned with the money, some people concerned with cleaning and maintaining, some with how you carry out the clinical procedures, and others who looking for more difficult-to-define aspirations, the aesthetics or the design philosophy'* [P1-6].

Appropriate interaction and relationship among stakeholders is seen as highly important considering that they usually have varying power to influence decisions, as demonstrated in the previous section. To deal with this, P1-1 believed that stakeholder groups should be met individually in order to understand their influence as well as needs but also to *'equally make them understand that there are several other groups with different perspectives and*

needs'. P1-9, interestingly, was of the opinion that the best way is to gather all stakeholders together so that they can talk and communicate with each other and the decisions can be made quicker, as a result.

With respect to the language barrier, P1-1 urged the importance of asking the appropriate questions. Similarly, P1-6 warned not to '*lose people through technical summaries'.* P1-2 also pointed out that sometimes architects fail to explain their work in a jargon-free, understandable manner for ordinary people and gave an example of such happening in a project where this caused considerable project delay.

Managing stakeholders and their interactions demand skilful architects and managers. Macmillan (2006), by referring to the complexity of stakeholder relationships, urged the need for a skilled facilitation process. Evidence was also present in the responses. P1-4 believed properly discovering stakeholders' needs is '*an art or skill that you gain through experience'.* P1-10 thought it is a technique to '*draw out information'* and that the questions '*have to be worded quite cleverly'.* P1-1's comment was also noteworthy:

> *'You need to be a politician, a headmaster, a psychologist, you need to have all those attributes to bring these different people into one room and have a meaningful and useful conversation'.*

To facilitate effective interactions and communications, a range of tools are also used from drawings, mock-ups, and 3D visualisation to evaluation and appraisal methods. The role of Post-Occupancy Evaluations (POEs) and the Design Quality Indicator (DQI) was a major point of reference during the interviews. All participants asserted the value of POEs for design quality evaluation.

> *'I think it is absolutely fundamental and of paramount importance to evaluate projects by post occupancy evaluation'.* [P1-1]

'I think it is extremely useful, it might dust a few myths in terms of what we believe we are doing it right'. [P1-7]

P1-4 and P1-6 talked about the role of POE in providing learnings and informing future projects. According to P1-1, conducting POE can reveal where stakeholders' needs were not understood appropriately. He gave an example:

'A portable heating system shows lack of understanding or engagement in the design process'

Despite the importance, most believed POEs were not implemented adequately or flawlessly. P1-9 and P1-11 mentioned they do POEs only sometimes. P1-7 and P1-1 echoed by saying:

'The evaluation happens so seldom... in my experience, you design a building and you will start a new one and do not look back.' [P1-7]

'People can't be bothered to, we just do not do it, or it gets evaluated in an unstructured way'. [P1-1]

The reasons for not conducting POEs were said by the participants to be mostly time constraints and not seeing the value of it. Hadjri and Crozier (2009) reported similar barriers and some others such as cost, skills and lack of agreed and reliable indicators.

The discussion on tools delved into the use and usefulness of DQI tool. Six of the participants mentioned they had used DQI tool (or its healthcare version then, AEDET[2]) in their projects. They had a positive opinion on the DQI conceptual framework with P1-6 referring to it as the '*best and universal summary*' of design quality evaluation criteria.

[2] 'Achieving Excellence Design Evaluation Toolkit'

Operationally though, there were altered opinions. P1-2 found it '*operationally too complicated*' and believed a smaller number of questions are more suitable. P1-1 lamented that '*a meeting of 30 minutes is insufficient for a £30 million project*'. P1-2, who himself was a contributor to DQI development, believed the usefulness is somewhere else.

> '*First to facilitate a conversation within an organisation that never normally happened before. Second to show them what design is. Most people think the architecture is only about pretty pictures*' [P1-2]

He also added that although people score the statements, what is valuable is the conversation happening between participants on the design quality attributes. As discussed in section 2.2.4.1, Gann et al. (2003) suggested the same and called the DQI as '*a tool for thinking*'. Most participants were of the opinion that the tool's outcomes are not often integrated into the decisions with P1-11 saying in the majority of cases, it is just to '*tick a box*'. P1-7 restated by saying '*there is no transition between the results coming out of the DQI and how the decisions are made*'. P1-2 believed this integration is '*quite difficult*'.

4.4.4 Discussion of the study approach

The study approach was successful in eliciting the opinions of the participants and stimulating valuable discussions. The defined topic areas and main questions were covered during all of the interviews, contributing to the credibility (validity) of the study. Credibility was also ensured by using well-established methods of semi-structured interviews and thematic analysis. The involvement of highly knowledgeable and experienced participants and the overall alignment between the findings and the literature also contributed to the study's credibility. With respect to the stakeholder model used, it was immediately noticeable during the interviews that the participants found it interesting, useful and engaging. Although simple, it proved to be a powerful tool to explore the phenomena.

The raw data was considerably voluminous and messy, however, the iterative analysis method used allowed appropriate theme development - although one could still find degrees of overlap. The findings were presented using verbatim quotations and comparison between participants. The results of stakeholder matrices were demonstrated both in-case and cross-case. Triangulation of data sources, i.e., the stakeholder model results and qualitative discussions, at both stages of data collection and analysis improved credibility as well as dependability (reliability) of findings. As mentioned in Chapter 3, the mixed methods approach assisted in providing a more comprehensive account of the topic and explanation over numerical choices by the participants.

Many scholars question whether generalisation should be an aim in qualitative research since it involves a small number of subjects (Shenton, 2004). The numerical findings assigned to stakeholders on the matrices are not numerically generalizable, although the overall imbalance in the stakeholder variables was mentioned by the participants to be present in other settings. To this, one could add the characteristics of design quality and the need for stakeholder relationship analysis and management. The study was bounded to the healthcare sector and obviously other settings could have different stakeholder groups, although many like architects or clients should be present in other built environment settings as well. The devised and tested stakeholder model, however, could be applicable to other settings and projects. It should be also noted that the dependability of the findings could be further enhanced by using peer scrutiny of the data, which was not possible due to practical constraints.

4.5 Conclusion

The study fulfilled the preliminary objective 2, defined in section 4.2. It revealed that the architects' opinions regarding the concept of design quality in a multi-stakeholder project environment such as healthcare could be described in terms of 'design quality characteristics', 'two-way relationship between design quality and stakeholders', and

‘stakeholder relationship regarding design quality’. Several characteristics such as ‘multi-attribute’, ‘subjective’, and ‘context-specificity’ were derived. It was concluded that there is an interdependence between design quality and stakeholders, who have varying degrees in terms of their ability to affect and their being affected by design quality. These could be dependent on the type of building or the procurement method used. According to the study results, the end users such as patients and non-clinical staff do not have enough influence in design quality decisions, while being highly affected by. Stakeholder relationship and the need for their management, although challenging, were highlighted as well. In doing so, tools such as POEs and the DQI are useful.

The study was also able to utilise the matrix-based stakeholder model (objective b1) through which seventeen stakeholders of design quality were identified, and evaluated in the context of healthcare buildings. This stakeholder analysis technique was found to be effective and an appropriate response to the lack of empirical operationalisation of stakeholder definition highlighted by Money et al. (2012) – as discussed in Chapter 2.

The study was instrumental in informing the next research stages and in verifying the value of the postulated research aim and questions. The findings in all three themes, while emphasising on the importance of achieving design quality, hinted on a number of important factors to maintain in the projects. Examples are ‘appropriate briefing’, ‘prioritisation of objectives’, ‘whole-life view’, ‘stakeholder identification’, ‘appropriate level of influence’, ‘stakeholder involvement’, ‘effective communication’, ‘competence’ and ‘evaluation tools’. These could not be considered as thorough and were not the result of a methodical approach. Hence, a dedicated study to identify and evaluate design quality CSFs would be valuable and needed. The DQI classification, credited both in the literature and by the study participants, could be used as the ‘success criteria’ – or outcome variables in a later quantitative study.

Moreover, the use of a stakeholder analysis model for better understanding of the attributes of design quality stakeholders was promising in the study. The model used here was a

simple one and there are more advanced models to enhance this aimed-for understanding, as discussed in Chapter 2. In addition, the unbalanced distribution of power between the stakeholders depicted in the matrices urges the need for an effective relationship between them. This relationship could also be modelled and examined using the network-based models. The two more advanced stakeholder analysis models are used in Study 3 and Study 4.

5 Chapter Five

Exploring expert opinion on CSFs for design quality achievement (study 2)

5.1 Introduction

Study One, into the architects' viewpoints of design quality, showed a notable part of the interview responses to be about how design quality should be achieved with the participants providing many hints about important factors. This further supports the primary objective A of this research to explore and improve the understanding about critical success factors (CSFs) for design quality achievement in building projects. As the literature review (Chapter 2) showed, there is a lack of coverage of this topic in 'design quality' as well as 'project success' areas despite its value.

Obviously, the factors expressed by the participants in Study One cannot represent a thorough and reliable CSFs list and a methodical study focused on obtaining such a list is needed. For this purpose, the rich literature of project success with various methods and aspects to CSFs identification and evaluation, as reviewed in section 2.3.2, is helpful. As stated in Chapter 3, the specific objectives pertinent to the CSFs strand are addressed in the second and third empirical studies. This chapter reports on the former to identify potential CSFs from the viewpoint of area experts.

5.2 Objective

This study pursued the following objective:

> **(specific objective a1)** To identify potential CSFs for design quality achievement from the viewpoint of area experts

Therefore, it addresses 'the how' question to design quality achievement. It should be noted that the factors found through this study will be further validated in the next study, hence, are named as 'potential' here.

5.3 Study design

This section describes the study design and its implementation process.

5.3.1 Data collection

As stated in Chapter 2 (section 2.3.2), the majority of CSFs studies have relied on previous literature as their main source to develop a factor list prior to evaluating them in their specific contexts (if they have done so). This approach could be appropriate in areas where there is adequate prior research on CSFs, for instance, where general project success is concerned. However, design quality achievement, or in other words, building success, does not benefit from a body of previous CSFs literature. In fact, as mentioned earlier, there was little attempt found with focus on design quality to date. Therefore, a solely deductive method could not be an appropriate choice for the purpose of this study. Instead, a more grounded, inductive approach where first-hand knowledge is collected through interviewing experts – as similarly pursued by Phua (2004) – was justified.

5.3.1.1 Data collection instrument

The study questionnaire contained only one question regarding what the participants perceived as to be the critical factors for design quality achievement in building projects. A copy of the questionnaire is provided in Appendix B. To ensure clarity and also facilitating the identification process, a number of points were considered in the questionnaire development. Besides the intention and context of the study, the concept of CSF and its relationship with project success, based on the literature, was described. The participants were asked to identify between 15 to 25 factors critical for design quality achievement, which were as mutually exclusive and collectively exhaustive as possible.

Two facilitating components were also included. First one was a framework that could aid in identifying the factors with respect to specific perspectives (figure 5-1). The participants could identify their perceived CSFs for different areas of design quality, project stages,

stakeholder groups and in terms of issues that could be an enabler or a barrier. To further facilitate the process, a list of examples of CSFs identified in the construction literature was included in the questionnaire, in case the participants would perceive any of them to be applicable to the design quality achievement. This list is also given in the appendix B with their reference sources.

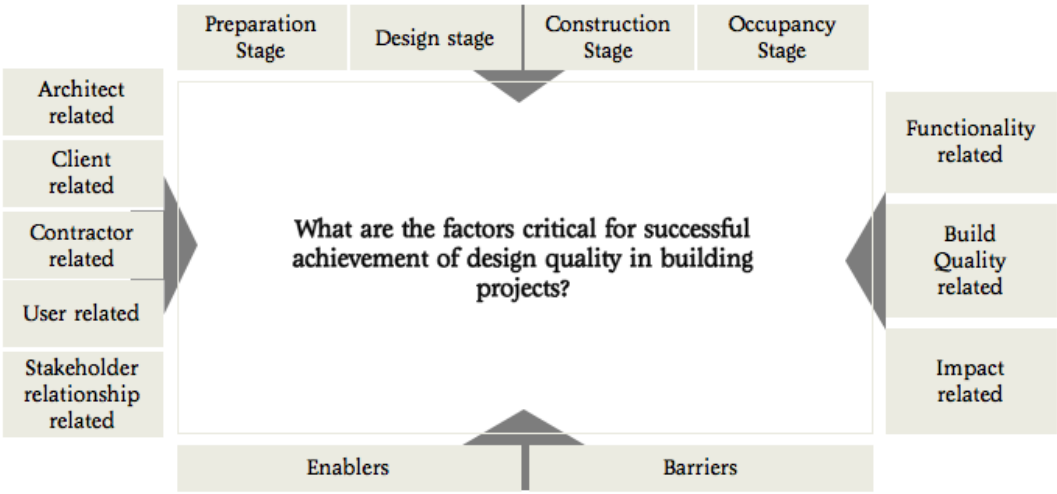


Figure 5-1: Facilitating framework used in the questionnaire for CSFs identification

5.3.1.2 Recruitment and participants

The aim was to approach those experts in the area with rich knowledge and experience on the issue of design quality. The target population was not limited to architects like the study one as it could benefit from the viewpoint of other stakeholder groups as well. The rationale for this choice of sample was that these experts were knowledgeable and experienced in terms of design quality and the critical factors for its achievement in building project. Approaching individuals with different backgrounds, e.g., architect, contractor or client, could result in multiple perspectives and thus, broadening the findings - as the exploratory nature of the study strived for. Similar to study one, 'data saturation' as recommended by Marshall (1996) for exploratory, qualitative studies was used for setting the sample size. Non-probability sampling was used. Through previous acquaintances and referrals, 10 individuals, out of 13 invited, participated in the study. Three participants were also involved in the first study and others were approached based on their

recommendations. Therefore, the sampling had a 'snowball' element as well (together with 'purposive' and 'convenience' techniques described in section 3.3.2). Table 5-1 gives the profile of the study participants. They all had senior positions in their organisations and more than 10 years of experience (half more than 20 years). Due to the focus on design quality, many were from architecture firms, however, the sample also benefited from individuals with client, project management, contractor and engineering backgrounds.

Face-to-face interviews incorporating the developed questionnaire was the preferred data collection method for the study and carried out with the first three participants in the table 5-1. However, two preferred to review their identified factors and return it through email later on. Due to this observed preference and also owing to the fact that the questionnaire was developed to be sufficiently self-explanatory, the rest of the participants were not met personally and instead, were asked to fill the questionnaire and return it through email. Therefore, the method changed to 'email interviewing'. According to Gillham (2005), email interviewing could facilitate easier access to the study participants – who due to their positions are deemed as busy individuals. For all the participants, the study information sheet was provided and consent was obtained (Appendix E).

ID	Position	Experience	Parent Organisation
P2-1	Partner	Over 20 years	Architecture
P2-2	Partner	Over 20 years	Architecture
P2-3	Managing Principal	Over 20 years	Architecture
P2-4	Senior Director	Over 20 years	Architecture
P2-5	Partner	10-20 years	Architecture
P2-6	Partner	10-20 years	Architecture
P2-7	Director	10-20 years	Contractor
P2-8	Consultant	Over 20 years	Engineering
P2-9	Programme Manager	10-20 years	Client
P2-10	Senior Project Manager	10-20 years	Project Management & Engineering

Table 5-1: Profile of the participants in study two

5.3.2 Data analysis

Once the data collection was completed, a procedure of refinement and consolidation was carried out in order to obtain a denser, manageable list of CSFs (figure 5-2). Thematic

analysis was used similar to Study One. The participants collectively identified 167 factors. In the first step, the data were imported to MS Excel for analysis and read through a few times for 'data familiarisation' as suggested by Spencer et al. (2013). P2-2 identified the highest number of factors (i.e. 25) and the lowest belonged to P2-5 with 9 factors. It was noticeable that many have identified similar factors although not all factors were mentioned by every participant. Some used a long statement and others a few words to represent a factor. Instead of copying the factors from the CSFs framework given in the questionnaire, almost all factors were originally defined by the participants themselves (although similarities existed). This could be a result of interviewing experts who have strong opinions (Gillham, 2005) and the fact that design quality needs its own CSFs.

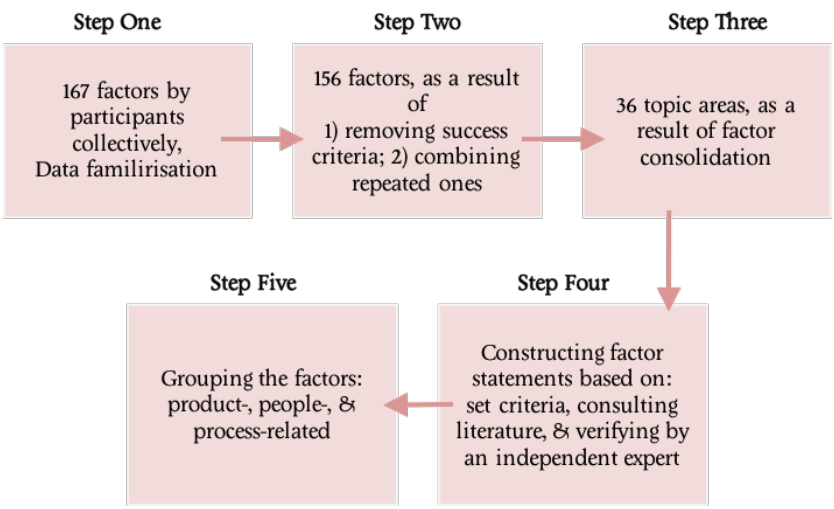


Figure 5-2: Data analysis procedure for study two

In the second step, the number of factors were reduced to 156 due to two reasons. First, some factors were in essence a success criterion instead of a CSF (difference discussed in section 2.3.2). These were '*fitness for purpose*' [P2-6], '*flexibility and adaptability*' [P2-8] and '*low-energy design*' [P2-3]. Interestingly, Al-Tmeemy et al. (2011) also detected the same issue when evaluating the CSFs framework by Ellattar (2009). The second reason was that some participants identified the same factor topic more than once. For example, P2-2 referred to 'communication' and 'dialogue' separately. Although, a small distinction could exist, as the aim was to move towards a parsimonious list, these were put together. In the third step, individual lists were combined and those factors belonging to a same topic area were put

together. After a few iterations, all identified factors were grouped into 36 categories. In a more interpretative manner (Spencer et al., 2013), the aim of the next step was to construct 'factor statements' for each topic area using suitable sentence elements. A few criteria were set. In addition to clarity and brevity, the statements needed to be design quality oriented and a balance to be maintained between being too general or too specific. Also, wherever a requirement of a specific stakeholder was given, like '*make sure the construction team are able to work together*' [P2-5], this was generalised to all project participants in the associated statement. Otherwise, if this was supposed to be repeated for every group, the list of factors would exceed a viable limit. In ensuring the appropriateness of the statements, the relevant literature was also consulted and the final list was checked with an 11th expert – a director of a construction consulting firm – in a face-to-face interview.

In the last stage, the 36 consolidated factors were put into three broad groupings of product, people- and –process related, for better organisation (table 5-2). This was partially inspired by the salient themes identified in the first study (figure 4-2) and also Sebastian's (2005) point that a design management approach could be categorised as managing the product, managing the process and managing the organisation. It should be noted that, despite the effort to make these groupings as distinct as possible, one could still notice overlaps.

Product-related	Adequate attention and emphasis on building design quality
People-related	Stakeholders attributes, relationships and management
Process-related	Considerations in managing the design and project process

Table 5-2: Broad groupings of the 36 identified factors

5.4 Findings and discussion

This section presents and discusses the 36 factors developed in the study based on the above groupings. Table 5-4 has illustrated these based on their labelled 'topic areas' together with the study participants who identified relevant factors in their lists. For consistency and clarity purposes, simple IDs are used (e.g. F1). In the following sub-sections, each factor is presented with their full 'factor statements', selective participant quotes and supporting literature.

ID	*CSFs topic areas*	*P2-1*	*P2-2*	*P2-3*	*P2-4*	*P2-5*	*P2-6*	*P2-7*	*P2-8*	*P2-9*	*P2-10*	*count*
	Product-related factors											
F1	DQ criteria appreciation	✗	✗		✗		✗	✗				5
F2	DQ importance	✗				✗		✗	✗			4
F3	DQ objectives	✗	✗	✗	✗		✗	✗				6
F4	DQ value analysis			✗			✗		✗	✗	✗	5
F5	DQ time	✗	✗		✗		✗			✗	✗	6
F6	DQ Budget	✗	✗		✗	✗	✗	✗		✗	✗	8
F7	Whole-life view		✗	✗	✗			✗			✗	5
F8	Procurement		✗	✗				✗			✗	4
F9	Appointments	✗	✗	✗			✗					4
	People-related factors											
F10	STK identification	✗				✗			✗			3
F11	STK requirement discovery		✗				✗					2
F12	STK objectives balancing			✗							✗	2
F13	STK engagement	✗	✗	✗		✗	✗		✗			6
F14	STK analysis										✗	1
F15	Roles & responsibilities		✗					✗				2
F16	Knowledge & skills		✗	✗	✗	✗			✗	✗	✗	7
F17	Experience			✗					✗	✗		3
F18	Leadership		✗		✗		✗	✗	✗	✗	✗	7
F19	Commitment	✗	✗		✗			✗	✗			5
F20	Creativity	✗	✗	✗						✗		4
F21	Communications		✗	✗	✗		✗			✗		5
F22	Collaboration		✗	✗	✗	✗			✗			5
F23	Trust		✗		✗					✗		3
F24	Conflict management	✗						✗		✗	✗	4
F25	STK power distribution							✗	✗		✗	3
	Process-related factors											
F26	Brief	✗	✗		✗	✗	✗	✗	✗	✗		8
F27	Phased process				✗		✗	✗			✗	4
F28	Information management				✗			✗				2
F29	Drawings & specifications		✗				✗				✗	3
F30	Modelling & simulation			✗				✗	✗			3
F31	Design Translation			✗		✗	✗	✗				4
F32	Change management	✗	✗				✗			✗		4
F33	DQ monitoring	✗	✗						✗	✗		4
F34	POE	✗	✗		✗			✗	✗	✗		6
F35	Construction quality		✗		✗	✗	✗			✗		5
F36	Feedback		✗					✗		✗	✗	4
		15	24	14	16	9	16	18	14	16	14	156

Table 5-3: CSFs 'topic areas' and the participants identified them (DQ: design quality; STK: stakeholders)

5.4.1 Product-related factors

The first grouping could be described as to be predominantly concerned with the product of the building project and includes factors putting emphasis on its required design quality. They are rooted in the concern exist over lack of adequate attention to building quality and in encouraging design quality focused strategies and activities in the building project.

5.4.1.1 F1: Shared understanding of design quality and its indicators between stakeholders (DQ criteria appreciation)

Perhaps the first important factor in achieving design quality in building projects is the stakeholders' shared awareness of what design quality and its indicators are for the project. That is, the design quality 'success criteria' against which the building is evaluated. This is perfectly in line with the point made by Turner (1999) and Westerveld (2003) that an appreciation of success criteria is a precursor for identifying CSFs. This could be deemed as particularly important with respect to design quality as its determinants is yet to fully appreciated in the industry (Keniger, 2004).

As it can be seen in table 5-4, the study participants clearly pointed to this factor. For example, P2-2 emphasised on a *'shared'* understanding of the scope and P2-1 on the need for '*all stakeholders'* to hold this understanding. The word *'scope'* mentioned by P2-2, has two distinct uses in project management, i.e., project scope and product scope, where the latter is defined as *'the features and functions that characterise a product, service, or result'* (PMI, 2013). This is in line with the factor identified here. Songer and Molenaar (1997) believed there should be '*a shared understanding of functional and technical performance required in the finished project'*. CABE (2005b) stated that improvements in design quality needs clear criteria and taking cognisance of them. CABE (2009) also emphasised the need for all stakeholders to have a shared understanding of the design quality success criteria before the start of the project. Interestingly, P2-6 explicitly referred to the DQI classification as the relevant success criteria while Gann et al. (2003) similarly introduced this

classification as evaluation criteria for design quality. As a result, a suitable alignment exists between the findings and the literature with regard to F1.

'An understanding by all stakeholders as to what design quality is'	P2-1
'Shared understanding of the scope –with focus on 'shared'.'	P2-2
'Timeless universal design characteristics; commodity, firmness and delight'	P2-6
'A shared vision of quality'	P2-7

Table 5-4: Selective quotes for F1 'DQ criteria appreciation'

5.4.1.2 F2: Recognition of the importance of design quality when defining project objectives and constraints (DQ importance)

Once a shared understanding of design quality success criteria is achieved, it is also important to acknowledge that there are other project objectives like time and cost performance. The study participants' emphasis over this issue was evident (table 5-5). They called for ensuring that design quality is not compromised (P2-5) and is seen as equally important as cost and time (P2-1). The importance of this factor is more evident when considering that the literature points to a lack of adequate attention to design quality in the industry. According to Gann et al. (2003), the quality of the end product is often neglected in favour of time and cost objectives. Thus, it is important to give the deserved importance to design quality as an important objective when setting and prioritising overall objectives and project constraints.

'Placing design quality alongside time and cost as equal objectives'	P2-1
'Construction company will always want to say costs the design; need to make sure it doesn't compromise the design.'	P2-5
'Consultants able to articulate, debate, synthesize and agree T/C/Q goals'	P2-8
'Clearly identify the priority of cost, time and quality'	P2-7

Table 5-5: Selective quotes for F2 'DQ importance'

5.4.1.3 F3: Early definition and prioritisation of DQ goals and aspirations (DQ objectives)

As exists potential tension between overall project objectives (time, cost and quality), so does between various design quality objectives. This was discussed in chapter four (section 4.4.1) and was also mentioned by the participant of this study (table 5-6). '*Early*' (P2-6) and *'ordered'* (P2-4) definition of *'design quality aspirations and goals'* (P2-1) were emphasised by the participants and the factor statement was constructed accordingly. Therefore, it is imperative to define these at the project outset and prioritise them based on their importance. There is considerable support for this factor in the literature. For instance, Yu et al. (2006) emphasised on early objective definition and proper priority setting as part of design briefing. Nash et al. (2010) also referred to the need for prioritisation and optimisation in order to make the best decisions.

'Early definition and prioritisation of design quality aspirations'	P2-6
'Agreed methodology for setting design quality aspirations and goals'	P2-1
'A clearly defined and expressed business requirement (whether public or private sector)'	P2-3
'Clearly ordered objectives; identify the overarching matters and those that are secondary'	P2-4

Table 5-6: Selective quotes for F3 'DQ objectives'

5.4.1.4 F4: Appropriate method to define value of design elements and outcomes for stakeholders (DQ value analysis)

Perhaps an instrumental factor to establish the importance of design quality (F1) and a pre-requisite for prioritisation of different design quality objectives (F3) is an appropriate value analysis. Several participants nominated this as their perceived CSF (table 5-7) with an emphasis on doing it for *'every design element'* and considering its '*impact*' on users and other stakeholders. Since the participants referred to this point using different terms such as '*value engineering' or 'value appraisal'*, a broader term, i.e. value analysis, is used here for the construction of the 'topic area'. An understanding of evidence-based design (e.g.

Ulrich (2008)) and value assessment methods (e.g., Thomson and Austin (2006)) could assist in maintaining this factor in projects. In order to do so, Macmillan (2006) suggested that appropriately eliciting the benefits of design quality could better justify the additional investment into the built environment.

'Early Value Engineering to optimise rather than reduce costs'	P2-6
'Clear value appraisal in the selection of every building element and release funds for top quality products.'	P2-8
'To understand the true value of every design elements to ensure the best value is being achieved on the project to allow prioritisation of goals'	P2-10
'Impact on the users'	P2-9

Table 5-7: Selective quotes for F4 'DQ value analysis'

5.4.1.5 F5: Allocation of adequate time to design and its development (DQ time)

Two other components of the 'iron triangle' (Atkinson, 1999), the project cost and time, could impose constraint on design quality achievement. The above CSFs provide a strong backing for allocating adequate time and budget for appropriately developing design. The time factor was expressed by 60% of the participants as critical, some of which are given in table 5-8. A *'realistic'* schedule (P2-1) which allows for *'adequate time'* (P2-4) for design was emphasised by the participants. There is also a good alignment between the participants' quotes and the literature over the importance of this factor. Nicholson (2004) stressed out this point and urged that without spending more time and money on design, the best quality could not be achieved. The literature also mentions the lack of adequate attention to this factor in projects. Santo (2002) mentioned lack of accuracy in defining work schedule as one of the frequent causes for lack of quality in design projects. Time for brief is also reported to be frequently underestimated (Yu et al., 2006).

'Allow time for design and developing/playing around with ideas and design. Designing is about trying things out.'	P2-6
'Realistic schedule... Having enough time to understand the consequences'	P2-1
'Adequate time and money for design'	P2-4
'Realistic programme'	P2-9

Table 5-8: Selective quotes for F5 'DQ time'

5.4.1.6 F6: Allocation of adequate budget to design and its Development (DQ budget)

Similar to the need for adequate time, realistic and sufficient budget is also required. 8 participants out of the total 10 mentioned adequate budget for design as their perceived CSFs. Table 5-9 exhibits a few quotes from the participants. They urged to consider adequate *'investment in design development'* (P2-6), allocation of *'realistic budget'* (P2-7) and also proper payment to the design team members (P2-1). Literature also supports this factor. Hwang and Lim (2013) as well as Songer and Molenaar (1997) are among several authors who emphasised on the budget factor as a CSF in construction projects. Treasury Taskforce (2007), also, pinpointed the consistency between design and budget as one of the attention areas for design quality achievement. Moreover, according to Dickson (2004), real progress in terms of design quality is unattainable without early budgetary resolution between stakeholders.

'Investment in design development process'	P2-6
'A realistic budget and realistic design fees'	P2-7
'Ensure that design team members are properly paid. The tendency to drive down fee levels has reduced designers to providing minimum service and hence a move away from creativity'	P2-1
'The money the client is willing to allocate is crucial.'	P2-2

Table 5-9: Selective quotes for F6 'DQ budget'

5.4.1.7 F7: Understanding of project whole lifecycle and design requirements over time (Whole-life view)

A whole-life perspective helps allocation of adequate time (F5) and budget (F6) for design and its development. This factor was both mentioned in the design quality literature as well as the Study One. Half of the participants of the second study identified this factor as critical for design quality achievement. They emphasised that there should be an understanding of the possible design requirements and costs in the future stages of the project lifecycle when considering the quality of design. According to Saxon (2005), good

design does not cost more when measured across the lifetime of the building. There is however a frequent reluctance to increase short-term costs for long-term gains in the industry (Macmillan, 2006).

'Whole Life Costing'	P2-7
'Whole life approach providing a sense of how the facility will grow, adapt, and eventually be decommissioned.	P2-3
'An understanding of whole life and operational cost.'	P2-4
'Any design must take into account the lifecycle of a project to ensure that unnecessary costs or programme delays are not encountered going forward.'	P2-10

Table 5-10: Selective quotes for F7 'Whole-life view'

5.4.1.8 F8: Design quality oriented selection of procurement/contract method (Procurement)

Another factor raised by the participants (table 5-11) and argued in the literature (e.g. Chan et al., 2004 and Chua, 1999) with impact on the outcome of a building project is procurement and contractual arrangements. These define the framework for project execution, obligations for different parties and risk allocations (Cooke and Williams, 2009). There exist various types of procurement routes and classifications. Traditional (design-bid-build), design-and-build, management contracting and construction management are among those commonly adopted (Morledge and Smith, 2013). Criteria like project complexity, client responsibility and the desired time/cost/quality should be considered for the effective selection of the procurement route (Cook and Williams, 2009).

Within the design community, the procurement choice and its bearing on design quality have been a point of controversy. For example, Giddings et al. (2010) pointed to the architects' suspicion towards some routes like the Design and Build or Private Finance Initiatives (PFI) due to their finance-led nature and the lower influence architects have on design decisions. Some may believe this would lead to a diminished quality in design. CABE (2005b), however, stated that delivery of good design is primarily dependent on the

details of the procurement process even if it is a finance-led one. Early involvement of the contractor (Walker et al., 2009) and improved integration of design and construction stages (Cook, 2007) could contribute to better achievement of design quality goals.

'Procurement: risk allocated and risk managed'	P2-2
'Consider designers input into procurement partnering strategy'	P2-3
'Innovative procurement'	P2-7

Table 5-11: Selective quotes for F8 'Procurement'

5.4.1.9 F9: Design quality oriented appointment of all project participants (Appointments)

The last identified factor in this grouping is about the selection and appointment of project members with design quality in mind. The study participants - as can be seen in table 5-12 - propounded that the appointment of '*all members*' (P2-1) of the design and project team should follow this consideration. For instance, P2-6 emphasised on the impact of designating '*contractor/subcontractors*' and P2-1 on '*QS* (quantity surveyor) and *PM* (project managers)' on design quality achievement. Appropriate contractor tendering process (P2-2) and timely appointment of designers (P2-3) were raised as well. Similarly, Walker et al. (2009) stressed on the early appointment of the delivery team. Yong and Mustaffa (2011) and Chen et al. (2012) also viewed appropriate tendering as a success factor in projects.

'Appointment of good quality contractor/sub-contractor'	P2-6
'Design quality as a headline in appointment of all members of the design & project team – even the QS and PM'	P2-1
'Consider the benefits of early appointment of design team during and through initial option assessment.'	P2-3
'Competitive tendering'	P2-2

Table 5-12: Selective quotes for F9 'Appointments'

5.4.2 People-related factors

The second group of factors are predominantly concerned with stakeholders in the project. As previously mentioned, the stakeholders in this research are referred to those individuals or groups who can affect or are affected by design quality achievement. These could be those participating in the project or others who are not involved, yet are affected and their support is needed. Factors related to stakeholder management, required traits and the relationship between the stakeholders are included in this grouping.

5.4.2.1 F10: Early, comprehensive identification of all stakeholders (STK identification)

The first factor related to the stakeholders is the appropriate identification of them early in the project. Three of the study participants identified this factor as critical for design quality achievement. As it can be seen in table 5-13, the word *'relevant'* and '*key'* are used by P2-1 and P2-5, which could imply those who are the stakeholders of design quality and thus, in line with the definition used in this research.

This point has also risen by many authors in the literature including Kelly et al. (2004) who urged the identification of all types of stakeholders during the early stages of the project. Macmillan (2006) also highlighted this point and indicated that the commissioning client and user client are often different people. As discussed in Chapter 2 (section 2.4), there is a great emphasis on stakeholder identification in stakeholder management process and analysis.

'Early comprehensive identification of relevant stakeholders'	P2-1
'Identification of relevant stakeholders.'	P2-5
'Identification of key stakeholders'	P2-8

Table 5-13: Selective quotes for F10 'STK identification'

5.4.2.2 F11: Appropriate method for discovering stakeholders' requirements and interests (STK requirement discovery)

Two members of the study participants identified this factor as critical for the achievement of design quality in building projects (table 5-14). They referred to both the *'requirements'* (P2-6) and *'wants'* (P2-2) of the stakeholders. They also emphasised on the importance of appropriately *'discovering'* (P2-2) these by the design team with an ability to '*listen and understand'* (P2-6). The same points have been mentioned in the literature, with a concern over inadequate attention to the users' needs. Although users and other stakeholders are of utmost importance in successful delivery of high quality buildings, their needs and interests are not always easy to discern (Gann et al., 2003). Appropriate methods and skills are required for this purpose especially considering that users often lack the technical knowledge and are not fully certain of what they need (Giddings et al., 2010). In the project CSFs literature, in line with the opinion of the study participants', Yu et al. (2006) and Toor and Ogunlana (2008) stressed on 'clear end-user requirements' and 'alignment of project goals with stakeholders' interests', respectively.

'Discovering what the client really wants'; 'Thorough understanding of user needs'	P2-2
'Client being able to clearly articulate their requirements & design team's ability to listen and understand these.'	P2-6

Table 5-14: Selective quotes for F11 'STK requirements discovery'

5.4.2.3 F12: Appropriate method for balancing varying objectives of stakeholders (STK objectives balancing)

Two study participants mentioned this factor (table 5-15). They underlined the need for appropriately balancing different requirements of stakeholders through consultation and arbitration. The literature of design quality supports the need for balancing design objectives. Slaughter et al. (2004) pointed out that the understanding of the stakeholder requirements should be followed by an attempt to reach a consensus on shared priorities. Karlsen (2002) emphasised on maintaining an acceptable balance between stakeholders'

interests in order to achieve project success. Therefore, not only is it imperative to correctly discover the needs and wants of stakeholders (F11) to achieve design quality, but also to balance those which are conflicting. This point has also appeared in the previous CSFs lists in relation to construction projects. For instance, Tang et al. (2013) identified 'balance of the needs/requirements of different stakeholders' as a CSF for briefing in construction projects.

'Considering what the designer's idea is of what is 'sacred' and what is not. Does the client agree? Who arbitrates and how?'	P2-3
'Balancing different requirements through ongoing periodic consultations.'	P2-10

Table 5-15: Selective quotes for F12 'STK objectives balancing'

5.4.2.4 F13: Appropriate stakeholder engagement throughout the project lifecycle (STK engagement)

A prominent CSFs from the viewpoint of the study participant was stakeholder engagement. Six participants identified this factor – four of which are shown in table 5-16. Two points were notable in their quotes; First, the need for *'continuity'* (P2-1) of engagement '*throughout the project lifecycle*' (P2-6), and second, the need for it to include various types of stakeholders such as *'users'* (P2-2) and *'subcontractors'* (P2-8).

As discussed in section 2.4, the importance of stakeholder engagement is prevalent in the stakeholder management literature (Newcombe, 2003; Olander and Landin, 2005; Yang et al, 2009). Macmillan (2006) urged the industry to engage more with stakeholders to better fulfil their value needs. This together with the above points mentioned by the study participants have been underlined in the CSFs studies as well. For example, Nguyen et al. (2004) identified 'continuing involvement of stakeholders' as a CSF for large construction projects. Cheng and Li (2002), moreover, listed 'stakeholder workshops' as critical for success in construction partnering.

'Stakeholder engagement throughout the project lifecycle'	*P2-6*
'Stakeholder involvement protocols – must be continuity'	*P2-1*
'Early and continued involvement of users.'	*P2-2*
'Bring in the contractor and its principal subcontractors soon to achieve a target cost'	*P2-8*

Table 5-16: Selective quotes for F13 'STK engagement'

5.4.2.5 F14: Appropriate analysis of stakeholders' attributes and relationships (STK analysis)

The literature strongly emphasises on the role of stakeholder analysis for project success especially in construction (Chinyio and Akintoye, 2008; Olander, 2007; Missonier and Loufrani-Fedida, 2015). As mentioned in Chapter 2 (section 2.4.1), activities such as stakeholder identification and evaluation of their attributes are seen as part of stakeholder analysis (Yang et al., 2011). It is recommended that project managers analyse stakeholders using intuitive and analytical skills (Jepsen and Eskerod, 2009). Although the study participants identified factors which could result from an effective stakeholder analysis (e.g. F10, F13, F21 & F25), only P2-10 referred to it in an implicit way (table 5-17). This is in line with Karlsen's (2002) observation that formal stakeholder management process only happens randomly in projects. As the study is exploratory and stakeholder analysis is the second research strand, this factor is also considered here to be further validated in the next study.

'Early establishment of a stakeholder management plan, communication + meetings strategy are crucial.'	P2-10

Table 5-17: Selective quotes for F14 'STK analysis'

5.4.2.6 F15: Clearly defined roles and responsibilities of all project participants (Roles & Responsibilities)

Another factor deemed as important was clear roles and responsibilities of project participants. Two study participants mentioned this factor as critical for design quality

achievement (table 5-18). In accordance, Koutsikouri et al. (2008) identified 'defined roles and responsibilities' as a critical factor for collaborative multi-disciplinary design projects. Jacobson and Choi (2008), also, stressed on the clear definition of roles and responsibilities for each key project member and linked it to developing mutual goals. Clarity of roles of stakeholders also has been mentioned as critical for briefing (Tang et al., 2013).

'Clear roles and responsibilities'	P2-6
'Clear definition of responsibilities'	P2-2

Table 5-18: Selective quotes for F15 'Roles & Responsibilties'

5.4.2.7 F16: Appropriate knowledge and skills in design development (Knowledge & Skills)

Technical knowledge and design skills are essential for achieving design quality and therefore, project success. The majority of the study participants (7 out of 10) identified this factor, some of which are given in table 5-19. Likewise, it has been indicated by many authors in the literature. Tzortzopoulos and Cooper (2007) saw design skills an essential trait for architectural design. It was seen as important for other project parties as well. According to Dewulf and van Meel (2004), architects are not the sole expert responsible for design quality. The knowledge and competency of other project members such as the client and project manager are identified as critical for project success as well (Yu et al., 2006; Iyer and Jha, 2006).

'Competence which brings a balance of know-how and innovation'	P2-8
'A balanced competent design team'	P2-10
'Design skill and expertise'	P2-4
'Architect's knowledge and understanding'	P2-1
'Consider how mature and reliable is the designer's knowledge'	P2-3

Table 5-19: Selective quotes for F16 'Knowledge & Skills'

5.4.2.8 F17: Appropriate experience and track record in design development (Experience)

Besides knowledge and skills, three study participants underscored the importance of experience and track record of the project team, especially that of the designer (table 5-20). Some previous CSFs lists in the construction field also identified this factor as critical. For instance, Hwang and Lim (2013) discussed that inadequate experience of design consultants could cause late submission of drawings and approvals, poor communication and change orders. According to Volker (2010), research has shown that experienced designers and other project players could interpret and manage complex matters more accurately and faster. As a result, this factor was added to the list of potential CSFs for design quality achievement in the current study.

'Experience of the professional team'	P2-9
'Designer's track record especially related to successful delivery'	P2-3
'Consultants with prior collaborative track record'	P2-8

Table 5-20: Selective quotes for F17 'Experience'

5.4.2.9 F18: Effective design leadership (Leadership)

70% of the study participants identified effective design leadership as a CSF for design quality achievement (table 5-21). According to P2-8, architects are often considered as the design leader, although in some projects a separate project manager or consultant could play the role. Increasingly, the construction projects seek leadership skills besides technical ones in project managers in order for effective management of project people (Toor and Ofori, 2008). However, Turner and Muller (2005), in their review of leadership literature in projects, found out that only recently this trait has been included in the CSFs lists. For example, in construction projects, Koutsikouri et al. (2008) identified 'quality of leadership' as critical for multi-disciplinary design projects. CABE (2006d) also indicated that to create places with high design quality, 'dedicated and determined' leadership or 'championship' is needed.

'Strategic design direction/leadership'	P2-6
'Leadership through the design and construction process'	P2-7
'Professional design leadership; the role normally defaults to the architect (or the consultant playing the major role).'	P2-8
'Leadership quality of Architect/Project Manager'	P2-1

Table 5-21: Selective quotes for SF18 'Leadership'

5.4.2.10 F19: Continuous commitment to design quality by all project participants (Commitment)

Similar to the stakeholder engagement (F15), study participants saw the need for continuity in commitment to design quality as well. Half of the participants identified this factor. Table 5-22 demonstrates selective quotes. Interesting in their statements are the emphasis on the continuity of commitment both throughout the project process (P2-1) as well as by 'all parties' (P2-2). According to Iyer and Jha (2006), commitment refers to the '*willingness of an individual or organisation to exert effort*'.

Many CSFs authors included this factor in their lists. Kog and Loh (2012) underlined the project manager commitment. Chan et al. (2004), however, viewed commitment to be required from top to bottom of all stakeholder organisations, similar to the point raised by P2-2. Cheng (2002) stressed on the long-term element of commitment and Chen – as emphasised by P2-1 - and Chen (2007) specifically on commitment to quality for successful projects. Despite its important, commitment was found by Chan et al. (2003) to be difficult to maintain and uneven among project participants.

'Early and continued commitment to design quality by all stakeholders'	P2-1
'All parties long-term commitment'	P2-2
'A team of equals committed to making the project work'	P2-7

Table 5-22: Selective quotes for F19 'Commitment'

5.4.2.11 F20: Creativity and innovation from project participants (Creativity)

Creativity and innovation is another critical factor to consider for project success especially with regard to design quality. Four members of the study sample identified this factor in their lists, with P2-1 emphasising on the fact that all stakeholders should be creative (Table 5-23). The need for creativity and innovation has been also mentioned in the literature. In the field of design quality. Both Macmillan (2004) and CABE (2006) indicated that good design requires creativity. Egan (2002), also, emphasised on innovation at the expense of conventional and established way of doing things. The literature of CSFs studies in the field of construction encompasses the identification of similar factors. For instance, 'generating innovative ideas' (Chan, 2004) and 'technology advanced nature of material/method used' (Phua, 2004) were seen as critical for general construction project success.

'Creativity. By everyone involved. Any of the stakeholders can be creative about any aspect of the project.'	P2-1
'Creativity of the team'	P2-9
'Creativity and innovation'	P2-1

Table 5-23: Selective quotes for F20 'Creativity'

5.4.2.12 F21: Effective two-way communication and dialogue between stakeholders (Communications)

Half of the study participants identified communications as a critical factor for design quality achievement in building projects. Selective quotes are given in table 5-24. They emphasised on *'effective'* (P2-3), *'frequent'* (P2-2) communications at both *'formal and informal levels'* (P2-4) which is *'two-way'* (P2-4) and occurs across *'the whole team'* (P2-9).

Same significance to effective communications are also given in the literature. According to Saxon (2005), Strong communication skills are required to appropriately listening to stakeholders and also to debate proposing solutions in successful projects. Stakeholder dialogue is an important element of effective communication and is stated to be the best

way to reach an understanding of design quality criteria (CABE, 2009). Previous CSFs studies in the field of construction also identified this factor in their list. Jha and Iyer (2006) stressed upon appropriate interaction among project participants. Other examples are clear communication (Nguyen et al., 2004) and formal and informal communications (Pinto and Slevin, 1987).

'Clear two-way communications on formal and informal levels'	P2-4
'Good communication across the whole team'	P2-9
'Good communication (listening and explaining)'; Frequent meetings amongst various stakeholders', 'Need to be creative dialogue'	P2-2
'Effective communication between designers and stakeholders'	P2-3

Table 5-24: Selective quotes for F21 'Communications'

5.4.2.13 F22: Effective inter-disciplinary collaboration between stakeholders (Collaboration)

Like 'Communications' (F21), half of the study participants underlined the importance of effective collaboration between stakeholders for the achievement of design quality. P2-8 specifically referred to the need for collaboration between designers and contractors. P2-4 also urged for a collaboration culture that is positive and respectful (table 5-25). In the same vein, Hegazy et al. (2001) stated that achieving design quality relies on effective interactions between different project disciplines. Otter and Emmitt (2008) also viewed architectural design as a collaborative activity. A particular supporting reason for the criticality of this factor the fragmentation that exists in the construction industry between different disciplines (Fellows and Liu, 2012). Therefore, Bresnen and Marshall (2000) recommended the employment of working collaboration approaches, e.g. partnering, in order to positively impact of project success.

'Make sure the construction team are able to work together.'	P2-5
'A positive and respectful collaboration culture'	P2-4
'Collaboration between the designer and contractor'	P2-8

Table 5-25: Selective quotes for F22 'Collaboration'

5.4.2.14 F23: Mutual trust and respect between stakeholders (Trust)

Another factor identified by the study participants with respect to the relationship between the stakeholders was trust. Three participants mentioned to this factor. They emphasised that trust is essential and needs to be mutual and across the whole project team. The F23 was therefore constructed based on the participants' quotes (table 5-26).

Trust is defined by Smyth and Edkins (2007) as '*a disposition and attitude concerning the willingness to rely upon the actions of or to be vulnerable towards another party with the potential for collaboration'*. Thus, trust could clearly impact on the stakeholder relationship in a construction project. This factor is also prevalent in the CSFs lists developed in the field of construction. For instance, Toor and Ogunlana (2008) identified 'mutual trust among project stakeholders' for the success of large-scale construction projects.

'Trust is essential.'	P2-2
'Mutual trust and respect across the project team'	P2-9

Table 5-26: Selective quotes for F23 'Trust'

5.4.2.15 F24: Effective resolution of conflicts and disagreements between stakeholders (Conflict management)

Four members of the study participants identified this factor as critical for design quality achievement in building projects. They recommended an effective approach to '*collectively discuss and resolve issues'* (P2-9), while also encouraged a *'no blame culture'* (P2-7) in the project team. This is because, in a multi-stakeholder project environment occurrence of disagreements or disputes is often inevitable. In the same vein, Chinyio and Olomolaye (2010) argued that due to the presence of many stakeholders in most construction projects, a potential conflict of interest exists. Iyer and Jha (2006) considered conflict as a failure factor endangering project success, so the need to address it effectively. Establishment of a conflict resolution strategy has been advocated for project success (Chan et al., 2004; Toor

and Ogunlana, 2008). A no-blame culture, which creates opportunity for joint working and effective problem-solving is similarly seen importance in both literature (Meng, 2012). Overall, there is a good alignment between the study findings and the literature regarding this identified CSF.

'Managing disputes and disagreements. Try and instil a 'no-blame' culture where problems are not problematic but new issues to be solved.'	P2-1
'Work to ensure a no blame culture exists within the team'	P2-7
'Ability to collectively discuss and resolve issues that arise'	P2-9
'Important to resolve conflicts to allow project to progress'	P2-10

Table 5-27: Selective quotes for F24 'Conflict management'

5.4.2.16 F25: Appropriate level of power possessed by stakeholder groups to influence design decisions (STK power distribution)

Three study participants referred to this success factor in their lists (table 5-28). P2-7 especially pointed to the need for empowering stakeholders, suggesting that in current practice, not every stakeholder of design is given the power level it deserves to influence decisions. P2-8 also recommended a competent client who has given adequate power through effective relationships in order to represent user stakeholder groups in design related decisions.

As shown in Study One, different stakeholders have different levels of power to influence design quality and sometimes, stakeholders like users or facility managers are not given enough ability to influence decisions.

Expert, serial client – empowered fully to represent all client stakeholders – where the ongoing relationship is important to all players.	P2-8
Stakeholder power – different stakeholder have different responsibilities, authority and influence.	P2-10
Empowerment of stakeholders	P2-7

Table 5-28: Selective quotes for F25 'STK power distribution'

5.4.3 Process-related factors

Product- and people-related identified factors were described in previous sections. The final grouping concerning the management of design and construction process and the necessary activities with influence on design quality achievement is reported in this section.

5.4.3.1 F26: Development of a clear, comprehensive brief agreed by all stakeholders (Brief)

An appropriate brief was identified by 8 study participants, implying its high importance in their perception for achieving design quality. As it is evident in table 5-29, they put emphasis on a *'realistic'*, *'simple'* and '*comprehensive*' brief *'owned by all parties'*. These elements have also been emphasised in the existing literature. For example, Morledge and Smith (2013) recommended clarity and avoidance of ambiguous phrases such as *'the highest quality attainable within the budget'* in design briefs.

Hansen and Vanegas (2003) defined design brief as *'a statement of requirements that ideally should contain everything a designer needs to know about a client's proposed project'*, hence, the need for comprehensiveness. They also asserted that obtaining a right brief early in the process could result in improved design quality, a point which did not appear implicitly in the participants' quotes. Clear briefing by the client stakeholder was also identified by Yong and Mustaffa (2011) as a CSF for construction projects and likewise, the Client's ability to brief by Chan et al. (2004).

'Recognition of the importance of brief development'	P2-8
'A realistic brief that is owned by all parties'	P2-7
'Simple and comprehensive definition of the brief – a written document, in simple language which is signed up to by all stakeholders'	P2-1
'A holistic design proposal where holistic refers to comprehensive brief'	P2-6

Table 5-29: Selective quotes for SF26 'Brief'

5.4.3.2 F27: Appropriate design/project process with agreed stages and deliverables (Phased process)

Half of the study participants indicated in their list to an appropriate process framework for design and other stages of the project with '*milestones*' and *'deliverables'* (table 5-30). This factor seems to be an established one for project success in the literature and also in practice. Tzortzopoulos and Cooper (2007) stated that improvement in design and construction process is instrumental for delivery on targeted time, cost and quality, and advocated for the development and implementation of generic process models. Winch (2010) refers to the process protocols that defines how the process ought to work and named RIBA 'plan of work' as the commonly employed model in the UK. This model details the tasks and outputs of each stage as well as the role of different project parties at each stage (Cooke and Williams, 2009). The final edition of RIBA plan of work has been published in 2013 and comprises of eight stages (ribaplanofwork.com).

'Clearly programmed design stages, concept to completion. Agreed design deliverables programme with milestones and review period'	P2-4
'Handover/commissioning from design to construction to operation in use'	P2-6
'Design/project process with agreed milestones, deliverables'	P2-10

Table 5-30: Selective quotes for F27 'Phased process'

5.4.3.3 F28: Appropriate management and exchange of design information (Information management)

Two members of the study sample referred to this factor. P2-7 emphasised on the completeness of the design information and P2-4 to an information management system (i.e. BIM level 2+) for appropriate integration and exchange of design related information.

According to Harris et al. (2013), a substantial amount of design information is transacted between different parties involved in a construction project and therefore, effective management of this information impacts on project success. Dainty et al (2006) also referred

to the fragmentation issue exist in the construction industry and emphasised on the use of information systems in projects that could facilitate both the exchange of information and the management of its flow. Besides various multi-media and CAD enabled information exchange techniques, BIM (building information modelling) has received recognition in recent years as an advanced tool for building information management (Goedert and Meadati, 2008). According to Sebastian (2011), it provides an integrated knowledge resource accessible to all project parties.

Similar to the study participants, in the CSFs literature, Nguyen (2004) and Abdullah (2011) both labelled information management as a critical success factor. Tzortzopoulos and Cooper (2007), also, pointed out to the fact that in practice the information generally is exchanged with delay or in an inaccurate format.

'A complete package of design information that fully represents the project requirements'	P2-7
'Properly integrated design (BIM level 2+) which is a bit of a challenge to service engineering at present.	P2-4

Table 5-31: Selective quotes for F28 'Information Management'

5.4.3.4 F29: Development of clear, coordinated design drawings and specifications (Drawings & Specifications)

Three members of the study participants put this factor in their CSFs list for design quality achievement (table 5-32). Highlighted in their quotes were the need for drawings and specifications which are 'clear', 'detailed' and co-ordinated' and resulted from necessary 'skills'. Completeness of plans and specifications was raised as critical in studies by Kog and Loh (2012) and Phua (2004). According to Hwang and Lim (2013), plans are official drawings showing the work details that need to be executed and specifications refer to the written directions and requirements to complete the work.

Drawings and specifications are two documents that are passed to the contractor delineating design concept, scope, information on materials and required performance. These need to be clear, concise and uniform and could affect the quality of the constructed facility (Arditi and Gunaydin, 1997). However, in Chan's (2003) experience, there are many cases where these documents are developed with error by design consultants.

'Detailed, co-ordination of specialist input/design elements'	P2-6
'Clear drawings and specifications'	P2-10
'Planning skills'	P2-2

Table 5-32: Selective quotes for F29 'Drawings & Specifications'

5.4.3.5 F30: Appropriate mechanism for rigorous design modelling and simulations (Modelling & Simulations)

This point was made by many of the study participants who urged for *'rigorous'* and appropriate *'mechanism'* for modelling and simulations allowing for design *'review'* and *'testing'* (table 5-33). The point was also mentioned in the literature. For instance, Morledge and Smith (2013) recommended the use of pictorial views and 3D visualisation to present and communicate proposed design solutions. This is especially due to the fact that not all stakeholders are cognizant of the technicality of design drawings.

'Applying rigorous testing procedures and rigorous modelling and simulations'	P2-8
'Mechanism for simulation, testing and design review'	P2-4
'Commitment to testing and reliability'	P2-3
'If a complex project, include early mock-ups to ensure user involvement'	P2-7

Table 5-33: Selective quotes for F30 'Modelling & simulation'

5.4.3.6 F31: Appropriate translation of design intent into construction and operation Phases (Design translation)

An appropriate design translation between process interfaces was found critical and raised by several study participants (table 5-34). The idea of appropriately conveying the design throughout the project lifecycle stages is mentioned with an emphasis on preserving the quality of design (P2-7) and resilience of the concept (P2-3). According to Whyte et al. (2004), design intent is developed throughout the design process. If expected design quality is to be achieved, it is imperative that the initial brief and design concept transfer properly to detailed and technical designs and afterwards, to tender and construction scheme. This is also important for the operation stage in that the users need to be informed so the building could be utilised as intended. A similar factor could not be found in the construction CSFs literature. Instead, 'buildability of design' is listed in these studies (e.g. Chan, 2001) which could imply more emphasis given to other project objectives compared to ensuring design quality.

'Quality of translation from design intent to delivery process'	P2-6
'The ability to embed quality in the brief and see it through to construction'	P2-7
'Consider: resilience of concept - how robust will the ideas be when translated into a build scheme' 'Guarding the concept into the implementation stage.'	P2-3

Table 5-34: Selective quotes for F31 'Design translation'

5.4.3.7 F32: Appropriate management of design changes (Change management)

While all project members should put in sustained effort to maintain design intent throughout all stages (i.e., F31), change in design is often inevitable, as alluded by P2-2 (table 5-35). Four study participants pointed to appropriate change management in relation to design. 'Continuous design changes' are destructive as was pointed out by P2-1. P2-9 also suggested a sign off procedure to resist design changes that cause reduced quality. Similarly, the requirement of an appropriate change management is also mentioned in previous CSFs

studies in construction. Many authors asserted that there should be an agreed time to 'freeze' design (Tang et al., 2013) especially during the construction stage (e.g., Chan et al., 1999; Tabish and Jha, 2011). Toor and Ogunlana (2008) identified 'effective change management' in their list of CSFs for large-scale construction projects. Same was also identified by Khan and Spang (2011) in the context of international projects.

'Change control/Management'	P2-6
'Freeze design once signed off – Robustly challenge need for change'	P2-9
'Managing change through the process -accept that things will change and devise a simple system for dealing with this'	P2-2
'Avoid the destructive continuous design changes by the owner'	P2-1

Table 5-35: Selective quotes for F32 'Change management'

5.4.3.8 F33: Appropriate monitoring and control of design quality development during project process (DQ monitoring)

One way to assist appropriate design translation (F31) and change management (F32) could be to evaluate design quality progress during the project process. '*Monitoring and control*' (P2-1 and P2-9) of '*design quality progress*' (P2-2) in an effective way during project process has been emphasised as critical by the study participants (table 5-36). This has also been mentioned in the design quality literature. According to CABE (2009), progress should be monitored and evaluated throughout the project against the targeted objectives, for which an evaluation tool like the DQI could be used. Slaughter (2004) also saw the DQI capable of monitoring design quality achievement and to set accountability for it. As mentioned in Chapter 2 (section 2.2.4.1), two DQI versions, i.e., 'brief' and 'mid-design' could be used for this purpose. Effective monitoring and control - where monitoring refers to observing the actual progress against expected one and control means taking actions to ensure progress towards intended objectives (Chua, 1999) – has also been nominated as a CSFs in many construction studies (Toor and Ogunlana, 2008; Tabish and Jha, 2011).

'Effective monitoring and control'	P2-9
'Effective monitoring and control'	P2-1
'Agreed methodology for monitoring design quality progress during design and construction.'	P2-2

Table 5-36: Selective quotes for F33 'DQ monitoring'

5.4.3.9 F34: Appropriate method for post-project and post-occupancy evaluation (POE)

In addition to the need for regularly monitoring design development and ensuring that the set quality is preserved during project process, it is considered as critical by five members of the study participants to do post-project and post-occupancy evaluation as well (table 5-37). P2-2 emphasised on the importance of design evaluation at 'completion' as well as later when the building is in 'use'. The 'ready for occupation' and 'in-use' versions of the DQI tool are designed for this purpose – although many may use their bespoke/in-house tools. P2-4 saw the value of evaluation in 1 to 5 years into occupancy, suggesting the need for POE after early occupancy as well. Much literature exists on the usefulness of POE as described in section 2.2.4 and section 4.4.3; In general, two purposes for an end-of-project evaluation activity could be considered; First, it could detect any defect in the completed building and second, to provide feedback valuable for future projects. The former could also be seen to unearth any misuse by occupants or facility management team. P2-8's indication to 'soft landing' could be seen in this regard.

'Effective post project evaluation'	P2-9
'Post-occupancy evaluation processes and soft landing'	P2-8
'Post operational testing (1-5 years into operation) with feedback to participating organisations.'	P2-4
'Agreed methodology for assessing whether original aspirations have been achieved at completion and subsequently once the building is in use.'	P2-2

Table 5-37: Selective quotes for F34 'POE'

5.4.3.10 F35: Appropriate construction methods and quality of execution on site (Construction quality)

Half of the study participant identified this factor in their CSFs lists for design quality achievement. Borrowing from P2-5, '*a design is only as good as the quality of the final product*' (table 5-38). In their quotes, the participants indicated to both appropriate management of the work on site and also the quality and skills required for the execution of the construction.

In the same vein, Trebilock (2004) stated that although design may be in control of the architect, its successful execution depends on many other project participants. Half of the study participants identified this factor. This gives prominence to the quality of execution and construction excellence. The use of appropriate construction methods (Chan, 2011), high quality workmanship (Yong, 2011), adequate staff for execution (Tabish and Jha, 2011), and effective site management (Hwang et al., 2013) are relevant CSFs mentioned in the construction project success literature.

'Quality in execution of construction/workmanship'	P2-6
'Appropriate management of work once on site'	P2-9
'Good site management'	P2-1
Make sure the construction team have good fabrication and manufacture skills; a design is only as good as the quality of the final product.	P2-5

Table 5-38: Selective quotes for F35 'Construction quality'

5.4.3.11 F36: Effective learning and incorporation of feedback from similar projects (Feedback)

The last CSF identified in this study is the one linking past projects to a present one through lessons learned and feedback loop. Four participants put an emphasis on this factor. P2-1 and P2-9 emphasised the role of previous project experiences in providing useful lessons for a new project when considering design quality achievement. P2-10 also implied the

importance of formal sessions held for lessons learned. The importance of feedback is emphasised in the literature as well. Leaman et al. (2010) in their analysis of building evaluation practice and principles suggested five types of feedback where one type reads as 'review the past to benefit now'. Yu et al. (2006) also pointed to the fact that the experience from past project could be fed into the briefing process.

'Effective lessons learned from other projects'	P2-9
'Feedback capabilities and learning from previous experiences'	P2-1
'Lessons learned sessions to be held'	P2-10

Table 5-39: Selective quotes for SF36 'Feedback'

5.4.4 Discussion of the study approach

The study approach had its strengths and limitations. To ensure credibility (or validity), the intention of the study, the meaning of relevant concepts and facilitating materials were provided in the data collection instrument. Also, only area experts with senior positions and high experience were approached. The factors were synthesised through a qualitative analysis by the researcher, thus a degree of researcher bias exists. However, this has been minimised by employing a multi-step process together with literature consultation and a final verification by an expert. To address the dependability (or reliability) issue, the design and implementation process was explained in detail. The original quotes from the participants were presented for each factor identified by the study. The aim was to obtain an exhaustive list with factors being mutually exclusive. Although considerable effort was put towards this purpose, putting a larger number of factors would both weaken the aim for 'a limited' number of CSFs (as the definition implies, section 2.3.2) and add practical issues. Based on the norm of previous CSFs studies (section 2.3.2, table 2-4), 36 is a reasonable number for a CSFs list. Moreover, one still could find degrees of interrelationship and overlap between the factors. The derived CSFs list needs to be further validated before a generalisation claim; this will be done in the next study. As discussed in Chapter 3, the

mixed methods approach in phase 2 led to the development of an appropriate instrument for the next quantitative study using the list of factors here. Finally, other methods could also be used like Delphi, however it would need multiple rounds of approaching experts.

5.5 Conclusion

This study fulfilled the specific objective a1 to identify potential CSFs for design quality achievement (the how) from the viewpoint of area experts. A CSFs list encompassing 36 factors in three groupings was resulted from this study. These were presented using developed 'factor statements' along with an abridged 'factor area' version. The factors, however, were called 'potential' until being validated in the next study. It was concluded that design quality achievement has its own success factors although similarities exist in places with the success factors from general construction projects. Some factors in construction project success could favour other project objectives. For example, while 'design translation' encourages guardian of original design intent, 'buildability' – in other studies - may not put design quality a priority. Similar example could be 'affordable design' versus 'adequate budget for design'. It was also revealed that factors are interrelated and could correlate with each other. Therefore, in the next study this interrelationship will be examined.

6 Chapter Six

An industry survey for CSFs Validation and Evaluation in Building Projects (study 3)

6.1 Introduction

Chapter 5 revealed 36 potential CSFs for design quality achievement. This chapter reports on the third empirical study with the aim to put these factors into further validation and evaluation, and thus, a deeper level of understanding of the concept. Following the qualitative approach taken in the previous study, Study Three employs a quantitative survey of industry professionals to capture their opinions on the potential CSFs in terms of their level of importance as well as presence in real-world building projects. In assessing these projects, the second stakeholder analysis model exploring the attributes of key stakeholders with regard to design quality is also included.

6.2 Objectives

The objectives set out for this study are as follows:

(specific objective a2) To rank and validate the identified potential CSFs based on their relative importance.

(specific objective a3) To determine if there is any significant difference in perception between different stakeholder groups regarding the importance of the potential CSFs.

(specific objective a4) To explore the interrelationships between the validated CSFs and to identify the underlying components.

(specific objective a5) To assess the relative impact of the derived CSFs components on the achievement of design quality success criteria, i.e., functionality, build quality and impact.

(specific objective b2) To compare key stakeholders in terms of their power, proximity and urgency and to identify any significant association between these attributes.

6.3 Study design

This section describes the methods, procedure and considerations taken in designing and implementing the study.

6.3.1 Data collection

The study utilised a questionnaire with close-ended questions and numerical scales and approached professionals from the two stakeholder groups of architects and clients.

6.3.1.1 Data collection instrument

Based on the CSFs list obtained in the previous study, a questionnaire was designed consisting of two main question sections. The first section was concerned with the relative importance of the factors in the view of the respondent. The second section intended to capture the respondents' perceptions regarding the level of presence of these factors in a building project in which they were involved. This section also required the respondents to evaluate the design quality achieved in the building project, alongside the attributes of key stakeholders. Background information was also gathered in an additional section. In the following, the questionnaire sections are described in detail. Figure 6-1 also shows its structure and a copy of the actual questionnaire is further provided in Appendix C.

Cover page

The cover page served as an invitation for participation. It provided information about the study and its purpose, the questions and the options available for completion (explained in next section). It also detailed on ethical issues and contact information.

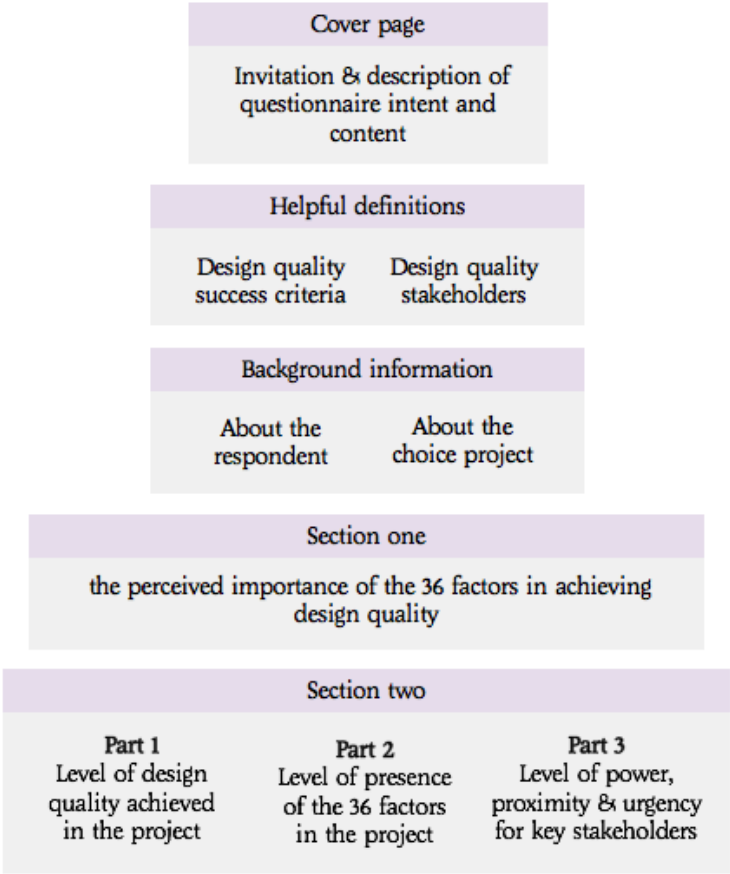


Figure 6-1: The sections and structure of the questionnaire

Helpful definitions

Similar to the approach of other studies, to ensure clarity and curb possible alternative interpretations, design quality and its stakeholders were defined in this part of the questionnaire. The DQI classification and its origin were given and its criteria of 'functionality', 'build quality' and 'impact' were delineated – as 'the what' of design quality achievement.

Background information

Two types of background information were intended to be collected: about the respondents, their position and experience, and also about their choice project, its sector and

procurement route used. Response options for the procurement were given based on the most common procurement routes found in a 2012 RIBA's[3] survey (RIBA, 2013).

Section One

This section was concerned with addressing objectives a2 and a3. The 36 factors were given by their factor statements and the respondents were asked to rate each in terms of how important they were, in their opinion, for the achievement of design quality in building projects with multiple stakeholders. A 5-point Likert scale was used for response options where 1: not important, 2: slightly important, 3: moderately important, 4: very important, and 5: extremely important. For better organisation, the factor statements were presented based on the three groupings defined in the previous study, i.e., 'product-related: focus on design quality', 'people-related: design quality stakeholders', and 'process-related: design/project process'. A blank space was also provided in the end of the section for any further comment by the respondents.

Section Two

The second section comprised of three parts. The first part was concerned with the achieved design quality in the completed building of the choice project in terms of its 'functionality', 'build quality, and 'impact' (figure 6-2). Due to the subjective nature of design quality assessment and the fact that different projects could set different design quality targets based on which success could be judged, it was decided to ask the question with reference to what was targeted or expected to be achieved in terms of the three success criteria in the choice project. Thus, a symmetrical 7-point Likert scale was used ranging from '1: Far short of expectations' to '7: Far exceeds expectations'. Interestingly, Savindo et al. (1992) related the project success to the expectation of its participants and in a similar vein, Lehtiranta et al. (2012) viewed expectation as the reference to assess performance and satisfaction in construction projects. Time and cost performance of the choice project were also put into question for contextual information.

[3] Royal Institute of British Architects

The second part was concerned with the level of respondents' agreement on the presence of the 36 factors in the choice project. The factor statements were given and a symmetrical 7-point Likert scale was used ranging from 'strongly disagree' to 'strongly agree'. The analysis of these two parts could fulfil the study objectives a4 and a5.

Functionality (or Commodity) is concerned with how well the building is designed to be useful.

It encompasses areas like accessibility & wayfinding, suitability of spaces & layout, and suitability of design to accommodate original & changing operational needs.

Build Quality (or Firmness) is concerned with how well the building and its components are constructed.

It encompasses areas like performance of environmental, engineering & control systems, energy efficiency and quality of construction, structure & materials.

Impact (or Delight) is concerned with how well the building creates a sense of place & contributes to local environment.

It encompasses areas like pleasantness of inside & outside areas, landscape, look & feel of materials & finishes, and ability to create positive image & character and contribute to new knowledge & innovation.

Figure 6-2: Three design quality success criteria and their descriptions given in the questionnaire

The information regarding the stakeholder analysis model – associated with objective b2-, were collected in the third part of the questionnaire. The extent of power, proximity and urgency possessed by five key stakeholders, namely, architect, client, builder contractor, user group and facility management team, were asked. As given in Chapter 2, these stakeholder attributes were derived from a variation of Mitchell et al.'s, (1997) stakeholder salience model used in 'Stakeholder circle™' (Bourne, 2005; Walker et al., 2008) in which proximity is used instead of legitimacy. For this study, the questions were orientated around 'design quality' and a 7-point Likert scale was used for each question ranging from 'very low' to 'very high' (table 6-1).

Stakeholder attribute	*description*
power	The level the stakeholders had power to influence or change design quality decisions
proximity	The level the stakeholders were involved in design quality decision makings
urgency	The level the stakeholders' design quality related interests/preferences were considered as critical and of high priority.

Table 6-1: Description of the stakeholder attributes used in questionnaire section two.

It should be noted that for all the questions in Section Two an additional response option was added as 'don't know', in case the respondent was unable to give an answer. Also, blank spaces were included for any additional comments. At the end of the questionnaire, the respondents were thanked for their participation and informed of the questionnaire return options.

6.3.1.2 Respondents and recruitment

The aim was to approach professionals from client organisations and architecture firms – the two main stakeholder groups of building projects in the UK - with adequate experience in multi-stakeholder building projects as the target population. Initially, it was desirable to approach other stakeholder groups as well, but due to (a) practical and accessibility issues, (b) the need to maintain a reasonable scope, and (c) the fact that clients and architects would be more interested in the topic and (d) be in a better position to assess design quality achievement, these two groups were targeted. Non-probability sampling with 'convenience' and 'purposive' elements was used with the aim to approach those relevant and to obtain an adequate response rate for the planned statistical analyses.

For the choice project - with respect to which the second section was to be answered - the respondents were asked to select a building project (a) in which they were involved and had good knowledge about its process and the achieved design quality, (b) that was completed within the last 10 years, and, (c) was preferably in the healthcare or higher education sectors. The reason for this sector preference was three-fold. First, these two sectors represent multi-stakeholder environments. Many of the factors if the selected project was, for instance, a plant, would not be considered as important. This point was also emphasised by the participant P2-1 in the second study. The second reason was concerned with the important role the building design has in these types of buildings. As shown in Chapter 2 (section 2.2.2), many studies found association between design attributes and outcomes such as improved health and learning. The final reason was practical since the first study was conducted for the healthcare sector and also a higher education building

was secured for the case study of the fourth study (Chapter 7). As it will be shown later, 85% of the choice projects were in these two sectors and the rest also representing a multi-stakeholder building.

Both paper-based and online versions of the questionnaire were created. For the paper-based version, a postal package was prepared which contained a copy of the questionnaire, a pre-paid return envelope, a study leaflet and a pencil. The online version was created using the Qualtrics[4] survey tool. A dedicated webpage on the University's website was also created including study and ethical information and a link to the online questionnaire. The aim was to facilitate as much as possible the dissemination of the study and distribution of the questionnaire. The survey URL (warwick.ac.uk/design-quality) was provided on the paper questionnaire as well as on the leaflet and the pencil. A downloadable version of the paper questionnaire was also made available on the webpage. With these considerations, the potential participants could choose whichever version they would prefer to complete and submit the questionnaire and also could share it with colleagues in their firms or other relevant individuals. The appendix C provides images of these materials.

Postal Package	Study Webpage
Paper questionnaire Pre-paid return envelope Study leaflet Promotional Pencil	Link to online version Study information sheet Downloadable PDF version

Table 6-2: Approaches and materials for survey distribution

The RIBA directory of UK architecture firms was used to create a list of architecture firms active in healthcare or higher education sectors. Regarding the client respondents, two main sources were used: for higher education, the membership list of UK higher education estates

[4] www.qualtrics.com

departments (AUDE.ac.uk) and for healthcare, the NHS directory of estates and foundation trusts.

For each organisation identified through the source directories, their websites were scrutinised in order to find appropriate individuals with contact information. Several of these did not include the required information. For instance, there were architecture firms which did not include personal email addresses on their websites or client organisations with no information about the staff members. In the first attempt of the survey distribution, therefore, an invitation email containing the online survey link was sent to those individuals whose email addresses were available but also to general contact emails provided on other firms' websites. 300 emails were sent. However, a very low response rate was achieved (12 responses). This led to the speculation that despite the increasing popularity and convenience of online surveys and the use of an advanced survey design tool (i.e. Qualtrics), the abundant number of emails that professionals might receive nowadays could discourage responding. The ill-targeted emails to firms' general email addresses could stand as another culprit.

Therefore, in the second attempt, the focus was put on using the paper-based version as part of the postal package described above. This would hopefully allow for approaching a larger number of potential respondents since the mailing address of the firms could be used instead of emails, and also, to provide more visibility and appeal to fill the questionnaire. In this round, 650 questionnaire packages were distributed resulting in a much better response rate.

6.3.2 Data analysis

Prior to survey distribution, the questionnaire was pre-tested for face validity. Feedback was obtained from five colleagues on the suitability and clarity of the organisation, presentation and question statements which resulted in minor modifications. Moreover, the aim of the

overall study and question sections was discussed with and supported by an external independent senior academic who specialised in design quality research.

Upon completion of the data collection process, the responses were first imported into MS Excel to record the demographics and to examine for any missing scores. It, afterwards, was imported into IBM SPSS software (version 22) for analysis. Prior to the core analysis, the dataset was also assessed in terms of outlier, normality and reliability tests. Table 6-3 exhibits the statistical techniques used for the analysis of different sections.

Statistics	*Questionnaire section – purpose (related objectives)*
Mean value	Section 1 – ranking the factors (objective a2) Section 2 – comparing stakeholder attributes (objective b2)
Mann-Whitney test	Section 1 – difference in perception between client and architects (objective a3)
Principal Component Analysis (PCA)	Section 2 – underlying CSFs components (objective a4)
Spearman Correlation	Section 2 – association between stakeholder attributes (objective b2)
Multiple linear regression (MLR)	Section 2 – relative impact of CSFs components on the success criteria (objective a5)

Table 6-3: Statistical analysis methods used and their purposes

Mean value as a measure of central tendency was used for descriptive analysis in section one for ranking the factors (objective a2) as well as in section two for comparing stakeholder attributes (objective b2). A Mann-Whitney test was used to tackle objective a3. According to Field (2009), this test is the non-parametric equivalent of the independent t-test used to test differences between two groups (in here, two respondent groups of clients and architects). It is suitable for ordinal variables and non-normally distributed data.

Spearman correlation is also a non-parametric test used to determine whether there is an association between two variables by calculating the coefficient r_s which shows the strength and direction of the association. It is suitable for ordinal variables and non-normally distributed data (Field, 2009). This test is used in this study to determine any pair association between the stakeholder attributes (section 1, objective b2).

Another statistic used was Principal Component Analysis (PCA) in order to explore the interrelationship between the factors and to determine their underlying components (objective a4). According to Hair et al. (2014), the method could be used as a variable reduction and summarisation technique to put highly correlated variables into a single artificial one. This could also remove multicollinearity issue for the next regression test in this study.

To assess the impact of CSFs components on the success criteria, multiple linear regression (MLR) was used. MLR is a dependence technique used to analyse the relationship between a dependent variable and multiple independent variables. It can be used for both predication and explanation, according to Hair et al. (2014). It solves the below formulation where Y is the dependent variable, X the independent variable, b the coefficient and ε_i the model error.

$$Y_i = (b_0 + b_1 X_{i1} + b_2 X_{i2} + \cdots + b_n X_{in}) + \varepsilon_i$$

6.4 Findings and discussion

This section presents and discusses the findings yielded from data analysis and is organised based on two sections of the questionnaire and the specific objectives addressed in each part. 129 valid responses were obtained giving a response rate of %13.6. Five survey envelopes were returned undelivered.

Section one of the questionnaire was concerned with objectives a2 and a3. The dataset had only 9 missing data across all responses[5] which were replaced with the median value. To verify the internal consistency of the questions (reliability), Cronbach's alpha coefficient was calculated. According to Field (2009), this coefficient indicates the overall reliability of a questionnaire; the higher the better and around 0.8 as good. Here, alpha was 0.859.

6.4.1 Profile of the respondents

A relatively high experience and position were desirable for the respondents. This could enhance the credibility of the findings since the questions in this section were based on personal opinions. Table 6-4 outlines the profile of the respondents. 65% of the respondents were from architecture firms, with the remainder representing client organisations. About 95% of all respondents, favourably, had 10 years or more of experience. In terms of the positions held, the data are presented separately for architects and clients. Various types of positions were reported; here these are grouped into those deemed as 'higher' and those as 'lower'. Again, the data demonstrates a good proportion of seniority among the respondents, with 68% of architects and 62% of clients having high positions such as 'director'.

[5] less than 0.2% of all data

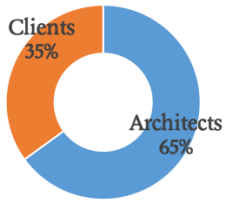
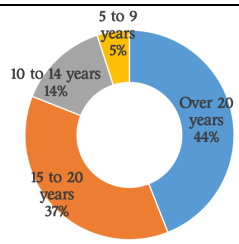
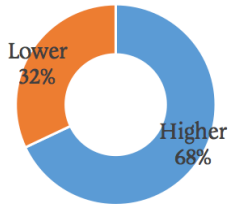
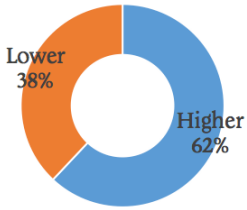
		Count	*Percentage*
Respondent Group	Architecture Firms	84	
	Client Organisations	45	
Experience	Over 20 years	57	
	15 to 20 years	48	
	10 to 14 years	18	
	5 to 9 years	6	
Position (Architecture Firm)	Higher: Partner/Director /Principal/Head	57	
	Lower: Associate/Architect /Project Manager	27	
Position (Client Organisation)	Higher: Director/Manager /Head	28	
	Lower: Project Manager	17	

Table 6-4: Profile of the respondents in study three

6.4.2 Ranking and validation

The respondents, in section one, were asked to rate the importance of the 36 factors identified in the previous study using a 5-point Likert scale. The ranking of the factors was performed on the basis of their mean values. The results are shown for overall as well as each respondent group in Table 6-5 and figure 6-3. The mean values ranged from 3.426 for F30 'modelling & simulation' to 4.426 for F26 'brief'. Apart from the 'brief', four other factors with the highest perceived importance were F21 'communications', F18 'leadership', F16 'knowledge & skills', and F35 'construction-quality' respectively. On the other hand, the lowest importance was given to F30 'modelling & simulation', F20 'creativity', F17 'experience', F4 'DQ value analysis', and F34 'POE'. Interestingly, both respondent groups ranked the 'brief' as the most important factor and the 'communications' among top three.

Another interesting point is that the 'brief' and 'leadership' that have received high ranks here, were also nominated by respectively 80% and 70% of the participants in Study Two.

ID	*Factors' topic areas*	*Overall*		*Architecture Firm*		*Client Organisation*	
		Mean	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*
F1	DQ criteria appreciation	4.202	7	4.153	15	4.295	4
F2	DQ Importance	4.178	=10	4.165	=12	4.205	=9
F3	DQ Objectives	4.116	=17	4.212	7	3.932	28
F4	DQ value analysis	3.643	33	3.600	=32	3.727	31
F5	DQ time	4.209	6	4.141	16	4.341	=2
F6	DQ budget	4.178	=10	4.235	=4	4.068	=24
F7	Whole-life view	4.078	22	4.024	=23	4.182	=14
F8	Procurement	4.070	23	4.024	=23	4.159	=17
F9	Appointments	4.054	25	3.988	25	4.182	=14
F10	STK identification	4.023	27	3.906	28	4.250	5
F11	STK requirement discovery	4.062	24	4.047	21	4.091	=21
F12	STK balancing objectives	4.047	26	3.965	27	4.205	=9
F13	STK engagement	4.101	=20	4.035	22	4.227	=6
F14	STK analysis	3.752	30	3.800	30	3.659	=33
F15	Roles & Responsibilities	4.155	15	4.200	=8	4.068	=24
F16	Knowledge & Skills	4.233	4	4.235	=4	4.227	=6
F17	Experience	3.574	34	3.600	=32	3.523	35
F18	Leadership	4.271	3	4.306	2	4.205	=9
F19	Commitment	4.186	9	4.200	=8	4.159	=17
F20	Creativity	3.550	35	3.494	35	3.659	=33
F21	Communications	4.310	2	4.294	3	4.341	=2
F22	Collaboration	4.171	=13	4.141	=16	4.227	=6
F23	Trust	4.124	16	4.129	=18	4.114	20
F24	Conflict management	3.907	29	3.906	=28	3.909	29
F25	STK power distribution	4.008	28	3.976	26	4.068	=24
F26	Brief	4.426	1	4.447	1	4.386	1
F27	Phased process	4.178	=10	4.188	=10	4.159	=17
F28	Information management	4.116	=17	4.129	=18	4.091	=21
F29	Drawings & Specifications	4.109	19	4.165	=12	4.000	27
F30	Modelling & Simulations	3.426	36	3.471	36	3.341	36
F31	Design translation	4.194	8	4.188	=10	4.205	=9
F32	Change management	4.101	=20	4.106	20	4.091	=21
F33	DQ monitoring	4.171	=13	4.165	=12	4.182	=14
F34	POE	3.667	32	3.576	34	3.841	30
F35	Construction quality	4.217	5	4.224	6	4.205	=9
F36	Feedback	3.744	31	3.765	31	3.705	32

Table 6-5: Mean value and rank of the factors for overall and each respondent group

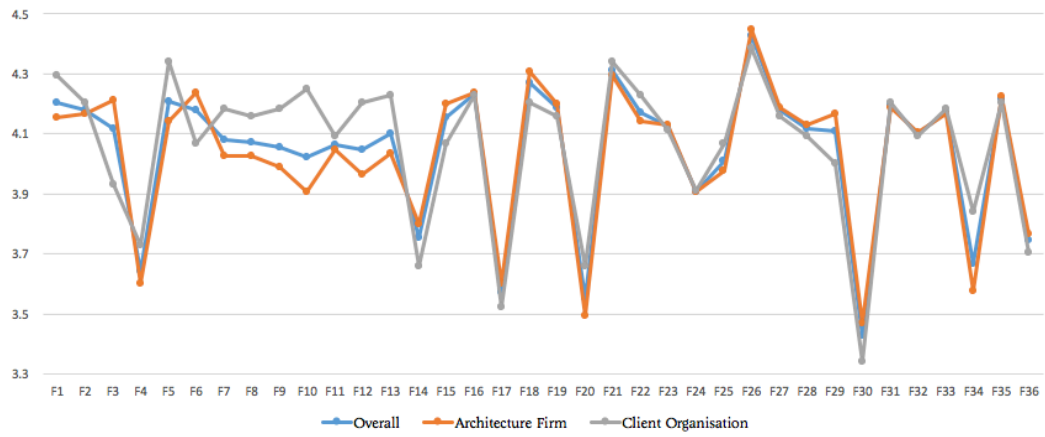


Figure 6-3: Mean value of the factors based on respondent group

Besides the ranking of the factors, more importantly for the study was to validate the criticality of them. This was important because as mentioned previously the inductively identified factors in Study Two needed further validation if they are to be called critical success factors with confidence. Two viewpoints could be considered here. First, all the 36 factors were rated high and there is not a very large discrepancy between the mean values of adjacent factors. The median value – the middle score in the dataset - was found to be 4 (i.e., highly important) for all the factors. Therefore, one could consider all of the factors as critical for design quality achievement. There are also supporting comments from the survey respondents:

> *'It is very difficult not to rate all the above factors as extremely important - they are all critical to the success of any project.'*

> *'You have pretty well covered it in my opinion/experience (60 years old architect with nearly 30 years of private practice).'*

Considering a threshold value as a filtering stage is another approach for the validation task. Several CSFs studies used a cut-off point of the mean value, although according to Won et al. (2013) there does not exist a standardised method or consensus on this threshold value. For example, both Kulatunga et al. (2009) and Shen and Liu (2003) considered 4 on a

5-point scale as their threshold value where 4 was labelled as 'moderately important' in the prior and 'important' in the latter studies. Meanwhile, some authors like Yang et al. (2009) did not establish a separate threshold and accepted all the factors that were identified earlier in the research. There are also studies that had to consider the requirements of a subsequent statistical analysis and filter out the success factors with the lowest mean value. For instance, Toor and Ogunlana (2008) had to omit 19 out of 39 CSFs to satisfy the 5:1 'sample size to variable' ratio needed for subsequent Factor Analysis.

For the present study, it was sensible to consider the meaning of the scale points used (1=not important, 2=slightly important, 3=moderately important, 4=very important, and 5=extremely important). Any success factor with a mean value of 4 and above was assigned to be 'critical', meaning those falling between 'highly' and 'extremely' important points. With respect to the table 6-5, 28 factors out of the original 36 were passed this filtering stage and were validated to be the critical success factors for design quality achievement and were, thus, used in the analysis of the section two. The 8 factors that did not pass are underlined in table 6-5. Of note were the exclusion of F14 and F34. In line with the discussion given in Chapter 4 regarding the industry view on the need for stakeholder analysis, this factor did not pass the validation test. Post occupancy evaluation (POE) was also omitted which could be linked to the practical barriers mentioned in Chapter 2 (section 2.2.4) and Chapter 4 (section 5.4.3.10). It should be noted that the sample requirement of the next statistical analysis (i.e. PCA), if a 5:1 ratio was to comply to, would also require a smaller number of factors. As a result of this section, the objective a2 to rank and validate the identified potential CSFs based on their relative importance was fulfilled.

6.4.3 Significant difference between respondent groups

Before moving on to the next section of the questionnaire to examine real-world projects against the CSFs, it would be valuable to compare the two respondent groups of architects and clients for their perceptions regarding the importance of the factors (objective a3). This

is a common analysis in CSFs studies as described in section 2.3.2. Examples are Yang et al. (2010), Toor and Ogunlana (2008) and Chen and Chen (2007). Therefore, the objective a3 was defined to explore if there was any significant difference between the respondent groups regarding their perception on the importance of the factors. The null hypothesis that the respondent groups differ in their opinion about the importance of the 36 factors for design quality achievement was examined using a Mann-Whitney test. In this test, the findings are interpreted by the probability value (p-value). If the p-value is less than 0.05, then there is a significant difference between the groups (Field, 2009).

The asymptotic significance values for the 36 factors were obtained but for brevity is moved to Appendix C. The results show that the two respondent groups did not differ significantly in perceiving the importance of the factors (null hypothesis was rejected) except for F10 'STK identification' and F34 'POE', for which the p-value was found significant (F10 sig.=0.035; F34 sig.=0.044). The associated population pyramid histograms are also given in Appendix C. Consulting the mean values in Table 6-5 shows that in both cases the client group rated the factors higher than architects. This may be interpreted as clients consider the comprehensive identification of stakeholders as more important because if any stakeholder is not identified, the consequences will be primarily for the client. Similarly, POEs are more important to clients as they are the ones who have to deal with any possible design errors in the completed building.

In the following, the findings from section two of the questionnaire will be presented. Using data from real-world projects, the 28 CSFs will be explored for interrelationships and underlying components (objective a4). Also, the relative impact of these components on functionality, build quality and impact outcomes, as three success criteria of design quality, will be assessed (objective a5). Three responses had to be removed from the analysis due to outliers and no-response[6], leaving 126 valid responses for analysis. Cronbach Alpha was 0.958, thus a high reliability for the questions.

[6] One response had '6' for all questions; one response had several 'don't knows'; one response had part 1 unanswered.

6.4.4 Profile of the choice projects

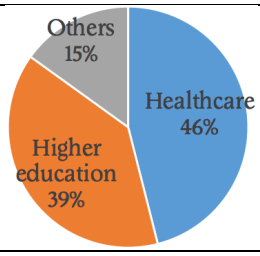
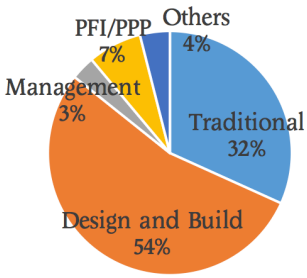
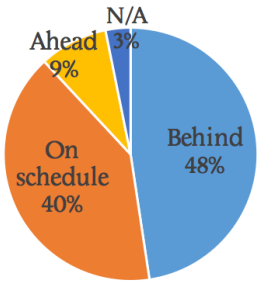
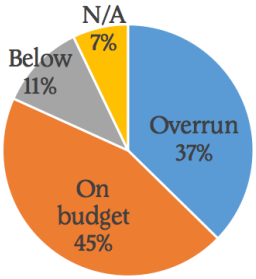
		Count	Percentage
Project Sector	Healthcare	58	
	Higher Education	49	
	Workplace	13	
	Residential	3	
	Others (secondary education, retail, museum)	3	
Procurement Route	Traditional	40	
	Design and Build (1-stage)	31	
	Design and Build (2-stage)	37	
	Management	4	
	PFI/PPP	9	
	Others (P21, NBC3, Supply Chain)	5	
Time Performance	Behind schedule by over 10%	13	
	Behind schedule by 5-10%	16	
	Behind schedule by below 5%	31	
	On schedule	51	
	Ahead of schedule by below 5%	6	
	Ahead of schedule by 5-10%	5	
	Ahead of schedule by over 10%	0	
	Not available (N/A)	4	
Cost Performance	Overrun budget by over 10%	12	
	Overrun budget by 5-10%	11	
	Overrun budget by below 5%	24	
	On budget	56	
	Below budget by below 5%	10	
	Below budget by 5-10%	4	
	Below budget by over 10%	0	
	Not available (N/A)	9	

Table 6-6: Profile of the choice projects in study three

Table 6-6 depicts the profile information of the choice projects in the study. As it can be seen, 85% of the projects were either healthcare or higher education. The remainder, e.g. workplace or residential, also can be classified as multi-stakeholder environments. About one third of the projects had a 'traditional' procurement while 'design-and-build' (in both forms of 1-stage and 2-stage) was responsible for 54% of the total projects. Other procurement

routes were responsible for only 18 projects. Interestingly, the distribution of the procurement routes in the study is to a large extent similar to the RIBA's (2013) survey of the most commonly used routes in the UK. This could contribute to the representativeness of the study sample. About half of the projects completed behind the schedule, with 40% of them finishing on time and only 9% ahead of schedule. 56% of the choice projects were finished within the budget (i.e. on or below budget) and the rest went over-budget. Interestingly, no project was below budget or ahead of schedule by more than 10% and the majority of time or cost under-performance was by below 5%.

In addition to the above information about the choice projects, the mean value of the variables - both the success factors and the success criteria were also examined. This was based on the extent of agreement on the presence of the factors in the choice project as well as the extent of design quality achievement in the three criteria. As mentioned before, a symmetrical 7-point scale with a middle point meaning 'neither agree nor disagree' was used as response options. The complete results are given in Appendix C. However, noteworthy was the factors F34 'POE', F14 'STK analysis', F4 'DQ value analysis, and F30 'modelling & simulation' which were deemed to be the least present factors in the projects respectively. Not only these were among those that did not pass the criticality test (section 6.4.2), but also were deemed to be less present in the projects. On the other hand, F16 'knowledge & skills' had the highest mean value (=5.75). The mean values for functionality, build quality and impact were 4.86, 4.31 and 4.67 respectively.

6.4.5 CSFs interrelationships and underlying components

As mentioned in Chapter 2 (section 2.3.2), a common analysis in the CSFs studies is the evaluation of the interrelationships. It was also learned from Study Two that many factors seemingly had some degree of overlap and association. Therefore, it would be valuable to explore the CSFs from this angle and as a result, add a deeper layer of understanding - as desired by primary objective A. The PCA is useful for this purpose which through its data

reduction process, a more parsimonious yet meaningful structure of CSFs could be reached. Moreover, it would benefit the next analysis in the study, i.e., regression, by removing the multicollinearity issue.

The validated 28 CSFs were used for the PCA. According to Field (2009), sample size could affect the reliability of the PCA and often a rule of thumb of 5:1 (sample size to number of variables) is used to determine the adequacy of it. However, he added that this should be treated as a starting point and other criteria such as the values of KMO (Kaiser-Meyer-Olkin) and communalities are more accurate tests. Considering the 126 valid responses, the 28 factors could marginally satisfy the 5:1 rule of thumb. However, as it will be shown in the following, KMO was satisfactory and also all communalities were above 0.6 (table 6.8). According to MacCallum et al. (1999), with all communalities above 0.6, relatively small samples (less than 100) may be perfectly adequate.

The SPSS 'dimension reduction' procedure was used to conduct the PCA on the 28 variables with orthogonal (varimax) rotation. The suitability of PCA was assessed primarily. The overall KMO measure of sampling adequacy was 0.893 ('great' according to Field (2009)), and all KMO values for individual variables were greater than 0.778, which is well above the acceptable limit of 0.5 (Field, 2009). Bartlett's test of sphericity was statistically significant ($p<0.0005$), indicating that correlations between variables were sufficiently large for conducting the PCA. Examination of the correlation matrix showed that, as required, all variables had at least one correlation coefficient greater than 0.3 and there was no very high correlation (r=0.9). The criteria of 'Kaiser criterion', 'total variance', and 'interpretability' were used for component extraction (Hair et al., 2014).

An initial analysis was run to obtain eigenvalues for each component in the data. Six components were revealed each with an eigenvalue greater than 1 (Kaiser criterion) and in combination explaining 69.8% of the total variance (total variance criterion). However, these components did not meet the interpretability criterion, arguably the most important one. As it can be seen in the 'rotated component matrix' (figure 6-4, left side table), a 'simple

structure' was not achieved. Simple structure exists when all variables have high loadings only on a single component and each component loads strongly (0.5) on at least three variables (Hair et al., 2014). Often, variables having a loading smaller than 0.5 are considered as insignificant in contributing to the interpretation of the component and are not included. 'STK engagement' is loading strongly on both components one and two, so does 'information management' on the components two and four. Moreover, 'STK power distribution' and 'Phased process' do not load adequately on any component. Beside these, the component six does not load strongly on at least three components where 'knowledge & skills' has even a negative loading.

	Component					
	1	2	3	4	5	6
STK Requirements discovery	.804					
DQ Objectives	.779					
Brief	.778					
STK Identification	.740					
STK objectives balancing	.733					
DQ Importance	.692					
DQ criteria appreciation	.680					
STK engagement	.553	.524				
Collaboration		.801				
Communications		.743				
Trust		.666	.478			
Infortmation Management		.568		.530		
Leadership		.561				
Roles & Responsibilities		.533				
Commitment			.806			
Appointments			.749			
Construction Quality			.694	.409		
DQ Monitoring			.687			
Change Management				.752		
Design Translation				.734		
Drawings & Specifications		.498		.592		
Phased process		.472		.476		
DQ Budget					.791	
DQ Time					.767	
Whole-Life View	.493				.613	
Knowledge & Skills	.430					-.660
Procurement						.634
STK Power Distribution		.452				.461

	Component					
	1	2	3	4	5	6
STK Requirements discovery	.809					
DQ Objectives	.790					
Brief	.788					
STK Identification	.746					
STK objectives balancing	.721					
DQ Importance	.673					
DQ criteria appreciation	.667					
STK engagement	.546			.484		
Commitment		.797				
Appointments		.744				
DQ Monitoring		.709				
Construction Quality		.686	.402			
Design Translation			.724			
Change Management		.406	.721			
Drawings & Specifications			.677	.444		
Infortmation Management			.602	.461		
Phased process			.530			
Collaboration				.763		
Communications				.724		
Trust		.464		.644		
Roles & Responsibilities					.709	
STK Power Distribution					.704	
Leadership					.566	
Procurement		.469			.524	
DQ Budget						.779
DQ Time						.766
Whole-Life View	.491					.610

Figure 6-4: Rotated component matrix for PCA: run one (left side table) and run two (right side table)

As it is stated by Field (2009), PCA is an exploratory process involving subjective reasoning. There might not be only one correct answer and a number of iterations and variable omissions (in case of cross-loading variables) are needed until a sensible component structure is obtained. The interpretability criterion requires that the final rotated solution to make sense and be explainable (Hair et al., 2014). There are similar examples in the CSFs

literature and elsewhere where a simple structure has not been achieved in the first run leading to removing the problematic variables from the analysis (e.g. Yang, 2009b; Alzahrani and Emsley, 2013; Al-Tmeemy et al., 2010). Here, the same was performed by testing the impact of dropping each of the problematic variables mentioned above. The aim was to lose the minimum information possible by removing the lowest number of variables. Delightedly, removing only the F16 'Knowledge & Skills' from the variable list solved the complex structure shown above. However, this factor was ranked as the 4th most important CSF in section 6.4.2 and also was identified by 70% of the participants in the Study Two. Therefore, it would be undesirable to exclude it from the regression analysis of the next section (6.4.6). However, this would require the absence of multicollinearity between this factor and other derived components. Thankfully, this requirement was satisfied as shown in the next section.[7]

Consequently, the PCA procedure was run for the second time using 27 variables. The preliminary analysis showed an overall KMO measure of 0.9 ('superb' according to Field (2009). Individual KMO measures were also all greater than 0.826. The Bartlett test was also statistically significant, as required (table 6-3).

KMO and Bartlett Test –Run Two		
KMO measure		.900
Bartlett's test	Approx. Chi-square	2241.68
	df	351
	Sig.	0.000

Table 6-7: KMO and Bartlett tests for PCA run two

Six components, i.e., C1 to C6, were extracted with an eigenvalue greater than 1 (related SPSS output given in Appendix C). The obtained components each explained a variance between %7.79 (C7) and %19.58 (C1) and together they explained 70.67% of the total variance, which is suitable for the 'variance criterion' (Field, 2009). A simple structure was obtained (figure 6-4, right-side table) with each variable loading strongly on only one component and each component having at least three loaded variables greater than 0.5. Several factors loaded

[7] The researcher also ran the PCA with the original 36 factors. However, no simple structure was obtained after the omission of several variables, among which many were ranked as highly important in section one.

highly (more than 0.6) and the communalities are all above 0.6 as required (table 6-8), according to Field (2009). Perhaps the most importantly, the variables under these components are fairly related in meaning (interpretability criterion) allowing for better labelling of the components.

Table 6-8 summarises the results of the PCA. The first column shows the CSFs grouped under each of the components (grouping of 'how' factors). PCA uses the idea of pair correlations to identify components. It clusters together the correlated CSFs, indicating all could measure the same underlying unobserved variable (Field, 2009). The second and third columns list the 'loading' and 'communality' values for each CSF. The loading represents the correlation between the CSFs and the extracted components. It is a gauge of the substantive importance of a given CSF to a given component. Square loadings indicate what percentage of the variance in a CSF variable is explained by a component (Field, 2009). For example, as it can be seen in table 6-8, 46% ($=0.677^2$) of the variance in F29 is explained by C3. Stevens (2002) recommends interpreting only loadings with an absolute value greater than 0.5, which explain at least 25% of the variance in the variable.

Communality shows the total amount of variance an original variable shares with all other variables included in the analysis. It is calculated by the sum of the squared loadings for all components for a given variable. The closer communalities to 1, the better the components at explaining the original data (Field, 2009). The table, also, presents the 'eigenvalue' and 'variance explained' values for each extracted components. As described earlier, eigenvalues are used as part of the Kaiser criterion for component extractions. Its value needs to be above 1. Eigenvalues measure the amount of variation in the total sample accounted for by each component. The 'variance explained' in the table indicates the percentage of this variation (Hair et al., 2014). In the followings, each component will be discussed.

	Loading	*Communality*
Component One: Appropriate briefing with shared vision on DQ		
F11: STK requirements discovery	.809	.720
F3: DQ objectives	.790	.703
F26: Brief	.788	.763
F10: STK identification	.746	.698
F12: Stk objectives balancing	.721	.657
F2: DQ importance recognition	.673	.610
F1: DQ criteria appreciation	.667	.684
F13: STK engagement	.546	.640
Variance Explained: 19.57% (eigenvalue: 11.249)		
Component Two: Overseen DQ execution with commitment		
F19: STK commitment	.797	.792
F9: Appointments	.744	.681
F33: DQ monitoring	.709	.755
F35: Construction quality	.686	.649
Variance Explained: 12.55% (eigenvalue: 2.335)		
Component Three: Appropriate DQ transition at project process interfaces		
F31: Design Translation	.724	.764
F32: Change Management	.721	.781
F29: Drawings & Specifications	.677	.696
F28: Information Management	.602	.693
F27: Phased Process	.530	.604
Variance Explained: 11.4% (eigenvalue: 2.009)		
Component Four: Stakeholder interaction & working relationship		
F22: Collaboration	.763	.786
F21: Communications	.724	.739
F23: Trust	.644	.759
Variance Explained: 11.14% (eigenvalue: 1.351)		
Component Five: appropriate allocation of stakeholders roles and power		
F15: Roles & Responsibilities	.709	.772
F25: STK Power Distribution	.704	.726
F18: Leadership	.566	.661
F8: Procurement	.524	.621
Variance Explained: 8.22% (eigenvalue: 1.126)		
Component Six: Pro-DQ resource consideration		
F6: DQ budget	.779	.773
F5: DQ time	.766	.684
F7: Whole-life view	.610	.669
Variance Explained: 7.79% (eigenvalue: 1.012)		
Total Variance Explained: 70.67%		

Table 6-8: Results of principal component analysis/component structure for success factors

Component One (C1): ***Appropriate briefing with shared vision on DQ***

The first component includes eight CSFs and is accounted for 19.57% of the total variance - the highest among the extracted components. The high loading variables –which contribute

more to the interpretation of the components - clearly underscore the activity of briefing, in that, to obtain a right brief (F26) where DQ objectives are defined and prioritised (F3), the stakeholders should be identified (F10), their potentially differing requirements be elicited (F11) and appropriately balanced (F12). The other correlated variables also, indicate that a proper briefing activity should engage all stakeholders (F13) who have developed a shared appreciation of the DQ success criteria (F1). This outcome is in line with the literature. Hansen and Vanegas (2003) indicated that an appropriate early briefing process is key to achieving successful building quality. Yu et al. (2006) also found factors such as clear objective definition, thorough understanding of stakeholder requirements and consensus building are critical for a successful briefing activity. Moreover, Jensen (2011) emphasised on the need for briefing to be an interactive process with the involvement of all stakeholders.

Component Two (C2): ***Overseen DQ execution with commitment***

The second extracted component consists of four variables, accounting for 12.55% of the total variance. The variable with the highest loading is the continuous commitment to design quality by everyone involved (F19) which could sensibly require the appointment of those interested in design quality achievement (F9). Both the quality of construction methods (F35) and monitoring design quality development during the project (F33) are interestingly located in this component as well. This could imply that commitment and the recruitment of design quality enthusiasts in the project are especially important at the construction stage and could lead to the use of high quality methods and continuous evaluation of design quality. Another interesting observation is that unlike the first component that refers to the early project stages, C2 is concerned with the later project stages.

Component Three (C3): ***Appropriate DQ transition at project process interfaces***

Five variables emerged under this component accounting for 11.4% of variance. Due to the nature of these CSFs, this component could be seen to be concerned with the appropriate conveyance of design quality intent and information between project stages. Design

translation (F31) - the highest loading variable - clearly reflects this point on the basis of a phased process with defined deliverables (F27) and appropriate change management (F32). Other CSFs in this component also indicate relevant themes. It could be implied that appropriate translation of design quality requires suitable drawings and specifications (F29) and the utilisation of appropriate information management methods (F28). Interestingly, all the variables in this component were previously grouped under 'process-related' factors in the second study. Also, while the C1 focus on early project stages and C2 on the later ones, the Component Three, plays a bridging role between the two.

Component Four (C4): ***Stakeholder interaction & working relationship***

This component explains 11.14% of the variance and involves three CSFs of collaboration, communication and trust. These immediately remind us of the need for an appropriate stakeholder interaction and working relationship. The literature supports the correlation between these factors. According to Cheng et al. (2000), effective communications could stimulate mutual trust and both are necessary for collaboration and partnership between the project organisations.

Component Five (C5): ***Appropriate allocation of stakeholders' roles and power***

Similar to the previous component, the component five is also concerned with the stakeholders in the project. This component explains 8.22% of the variance and includes four CSFs. Clearly defined 'roles and responsibilities' (F15) is the variable with the highest loading in this grouping. The second factor which concerns the power distribution (F25) is meaningfully related to roles and responsibilities of the stakeholders. The project procurement method (F8) is what defines the roles and the authority of different project parties. According to Bourne and Walker (2006), procurement strategies underpin the level of power stakeholders have and the way they can use it to influence decisions. For example, a traditional design-led procurement gives more power in hand of the architect whereas design and build procurement gives more responsibility and power to the contractor in controlling the design (Nash et al., 2010). Leadership (F18) is also meaningfully related to the

other factors in this component. According to Toor and Ogunlana (2008), the concept of leadership highly revolves around power, authority and task-orientation. Limsila and Ogunlana (2008) also defined the leadership as the process of influencing the activities of others in a group.

Component Six: ***Pro-DQ resource consideration***

The last group of inter-related CSFs accounted for 7.79% of the variance. Three variables emerged under this component all of which are related to ensuring adequate resources are allocated to design and its development. As discussed in Chapter 4, both time and cost are required for design quality achievement and a whole-life view would encourage their allocation. This component, also, seems to be relevant to the early project stages.

These components which allowed for a better summarisation and categorisation of the CSFs based on the data from real-world projects, could be put together to form a framework of design quality CSFs. Similar attempts have been done by other scholars like Yang et al. (2009) and Chan et al. (2010). This framework will be given and discussed in Chapter 8. As a result of this section, the objective a4 to explore the interrelationships between the validated CSFs and to identify the underlying components (i.e., grouping of the CSFs) is fulfilled.

6.4.6 Relative impact of CSFs components on design quality success criteria

The PCA used in the previous section revealed the interrelationship between the success factors and their underlying components, however, it could not determine how these components could contribute to different aspects of design quality achievement (i.e. the success criteria). For this purpose, this section will explore the relative impact of the derived components on each of the success criteria of functionality, build quality and impact. Regression analysis capable of modelling a causal relationship between a set of independent variables and a dependent variable is used. The SPSS automatically outputs

the 'factor scores' for the six components. These, together with the F16 'knowledge & Skills', are used here as the independent variables. Interestingly, 'knowledge and skills' depicts an aspect of the CSFs that is not represented by any of the identified components. Therefore, provided that there is no multicollinearity, addition of this factor to the regression models would be valuable. Table 6-9 shows the 7 independent variables and the 3 dependent variables. The aim is to find out which of the independent variables contribute significantly – and to what extent - to the achievement of each of the dependent variables based on the data from real-world projects.

Independent Variables	Dependent variables
C1: Appropriate briefing with shared vision on DQ	Functionality
C2: Overseen DQ execution with commitment	Build quality
C3: Appropriate DQ transition at project process interfaces	Impact
C4: Stakeholder interaction & working relationship	
C5: appropriate allocation of stakeholders roles and power	
C6: Pro-DQ resource consideration	
F16: Appropriate knowledge and skills in design development	

Table 6-9: Independent and dependent variables for regression analysis

As the three dependent variables in this study have been measured on ordinal scales, the Ordinal Regression (OR) was the first choice for analysis. A fundamental assumption that needs to be satisfied for the OR to produce valid results is to having proportional odds. This assumption means that each independent variable has an identical effect at each cumulative split of the ordinal dependent variable (Agresti, 2010) and can be tested using 'test of parallel lines' output in the SPSS ordinal regression analysis. However, this assumption was violated for all the dependent variables in this study, as given in Appendix C.

Consequently, it was decided to use Multiple Linear Regression (MLR) instead, provided that its assumptions were fulfilled. MLR is suggested for when the dependent variable has a continuous scale. However, it is commonly used with Likert scales as well and the examples of studies taking such an approach in construction and beyond are plentiful

(Cserhati and Szabo, 2014). For using MLR with Likert scales, some have provided recommendations. According to Johnson and Creech (1983) as well as Zumbo and Zimmerman (1993), when there are 5 or more points in the scale, there is relatively little harm to use MRL. Also, Menard (2010) stated that it is usual practice to treat ordinal scales as continuous when the underlying concept is continuous and the intervals between the scale points are approximately equal. In this study, the dependent variables were measured on a 7-point Likert scale with equal distance and a mid-point to measure the continuous concept of 'design quality achievement as expected'. The MLR has several assumptions. These are 'independence of observation', 'linearity', 'Homoscedasticity', 'no multicollinearity', 'no significant outliers, 'no leverage points or influential points', and 'normally distributed errors' (Field, 2009). These assumptions were tested and fortunately were satisfied. The detail of these are given in Appendix C.

Apart from the assumptions, there are also requirements regarding the sample size. There are different recommendations for sample size. Hair et al. (2014) suggest 15:1 or 20:1 as the preferred ratio of sample size to the number of independent variables. Field (2013), however, prefers a more accurate guideline offered by Green (1991) who gave two formulas to ensure adequacy of sample size. The first concerns the adequacy of sample size in order to test the overall model fit for which, at least 50 + 8K samples are needed (where k is the number of independent variables). The second requires 104 + K which is the minimum sample size if the contribution of individual independent variable is to be tested. Field (2009) adds that as the interest is often in both the above, both should be calculated and the one with larger value be considered. The sample size of 126 satisfies 15:1 ratio as well as both the formulas stated above. Field (2009) also suggests considering the expected effect size (i.e. how well the independent variables predict the dependent variable) and statistical power[8]. The latter is often considered at 0.8 (Cohen, 1988). According to Field (2009), if a medium effect size is expected, for 6 or 10 independent variables, respectively 100 and 150 samples are needed. In here, with 7 variables, the sample of 126 is adequate[9].

[8] Power refers to the probability of detecting as statistically significant a specific level of R^2 (Hair et al., 2014).
[9] A large effect size requires smaller sample size and a small effect size requires a larger number of samples.

The SPSS module for MLR outputs three result tables. The first two, i.e., model summary and ANOVA, are concerned with the assessment of the overall fit of the regression model and the third table, i.e., coefficients, provides information about the individual contribution of the independent variables. The model summary shows three important values. The R value, or the multiple correlation coefficient, indicates how good the independent variables are at predicting the dependent variables. The R^2 value, called the coefficient of determination, gives the proportion of variance explained by the model (Field, 2009). The higher the value of R, the greater the power of the regression equation, and therefore, the better the prediction of the dependent variable (Hair et al. 2014). The 'adjusted $R^{2'}$ is an estimate of the effect size and ideally its value should be the same, or very close to the value of R^2. The closeness of these two values indicate that the cross-validity of the model is good. Cross-validation is evaluating the accuracy of a model across different samples and is an indication of the representativeness of the study sample, and therefore, the generalisability of the findings to the population (Field, 2009).

The ANOVA results indicate whether or not the regression model is a significant fit of the data. In other words, it states whether the model, in overall, results in a significantly good degree of prediction of the dependent variable. The most important part of the table is F-ratio. F is the ratio of the mean sum of squares for regression to the mean sum of squares for the residuals and it needs to be significant ($p<0.05$) (Field, 2009).

The third table assesses the individual independent variables. The main outputs are b-values, beta-values and t-statistics. B-values indicate the degree each individual independent variable contributes to the model. However, this is when the effects of all other predictors are held constant. Therefore, the standardised versions of the b-values (i.e. beta-values or model parameters) are easier to interpret (Field, 2009). The t-statistics shows whether or not the variables contribute significantly to the ability to estimate values of the outcome variable. Therefore, if the t-test associated with the b-value is significant then the independent variable is making a significant contribution to the model. The smaller the

value of sig., the greater the contribution of that predictor. In the following the results of the regression analysis is given for each of the three dependent variables.

Functionality:

As it can be seen in table 6-10, the R value is 0.669 which indicates a good level for the independent variables at predicting the dependent variable 'functionality'. The value for R^2 is 0.448, meaning that the independent variables explain 44.8% of the variability of the dependent variable. For functionality, the adjusted R^2 is 0.415, which is considered as medium effect size according to Cohen's (1988) classification. The difference between R^2 and adjusted R^2 is only 3.3%. This means that if the model was derived from the population rather than the study sample, it would account for 3.3% less variance in the outcome.

Model Summary					
R	R^2	Adjusted R^2	Std. error of the estimate		
.669	.448	.415	.906		
ANOVA					
	Sum of squares	df	Mean square	F	Sig.
Regression	78.569	7	11.224	13.674	.000
Residual	96.860	118	.821		
Total	175.429	125			
Coefficients					
	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
Constant	3.106	.493		6.301	.000
C1	.242	.089	.205	2.713	.008
C2	.178	.081	.150	2.197	.030
C3	.303	.086	.256	3.542	.001
C4	.355	.085	.300	4.197	.000
C5	.072	.081	.061	.892	.374
C6	.073	.081	.062	.900	.370
F16	.305	.085	.295	3.602	.000

Table 6-10: Results of regression analysis for dependent variable: Functionality

The ANOVA result shows that F=13.674 and significant (p<0.001). Therefore, the overall model is a significant fit of the data. According to the Sig. values for the independent variables, C1, C2, C3, C4 and F16 have significant impact on functionality. Among these, C4 'stakeholder interaction & working relationship' with beta=0.3 has the greatest contribution in explaining the achievement of building functionality.

Build quality:

Table 6-11 exhibits the results for dependent variable 'build quality'. The R value is favourably high (R=0.717) and the model explains 51.5% of 'build quality' variance (R^2=.515). Adjusted R^2 is .486 which again shows a medium effect size. The difference between R^2 and the adjusted R^2 is small at 2.9%. With F=17.871, p<0.001, the model explains build quality statistically significantly. Based on the Sig. column, it is concluded that C2, C3, C5 and F16 have significant influence on the achievement of build quality in building projects. The C2 'overseen DQ execution with commitment' has the highest impact on the dependent variable (beta=.555)

Model Summary					
R	R^2	Adjusted R^2	Std. error of the estimate		
0.717	.515	.486	.872		
ANOVA					
	Sum of squares	df	Mean square	f	Sig.
Regression	95.164	7	13.595	17.871	.000
Residual	89.765	118	.761		
Total	184.929	125			
Coefficients					
	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
Constant	3.224	.475		6.793	.000
C1	.160	.086	.132	1.866	.064
C2	.675	.078	.555	8.653	.000
C3	.313	.082	.258	3.804	.000
C4	.118	.081	.097	1.452	.149
C5	.217	.078	.178	2.773	.006
C6	.039	.078	.032	.492	.623
F16	.189	.081	.178	2.320	.022

Table 6-11: Results of regression analysis for dependent variable: Build Quality

Impact:

Finally, it can be observed from table 6-12 that C1, C4, C5, C6 and F16 have significantly contributed to the achievement of 'impact' in the building projects. The regression model is also revealed to be a good fit for the data (F=10.586, p<0.001) accounting for 38.6% of the variation in the dependent variable (R^2=.386). The adjusted R^2 at .349 shows a fairly medium

effect and its difference with R^2 is small (3.7%). F16 'appropriate knowledge and skills in design development' has the highest impact on the achievement of impact (beta=.305).

Model Summary			
R	R^2	Adjusted R^2	Std. error of the estimate
.621	.386	.349	1.1037

ANOVA					
	Sum of squares	df	Mean square	f	Sig.
Regression	90.262	7	12.895	10.586	.000[b]
Residual	143.738	118	1.218		
Total	234.000	125			

Coefficients					
	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
Constant	2.574	.600		4.286	.000
C1	.223	.109	.163	2.054	.042
C2	.191	.099	.140	1.933	.056
C3	.199	.104	.145	1.905	.059
C4	.346	.103	.253	3.355	.001
C5	.256	.099	.187	2.584	.011
C6	.217	.099	.159	2.194	.030
Factor 16	.364	.103	.305	3.533	.001

Table 6-12: Results of regression analysis for dependent variable: Impact

A summary of findings is shown in figure 6-5. The first noticeable point is that all independent variables (C1 to C6 & F16) as the design quality CSFs had at least one significant relationship with the design quality success criteria in real-world building projects. This further validates the findings achieved from Study Two and questionnaire section one which were based on opinions. Another notable point is that not all of the independent variables influence significantly each of the three success criteria. Functionality and impact are influenced by 5 and build quality by 4 variables. Unfortunately, there is no similar previous study assessing the impact of CSFs on design quality and its criteria in order to compare the findings with. However, considering the focus and elements in each of the success criteria (given in Chapter 2 and also figure 6-2), one could attempt to interpret the findings.

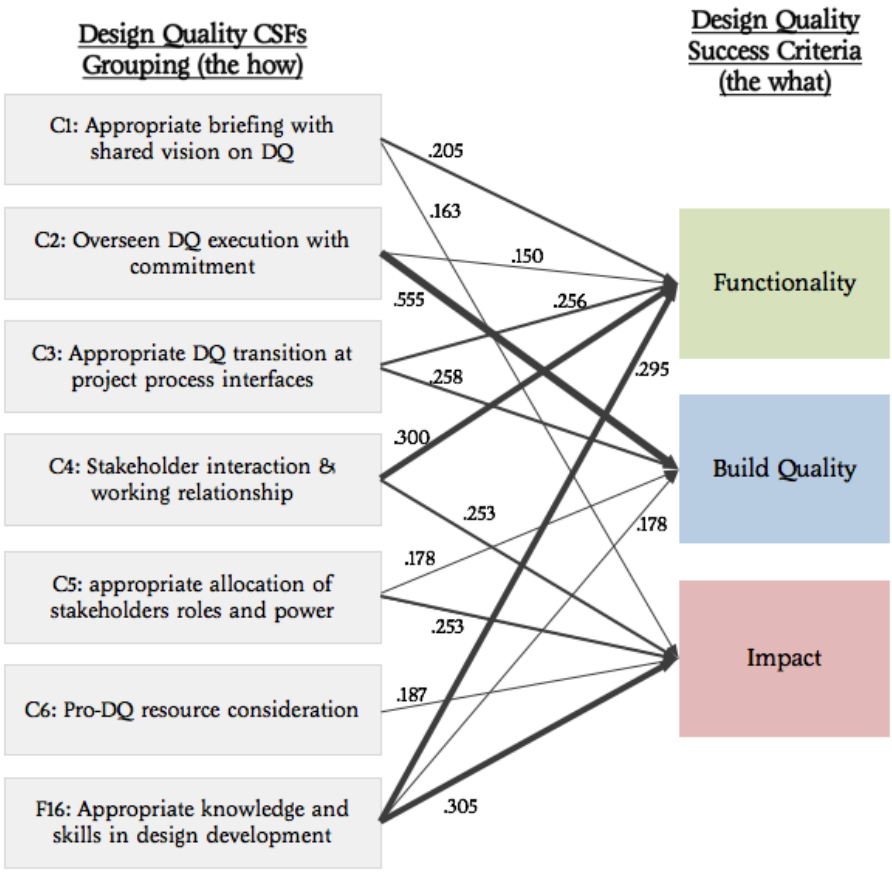


Figure 6-5: Summary of regression findings with beta values
(Thickness of lines are based on beta values.)

Appropriate knowledge and skills in design development influences significantly the design quality of constructed building at its all three areas. Hence, no matter it is about the functionality of a building, its build quality or impact, an essential requirement is that the design is developed by knowledgeable minds and skilful hands. In doing so, the beta values show F16 had a relatively high impact especially on functionality (.295) and impact (.305) in comparison to other independent variables. On build quality, it can be seen that C2 'overseen DQ execution with commitment' has a very high influence (0.555). Considering that building quality refers to how well the building and its components are constructed, and the component C2 includes related factors like appropriate construction methods, this identified significant relationship seems sensible.

Another interesting observation is that C6 'Pro-DQ resource considerations' significantly contribute only to the achievement of the impact criterion (although the beta value at .187 is not relatively very large). This shows that budget and time resources are especially influential in achieving the impact criterion which is concerned with the building delight and includes attributes like look and feel, pleasantness and character. One could interpret this as in order to achieve building aesthetics and winning viewers' delight, especial attention should be given to the adequacy of design budget and time. However, according to the results, this is not the case for achieving functionality and build quality. Instead, areas like C4 'stakeholder interaction & working relationship' (beta=0.300) are significantly influential in achieving functionality and areas like 'appropriate DQ transition between project process interfaces' (beta=0.258) for build quality achievement.

In interpreting the above results, two points are noteworthy. Firstly, the fact that some of the independent variables were found with significant contributions, does not mean that other variables did not have any influence on the dependent variables. As it can be seen in the above regression result tables, all variables had a positive beta value, however not all had a statistically significant contribution impact. Secondly, one should consider that although the respondents were able to distinguish between the three design quality success criteria and allocate different scores to each and also the fact that different findings were achieved with regard for each from the analysis, both theoretically and practically there exist degrees of overlap between these three areas. As a result of this section, the objective a5 to assess the relative impact of the derived CSFs components on the achievement of design quality success criteria is fulfilled.

6.4.7 Individual attributes of key stakeholders

The data regarding the attributes of key stakeholder groups in the choice projects were collected in the third part of questionnaire section two. 112 respondents filled the questions[10]. The mean value was used to compare the stakeholders based on their attributes.

[10] 16 missing entries replaced by median

The results are shown in figure 6-6. The questions asked with regard to each attribute could be found in table 6-1 given earlier. Some notable findings are presented here.

Clients had the highest power to influence design quality decisions in the choice projects. The second position was allocated to the architects. This is not surprising as the clients often have the highest authority and architects could influence their decisions (as also found in Study One). Among the stakeholders, users and facility management team (FM) had the lowest power. Although, architects had lower power compared to the clients, they were more involved (proximity) in design quality decision-makings. The clients were in the second and contractors in the third positions. For user group and FM who had low power and proximity, the urgency was found relatively higher. This indicates that although they did not hold high power to influence decisions and were not highly involved, their interests and requirements were considered relatively higher as critical by the decision makers. Still, their urgency levels were lower than that for clients and architects.

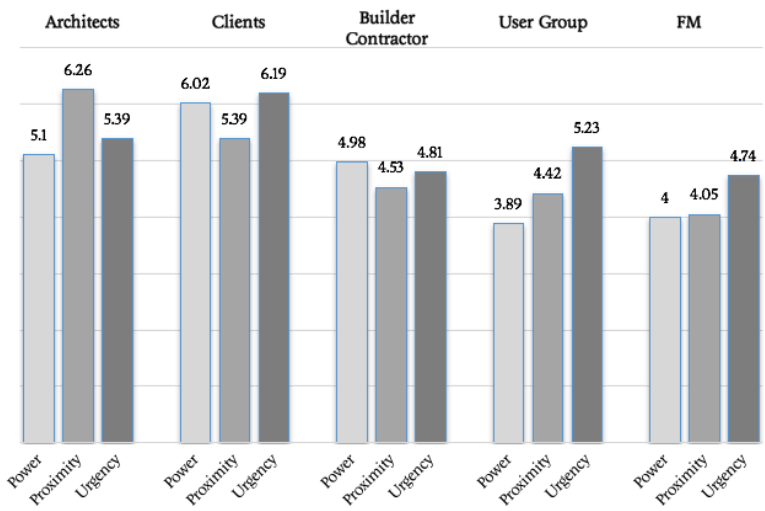


Figure 6-6: Mean values for stakeholder attributes in choice projects

Apart from the descriptive analysis above, a correlational statistical test was used in order to assess whether there is any significant association between these stakeholder attributes. As mentioned in section 6.3.2., Spearman correlation was used. The results are shown in table 6-13 for each stakeholder group. As it can be seen, all pairs of stakeholder attributes

correlate significantly (at 0.01) with each other. Moreover, this association is achieved consistently with regard to all five stakeholder groups. The finding indicates that the possession of high power to influence design quality could be accompanied by high involvement, which itself could be related to high urgency of the stakeholder requirements. It is interesting that, the association between the stakeholder attributes was never looked into by those investigating Mitchell et al.'s (1997) salient model or Stakeholder Circle™.

		Architects			Client			Builder Contractor			User Group			FM		
		Power	Proximity	Urgency	Power	Proximity	Urgency	Power	Proximity	Urgency	Power	Proximity	Urgency	Power	Proximity	Urgency
Architects	Power	1	.507**	.513**												
	Proximity		1	.537**												
	Urgency			1												
Client	Power				1	.543**	.528**									
	Proximity					1	.517**									
	Urgency						1									
Builder Contractor	Power							1	.543**	.565**						
	Proximity								1	.640**						
	Urgency									1						
User Group	Power										1	.572**	.479**			
	Proximity											1	.592**			
	Urgency												1			
FM	Power													1	.785**	.618**
	Proximity														1	.609**
	Urgency															1

Table 6-13: Results of Spearman correlation analysis (**: significant at 0.01)

6.4.8 Discussion of the study approach

Although the identified objectives were achieved, the study had some limitations. In this section, limitations as well as the strengths of the study approach are discussed. To start with, the study successfully completed the sequential mixed methods approach defined in Chapter 3. The qualitatively derived success factors in the second study were used to develop a data collection instrument in Study Three via which the factors were quantitatively

validated (triangulation) and further evaluated. A next sequence could however be designed in which the results of this study are verified in a number of case projects, which was not feasible in this research.

The use of pre-tests for the questionnaire and the inclusion of relevant definitions and clear instructions contributed to the face and content validity of the data collection instrument. The Cronbach's alpha with high coefficient computed for multiple question sections, also, addressed the reliability issue. The reliability was further strengthen by the participation of relevant and relatively highly experienced and senior respondents.

On the other hand, the use of non-probability sampling and approaching only two stakeholder groups in the UK could have a negative impact on the sample representativeness. The ideal was to obtain a random sample as a reliable representative of the study population, i.e., the clients and architects with experience in multi-stakeholder building projects in the UK. However, this required probabilistic methods – or probability sampling. On the other hand, non-probability sampling techniques rely on the subjective judgment of the researcher. A disadvantage of non-probability sampling is that the researcher could not make statistical inferences from the sample being studied to the population of interest. It would be very difficult to get access to and/or find a list of the population.

However, as mentioned earlier, this was necessary in order to maintain a manageable scope while approaching the most accessible, appropriate individuals. As discussed, the sample size was satisfactory for the statistical analyses in the study however the low response rate is an indication of the challenges occurred in the participant recruitment. To address this, the study utilised multiple approaches (online and paper-based) as discussed. Also, in comparison with similar studies, the sample size was still high and adequate. A reason for low response rate could be related to the questionnaire length, but one could argue that once a potential respondent, especially a professional or expert one, decides to fill the questionnaire, he or she would often do. It should also be noted that there were more

architect respondents than client ones, therefore, the findings may more closely reflects architects' opinions. Lastly, the findings are based on subjective perception, although the unit of analysis for the second section was concerned with choice projects.

With regard to the PCA, high KMO and communality values as well as the high total variance explained (70.67%) reflected the strength of the analysis. Due to the analysis constraints, one success factor had to be dropped for the second run, but the result showed meaningful interpretable components with a simple structure. This factor omission however was mitigated by its inclusion in the regression analysis as an individual variable. The PCA approach was exploratory, therefore, a next line of enquiry could be to conduct a Confirmatory Factor Analysis using a separate sample, to verify the groupings.

For the regression analysis, although OR was the first choice, its assumption was violated. Therefore, MLR, as a common approach in similar studies, was used for which the assumptions were fulfilled. The three regression models used in the study had satisfactory R^2 values, giving a good explanation of the variance by the model and effect size. In terms of the generalisability (external validity) a number of points should be considered: the sample size was adequate; the MLR assumptions were satisfied, and the cross-validation test showed suitable results. However, still, the sample could not be claimed to be an accurate representative of the population and the applicability of the findings should be considered with caution. A larger sample size with the inclusion of a more diverse respondent groups, project sectors, and other geographical locations could improve the representativeness issue. Finally, the comparison conducted between the stakeholders in terms of their attributes was descriptive and limited to the sample. Also, the identified correlation was not conclusive, yet its recurrence for all five stakeholder groups is indicative of such relationships in the population.

6.5 Conclusion

The study resulted in a better understanding of design quality CSFs at different layers. The study validated 28 factors as critical in successful achievement of design quality in building projects, where the 'brief', 'communications', 'leadership', 'knowledge & skills' and 'construction quality' were found to be the highest ranked factors in the perception of the participants. It was also found that architects and clients do not significantly differ in perception regarding the importance of the factors except for stakeholder identification and POE.

The study found that in real-world projects, the CSFs interrelate with each other and could be grouped into 7 categories (6 components + F16). This provided a more parsimonious yet meaningful summarisation of the CSFs list. The study further revealed how these CSFs categories (i.e., grouping of 'the how' factors) impact on different criteria of design quality success '(the what' to design quality achievement) in real-world projects. It was, for example, found that F16 'knowledge & skills' significantly contributed to the achievement of building functionality while its build quality is influenced largely by C2 'overseen DQ execution with commitment'. The study successfully modelled the relationship between design quality CSFs and success criteria. Lastly, through applying the second proposed stakeholder model, it was revealed that key stakeholders differ in terms of individual attributes of power, proximity and urgency. Moreover, these attributes were found to correlate with each other.

7 Chapter Seven

A case study to model design quality stakeholder relationships (Study 4)

7.1 Introduction

As mentioned in Chapter 2, three classes of stakeholder analysis models are given in the literature. Study One utilised a matrix-based model devised from the stakeholder definition (Freeman, 1984) in order to better understand stakeholder-design quality interplay. Study Three, also, examined individual attributes of key stakeholders in a large number of building projects and found correlation between them. This belonged to the second class derived from Mitchell's (1997) stakeholder salient model. Therefore, objectives b1 and b2 were addressed. The fourth study, to fulfil the objective b3, investigated the relational attributes of stakeholders in line with the third stakeholder analysis type associated with Rowley's (1997) network model. This would allow moving beyond merely looking at stakeholders in isolation, and analysing them in their networks of relationships.

For this purpose, a framework of stakeholder relations was firstly developed and then applied to a case building project using social network analysis (SNA). This chapter reports on this fourth study.

7.2 Objectives

This study attempts to address the following objective:

> **(specific objective b3)** To model and visualise the networks of relationships between design quality stakeholders in a building project.

7.3 Conceptual framework

Most often the relationships in social structures are complex and there exist multiple types of relations between individuals (Hanneman and Riddle, 2005). This is also the case for construction projects which are characterised with their complexity and the presence of

multiple stakeholder groups. Therefore, for this study a conceptual framework was developed in the first step to guide data collection. For doing so, four relevant topic areas were assessed in order to identify and integrate suitable concepts for this study. These areas are a) social capital, b) communication theory, c) stakeholder theory and d) design quality.

Social Capital

In recent decades, social capital has gained prominence in sociology and also in management to explore social systems and organisational structures. According to Burt (2000), social capital is the '*contextual complement*' to human capital, and is based on the proposition that individuals who *'are connected'* perform better. Various definitions of social capital are given by scholars. An often-cited one is by Nahapiet and Ghosham (1998) as: *'The sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit.'*

Increasingly, organisations and projects are viewed as social structures where one's resources and performance are dependent on his or her position within the network of relationships (Bresnen et al., 2005). Construction projects, from this perspective, are network-based organisations involving different stakeholders who may join or leave the network at different stages (Styhre et al., 2004). One of the challenges in studying social capital, unlike other forms of capital, is to quantify and measure it (Edelman et al., 2004). A few scholars, however, attempted to define its different dimensions. For example, Prell (2006) considered social networks, norms of reciprocity and levels of trust as social capital features. Another classification given by Nahapiet and Ghosham (1998) consists of structural, cognitive and relational dimensions, where structural dimension refers to the overall patterns and configuration of ties between actors; cognitive dimension is concerned with '*shared representations, interpretations and systems of meaning*' among actors; and, relational dimension includes '*the kind of personal relationships'* actors develop through interactions. This classification has been used by researchers such as Bresnen et al. (2005) and Koh and Rowlinson (2012) in studying construction projects. In particular, Koh and Rowlinson (2012),

operationalised the above dimensions respectively into 'network ties', 'shared understanding of project requirements or other parties' requirements' and 'trust'. These could also be considered in the framework of this study.

Communication theory

Clark (1991) defined communication as '*the imparting, conveyance, or exchange of ideas, knowledge or information*'. Otter and Emmitt (2008) also defined it as '*the sharing of meaning to reach a mutual understanding and to gain a response*'. An underlying point in these definitions and similar ones is a form of exchange between sender and receiver of a message. Construction projects are information-intensive environments (Wong and Lam, 2011) where communications extend across technical, financial, business and human topics (Mohamed and Stewart, 2003). Pryke (2012) found that, among various communication topics, design related information accounts for a large amount of total communications. This is while, the inherent complexity of design activity often results in poorly communicated design information (Tzortzopoulos and Cooper, 2007). Moreover, the construction industry is challenged by its fragmentation that makes effective communication troublesome (Fellows and Liu, 2012). These imply the importance of communication especially with regard to design information in construction projects. Therefore, it would be valuable for this study framework to include the measurement of design related information exchange.

The intensity and diversity of communication is not static and change over time across different project stages (Anumba and Evbuomwan, 1999). As stated in Chapter 2, currently the SNA studies in construction have only had a single observation approach mainly of the 'construction' stage. However, the front and bottom of the project lifecycle are also valuable and called to be investigated (Chinowsky and Taylor, 2012). A better picture could be achieved if the communication frequency being examined for multiple stages in this study.

Communications could occur through different mediums. Traditionally, project information exchange between designers and contractors has been mainly based on paper documents (Mohamed and Stewart, 2003). Shohet and Frydman (2003) found that approximately 50% of the communications are made by informal verbal means, while the other half consists of formal printed or electronic communications. Hence, it would be interesting and valuable to see how project parties exchange design information via different mediums. Previous researchers used different types; examples are hard and soft media (Otter and Emmit, 2008), or 'written technical', 'verbal face-to-face' and 'verbal electronic communication' (Shohet and Frydman, 2003). For the current study, however, as design is many times communicated via visualisation tools, it would be valuable to include 'visual' communications along with 'written' and 'verbal' as well.

Communication can also take place in two modes, i.e., formal and informal. Organisations not only have a formal structure and mechanisms of coordination but also an informal one (Dainty et al., 2006). The role of informal communication in construction projects is crucial to the effectiveness of construction (Shohet and Frydman, 2003). Communications now more frequently take place via informal, direct channels than those originally planned (Wong and Lam, 2011).

To positively contribute to the project performance and success, communication should happen in an effective manner. Numerous studies have highlighted the importance of effective communications for project success (as discussed in Chapter 5) but few have considered indicators for it. Thomas et al. (1998) identified six critical communication variables as listed in table 7-1. Xie et al. (2000) applied these in UK construction and found that in practitioners' opinion, 'accuracy', 'timeliness' and 'completeness' were the most important ones. Interestingly, 'understanding' to some extent reminds the 'shared understanding' aspect of social capital in Koh and Rowlinson's (2012) work. The other two variables, i.e. 'barriers' and 'procedure' do not represent a form of relationship and thus, not applicable to this study.

Accuracy	The accuracy of information received
Timeliness	The timeliness of information received
Completeness	The amount of relevant information received
Understanding	An understanding of information expectations with supervisors & other groups
Barriers	The presence of barriers interfering with communications
Procedure	The existence, use, and effectiveness of formally defined procedures outlining scope, methods, etc.

Table 7-1: Communication effectiveness variables (Thomas et al., 1998)

Stakeholder theory

As discussed in previous chapters, a key attribute of stakeholders is power through which they can influence project decisions and activities. In Freeman's (1984) definition and Mitchell's (1997) salient model, this aspect of stakeholder theory is highlighted. However, in both, it has been treated as an individual attribute. A network-based perspective would allow analysing this attribute of stakeholders as a result of their relationships with others in the project. In fact, the network approach emphasizes that power is inherently relational and an individual does not have power in the abstract, they have power because they can dominate others (Hanneman and Riddle, 2005). So far, among the SNA studies in construction, only Yang et al. (2011b) have measured power in form of the influence on decisions and others have mainly focused on information exchange networks only (as discussed in 2.4.2). Therefore, it would be valuable to add this variable in the conceptual framework.

Design Quality

As mentioned earlier, communications in construction occur with respect to different topics where design-related communication is an important yet challenging one. However, a more accurate and detailed analysis of design related communication networks would be to consider different design topics. Although the DQI tool is developed for building evaluation, the classification given in its conceptual framework, could also be used to analyse design related communications. As shown in Chapter 2, the DQI framework has classified design

quality into functionality, build quality and impact at the first level, and then into 10 design attributes in the second level. Moreover, dislike many other classifications, the DQI tool, as mentioned in section 2.2.4.1, was developed to be understandable for both professionals and laypeople. Therefore, it would be suitable to approach different stakeholder groups in this study with different backgrounds using DQI classification as communication topics. Figure 7-1 illustrates these 10 areas.

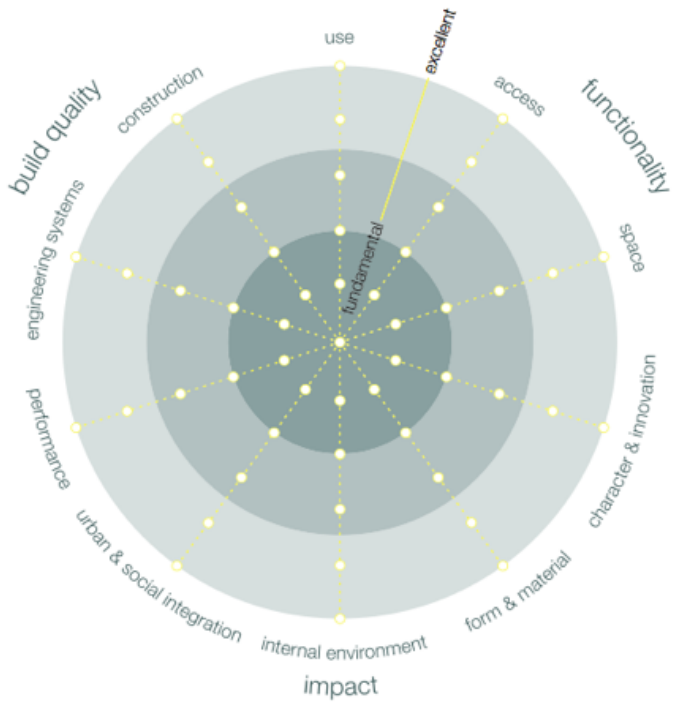


Figure 7-1: Ten design attributes in the DQI tool (Rogers, 2004)

Based on the identified concepts from the above topic areas, a conceptual framework was developed enabling the analysis of stakeholder relationships with regard to design quality. This framework is depicted in figure 7-2. The various relational variables were categorised into two groups. The 'structure of interactions' encompasses the variables dealing with the structure of stakeholder relationship without looking into how effective it is. 'Communication frequency' based on design related information exchange would be measured for five subsequent project lifecycle stages, from 'preparation stage' to 'occupancy stage'. Communication channels in terms of 'medium' and 'mode' are also in this group.

Finally, 'communication topic' between stakeholders could be examined based on the 10 design areas in the DQI conceptual framework.

The second group includes the variable that are concerned with the 'quality of interactions'. These variables are 'communication effectiveness', 'shared understanding', 'influence' and 'trust'. Effectiveness would be measured based on accuracy, timeliness and completeness of information exchange and the other three variables with a single-item measure.

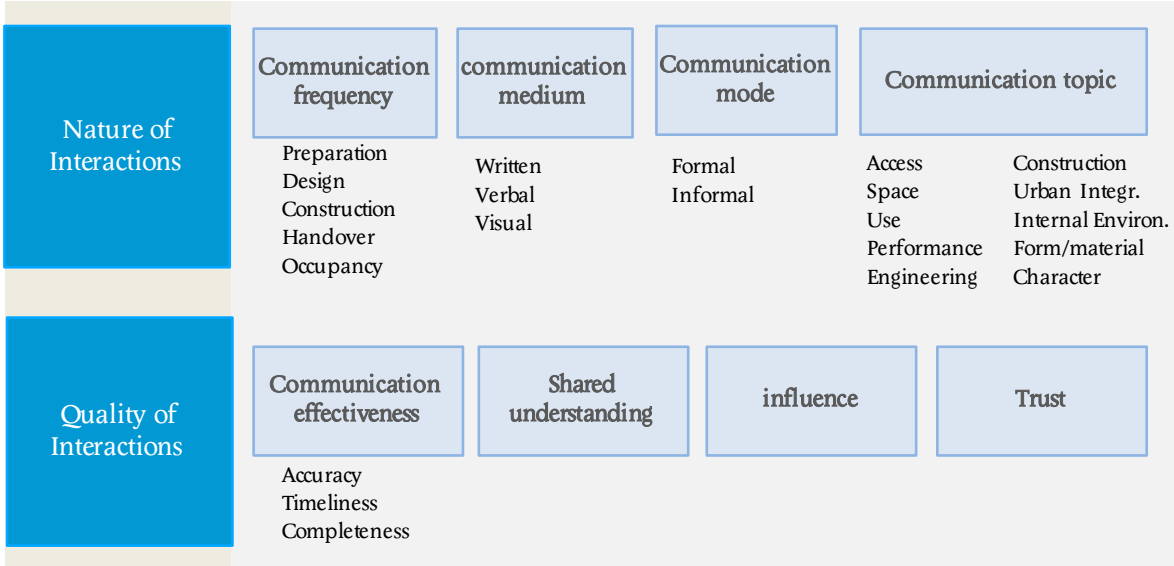


Figure 7-2: Conceptual framework for design related stakeholder relationship

7.4 Study design

This section describes how the empirical study was designed and implemented. It first describes the building project chosen as the study case. It, then, details on the data collection instrument developed based on the above framework, the recruitment and study participants, and finally the data analysis considerations based on the SNA.

7.4.1 The case project

To investigate stakeholder relationships through the application of the SNA, access to a building project was needed. As mentioned in Chapter 2 (table 2-8), previous SNA studies in the construction literature also employed case projects. Therefore, a 'case study' approach was undertaken where the case was a recently constructed building projects. Gummesson (2007) advocated for management research where case study and network theory are combined and used as supplementary methodologies. He asserted that both these share a common feature that is addressing complexity.

According to Yin (2014), case study is *'an empirical enquiry that investigates a contemporary phenomenon within its real-life context.'* Creswell (2003), also, defined case study as *'a problem to be studied which will reveal an in-depth understanding of a case'.* According to him, this case could be an event, activity, process etc. A case study research involves gathering information from multiple sources and various individuals. It would allow for a comprehensive and detailed analysis and could lead to more accurate and convincing understanding of a phenomenon with its particular nature and complexity (Yin, 2014; Robson, 2011). Although the approach could be used for different research purposes, Flyvbjerg (2007) stated that its primarily usage is for exploratory or descriptive analysis.

Case study approach could incorporate single or multiple cases. Considering the accessibility and time constraint exist in both network research and construction project research, a single case has been studied here. The case chosen was a four-storey building project located in a major UK university campus. The study was conducted at three months of occupancy. This was considered as an appropriate time as the information about building design quality and success factors could be also collected and examined. Due to practical limitations, it was not possible to collect data over time during the project progress as it would take more than two years. Instead, data were collected in a retrospective manner.

The building was designed and built to house open-plan workplaces, a double-height rear workshop, conference and meetings rooms as well as showcase areas. The building aimed to accommodate research staff from three academic groups and a 'knowledge transfer' team who would provide support for regional small and medium sized enterprises (SMEs). These SMEs could benefit from occasional workshops and working areas in the building.

The building was designed through a joint venture between an architecture designer and a multidisciplinary engineering designer. With fixed budget and design-and-build (single stage) procurement route, the contractor was selected through tendering process conducted by the university Estate office. This main contractor was responsible for detailed design and construction on the site. The primary architecture designer was not novated after developed design stage and the contractor recruited another architecture firm to perform the detailed design. However, both the primary architect and the engineering designer stayed in the project as advisors to the client. Table 7-2 provides some general information about the case project.

Sector: Higher Education
Area: 2300m^2
Procurement route: Design and Build (Single-Stage)
Budget: £5.4m (£8.4m including fit-out)
Programme: 56 weeks (construction stage)

Table 7-2: Profile of the case project in study four

Various groups and organisations were involved in the project. In the following, these groups are described:

Project Sponsor – the project was jointly funded by a governmental body and the university.

Client Team – Three main groups were involved from the client body in the project. University Estate office allocated an internal senior project manager to act as the university representative in the project and to be responsible for project team recruitment. Other

groups from Estate office like 'procurement team', 'clerks of work', and 'fire/security' teams also played a role in the project. Other key players from the client body were the 'project manager' (PM) and 'facility management team' (FM) of the related department for which the new building was provided. The 'department PM' was responsible to look after the department's interests in the project, ensuring both user and sponsor requirements are met. The in-house FM team was also involved in the project to make sure that design would satisfy facility management requirements.

User Group – As mentioned earlier, the building would occupy four user groups; these belonged to three research groups and a knowledge transfer team. Their requirements were set to be coordinated through the 'department PM'.

Design Team – An architecture firm with previous working experience with the university was responsible for both concept and developed design. As stated earlier, the firm did not undertake the detailed design. A project director and his supporting design team were involved in the project from this firm. The 'engineering design' firm was, also, led by a project manager and supporting mechanical, electrical, structural and environmental design teams.

Construction Team – Upon winning the tendering and recruitment in the project, the main contractor was in charge of construction and delivery of the building. This main contractor, itself, recruited a number of subcontractors including an architectural firm to do the detailed design and a mechanical and electrical (M&E) contractor to install the engineering systems. Other subcontractors were also recruited to provide steel work, structural installation, and materials & equipment etc.

Peripheral Groups – A number of peripheral groups also had stake in the project, including, the visiting SMEs, audio/visual (AV) provider, furniture provider and the University IT services.

Statutory Bodies – Two regulatory bodies including 'Planning Authority' and 'Building Control' were in contact with the architects and main contractor of the project.

7.4.2 Recruitment and participants

Unlike the conventional social science research where a sample is selected and studied on behalf of the population, the SNA requires the participation of all actors present in a so-called 'network boundary'. Network boundary, according to Prell (2012), refers to *'the boundary around a set of actors that the researcher deems to be the complete set of actors for the network study'*. Identifying the boundary therefore is equivalent to identifying the study's population. Often in practice, due to uncertainty and practical difficulties, an approximation of the complete network is obtained (Prell, 2012).

There is no perfect solution for determining a network boundary, but there are a variety of options to approximate what the boundary might be. According to Prell (2012), these are (a) the realist approach, where a key informant determines the involving actors; (b) the nominalist approach, where the researcher himself defines the boundary based on theoretical justifications; and, (c) the snowball sampling through referrals. The process of boundary specification often results in a complete list or 'roster' of the study population (Prell, 2012). The rationale for the sample and sample size is therefore the fact that an SNA study requires the whole population as the study sample.

The target population for this study was the design quality stakeholders based on the definition used for it throughout this research. The aim was to approach appropriate representatives from each design quality stakeholder group present in the building project. For this purpose, 'department PM' was approached as key informant who had a very good understanding of the project actors. However, to ensure the nominated actors were design quality stakeholders, the definition used in this research – based on Freeman (1984) – was presented to him first. Thus, one could consider in this study a combination of the realist and nominalist approaches was used.

The obtained roster was used to recruit the study participants. The recruitment was initiated via the assistance of the department PM. An invitation for participation was sent by him and upon positive response, the researcher set an interview session with the participants at their convenient locations. In total, 21 individuals from 12 stakeholder groups were participated in the study. It should be noted that from the roster, statutory bodies and visitors could not be approached due to accessibility issues. Table 7-3 lists the study participants and their associated stakeholder group.

ID	*Participants*	*Interview type*	*Stakeholder ID*
P4-1	Department Project Manager	Face-to-face Interview	Department PM
P4-2	University Estates Office Project Manager	Face-to-face Interview	Estates
P4-3	Facilities Management – Head	Face-to-face Interview	FM
P4-4	Facilities Management - Officer		
P4-5	Research Group 1 Representative	Face-to-face Interview	User group
P4-6	Research Group 1 Representative	Face-to-face Interview	
P4-7	Research Group 2 Representative	Video-conference Interview	
P4-8	Research Group 3 Representative	Face-to-face Interview	
P4-9	Knowledge Transfer Team Representative	Face-to-face Interview	
P4-10	Primary architecture firm 'Project Director'	Face-to-face Interview	Primary Architect
P4-11	Primary architecture firm 'Assistant Architect'		
P4-12	Primary architecture firm 'Project Architect'	Email Interview	
P4-13	Engineering designer firm 'Project Manager'	Face-to-face Interview	Engineering designer
P4-14	Design Coordinator	Face-to-face Interview	Main Contractor
P4-15	Quantity Surveyor		
P4-16	Project Architect	Face-to-face Interview	Contractor Architect
P4-17	Audio/Visual provider firm 'Director'	Video-conference Interview	A/V Provider
P4-18	Audio/Visual provider firm 'Project Manager'		
P4-19	Mechanical & Engineering subcontractor 'Project Manager'	Face-to-face Interview	M&E contractor
P4-20	University IT 'Infrastructure Project Manager'	Face-to-face Interview	IT services
P4-21	University Furniture Consultant	Face-to-face Interview	Furniture provider

Table 7-3: Profile of the participants in study four

It was preferred to conduct face-to-face interviews since complementary, context-related information could also be obtained. These interviews were then followed up with email communications whenever further data was required. Due to geographical distance and interviewee preference, two interviews were conducted through video-conference.

It was not feasible to approach every member of a stakeholder group. Therefore, the most suitable representatives from each group were interviewed and were asked to answer the questions in the capacity of their associated stakeholder group. For instance, the senior project manager from the Estate office was approach to represent the university Estates office. Three individuals were approached from the 'primary architect'; two were met for a face-to-face interview and the third person approached via email. A representative from each user group was interviewed with the exception of 'research group 1' for which two individuals were met as it consisted two sub-groups.

7.4.3 Data collection instrument

Based on the study conceptual framework outlined earlier and the requirements of the SNA, a questionnaire with mainly close-ended questions was developed in order to collect the required relational data from the study participants. According to Chinowsky and Taylor (2012), questionnaire is the most common data collection method for SNA especially when the actors are people. Primarily, the variables in the framework needed to be operationalised with appropriate question statements and response options. Based on the literature and as a result of a number of pilot interviews – described in the next section –, the variables were operationalised (table 7-4). It should be noted that network data could be either binary or valued, directed or undirected. The table indicates the data type for each variable as well.

Variable	*Question Statement*	*Response Options*	*Data type*
Communication Frequency	How frequently did you exchange design-related information with the other stakeholders?	Never (0), Monthly (1), Biweekly (2), Weekly (3), Daily (4), Several times per day (5)	Valued, Undirected
Topic of communications	Which aspects of design (from the 10 areas) were the topics of communication between you and the other stakeholders?	Selecting any applicable from 10 design quality attributes	Binary, Undirected
Medium of communications	What percentage of the total design related communications occurred verbally, written, and/or visually between you and other stakeholders?	Percentage	Valued, Undirected
Mode of communications	What percentage of the total design related communications occurred formally or/and informally between you and other stakeholders?	Percentage	Valued, Undirected
Communication Effectiveness	Please rate the accuracy, timeliness and completeness of the received design-related information from other stakeholders.	Scale of 0 to 10 (with regard to each aspect.)	Valued, Directed
Influence	To what extent the other stakeholders could influence your design related decisions or activities?	Scale of 0 to 10	Valued, Directed
Shared understanding	To what extent did agreement exist between you and the other stakeholders regarding the priority of design quality & project objectives?	Scale of 0 to 10	Valued, Undirected,

Table 7-4: Study variables and associated question statements and response options

All the variables were measured based on the project in general, with the exception of the first variable, i.e., communication frequency, for which longitudinal data was collected - although retrospectively. This would help modelling the dynamism of stakeholder networks throughout the project lifecycle stages. Five stages were considered. These, together with their RIBA equivalents (RIBA (2013)), are given in table 7-5.

Study project stages	*RIBA Plan of Work 2013 Stage Equivalent*
Preparation Stage	Stage 0 (Strategic Definition) and Stage 1 (Preparation & Brief)
Design Stage	Stage 2 (Concept Design) and Stage 3 (Developed Design)
Construction Stage	Stage 4 (Detailed Design) and Stage 5 (Construction)
Handover Stage	Stage 6 (Handover & Close Out)
Occupancy Stage	Stage 7 (In-Use) *[first three months]*

Table 7-5: Project lifecycle stages used in the study and their RIBA equivalents (RIBA, 2013)

The study questionnaire was designed to incorporate the questions in table 7.4 and was used during the interviews. In the following, its sections and the interview procedure are described. A copy of the questionnaire is also provided in Appendix D.

Preliminary information

The interview session started with the researcher providing information about the study, its intent and the questionnaire content. The study information sheet was sent to the participants upon their acceptance to participate, however, it was also presented at the interview beginning and signed consents were collected. The first questions asked were regarding the participants' role in their organisations and in the project.

Name generator questions

After the preliminary section, the participants were asked to name other actors with whom they had interaction with during the project. These other actors – which are called 'alters' in SNA – would then be used in the next questionnaire section. Since it was an important section, two name generator prompts were used. First, the project stages with timescales were presented to the participants for them to identify at which stages they were involved. Second, the actor roster previously developed with the assistance of Department PM was given and the participants were asked to identify with whom they had interaction with. Adequate time allocated to this section to ensure all alters are identified.

Network questions

The main part of the questionnaire was concerned with the network questions. The participants were asked to answer the questions with regard to each identified alter (table 7-6). The question statements and response options were given in the questionnaire, along with the description of the 10 design quality attributes (table 7-7)[11].

Nominated Alters	Communication frequency					Medium			Mode		Communication Topic	Effectiveness			Power	Shared understanding
	Preparation	Design	Construction	Handover	Occupancy	Verbal	Written	Visual	Formal	Informal		Accuracy	Timeliness	Completeness		
Stakeholder x	2	3	4	2	0	50	40	10	90	10	Access – use	8	9	5	5	9
Stakeholder y																
Stakeholder z																

Table 7-6: Network questions used in the questionnaire

Complementary questions

Wherever possible, follow-up questions were asked in order to obtain explanatory or contextual information about the responses. Moreover, the participants were asked about their satisfaction with the final design quality achieved in the constructed building and their involvement in the project. In the end, the participants were thanked for their time and participation.

An equivalent MS Excel version of the questionnaire was also created for the purpose of email correspondences. Also, the face-to-face and video-conference interviews were audio recorded with the participants' permission.

[11] A DQI questionnaire was obtained from the 'primary architect' and the main points for each section were used to provide a summary description for each design quality attribute.

functionality	Access	Access for everyone including disables in & around, public transport, parking, wayfinding & signage
	Space	Size, layout & relationship and connectivities of rooms & circulation spaces, ratio of usable space, privacy (private/communal balance), storage
	Use	Functions for all users, organizational efficiency & productivity, flexibility & adaptability, security
Build quality	Performance	Maintenance & repair, tears & wears, durability, cleaning, replacement of components, lighting (natural & artificial), acoustics, temperature, safety and healthy to use
	Engineering	Building Control Systems, Engineering systems (heat, light, plumping etc.), energy & water usage, Emissions, Mechanical ventilation
	Construction	Construction methods/sequences, Material, Integration in layout, structure, fittings & finishes, sustainability, construction safety
Impact	Urban & Social Integration	Contribution to neighbourhood, local environment, landscape, pleasant outside area
	Internal Environment	Pleasant inside area, spatial quality, personal control, pleasantness of lighting, thermal climate, acoustics, indoor air, comfortable environment
	Form & Material	Overall form and shape of the building, visually pleasantness, look & feel of the materials, colour & texture, external material, locality
	Character & Innovation	Uplifting, reinforcing the image of the organisation, vision, character & personality, new knowledge aiding future design

Table 7-7: Summary description for each design quality attribute used in the questionnaire

7.4.3.1 Other sources of data

Two other sources of data regarding the project were also obtained. 'Department PM' was asked to rate and comment on the extent of his agreement with the presence of the 36 success factors - identified in the Study Three – in the project. Furthermore, the results document of a DQI workshop (ready-for-occupancy version) was also obtained from 'primary architect'.

7.4.4 Pilot interviews

Two pilot interviews were conducted prior to the main data collection in order to ensure the suitability, feasibility and rigor of the data collection instrument. These were instrumental and resulted in a number of modifications. A pilot interview was conducted

with the 'department FM' (in two sessions) and also with an independent senior architect with extensive interest in design quality research (who also participated in the previous studies but was not involved in the case project.) These two individuals were asked to answer the questions with regard to a previous project of theirs. The outcome of the pilot interviews are as follows.

- The study purpose and the way it visualises the networks of stakeholders were viewed as interesting and valuable by both individuals.

- The variable 'trust' was considered as sensitive causing hesitation in answering. Therefore, it was removed from the questionnaire.

- Originally, four project lifecycle stages were considered for the 'communication frequency' variable. However, a fifth stage, i.e., 'handover' was added as it was considered to have distinctive patterns of communication compared to other stages, and valuable to capture.

- The researcher faced two alternative types of questions for 'communication frequency' variable; either to ask 'send' and 'receive' information separately or as combined. The pilot interviewees were in favour of the combined version and they saw their communications in the projects to be very much reciprocal.

- Also with regard to the 'communication frequency' variable, there were two possible options for response scale; whether to use a relative scale (low to high) or time intervals (e.g. once a week). Based on the interviewees' opinion, the latter was chosen. In the same vein, Borgatti et al. (2013) stated that relative scales are *'quite vulnerable'* and a high level of interaction for one person may be interacting once a day, but for another person, it is once every two weeks, and there is no way to distinguish them using relative scales.

- There were also two formats available to structure the network questions, i.e. repeated roster and multi-grid. Although both are similar in terms of reliability and validity issues, the multi-grid is a more compact format aiding in reducing the questionnaire length (Borgatti et al., 2013). In the first pilot interview, the multi-grid format and in the second one the repeated roster was tested. It was found that the multi-grid approach was more suitable for the study purpose and the time available.

- It was noticed that some of the topic areas (table 7-7) have some overlap in description and needed to be clarified for the study participants. For instance, material in 'construction' refers to the build quality of the building material, while in 'form and material' it concerns the look and feel of it. Similarly, aspects such as lighting, acoustics and temperature mentioned in 'performance' refer to the performance of these yet in 'internal environment' they are concerned with the subjective pleasantness and comfort they provide for the building users. Consequently, these distinctions were explained to the participants before asking the network questions.

7.4.5 Data analysis

The data analysis followed the procedure, techniques and measures offered by SNA. Once the data collection was completed, the data was organised and entered into a matrix format for each relation network using MS Excel. In SNA, these are called adjacency matrices (Prell, 2012). As table 7-8 shows, the first row and the first column are identical listing the actors (i.e. stakeholders). The scores in the cells record information about the ties between each pair of actors. x_{ij} indicates what score the actor i has given with regard to her or his relation with actor j. For undirected relations (e.g. communication frequency), the adjacency matrix is symmetric and x_{ij} equals x_{ji}. The diagonal cells are set to zero in an adjacency matrix.

Design Stage	Department PM	Estates	FM	Primary Architect	Main Contractor	Engineering Designer	Contractor Architect	M&E Contractor	A/V Provider	Furniture Provider	IT Services	User Group	Visitors	Statutory Bodies
Department PM	0	4	3	5	0	4	0	0	0	0	1	3	0	0
Estates	4	0	3	4	0	3	0	0	0	0	1	1	0	0
FM	3	3	0	3	0	3	0	0	0	0	1	1	0	0
Primary Architect	4	4	3	0	0	4	0	0	0	0	1	2	0	1
Main Contractor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Engineering Designer	4	3	3	4	0	0	0	0	0	0	1	2	0	0
Contractor Architect	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M&E Contractor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A/V Provider	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Furniture Provider	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IT Services	1	1	1	1	0	2	0	0	0	0	0	0	0	0
User Group	3	1	1	2	0	1	0	0	0	0	0	0	0	0
Visitors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Statutory Bodies	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Table 7-8: An example of the adjacency matrix (here the matrix for 'design stage' network is used)

After constructing the adjacency matrices, the data were examined in detail for any missing score or inconsistency. The study managed to collect data directly from all members of the roster, with the exception of 'Visitors' and 'Statutory Bodies', as mentioned earlier. However, this was a minor problem as both these groups were involved in a limited number of pair relations, for which other participants provided the required information. An often-occurred issue in SNA studies involving people is the existence of potential mismatches between a pair of actors in scoring a logically symmetrical relation (Borgatti et al., 2013). For example, in table 7-8 which is concerned with the communication frequency at project 'design stage', 'primary architect' scored design related information exchange with 'department PM' at 4 (=daily), while Department PM scored this relation at 5 (=several times a day).

Examination of the dataset showed that a small proportion of data were mismatched. In fact, the majority of adjacency matrices showed more than 90% consistency with reciprocated nominations. However, the matrices associated with communication

‘medium’ and ‘mode’ which were measured in percentage and also the ‘shared understanding’ showed a large discrepancy between pair nominations. Therefore, these had to be omitted from the analysis to maintain accuracy and reliability of the findings. It should be noted that reciprocated nomination is required for ‘undirected’ networks and directed networks such as ‘influence’ did not need to be symmetrical.

After this initial examination, the data in the format of adjacency matrices were transferred into an SNA analysis software called UCINET (Borgatti et al., 2002), which in combination with its visualisation module, i.e., NetDraw, is one of the most popular software packages for network data analysis (Prell, 2012).

Symmetrisation

symmetrisation is one of the transformation techniques in UCINET and refers to creating a new dataset in which all ties are reciprocated and therefore, undirected (Borgatti et al., 2013). Here, this technique was used as part of data cleaning for cases where mismatches existed between a pair of actors. For ‘communication frequency’ networks the ‘average method’ was used and for the ‘communication topic’ networks the ‘maximum’ method. This means that for the abovementioned mismatch between ‘primary architect’ and ‘department PM’, the score of (4+5)/2=4.5 was put for both x_{ij} and x_{ji}. It should be noted that in ‘communication frequency’ networks, the difference in nomination were in all cases only one unit, with the exception of one occasion where the difference was two units. A more liberal approach was used for the binary ‘communication topic’ networks, in which, if any of the pair actors nominated a design area – even if the other did not mention it, it was included in the matrix.

Dichotomisation

Dichotomising refers to converting valued data into binary data (Borgatti et al., 2013). For this study, dichotomisation was applied to the ‘communication frequency’ networks in order to better investigate network properties. Two cut-off values were used: cut-off=1 and

cut-off=3. The first one produced a binary network where any existing tie is equal to 1 and any absent tie equals 0. The second dichotomisation would turn any tie at weekly frequency or higher to 1 and any less to 0. These are further described in section 7.5.2.

Combining nodes

Another SNA technique is to combine nodes. It is used when the analysis is desired to be done at a higher level instead of at individual level. For this study, the data from four user groups were combined together using the 'maximum' method. In a similar way, 'planning authority' and 'building control' were combined into a node called 'statutory bodies'. The same technique was used in Pryke (2012) as well.

Imputing missing data

As mentioned earlier, data could not be collected from 'statutory bodies' and 'visitors' directly. Therefore, in the associated undirected adjacency matrices, the missing rows were filled in with the data found in the corresponding column. According to Borgatti et al. (2013), the assumption is that, if the respondents had been able to answer, they would have scored similarly. Also, in the directed 'communication effectiveness' networks, a few missing scores were replaced with the 'median' value of the columns. This, as will be explained in section 7.5.4, was done to compensate for the bias that otherwise would occur towards those with more numbers of ties.

Visualisation

Once the adjacency matrices are imported into UCINET and transformation is done, the first step in analysis is to draw the graphs of the networks, which are called 'sociogram'. According to Borgatti et al. (2013), network visualisation is a method of exploration which provides a qualitative understanding that is hard to obtain quantitatively. Plotting the sociograms were done using NetDraw module within UCINET.

Network metrics

The SNA is equipped with a number of metrics in order to assess and interpret the network properties both at whole-network level and actor level. In this study, 'density' is used as a metric for 'whole-network' level and 'degree centrality' (or simply 'degree') for actor level analysis.

Density – For binary networks, density is the ratio of the number of existing ties to the number of maximum possible ties. For valued networks, the density score represents the sum of the ties (as ties could have values more than 1) divided by the number of possible ties (Prell, 2012). Density is an indication of network cohesion, in that a higher density score means a more cohesive network where more face-to-face connections exist (Borgatti et al., 2013). Density is best used in a comparative way. However, to compare density of different networks, the network size (i.e. number of nodes) should be kept equal (Prell, 2012).

Degree centrality - degree centrality for an actor in an undirected network is simply the number of ties connected to that actor (or, the row/column sums of the adjacency matrix). In directed networks, 'outdegree' counts the number of outgoing ties, whereas 'indegree' is equal to the number of incoming ties. In valued networks, it is the sum of the values attached to the ties connected to an actor. Degree centrality indicates an actor's level of involvement or activity (Prell, 2012). In a communication network, an actor with high degree centrality is one who can be considered to be a major channel of information in the particular network (Prell, 2012). High degree nodes are highly visible and tend to be seen as important (Hanneman and Riddel, 2005).

7.5 Findings and discussion

This section presents and discusses the study findings.

7.5.1 Design quality success factors and criteria

Before looking into the network findings, it would be useful to evaluate the case project based on its achieved design quality and also the presence of the design quality success factors. For the achieved design quality, the results of the DQI workshop (ready-for-occupation version) conducted by the 'primary architect', and for the success factors, the response from the 'department PM' were mainly used.

Figure 7-3 shows the DQI results which was obtained based on the collective opinion of 15 individuals from different stakeholder groups attended the DQI workshop. According to the DQI report, the level of satisfaction for 10 design quality areas averaged at 81% (ranging from 77% for 'space' to 88% for 'urban & social integration') (Figure 7-3, spider diagram). Considering the relative weights allocated by the participants to these 10 areas (figure 7-3, bar chart), 'space' and 'performance' were considered the most important areas closely followed by 'engineering' and 'use', in the perception of the stakeholders.

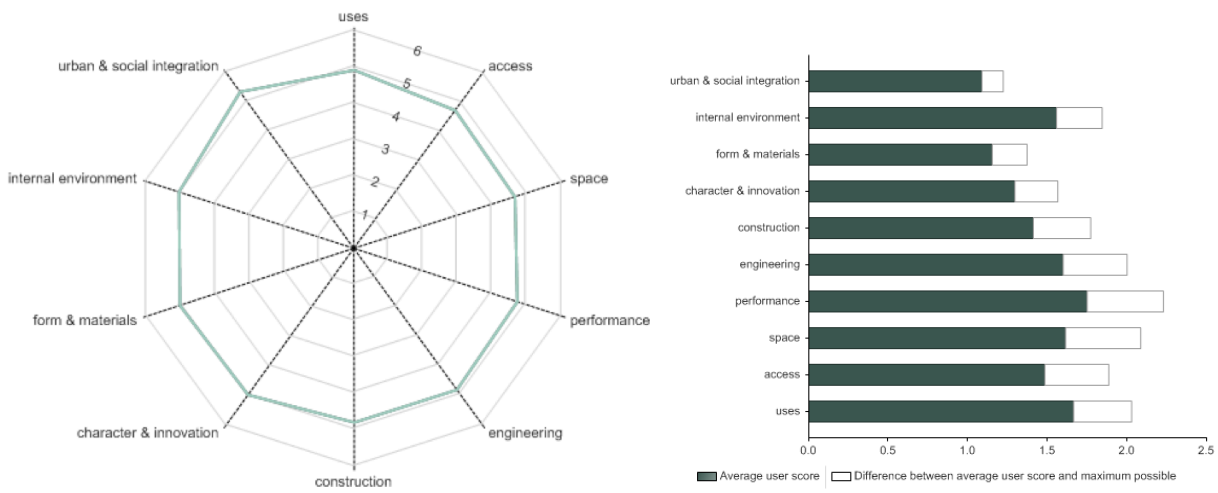


Figure 7-3: The DQI (ready-for-occupancy version) results

The results from the DQI workshop which was held just after the project 'handover' stage show a high and consistent level of satisfaction with the building design quality. However, the findings from the study interviews indicated mixed opinions. Many of the study participants were satisfied with the overall design quality, however, some also pointed to its shortcomings. Noteworthy was the opinion of 'department PM' who was familiar with the DQI classification. He believed that the quality was satisfactory in most areas except for 'build quality' sub-areas (i.e., performance, engineering and construction) for which a lower than expected quality was achieved. Table 7-9 gives selective quotes from other participants.

'Very satisfied, it is a very nice building'	P4-2
'The overall design is a good fit'	P4-3
'I am not happy with the design quality of the details; I am not happy with the build quality.'	P4-10
'There are various construction details which I found of low quality, rushed at the end and that impacted the quality'	P4-17

Table 7-9: Selective quotes from the participants about the building's design quality

It is interesting to note that the study was conducted at three months of occupancy and the discrepancy between the DQI results and the interview findings could imply that stakeholders evaluate building quality differently over time during the occupancy stage.

Table 7-10 shows the level of agreement 'department PM' had on the presence of design quality success factors in the project. As it is evident from the table, most success factors were to a high degree present in the projects. However, some of them were less achieved. For instance, with regard to F5 'DQ time', the 'department FM' believed that the main contractor did not allocate adequate time for detailed design. He also was on the opinion that F35 'construction quality' was not done to the standards expected. He believed that a different F8 'procurement' would better satisfy design quality objectives, however, according to P4-2, the university was restricted to use design-and-build. Interestingly, according to 'department PM', stakeholder analysis was conducted implicitly and no specific method was used, which is in line with the findings of the previous studies. He also believed that,

'design translation' was challenging as the main contractor '*tried to dilute intent to save money*'. On the positive side, he strongly agreed on the presence of appropriate 'communication', 'collaboration' and 'stakeholder engagement' in the project, among others. The project finished by 5-10% behind the schedule and was below budget by 5-10%, according to 'department PM'.

ID	*factors*		*ID*	*factors*	
F1	DQ criteria appreciation	agree	**F19**	Commitment	agree
F2	DQ Importance	strongly agree	**F20**	Creativity	agree
F3	DQ Objectives	agree	**F21**	Communications	strongly agree
F4	DQ Value analysis	agree	**F22**	Collaboration	strongly agree
F5	DQ Time	neutral	**F23**	Trust	agree
F6	DQ Budget	agree	**F24**	Conflict-management	agree
F7	Whole-life View	agree	**F25**	STK-Power distribution	agree
F8	Procurement	somewhat disagree	**F26**	Brief	agree
F9	Appointments	somewhat agree	**F27**	Phased-Process	strongly agree
F10	STK Identification	strongly agree	**F28**	Information-management	somewhat agree
F11	STK Require-discovery	strongly agree	**F29**	Drawings & Specifications	somewhat agree
F12	STK-Balancing-objectives	agree	**F30**	Modelling & Simulations	agree
F13	STK-Engagement	strongly agree	**F31**	Design-translation	somewhat agree
F14	STK-Analysis	neutral	**F32**	Change-management	agree
F15	Roles & Responsibilities	somewhat agree	**F33**	DQ-Monitoring	agree
F16	Knowledge & Skills	agree	**F34**	POE	agree
F17	Experience	agree	**F35**	Construction-Quality	somewhat disagree
F18	Leadership	agree	**F36**	Feedback	agree
	Time	Behind schedule by 5-10%		**Cost**	Below budget by below 5-10%

Table 7-10: Design quality success factors in the case project

7.5.2 Communication frequency

As mentioned earlier, the frequency of design related communications was measured for five consecutive project stages so that change in network pattern could be captured. The

findings are shown in table 7-11 and figure 7.4. Table 7-11 presents the properties of the actors (i.e. stakeholders) as well as the whole network for each project stage. For each actor, degree centrality and associated rank are given. With regard to the networks, density and the number of active actors are presented. The latter indicates which actors were involved in design communications in a particular stage. Moreover, the percentage of the reciprocated nominations are given with the number of mismatches in parenthesis. As it can be seen, in all the networks, more than 90% of pair nominations were identical. Therefore, the symmetrisation only affected a few scores. Figure 7-4 illustrates the network visualisation for each project stage. The thickness of ties indicates the frequency of design communication between a pair of actors. The node size, also, is an indication of actors' degree centrality scores. The ticker the ties, the more frequent design communication occurred and the larger the node size, the greater the degree centrality of the associated actor.

Actors (stakeholders)	**Preparation**		**Design**		**Construction**		**Handover**		**Occupancy**	
	degree	*rank*	*degree*	*rank*	*degree*	*rank*	*degree*	*rank*	*degree*	*rank*
Department PM	15.5	1	19.5	=1	27.5	2	34	=1	18	2
Estates	11	3	16	4	23.5	4	28	3	12.5	4
FM	7	6	14	5	19.5	7	34	=1	19.5	1
Primary Architect	13.5	2	19.5	=1	24	3	23	6	5	10
Main Contractor					29.5	1	27.5	4	9.5	5
Engineering Designer	10	4	17	3	21	5	17.5	8	6	=7
Contractor Architect					20	6	8.5	12	1	13
M&E Contractor					17.5	8	12	10	4.5	11
A/V Provider					14	9	15	9	6	=7
Furniture Provider					3	=12	10	11	6	=7
IT Services	4	7	5	7	11.5	10	24.5	5	9	6
User Group	7	5	8	6	6	11	18	7	13	3
Visitors	3	8					2	14	2	12
Statutory Bodies			1	8	3	=12	3	13		
Active actors	8		8		13		14		13	
Reciprocated nominations	96.43% (1)		93.33% (3)		90.11% (9)		92.31% (8)		95.6% (4)	
Density	0.390		0.555		1.209		1.412		0.615	

Table 7-11: Network properties at actor and whole network levels for 'communication frequency' networks

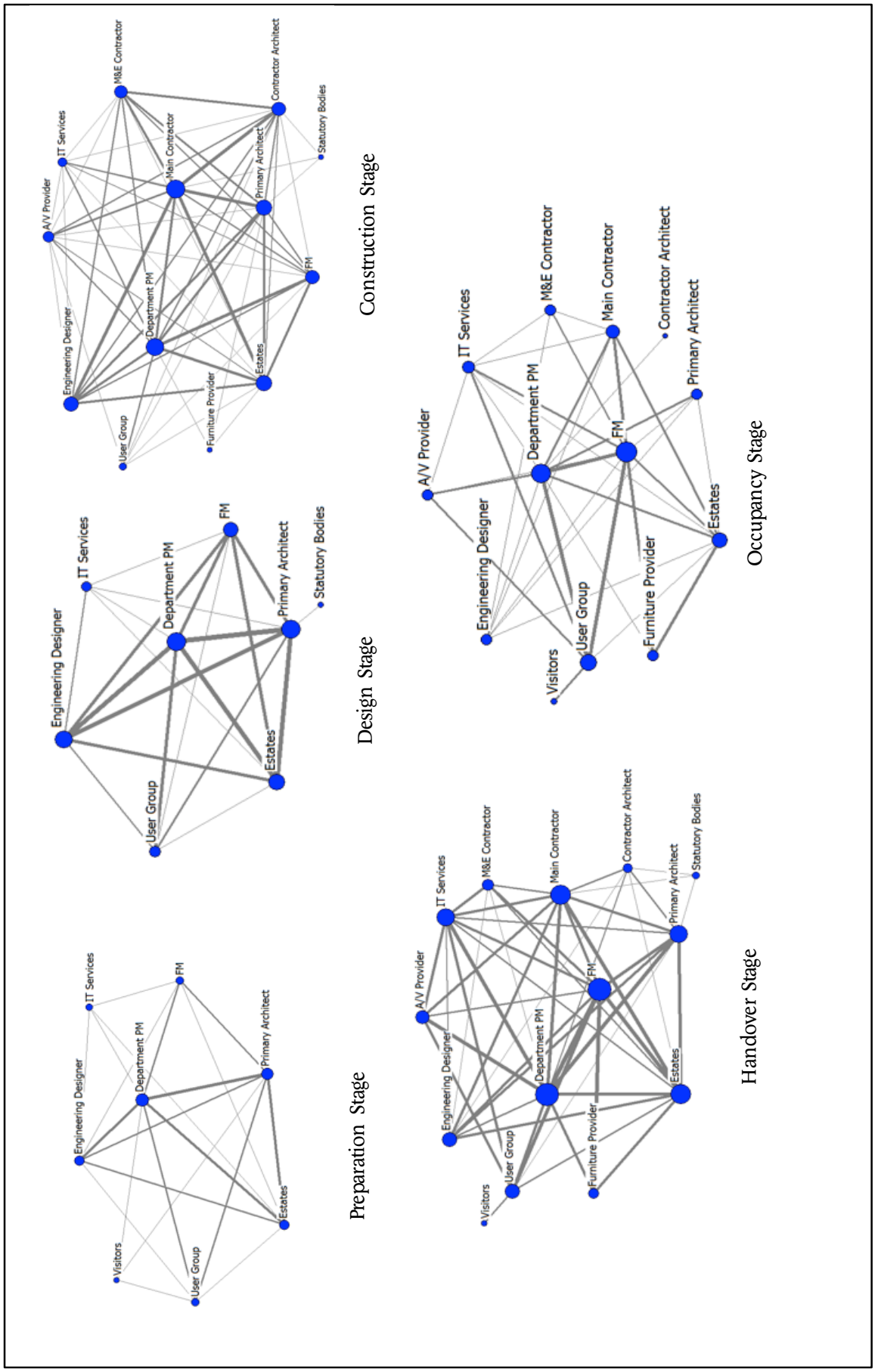


Figure 7-4: Network visualisation of design related communications throughout project lifecycle stages

As it can be seen in figure 7-4, network visualisation provides evidence that design communications changed during the project lifecycle stages. Table 7-10 shows that only 8 actors (out of 14) were involved in 'preparation' and 'design' stages. In other stages, almost all actors were present, with the 'handover' stage being full size with 14 active actors. Figure 7-5 compares the density scores for these five networks. The 'valued' density results show that the 'preparation' stage had the lowest and 'handover' stage had the highest density.

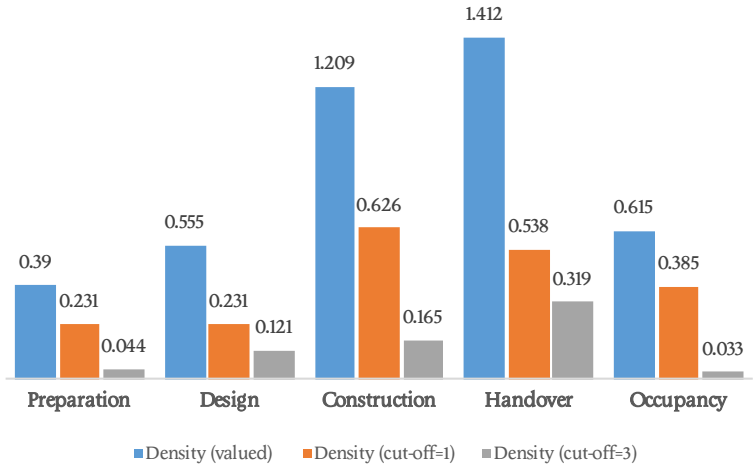


Figure 7-5: Density scores for 'communication frequency' networks

An interesting finding is that although 'construction' stage was initially expected to be the densest network, the 'handover' stage had a higher density in reality, although it only took one month. This could be due to the existence of greater tie strength in 'handover' stage. To test this speculation, the valued data was dichotomised with cut-off=1, to see which stage incorporated the highest number of ties. As it can be seen in figure 7-5, the dichotomised density (cut-off=1) for 'construction' stage was the highest, meaning that this stage saw the highest number of dyadic communications between actors. For further evaluation, the data was also dichotomised with cut-off=3 to include only high frequent communications (i.e. weekly or higher). The density across all stages reduced significantly, but still the 'handover' stage represented the highest frequent communications (figure 7-5). The network visualisation was created for this second level of dichotomisation as well but for brevity purposes was moved to appendix D.

Another interesting finding is that design communications still occurred after the building was constructed. When the participants were asked for the reason, they pointed out the communications that were mainly around how the building should be used or maintained. The network visualisation, in accord, shows that high frequent communications (weekly or higher) only took place between 'department PM', 'FM' and 'user group'.

One could also examine the evolution of stakeholders' involvement throughout project stages. Figure 7-6 shows the change in degree centrality for selective stakeholders together with associated ranks (based on table 7-10). This visualisation for other actors is also provided in Appendix D.

Figure 7-6: Change patterns in degree centrality and associated rank for selective stakeholders

The diagrams show that 'department PM' was constantly highly involved in all stages, holding 1st or 2nd rank in degree centrality. According to P4-5, this actor was '*instrumental*' in the communications and had the role to *'tie together diverse groups'*. Involvement of 'FM' also followed a similar pattern although with relatively lower degree scores. According to P4-3, 'FM' team worked very closely with 'department PM' in the project. 'FM' however ranked 1st in the handover stage, when it had the responsibility to prepare the building for occupancy. 'User group' was present in design communications in all stages but was more involved in 'handover' and 'occupancy' stages. P4-6, a member of the user group, believed that the project team *'genuinely did try to involve the user groups in the design of the building'* although it could be improved *'with working more closely with* [them]'. Also, P4-16, from the 'contractor architect', mentioned that *'it was great that everyone wanted to get involved'*.

'Main contractor' joined the project from 'construction' stage and was the most involved stakeholder in design communications in this stage. This is a sensible finding as this actor was responsible for project execution on site. Another sound finding was that 'primary architect' who was responsible for concept and developed design, was the most involved stakeholder in design communications occurred at the 'design' stage. Although, they changed their role to a client advisor after this stage, the findings show that they were more involved than the 'contractor architect' in the last three project stages.

7.5.3 Communication topics

The next group of networks were concerned with the 10 design areas as different topics of communications between the stakeholders. Similar to the previous section, the network properties are shown in table 7-12 and network visualisations in figure 7-7 and figure 7-8.

Stakeholders	Functionality						Build Quality						Impact							
	Access		Space		Use		Performance		Engineering		Construction		Urban & social integration		Internal environment		Form& material		Character & innovation	
	Degree	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*	*Degree*	*Rank*
Department PM	8	=2	9	=2	12	1	9	=1	8	=3	5	7	7	=1	11	1	9	1	10	1
Estates	7	=4	7	=4	10	=2	9	=1	8	=3	9	2	6	3	9	=3	7	3	9	2
FM	7	=4	7	=4	10	=2	9	=1	6	=6	4	=8	2	7	9	=3	4	8	5	6
Primary Architects	9	1	10	1	10	=2	9	=1	6	=6	8	3	7	=1	10	2	8	2	7	3
Main Contractor	8	=2	9	=2	8	8	9	=1	10	1	10	1	5	4	6	8	5	=6	6	=4
Engineering Designer	5	=8	5	=7	9	=6	8	=7	8	=3	6	=5	4	=5	7	=6	5	=6	4	=7
Contractor Architect	7	=4	6	6	10	=2	9	=1	5	=8	7	4	4	=5	8	5	6	=4	4	=7
M&E Contractor	1	=12	2	=10	6	11	8	=7	9	2	6	=5			5	=9				
A/V Provider	6	7	3	9	7	=9	5	9	3	9	4	=8			5	=9	3	=9	3	9
Furniture Provider	1	=12	2	=10	5	12									4	11	3	=9	2	=10
IT Services	2	=10	1	14	7	=9	3	11	5	=8	3	10			2	12				
User Group	5	=8	5	=7	9	=6	4	10	2	10			3	6	7	=6	6	=4	6	=4
Visitors			2	=10	2	13							1	=8	1	13	1	=11	2	=10
Statutory Bodies	2	=10	2	=10	1	14	2	12	2	11	2	11	1	=8			1	=11		
Active actors	13		14		14		12		12		11		10		13		12		11	
Reciprocated nomination	94.51% (5)		92.31% (7)		95.6% (4)		93.41% (6)		94.51% (5)		96.7% (3)		96.7% (3)		93.41% (6)		93.4% (6)		95.6% (5)	
Density	0.374		0.385		0.582		0.462		0.396		0.352		0.220		0.462		0.319		0.319	
Rank	6		5		1		=2		4		7		10		=2		=8		=8	

Table 7-12: network properties at actor and whole network levels for 'communication topic' networks

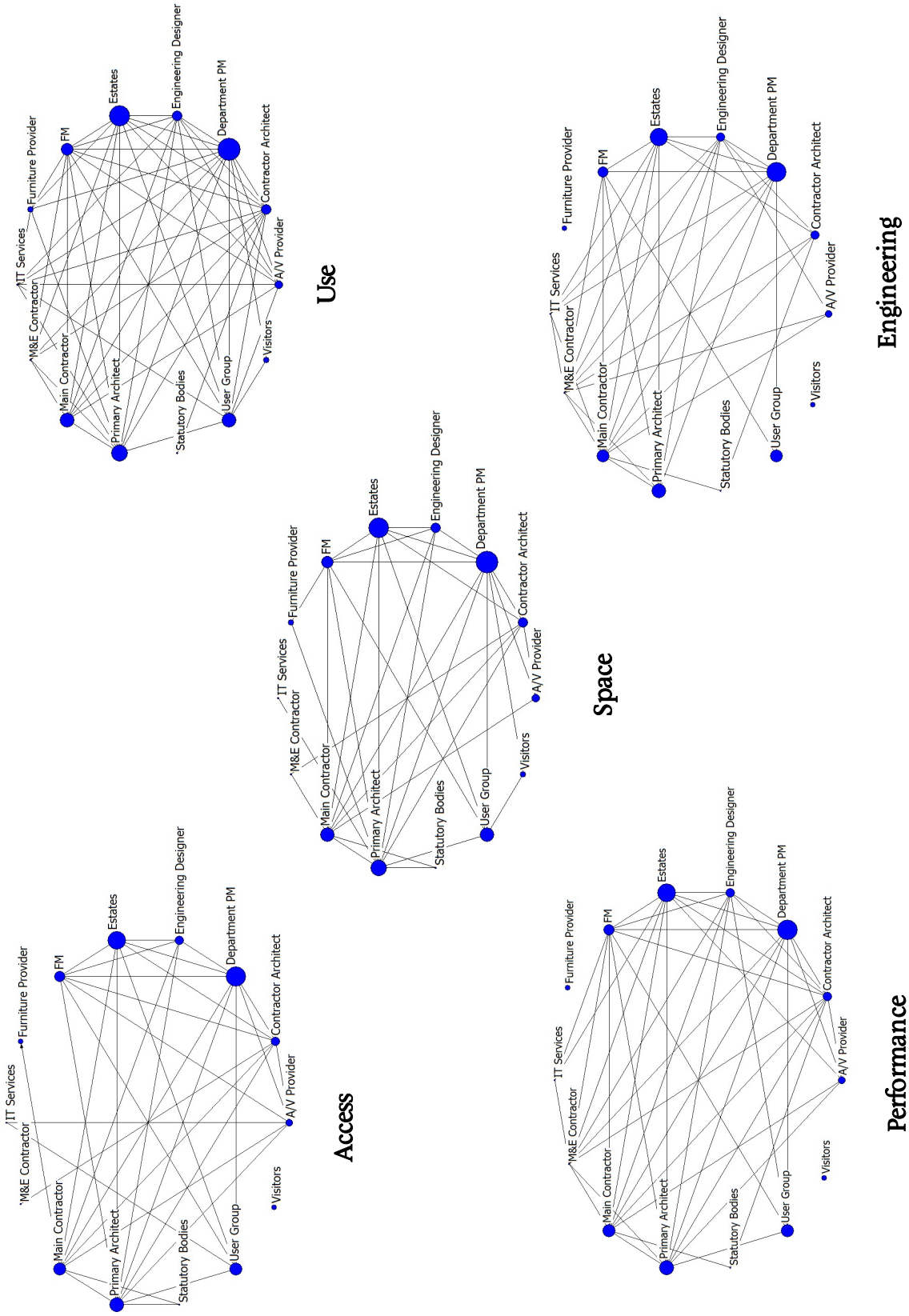


Figure 7-7: Network visualisation for communication topics – part a

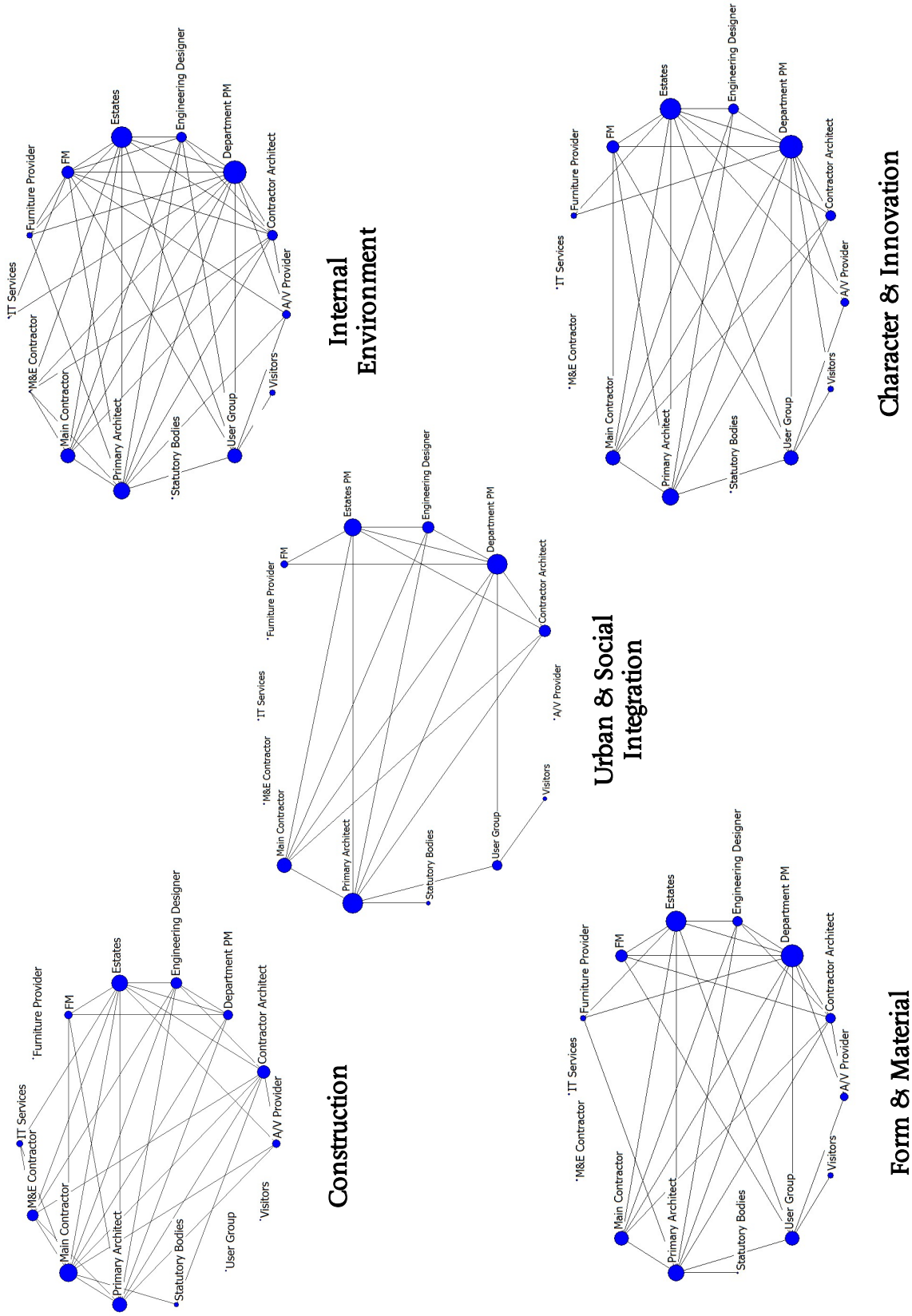


Figure 7-8: Network visualisation for communication topics – part b

As table 7-12 shows, all networks had more than 90% reciprocated nominations, therefore the applied symmetrisation could preserve the desired accuracy. The findings show that at least 10 stakeholders were involved in all communication topics, with 'construction'[12] having the lowest active actors and 'space' and 'use' having all actors involved. The density score for all networks are compared in figure 7-9. As it can be seen, 'use' was the most cohesive and 'urban and social integration' the least cohesive networks. Interestingly, 'use', 'performance' and 'internal environment' that had the highest number of face-to-face connections (i.e. density) also were seen to be among the most important design quality areas in the DQI results (section 7.5.1).

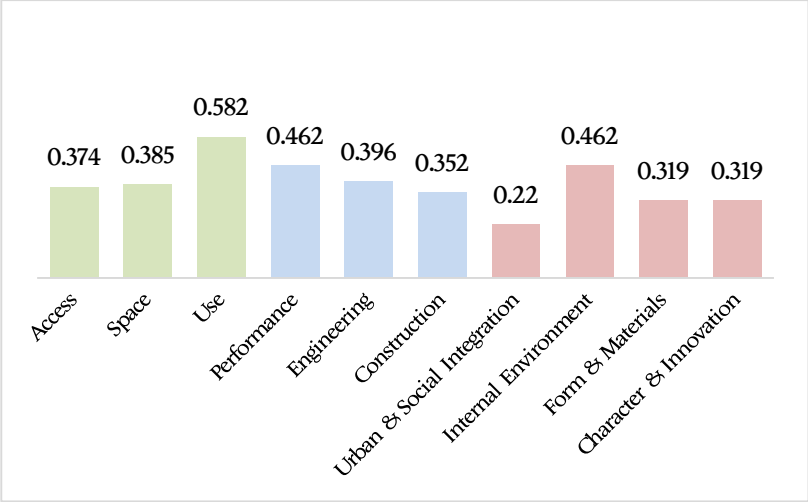


Figure 7-9: Density for 'communication topic' networks

In order to examine the involvement of each stakeholder in different topics, spider diagrams were constructed. Figure 7-10 compares a selective group of stakeholders. The first observation is that stakeholders were involved differently in design communication topics. 'Department PM', for instance, participated in communications regarding all areas. His degree centrality was the highest in six networks and his lowest involvement was in 'construction' area. This is in line with the findings in the previous section where this stakeholder held the highest ranks in most project stages. 'Main contractor', in comparison,

[12] 'Construction' was a design quality area, and is different to the 'construction stage' network discussed in the previous section.

was the most involved stakeholder in all 'build quality' areas, i.e., 'performance', 'engineering' and 'construction' but was less involved in 'impact' sub-areas such as 'urban & social integration' and 'character & innovation'.

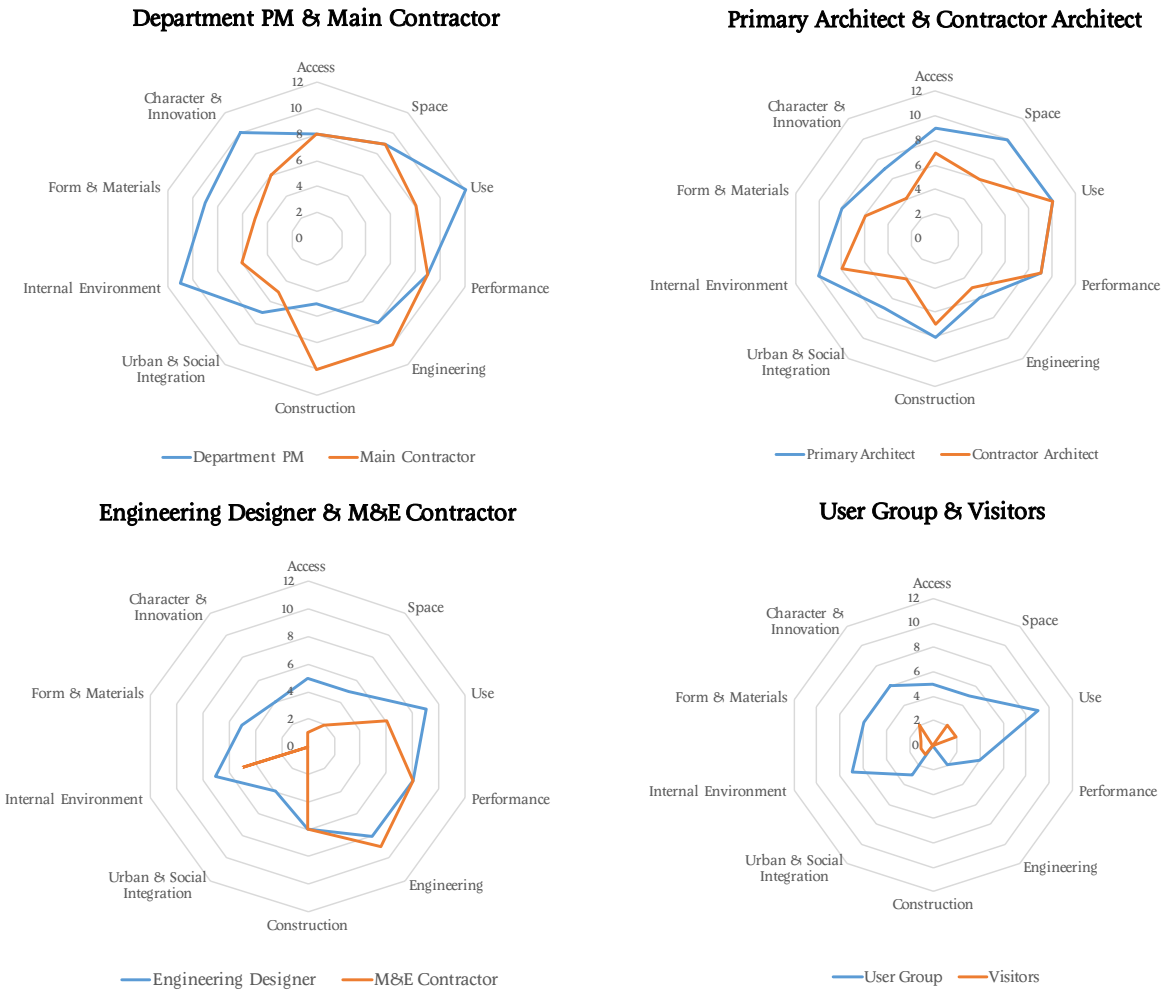


Figure 7-10: Involvement in different topics of design communications for selective stakeholders

The second diagram compares 'primary architect' and 'contractor architect'. Both were involved in all topic areas, however, the former had the highest degree among all stakeholders in 'access', 'space', 'performance' and 'urban & social integration' topics. The point that both architecture firms in this project were involved in all areas is very much in line with the findings in Study One (Chapter 4, section 4.1.1.4) that architects want to influence all aspects of design.

'Engineering designer' and 'M&E contractor', one responsible for designing and the other for installing building engineering elements, are compared next. Both were fairly involved in 'engineering' and 'performance' areas, however, unlike the 'engineering designer' which was involved in all areas, the 'M&E contractor' did not participate in communications about three sub-areas of 'impact'. The involvement of 'user group' and 'visitors' are also interesting to examine. The 'user group' was more involved in 'impact' aspects than in 'build quality'. As they are the building users, their involvement in 'use' related communications were rather high. They had dyadic communications with 9 other stakeholders with regard to this topic area. On the other hand, 'visitors' were one of the least involved stakeholders in design communications.

7.5.4 Communication effectiveness and influence

The networks examined in the previous sections were concerned with the 'structure of interactions'. This section looks into two variables of 'communication effectiveness' and 'influence' belonging to the 'quality of interactions' in the study framework. Unlike the previous networks, these two incorporated directed relations. As these present a different type of data, their adjacency matrices are given here for further transparency.

Table 7-13 shows the adjacency matrix together with the degree scores for three measures of 'communication effectiveness'. Figure 7-11 also depicts the associated network visualisations. As the networks are directed, there is no need for x_{ij} to be equal to x_{ji}. A score of '9/8/8', for instance, indicates that actor i rated the information received from actor j, 9 for its 'accuracy', 8 for its 'timeliness' and 8 for its 'completeness'. Also, the degree score for each stakeholder is the sum of the column values. In the network visualisation (figure 7-11), the arrows indicate that the relations are directed. The 'arrow head' size is based on the tie strength value. Therefore, an actor that have received ties with larger arrow heads had better performance in terms of the information he or she sent to others.

Accuracy/ Timeliness/ Completeness	Department PM	Estates	FM	Primary Architect	Main Contractor	Engineering Designer	Contractor Architect	M&E Contractor	A/V Provider	IT Services	User Group
Department PM		9/8/8	9/9/8	9/9/8	5/3/4	8/8/8	7/6/7	7/5/6	8/8/7	8/7/7	7/8/7
Estates	9/10/8		9/10/8	10/10/10	8/5/5	9/9/9	7/7/7	8/7/8	9/8/8	8/8/8	8/8/7
FM	10/10/10	10/10/10		10/10/10	5/5/3	9/9/9	6/6/5	3/3/3	9/9/9	8/7/7	7/9/8
Primary Architect	9/9/9	9/8/9	9/9/9		4/3/4	8/7/6	8/5/6	7/4/5	8/8/8	8/6/7	9/7/7
Main Contractor	8/8/7	8/8/7	8/8/7	7/8/8		8/8/7	6/6/6	8/7/8	8/8/8	7/8/8	8.5/7.5/.7.5
Engineering Designer	10/8/10	10/10/10	10/9/10	10/10/10	5/3/4		4/5/4	6/6/5	8/6/10	10/10/10	10/7/10
Contractor Architect	10/10/10	10/9/10	10/10/10	8/8/8	5/6/6	8/7/8		6/6/5	7/6/7	10/10/10	10/10/10
M&E Contractor	10/10/10	10/9/10	10/10/10	10/9/10	8/9/8	10/9/10	8/9/10		9/9/10	10/10/10	8.5/7.5/7.5
A/V Provider	10/10/10	10/10/10	10/9/8	8/10/10	5/3/1	9/8/10	8/4/5	10/10/10		9/6/7	7/6/6
IT Services	9/9/9	9/9/9	8/8/8	9/8/9	8/8/8	9/8/9	9/9/9	7/6/6	9/9/9		9/6/8
User Group	8/8/8	8/7/7	9/7/7	8/9/9	5/5/4	9/9/10	8/8/7	7/6/6	8/3/6	7/8/8	
Degree (accuracy)	93	93	92	89	58	87	71	62	83	85	84
Degree (timeliness)	92	88	89	91	50	82	59	60	74	80	76
Degree (completeness)	91	90	85	92	47	86	66	62	82	80	78

Table 7-13: Adjacency matrix for 'communication effectiveness'. The values are shown as accuracy/timeliness/completeness

'Furniture provider', 'statutory bodies', and 'visitors' had to be removed from the analysis since they had communications with less than half of the other stakeholders. Their inclusion would discriminate the effectiveness results in favour of those with a larger number of dyadic communications. 'User group' also did not have communication with 'main contractor' and 'M&E contractor'. As it still had communications with 8 other stakeholders, they have not been removed and the missing values are replaced with the 'median' value. These imputed missing values are underlined in the matrix.

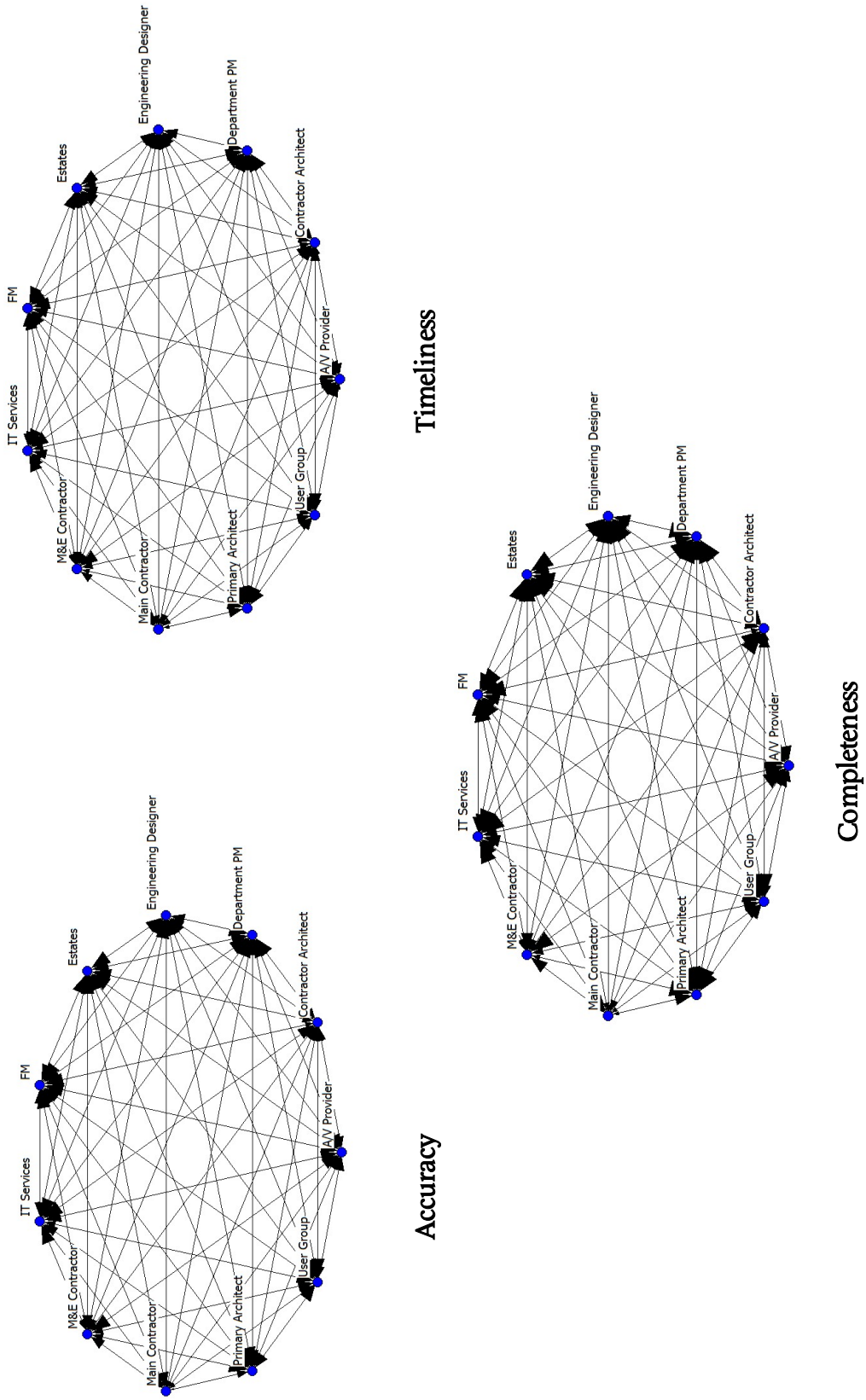


Figure 7-11: Network visualisation for 'communication effectiveness'

The findings show that 'main contractor' and 'M&E contractor' had the lowest design communication 'accuracy', in the collective viewpoint of other stakeholders. Their performance in terms of 'timeliness' was even lower with the 'contractor architect' also having a low score for its timeliness (=59). Similarly, these three stakeholders received the lowest scores for the completeness of their sent design information. Among these, 'main contractor' had the lowest effectiveness in terms of all three measures. This finding was in line with the comments given by P4-2 'Estates project manager'. He believed that the main contractor did not perform good enough in terms of design coordination.

> *'We had a quite communication issue with* [main contractor] *... Their involvement in the project was quite poor at times, they had no interactions with the user groups... They did not communicate. They did not finalise in time.'* [P4-2]

Table 7-14 and figure 7-12 also show the adjacency matrix and network visualisation for 'influence' variable.

Influence	Department PM	Estates	FM	Primary Architect	Main Contractor	Engineering Designer	Contractor Architect	M&E Contractor	A/V Provider	IT Services	User Group
Department PM		6	8	10	6	6	4	6	4	2	8
Estates	10		10	8	6	8	4	8	8	5	6
FM	10	6		10	8	6	6	4	6	8	8
Primary Architect	7	4	4		4	2	4	4	4	4	8
Main Contractor	10	10	10	9		8	2	6	4	5	0
Engineering Designer	8	6	8	6	6		4	4	0	2	8
Contractor Architect	8	8	10	9	6	6		6	6	5	8
M&E Contractor	8	6	4	10	4	10	8		0	7	0
A/V Provider	10	4	6	2	8	2	2	0		8	10
IT Services	0	6	6	6	10	6	8	10	6		8
User Group	8	4	6	8	0	4	0	0	8	2	
Degree centrality	79	60	72	78	58	58	42	48	46	48	64

Table 7-14: Adjacency matrix for 'influence' network

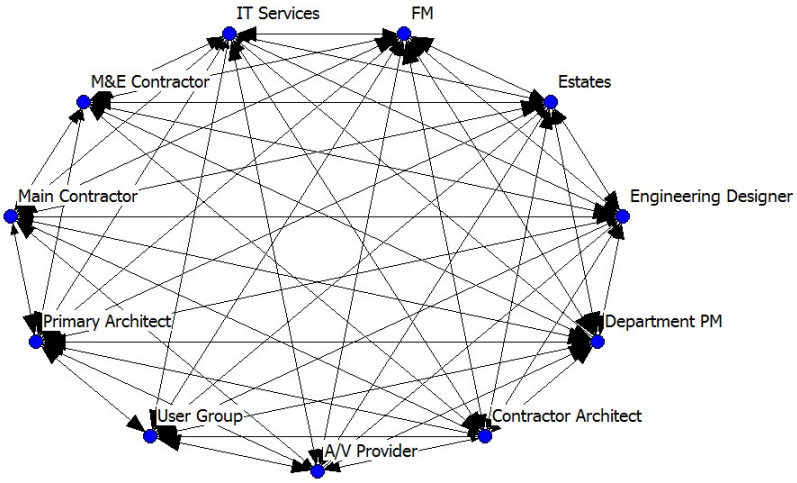


Figure 7-12: Network visualisation for 'influence'

The findings indicate that 'department PM' and 'primary architect' had the highest influence on design related decisions and activities in the project. This is very much in line with the findings of Study Three (Chapter 6, section 6.4.2.4). However, contrary to the findings there, 'FM' in this project had a high level of influence. User group also had a relatively high influence. In this regard, 'department PM' believed that *'all groups were empowered to feed into process which was deliberately set up to be inclusive'*. The findings also show that the lowest influence was allocated to 'contractor architect'.

7.5.5 Discussion of the case project

The quantitative and qualitative findings with regard to the DQI results, design quality success factors and stakeholder relationship led to a better understanding and evaluation of design quality achievement in the case project. There was an overall satisfaction about the building quality with some deficiencies in 'build quality' aspects and detailed design. The project completed with delay and adequate time was not allocated to the detailed design. Also, there was a lower satisfaction level in terms of 'construction quality' factor. However, it was believed that there was a good stakeholder engagement and empowerment

in the project. The relationship networks, in accord, showed a good level of involvement and influence by various stakeholders especially the user group, facility management and project management teams. The design expertise, experience and leadership were deemed as appropriate with a suitable in-process monitoring of design quality achievement by the 'primary architect'.

The communication effectiveness networks, however, showed some shortcomings between the main contractor and its sub-contractors on one side and other stakeholders on the other side, which caused design coordination and information exchange issues. The 'contractor architect', responsible for detailed design, was found to have a very low influence on design decisions and being less involved in the project, even lower than the 'primary architect' in the last three project stages when the latter changed its role to become client advisor. It should be noted that although they changed role, according to 'department PM' they *'acted as guardian throughout and were tenacious in defence of design quality'*.

One should not, however, neglect the impact of procurement and contractual arrangements. Although restricted by the university, the chosen method was not the most desirable, according to 'department PM'. He pointed out that the schedule was tight and more time was needed for detailed design. Moreover, the point that the 'primary architect' was not novated could cause 'design translation' problems between the 'design' and 'construction' stages.

According to Morledge and Smith (2013), novation is a variant of design-and-build where the client passes its architect to the contractor to produce detailed drawings as part of the contractor's team. Prior to the appointment of the contractor, the architect works directly for and paid by the client. After that, the architect's appointment is assigned to the contractor for whom the architect produces any outstanding information necessary to construct the work (Morledge and Smith, 2013). Novation entails the discontinuation of the architect's obligation to the client and the substitution of a new contract (Griffith et al., 2003).

Novation has become popular recently (Griffith et al., 2003). The merit of novation is, however, a point of dispute among scholars (Doloi, 2008). A number of benefits as well as drawbacks have been mentioned for it in the literature. From the client's point of view, it could be beneficial as it provides a single organisation responsible for the entire project (Doloi, 2008). Contractors might also favour novation as it could lead to a shorter schedule due to the previous knowledge the novated architect has about the design (Griffith et al., 2003). Although, novation could bring an increased revenue for the architect, it is also argued to put unrealistic time pressure by the contractor on them for producing the detailed design (Griffith et al., 2003). A key issue with regard to novation is the problem of 'divided loyalties' (Doloi, 2008). This arises from the misbelief the clients sometimes hold about the architect's loyalty to their interests after novation. Architects, nonetheless, are obliged to act in accordance to the contractor's interests, i.e., their new client. This has become a source of dissatisfaction, as in practice, this change of loyalty is not often appreciated (Griffith et al, 2003). Due to these issues, Doloi (2008) urges the need for compromises and effective communications if the novation is expected to be successfully implemented.

In the project under study, the 'primary architect' chose not to be novated. The reason could be its loyalty to the client which was built up during several previous projects they had together. To compensate, they remained in the project with the new role of client's advisor. The contractor however believed *'this project was better to have novation'*, according to P4-14. He believed that they had to wait for reviewing and agreement of the 'primary architect' while wanted the 'contractor architect' to finish detailed design as fast as possible. This seems to explain some of the occurred delay.

7.5.6 Discussion of the study approach

The study approach can be assessed from various aspects. The study framework, based on relevant theories and concepts in the literature, was instrumental in guiding the data collection. Not all of the defined variables could lead to reliable findings; 'Trust' was

excluded as a result of pilot interviews and 'medium', 'mode' and 'shared understanding' due to large number of paired mismatches. However, still several relational variables were modelled with high accuracy, contributing to the reliability of findings. In fact, a huge dataset was collected accounting for various aspects of stakeholder relationship in the case project. Even though it was attempted to examine and interpret all of the findings, some aspects, e.g., dyadic ties between two specific actors in the networks, could not be discussed.

Network data collection is often characterised as difficult, tedious and complicated (Pryke, 2012; Yang et al., 2011b) and this study was not an exception. However, with the support from 'department PM' and also the participants who gave their time willingly for the study, a reasonable approximation of network boundary was obtained. Access to construction projects is problematic and collecting data in a longitudinal manner even more. Therefore, in order to model network dynamics with regard to communication frequency – which was much called for in the literature – the data were collected in a retrospective manner. This could cause participant recall bias, to minimise which, a number of considerations were taken into account. First, the project stages were chosen to be easily distinguishable and to be in a manageable number. It was also attempted to collect supportive qualitative data and to use appropriate prompts in the data collection instrument. Moreover, for undirected networks, a pair of responses were collected from two participants and networks with more than 10% mismatch were removed.

To preserve validity, using face-to-face interviews instead of self-administered questionnaires as well as conducting pilot interviews were important. Although the findings were based on participants' perceptions, the employment of collective opinions with regard to one's position in the networks improved objectivity and accuracy. This was especially the case with directed networks, where one's effectiveness or influence was based on the opinion of all other stakeholders rather than an individual's opinion.

One of the strengths of the SNA is the graphical representation of networks in a systematic and compact way. Although network visualisation is still a developing topic in the SNA, in

this study it provided a rich, immediate picture of network patterns and actors' positions. The use of 'line' and 'spider' diagrams in this study also expanded this visualisation and was especially useful for comparing stakeholders.

The study was a single case study and the numerical findings are interpretative within the specific context of the case project. No numerical generalisation of these findings could be considered, however, the study contributed by a rich description and in-depth investigation of a unique building project. Even though only a single study was investigated, the analysis of multiple stakeholders and project stages allowed for valuable comparisons.

Finally, the use of mixed methods approach, as mentioned in Chapter 3, helped in complementing the quantitative findings with context-related and explanatory qualitative ones in this study. The information provided by the study participants helped the researcher to obtain necessary understanding about different aspects of the case project. It also explained the reasons attached to the numerical responses and to better make sense of them.

7.6 Conclusion

The study was to a great extent successful to model, visualise and analyse the relationships between design quality stakeholders in a building project. For doing this, a conceptual framework of design related stakeholder relationships, stemmed from the literature, was proposed. Although some of the variables could not lead to accurate findings, several valuable networks were visualised and their properties were evaluated and interpreted.

The study revealed that the consecutive project stages and various design topics differ in terms of their networks of communications and their cohesiveness. It found that the stakeholders, similarly, differ in terms of their involvement in different project stages and with respect to various design topics. For demonstrating these, various visualisation

techniques and network metrics were found useful to compare networks as well as stakeholders.

The study was the first attempt to model the dynamics of communication networks in the construction project management. As the longitudinal data was collected in a retrospective manner, the study should be seen as a first step and a launching pad for future studies that could afford multiple data collection phases in often-lengthy live projects.

The study also revealed that the DQI classification could be also used as design communication topics. Its application in this study resulted in interesting findings in terms of stakeholders' involvement in different design aspects. Moreover, it was shown that an understanding of stakeholder relationships and design quality success factors, along with building evaluation (i.e. DQI), could lead to a more holistic and in-depth evaluation of design quality achievement. This will be further discussed in the next chapter.

Lastly, several project-specific findings were obtained. For instance, interestingly, the 'handover' stage represented the highest number of face-to-face design related communications, even more than that in the 'construction' stage. Caution is required in interpreting this as 'handover' only took a month, and the construction stage could include periods with a higher density. To explore this, a further research could break down the project duration into equal time-scales (e.g. monthly) and construct the networks for each time interval, instead of each stage.

8 Chapter Eight

Overall Discussion

8.1 Introduction

This chapter integrates and discusses the main research findings with respect to the CSFs and stakeholder attributes strands. It, also, reflects on the learnings acquired on the concept of design quality and presents a holistic evaluation of design quality achievement as a practical recommendation. Lastly, it discusses the overall research process and the methodological considerations. The strengths and limitations of each research step together with the contributions to knowledge and potential future works are also embedded throughout the chapter.

8.2 Reflections on the CSFs strand

This section first discusses how the employed multi-step research process led to an evolving, in-depth understanding of the design quality CSFs and then examines the research position in its associated topic space.

8.2.1 An evolving understanding of design quality CSFs

As mentioned in section 1.2, a primary objective of the research was to explore and improve the understanding of the CSFs for design quality achievement in building projects. This exploration was aimed to be detailed and extensive so that an in-depth understanding of the subject matter could be obtained. As shown across the previous chapters, a multi-step development process was undertaken for this purpose. Figure 8-1 illustrates this process with the main outcomes and characteristics of each step. In the following, this process is discussed.

After establishing the research opportunity and identifying suitable methods through the literature review and a preliminary study, 10 experts in the subject area were approached in Study Two to identify their perceived CSFs. As a result of an incremental data analysis, 36 factors were obtained. The findings were significant since it was the first attempt in

project success discipline to identify CSFs for design quality as an important objective of building projects. It was also a response to the gap identified in design quality research regarding 'how' design quality is achieved (section 2.5). In other words, 36 critical areas were revealed, fulfilling of which in building projects could determine and ensure design quality of the constructed building. These factors were then grouped into general categories of product-, people-, and process-related factors corroborating Sebastian's (2005) argument that design management could be viewed from these three perspectives.

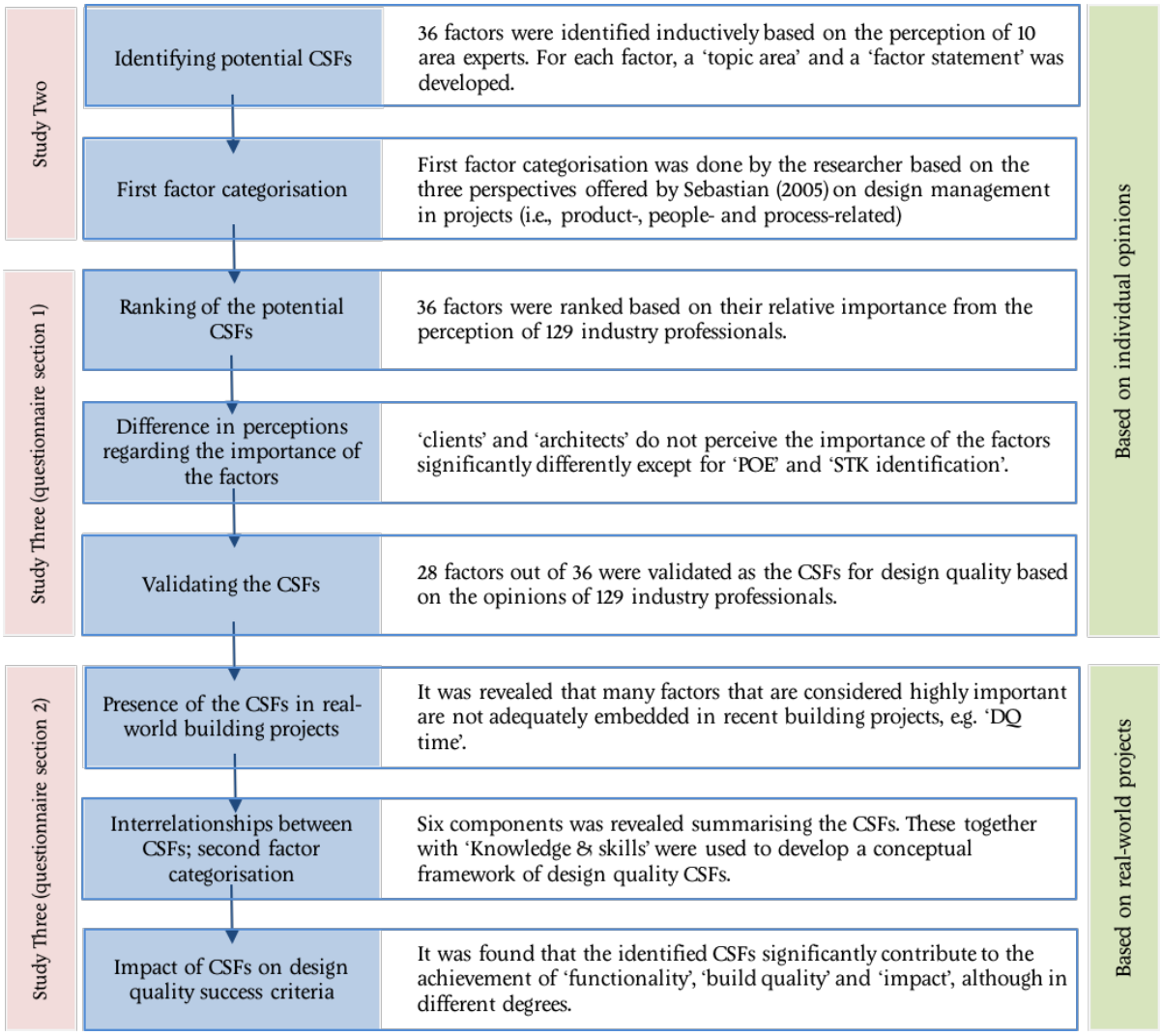


Figure 8-1: An evolving understanding of design quality CSFs

A strength of the resulted CSFs list compared to many CSFs studies in the literature is the formulation of 'factor statements'. Factors labelled solely as 'documentation' (Alzahrani and

Emsley, 2013) or 'complexity and uniqueness' (Gudiene et al., 2013), although are referring to an important area, do not indicate what would be a suitable action. In this research, it was attempted to construct an actionable statement for each factor, alongside the associated topic areas (e.g., F10 'early, comprehensive identification of all stakeholders). Another virtue of the derived list was its comprehensiveness in covering various topics from project objectives and process to stakeholder traits and relationships. According to Didenko and Konovets (2008), the CSFs studies in the last decade were mostly concerned with the categorisation of the previously developed factors without an attempt to identify new ones. Although the factors identified in this study were design quality oriented and new in that sense, there were areas such as F31 'design translation' that were not referred to even implicitly in the CSFs literature. Alongside the comprehensiveness, it was also attempted to keep the number of factors at a balanced level. Identifying too many factors, e.g. '71' in Gudiene et al. (2013) or too few, e.g. '9' in Pinto and Slevin (1987), would either contradict the conciseness required in a CSFs list or ignore the complexity inherent in building projects.

Despite the above strength points, the list at this step had a number of limitations. It could not provide an understanding of the relative importance of the factors and also whether or not different stakeholder groups would rank the factors similarly. More importantly, the factors were obtained in an inductive, qualitative way with a small number of participants. Therefore, a validation step was required. These limitations were addressed in the first section of the questionnaire in Study Three. A large sample of 129 professionals from 'client' and 'architecture' organisations were approached to rate the identified factors based on their importance. As a result, 28 factors were validated as the critical success factors for design quality achievement in building projects. It was also found that the respondent groups did not differ significantly in their perceptions regarding the importance of most of the factors. 'Brief', 'communications', 'leadership', 'knowledge & skills' and 'construction quality' were found to be the most important CSFs. Interestingly, these top-ranked factors were all nominated by at least half of the participants in Study Two, and hence a level of alignment between the two studies (Table 8-1).

	Mean (rank) in Study 3	Number of nominations in Study 2
F26 'Brief'	4.426 (1)	8
F21 'Communications'	4.310 (2)	5
F18 'Leadership'	4.271 (3)	7
F16 'Knowledge & Skills	4.233 (4)	7
F35 'Construction quality'	4.217 (5)	5

Table 8-1: Comparison between the findings of study two and study three (section 1) for selective CSFs

These findings added another layer of insight into the design quality CSFs. Particularly significant was the validation of the CSFs in a qualitative-quantitative sequential process, which is often missing in other CSFs studies. This step, however, was yet to provide a comprehensive account of the subject. Thus far, the findings were based on individual opinions. Therefore, in the next step (i.e. questionnaire section 2), 126 recently completed building projects were investigated for their achieved design quality and the presence of the CSFs. Table 8-2 gives the level of presence for selective factors in the projects together with their perceived importance (from the previous section). The table is useful in the sense that it provides an assessment of the projects against the presence of factors with different levels of importance. For instance, the choice projects were under-performing in two areas of 'commitment' and 'DQ time' while were considered as highly important for design quality achievement (ranked 9th and 6th respectively).

	Rank - Level of presence (questionnaire section 2)	Rank – level of importance (questionnaire section 1)
F16 'knowledge & Skills	1	4
F27 'Phased process'	3	10
F1 'DQ criteria appreciation'	17	7
F19 'Commitment'	23	9
F5 'DQ time'	28	6
F34 'POE'	36	32

Table 8-2: Comparison between the findings of study three section one and two for selective factors

Another step towards an in-depth understanding was to explore the interrelationships between the CSFs and as a result, establishing their underlying components. This analysis was conducted in response to the speculations emerged in Study Two that such

relationships might exist and also the parsimony required in the statistical analysis. As mentioned earlier, this step was performed based on the data from real-world projects. Many of the CSFs studies like Chen and Chen (2007) and Akintoye et al. (2005), nonetheless, use the data from the opinions on the importance of the CSFs for this purpose (i.e. the responses to the questionnaire section one). In the view of this research, this attempt is inaccurate. This is because the applied statistical methods (i.e., PCA or Factor Analysis) would group together those factors that have been rated similarly across all the respondents. Using 'importance' data, therefore, forms group of factors that are perceived to have similar levels of importance. This would not result in a useful understanding. However, using the data that reflects the level of factors' presence in real-world projects (i.e. questionnaire section 2) would group the factors that were concurrently present (or not adequately present) in the projects. As a result, they are influenced by the same underlying reason and are group together in a more meaningful manner.

As discussed in section 6.4.5, the PCA revealed six underlying components explaining 70.67% of the total variance, and therefore an appropriate summarisation of the CSFs. The components were favourably interpretable. It was also revealed that the derived components, to a great extent, refer to the different stages of project lifecycle process, and hence, can form a meaningful framework. It should be noted that the F16 'knowledge & skills' that had to be dropped in the PCA due to the method requirements, should be also included in this framework. This is because the findings from other steps signify its importance in achieving design quality and therefore, support the decision made (table 8-3).

F16 'Knowledge & Skills'

Number of nominations in Study 2	7 out of 10 participants
Rank – level of importance (questionnaire section 1)	4th among 36 factors
Regression analysis (questionnaire section 2)	Significant impact on all design quality success criteria

Table 8-3: F16 'Knowledge & Skills' across research steps

Figure 8-2 illustrates the developed conceptual framework of design quality CSFs Comprising of the developed components as a grouping of the CSFs (the how). The components are arranged based on their applicability to different stages of a building project. F16, C6 and C5 are the first group of CSFs that need to be considered when a building project commences. These could be seen as the pre-requisite for design quality achievement. That is, it should initially be ensured that the appropriate design knowledge and skills are brought to the project, adequate time and budget resources are considered and, the contractual arrangements appropriately allocate roles and power levels among the stakeholder groups.

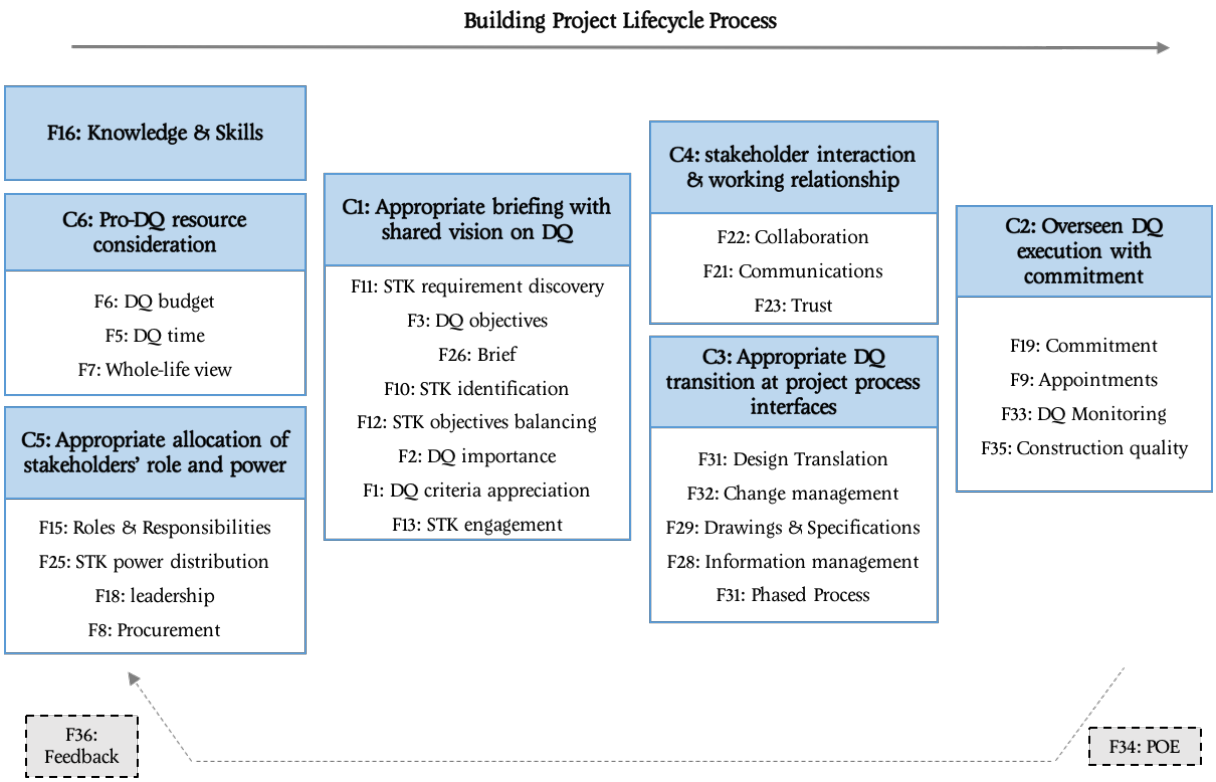


Figure 8-2: Developed conceptual framework of design quality CSFs

Briefing with shared vision on design quality (i.e., C1) can be seen as the next critical activity in the project towards design quality achievement. Its constituents indicate that an appropriate briefing activity should identify and engage stakeholders, discover and balance design requirements and produce a brief document. The next stage is concerned with the interactions between the stakeholders (C4) and also, between the process interfaces (C3). C4

highlights the importance of appropriate relationship and communication between the stakeholders involved in the project. The emphasis of C3 is also on appropriate translation of design from early stages to final ones without diluting the intended quality. Finally, the design quality brought to the construction stage, should be appropriately executed on site (C2). In doing so, constant monitoring of design quality progress and continuous commitment are essential.

It should be noted that these components include the 28 validated CSFs. However, it is known that projects form a closed loop in that the lessons learned from one project could feed-forward to a next one (section 2.2.4). Therefore, one could take advantage of the two factors of F34 'POE' and F36 'Feedback' to complement the above framework by a feedback loop.

This conceptual framework is one of the main knowledge contributions of the research that could enhance the understanding of how design quality is achieved in a systematic and compact way and it could be recommended to managers and practitioners in the UK construction industry to help achieve aspired design quality in multi-stakeholder building projects. Its value lies in the fact that it is derived from a gradual development process benefiting from various complementary methods, data sources and validation steps. A strength of the framework is that, unlike the earlier classification (i.e., product, people and process) and many similar ones in the literature (e.g. Kog and Loh, 2011; Chan et al., 2004) which were done by the researchers, the groupings here are rooted in the data from real-world projects and are mapped onto the project lifecycle process.

Another research contribution was the framework developed to link design quality CSFs (based on the above groupings) and the design quality success criteria. It was the last step in the CSFs strand. This framework was given and discussed in section 6.4.6, however, an overview of it, is also depicted in figure 8-3. The development of the CSFs in the prior steps could not provide an understanding about the impact of the factors on the constituents of design quality achievement (i.e. success criteria). Therefore, regression analysis was used to

assess whether the CSFs significantly contribute to the criteria of functionality, build quality and impact. It was revealed that all of the components significantly influence design quality achievement, which further verified the previous findings. The findings could complement the CSFs framework given in figure 8-2 in that they could further determine which aspect of design quality is particularly influenced by a specific CSFs component. For instance, if a project is primarily concerned with the achievement of 'build quality', it should appropriately embed the factors of C2, C3, C5 and F16 (figure 6.5). The framework was especially significant since the project success literature emphasises on the need for evaluating CSFs together with the success criteria (Ika, 2009), an attempt that has not been adequately considered in the existing studies according to Westerveld (2003).

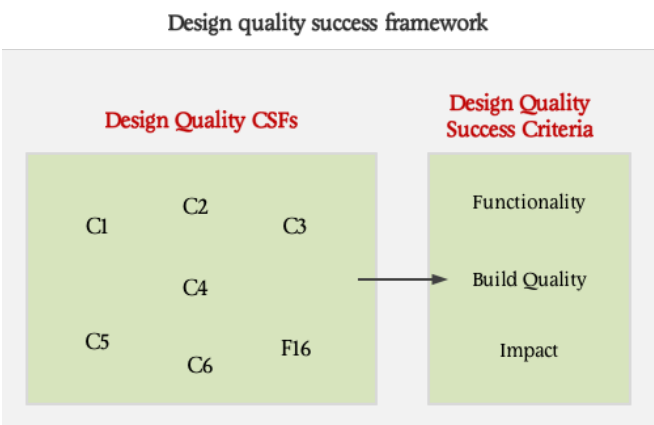


Figure 8-3: An overview of design quality success framework

As a consequence of the discussed process, the primary objective A, set to explore and improve the understanding of the CSFs for design quality achievement was fulfilled.

8.2.2 Design quality CSFs in its associated topic space

As reviewed in Chapter 2, CSFs is a topic in 'project success' discipline but is also related to building evaluation and stakeholder outcomes. The focus in this research was on the CSFs for design quality achievement. However, it would be valuable to see how this research is positioned in a chain of interlinked concepts. As a result, a better understanding of the

current progress in the topic area as well as the next possible step in the research sequence could be obtained. Figure 8-4 depicts this topic space that comprises of four concepts and three relationships bridging them.

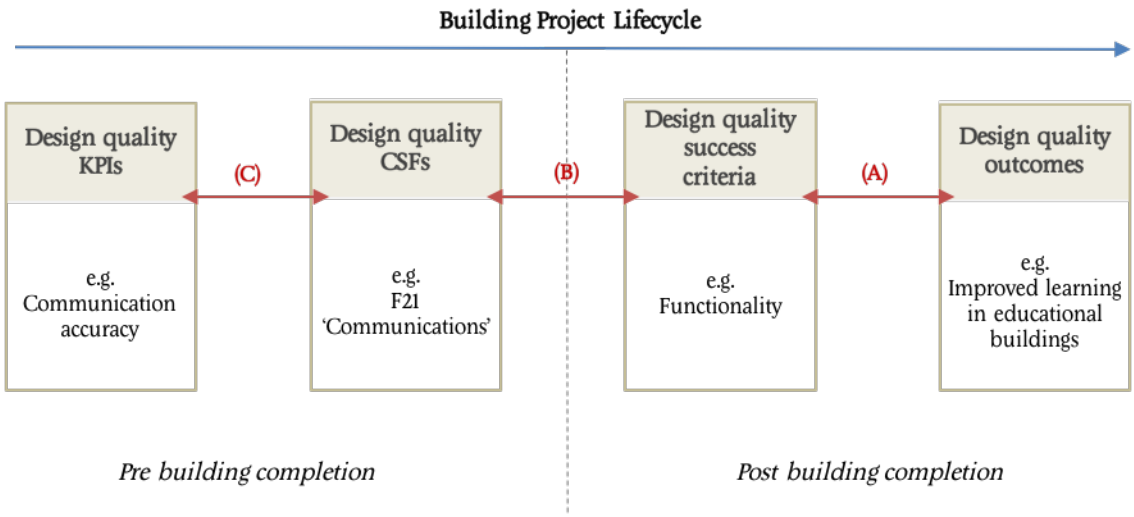


Figure 8-4: Design quality CSFs in its associated topic space

At one end of this chain, the design quality outcomes are located. It was discussed in section 2.2.2 that building design could provide various types of outcomes for different stakeholder groups (e.g. improved learning for students in an educational building). It can be argued that providing positive outcomes is the ultimate goal of building projects and the reason why the achievement of design quality is important. The design-outcome relationship ('A' in figure 8-4) was also discussed, where many studies such as Ulrich et al. (2008) in the field of EBD attempt to establish the link between various aspects of design and different types of outcomes.

The next concept in the topic space is 'design quality success criteria'. As given in section 2.3.1, success criteria are the standards or principles against which the design quality of built environments is judged. In other words, these are the 'what' of design quality achievement. In this research, the classification given in the DQI conceptual framework was used as the success criteria. The quality that is achieved in the constructed building is dependent on the appropriateness of the activities happening during the project process.

The concept of CSFs is used to define the elements defining this appropriateness and hence, the 'how' of design quality achievement. This research was conducted to identify the CSFs and also to explore their relationships with the success criteria ('B' in figure 8-4). It was the appropriate next research step in the topic space. The reason is that, as mentioned in section 2.3.2, once the success criteria are determined, then the CSFs should be identified (Turner, 1999). Moreover, this needs to involve the relationship between the CSFs and success criteria (Ika, 2009; Westerveld, 2003) as was the case with this research.

The above discussion leads to the question that what would be the next research step in the CSFs topic space. This research postulates that this can be the identification of Key Performance Indicators (KPIs) and their relationships with the CSFs ('C' in figure 8-4). Considering Toor and Ogunlana's (2009) description of the term, the KPIs for design quality CSFs could be defined as a number of measures that can offer a more detailed and objective assessment of the presence of each CSF in a project. As mentioned earlier, the CSFs in this research were attempted to be actionable rather than merely an indication of a critical area. However, these are still at a fairly general level and based on the respondents' subjective opinions. Identifying the defining elements of each CSF would allow for a more accurate assessment.[13]

Although it was not the aim of the research to systematically identify the KPIs, the Study Four suggested that F21 'communication', as a case in point, could be further assessed based on the existence of reciprocal ties and also the accuracy/timeliness/completeness of the communications.

[13] 'KPIs' is a broadly used term in the project context. Some even use the term to refer to success criteria or CSFs.

8.3 Reflections on the stakeholder attributes strand

Similar to the prior section, in this section, the evolving understanding obtained with regard to the stakeholder attributes and the research position in the relevant topic space are discussed.

8.3.1 An evolving understanding of stakeholder attributes

The second primary objective of this research was to explore and improve the understanding of the attributes of design quality stakeholders in building projects. Similar to the CSFs strand, a multi-step process was employed to fulfil this objective. The review of the literature, as shown in section 2.4.2, revealed that there exist three classes of stakeholder analysis models. Therefore, in this research, in order to explore the subject in detail and to provide an in-depth understanding, a model from each of these classes was applied in three empirical studies and from the simplest model to the most complex one. Figure 8-5 illustrates the process with the characteristics and main outcomes of each step.

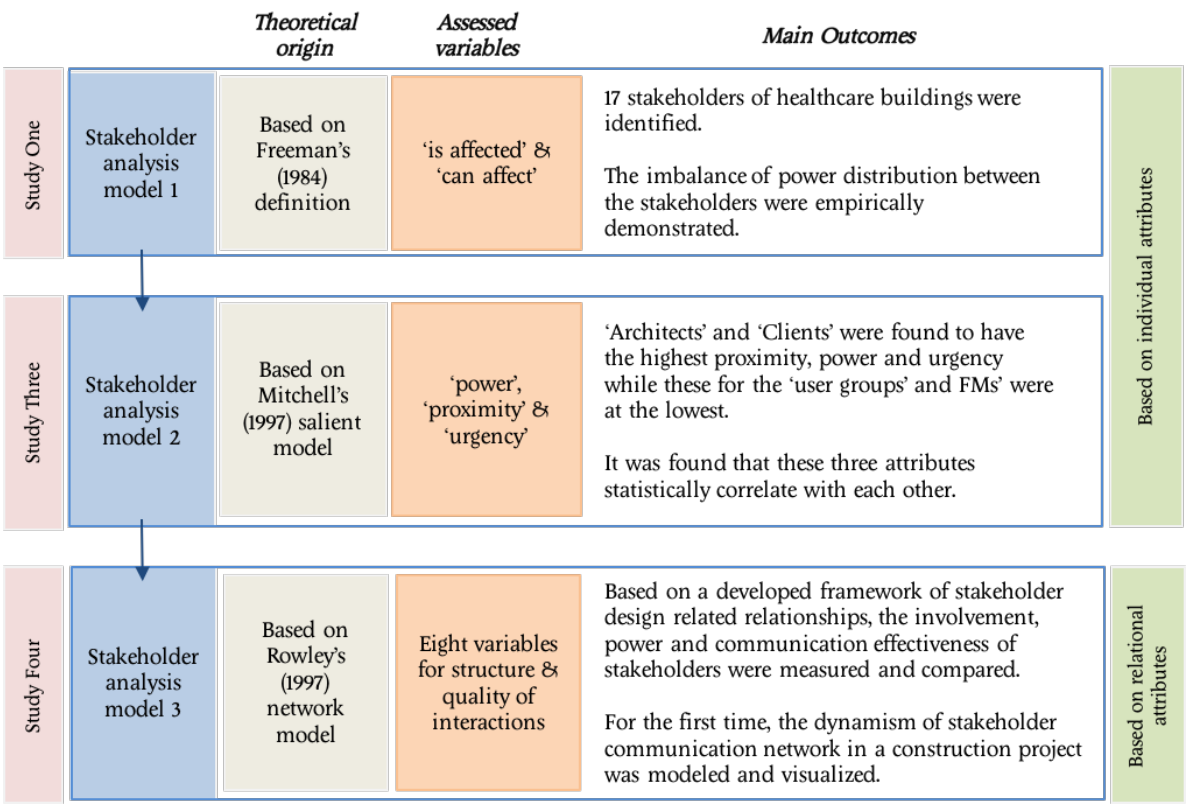


Figure 8-5: An evolving understanding of stakeholder attributes

The first model, belonging to the matrix-based class of stakeholder analysis, was applied in Study One. The devised two-axis matrix model was novel and significant due to a number of reasons. It was superior compared to the existing matrix-based models - reviewed in section 2.4.2, figure 2-6 – since unlike them, it does not take an instrumental perspective that is pre-occupied with the interest of the firms rather than all of the stakeholders. Second, it incorporates the Freeman's (1984) definition that not only is regarded as the most recognised definition of 'stakeholder' but also takes a broad, inclusive view in which the stakeholders go beyond merely those attached economically to the project. Moreover, the model offered a response to the lack of empirical application of the inherent bi-directionality in the definition which was raised by Money et al. (2012).

In fact, applying this stakeholder analysis model with two variables of 'is affected' and 'can affect' led to valuable findings about the two-way relationship between design quality and its stakeholders. First of all, it assisted in the identification of 17 stakeholders of healthcare built environments. Second, it provided empirical evidence that the degree to which a stakeholder can affect the design quality is not necessarily in proportion to the degree to which it is affected by. The graphical presentation, also, verified the fact that there is an imbalance in power distribution between the stakeholders, which could itself be influenced by factors such as the procurement choice.

Despite the successful application and valuable findings, the first model was capable of a relatively simple analysis. Moreover, it was used in Study One primarily to support the qualitative discussions so that it could not provide a proper understanding of stakeholder attributes in real-world projects. Therefore, in the next step, a more advanced analysis model was used. The second model was applied in Study Three to assess a number of key stakeholders in terms of their 'power', 'proximity' and 'urgency' attributes in 122 recently completed projects. Another merit of the second model is that although it was originated from Mitchell's (1997) salient model, it includes 'proximity' suggested by Bourne and Weaver

(2010) instead of 'legitimacy' that has been found inappropriate in the literature (Neville et al., 2011; Yang et al., 2011).

The findings (section 6.4.7) showed that 'architects' and 'clients' possessed the highest power, proximity and urgency with regard to design quality decisions and activities in the building projects whereas 'user groups' and 'FMs' were low with respect to these attributes. Interestingly, these findings were to a great extent in line with that resulted from the matrix model in Study One. Besides, the analysis of the findings led to the conclusion that these three attributes statistically correlate with each other in that an increase or decrease in one occurs simultaneously with the same change in another. This, which has not been previously explored in the literature, could be seen as a contribution made to the stakeholder theory.

The second model had its own limitations. It assessed the stakeholders individually and in isolation in spite the fact that stakeholders in reality are involved in a series of complex relationship networks which can affect their attributes. Moreover, the analysis was conducted for a few stakeholders and was based on the subjective perception of only one member of the project (i.e. the questionnaire respondents). Therefore, in the third step and in a comprehensive case study, a network-based stakeholder analysis model was employed in order to assess the relational attributes. This model belongs to the third class of analysis models that take advantage of the SNA capabilities and was firstly proposed by Rowley (1999).

One of the contributions to knowledge by the research was the conceptual model developed prior to the empirical data collection (section 7.3). The majority of the SNA studies in construction (section 2.4.2, table 2-8) only measure one or two types of relational attributes even though multiple relations exist between the stakeholders (Hanneman and Riddel, 2005). Therefore, they cannot provide a thorough understanding. An exception to these is Chinowsky et al. (2008) who initially identified 8 relational variables (e.g. information exchange, reliance and trust) to be then assessed in a case project. This was also found

necessary in Study Four however with the consideration that the variables should be design quality oriented. As a result of consulting four theoretical areas, 8 variables were identified and grouped into two categories of structure and quality of interactions.

Despite being based on a single project, a strength of Study Four compared to the previous step was that all of the stakeholders were analysed and this analysis was based on the data collected from all of the stakeholders as well. This allowed for a more accurate and objective assessment of the attributes. A significant aspect of the study was to provide a new perspective into stakeholders' involvement, influence and effectiveness in communicating with each other thanks to the SNA metrics and various visualisation techniques employed. For instance, never before was is possible to compare the stakeholders for their involvement in different project stages and different design communication topics. As the findings showed, certain stakeholders in the choice project were found to be more involved, influential or effective in communications compared to the others.

Another contribution made by the research was to respond to the significant gap in SNA literature emphasised by many scholars such as Mok et al. (2015) and Chinowsky and Taylor (2012) to model and visualise the dynamism of information exchange throughout project lifecycle stages (section 7.5.2). This, for the first time, provided an empirical evidence and a unique insight into the change patterns happening in stakeholder relationship in a building project. Moreover, as the SNA studies in construction projects are still handful and limited, this research contributed to the field by successfully demonstrating its application to stakeholder analysis and design quality related relationships, albeit the practical difficulties encountered.

As a result of the discussed multi-step process, the research primary objective B to explore and improve the understanding of the attributes of design quality stakeholders in building projects was fulfilled.

8.3.2 Stakeholder analysis in its topic space

Analysis of stakeholder attributes, as the focus of this research, could be also mapped into its wider topic space (figure 8-6). As reviewed in section 2.4.1, stakeholder analysis is part of a stakeholder management process. It was also mentioned that incorporating this process and formulating effective approaches for stakeholder analysis and engagement are imperative for the achievement of project goals (Chinyio and Akintoye, 2008). In this research, various individual and relational attributes of design quality stakeholders were explored by employing three different analysis models. However, inherent in this activity was also the identification and classification of the stakeholders. For instance, a by-product of the first model (two-axis matrix) was the identification and classification of 17 stakeholders of healthcare buildings. Also, in Study Four, the network roster identified 21 representatives from 12 stakeholder groups.

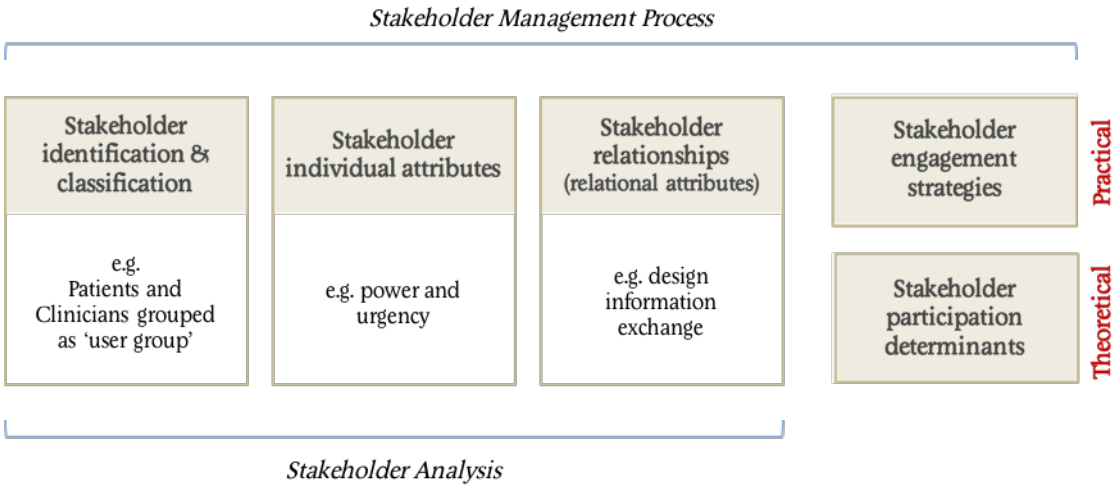


Figure 8-6: Stakeholder attributes in its associated topic space (partially adapted from Yang et al. (2011))

Although the aim of this research was to enhance the understanding of stakeholder attributes, there is also a practical application for stakeholder analysis. In fact, the next step in a stakeholder management process is to utilise the findings from a stakeholder analysis activity to formulate appropriate strategies for improving stakeholder engagement. Yang et al. (2011) defined stakeholder engagement as *'to communicate with, involve and develop*

relationships with stakeholders' and listed a number of approaches such as focus group and workshops for it. Therefore, a next step in the research sequence could be to investigate how the results of stakeholder analysis could feed into stakeholder engagement. For instance, if a stakeholder is found to be inadequately involved in a relevant communication topic or despite its importance, to receive low urgency, how these could be compensated for in the remaining of the project process. A relevant concept in SNA is 'network intervention' that can be used for the above purpose. According to Valente (2012), network intervention is the process of using data from network analysis to improve organisational performance.

Apart from this practical next step, a potential future work could be to investigate the concept of stakeholder participation[14] in a theoretical way. Participatory design is often used to describe a design process where the designer engages the users and the product is designed with their inputs. However, in here, in line with the rest of the research, the term is used with regard to all of the stakeholders based on the definition. A number of typologies have been proposed for stakeholder participation based on its objective (Lynam et al., 2007), direction of communication flow (Rowe and Frewer, 2000) or degrees of participation (Arnstein, 1969). Among these, much attention has been given to the latter in which participation is seen as a continuum of increasing involvement (Reed, 2008). A popular classification that is also used in the stakeholder literature includes five levels of inform, consult, involve, collaborate and empower (Yang et al., 2011). This implies that stakeholder participation is minimum by only sharing information with them or maximum by providing opportunities for their active involvement in decisions and activities.

Despite its value, describing stakeholder participation or participatory design based on this continuum would only give a partial picture of the concept, as it fails to define what

[14] The terms 'participation', 'involvement' and 'engagement' are used interchangeably in the literature and the industry. Here, 'participation' is preferred as it implies a broader definition and is in line with the concept of 'participatory design'.

activities or characteristics make a stakeholder more or less involved. In other words, if one considers the concept as two-dimensional, the degree is only one axis while the other should indicate the determinants of the participation (figure 8-7). In the view of this research, these determinants are relational. This is because participatory design is seen as a social process (Luck, 2003) and as discussed in Chapter 7, an individual's position in a social context is defined by his or her relationship with others. In fact, in the same chapter, it was found that someone's involvement could be determined based on the number of connections in different project stages and also in different design topics. Moreover, individuals with more influence on others' decisions could be seen as more involved. Therefore, this research recommends a next theoretical research could attempt to establish these relational determinants. In doing so, the work by Koh and Rowlinson (2012) in establishing the relational determinants of organisational processes of adaptation and cooperation could be guiding.

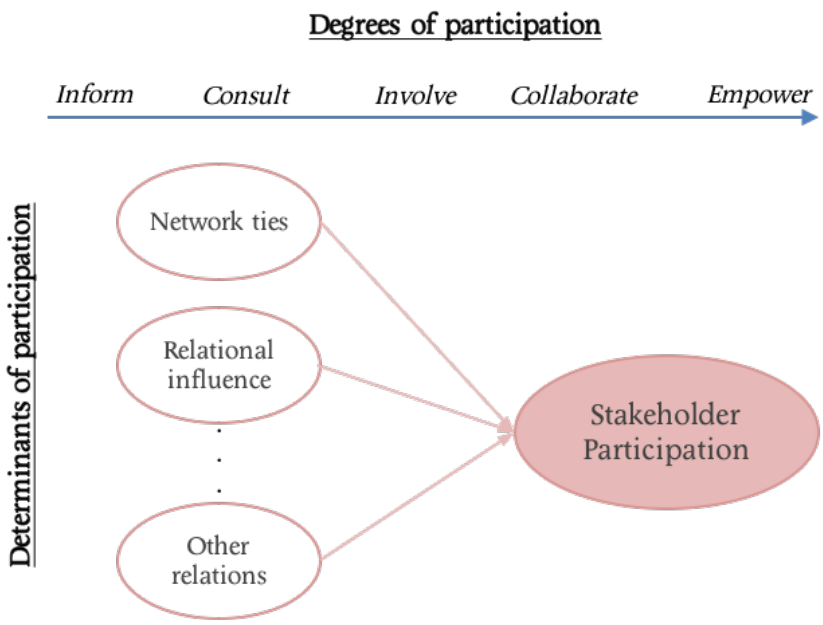


Figure 8-7: Establishing the relational determinants of stakeholder participation

8.4 Reflections on design quality and the DQI

In the previous sections, the fulfilment of the primary objectives through the strands of CSFs and stakeholder analysis was discussed. In fact, addressing these two aspects of how design quality is achieved also provided new insights about the concept of design quality and the DQI tool.

8.4.1 Design quality throughout the research process

Design quality was a focal point throughout the research and each research phase attempted to provide an insight into its concept and application (figure 8-8). The research commenced with the realisation that design quality, although being an important objective of building projects, has seen inadequate attention in the industry and academic publications.

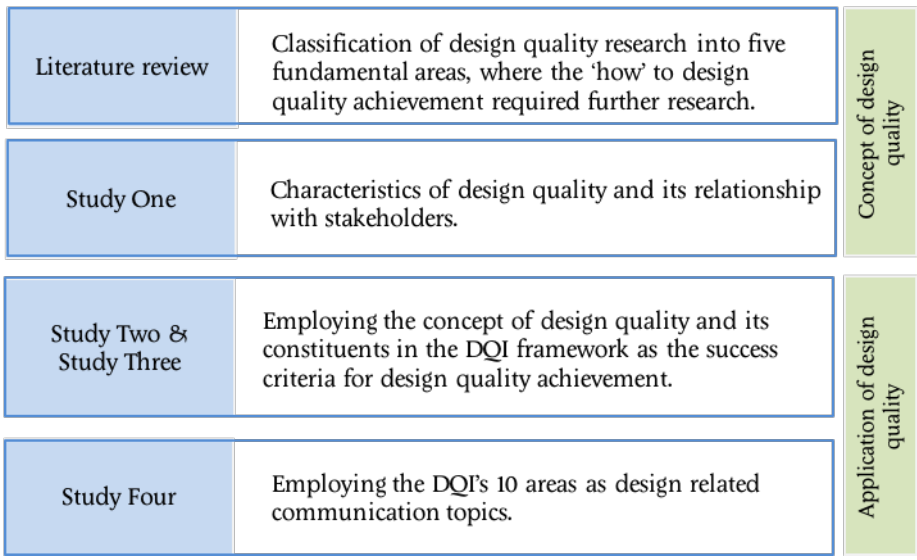


Figure 8-8: Design quality throughout the research process

As part of the preliminary objective 1 to identify key knowledge gaps in design quality research, it was suggested that the research domain could be classified into five areas, each associated with a fundamental research question (section 2.5, figure 2-11). These were then mapped onto pre- and post-project completion stages (figure 2-12) and it was concluded that pre-completion stage and the 'how' question to design quality achievement require

further empirical research. This classification, which was conducted through literature review, could be seen as a research contribution to design quality topic. Also, Study One, through tackling the preliminary objective 2 to explore architects' viewpoints, led to an improved understanding about the concept of design quality. Significant among the findings was the characteristics of the concept, e.g. multi-attribute and dynamic, and its crucial relationship with the stakeholders. It could be argued that, due to the impact of design quality on a broad range of stakeholders, the role of these stakeholders with regard to design quality is more critical in comparison with other project objectives such as time and cost.

Study Two and Study Three, which were concerned with the CSFs, utilised the concept of design quality as a project success criterion. Although the concept inherently implies this point, this research linked it to the 'project success' discipline and as a result, applied various methods available to identify and evaluate the CSFs for design quality achievement. Study Two and the first section of the questionnaire in Study Three referred to design quality as a whole. However, in the questionnaire section 2, the first level of classification offered by the DQI conceptual framework was used as three success criteria of design quality achievement. A future research could, of course, construct and investigate a more detailed and accurate model by utilising the ten design quality areas - at the second level of DQI framework. In this research, these ten areas were employed in the fourth study, not as the success criteria but as the topics of design related communications. This new application of the DQI classification allowed for the construction of design communication networks and an assessment of stakeholder involvement in each. Therefore, it could be stated that the research contributed to the design quality area by offering and testing new applications for DQI conceptual framework.

8.4.2 A framework of success criteria in building projects

As reviewed in section 2.3.1, the literature has offered several frameworks of project success and its components. It was also shown that over time these frameworks shifted from only

relying on the iron triangle (i.e. time, cost and quality) to distinguishing between project management success and product success. This research was in line with this trend by focusing on design quality and recognising its difference with process quality, as advocated in the literature (Thomson et al., 2003). In fact, in the context of building projects, the product is the constructed building, and building success equates the design quality achievement.

Therefore, this research proposes an updated framework for project success in building projects. As depicted in figure 8-9, 'project management success' and 'building success' are the two components of building project success, where the prior indicates the iron triangle with an exception. Instead of using the general term of 'quality' that could either refer to the quality of the process or that of the product, the more specific term of 'process quality' is used. By doing so, it could be argued that the elements under the project management success are process-oriented and concerned with the efficiency. On the other hand, 'building success' is outcome-oriented and concerned with the effectiveness. These differentiations are aligned with the frameworks given by Nelson (2005) and Deacon (2011) as reviewed in section 2.3.1

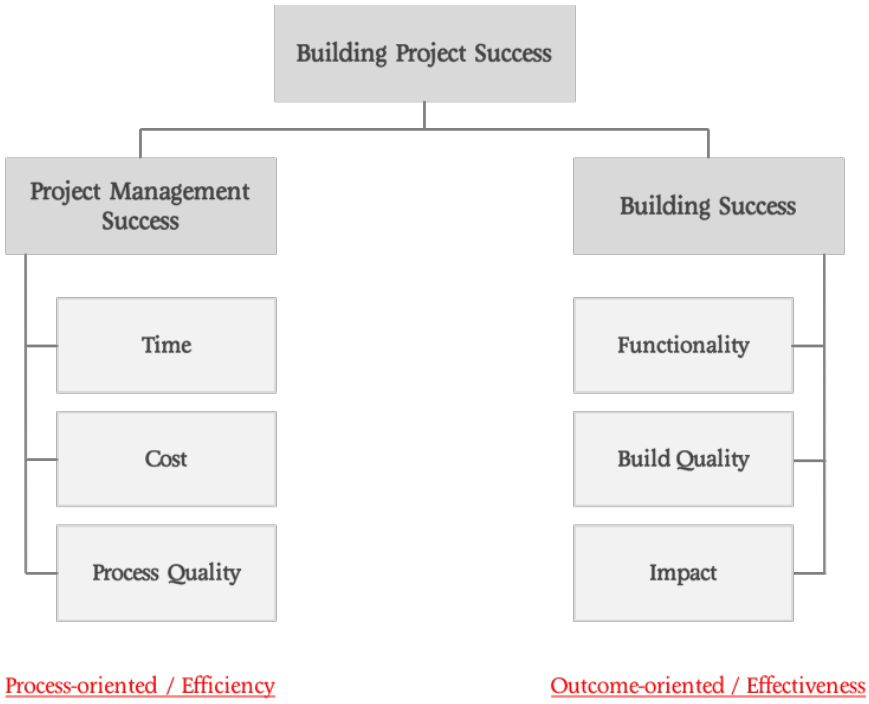


Figure 8-9: Proposed framework for building project success

8.4.3 Holistic evaluation of design quality achievement

The overall aim of this research was to improve the understanding of how design quality is achieved in building projects. This aim was fulfilled by exploring the factors that are critical for achieving design quality and also, by the analysis of stakeholder attributes who can affect design quality achievement. Although the purpose was to deepen the understanding of the subject matter and to provide new insights into its different aspects, the research also intends to offer a recommendation for the practice based on the findings and learnings obtained.

As mentioned in section 1.2, the research was initially inspired by the DQI tool and a motivation to improve it. Reviewing the literature about the tool and also attending a number of DQI stakeholder workshops suggested that despite some operational issues (Slaughter, 2004), it is an effective, easy to use and engaging method to capture the opinions of a broad range of stakeholders on the extent of design quality achievement. However, this would only allow for a limited assessment while there is a potential for an expansion to a holistic design quality evaluation. In fact, the existing tool is associated only with 'Whether or not design quality is achieved' question and the success criteria (section 2.5, figure 2-11), while a more thorough approach would also include the dimensions of the 'how' question.

The idea emerged especially from the fourth study. As given in Chapter 7, three types of data were collected about the project case. These were design quality success criteria (DQI results), design quality CSFs and stakeholders' design-related relationships. As discussed in section 7.5.5, the consolidation of the findings provided a comprehensive, in-depth assessment of the project, as a result of which, the strengths and shortcomings in specific areas could be detected with demonstrable empirical evidence.

Figure 8-10 outlines the components of the proposed design quality evaluation package. The first component is the existing DQI tool which captures the stakeholders' opinions on the

achievement of design quality with respect to 10 design quality indicators. In other words, it assesses the building quality against the success criteria.

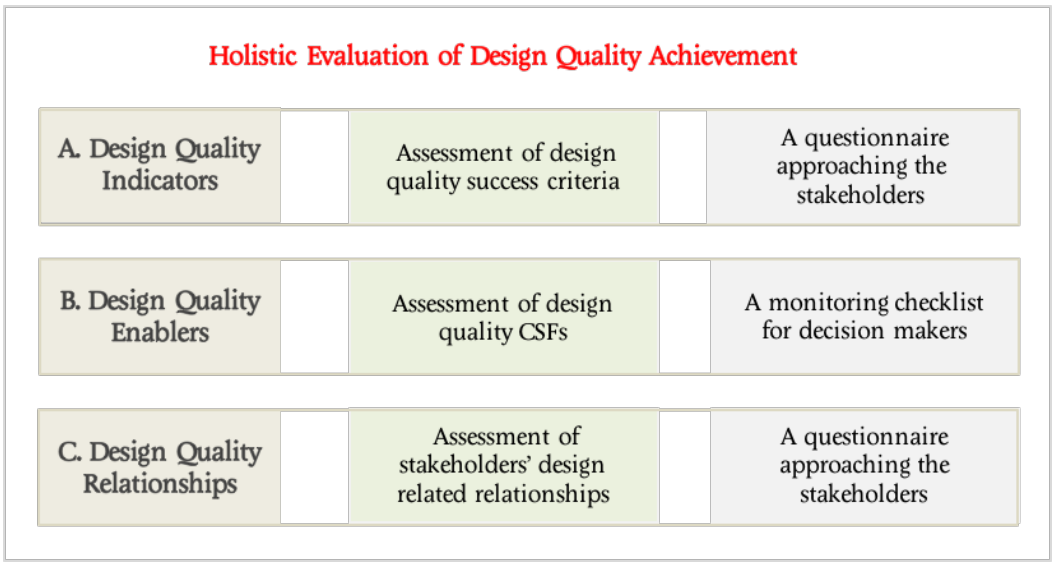


Figure 8-10: Components of the proposed holistic design quality evaluation

The second component includes the CSFs for design quality achievement and is called the 'design quality enablers'. As mentioned in section 2.2.4.1, the DQI tool considers an envelope of 'enablers' and 'constraints' that bound a building project. According to Gann et al. (2003), these are 'human resources', 'natural resources', 'time' and 'finances' and are used to help weigh the responses. Despite the value of reflecting on these for a building project, it seems that in practice they are not employed as part of the tool. In the observed DQI workshops, these were only briefly mentioned in the introductory presentation and were not referred to or utilised during the scoring activity. This could be due to the difficulty in capturing these with appropriate questions as Whyte et al. (2004) concluded from the piloting stage of the tool development. Apart from this, the four issues that the tool currently suggests are general and limited, while a useful set of enablers and constraints should be more specific and comprehensive.

In the view of this research, the identified CSFs could serve as the enablers[15], which is in line with the definition of CSFs for a project. The list of 28 CSFs is comprehensive and

[15] The term 'constraints' is not used since the identified CSFs denote a positive statement.

encompasses several areas such as 'procurement' or 'construction quality' that have not mentioned in the current tool. The factors are also more specific as, for example, instead of a general term such as 'human resources', the CSFs related to the project's 'people' include various specific areas from stakeholder management to stakeholder traits and relationship issues. In adding the CSFs to a holistic design quality evaluation package, the CSFs framework depicted earlier in figure 8-2 could be used.

The practical benefits of identifying the CSFs are also highlighted in the project success literature. A knowledge of CSFs could enable the effective allocation of projects' limited resources to the predominant areas (Chua et al., 1999). It could also serve as an underlying decision framework (Songer and Molaneer, 1997) and to help firms to decide about their strategic standing on the projects (Phua, 2004). Moreover, it could provide a checklist for an ongoing monitoring of the project performance (Toor and Ogunlana, 2008). For the purpose of the proposed holistic evaluation package here, the developed CSFs framework (figure 8-2) could serve as a monitoring checklist that allows the decision-makers to ensure the project's path towards the achievement of design quality and to make improvements in those areas where the project is found to be under-performing.

The third component is concerned with the assessment of stakeholders' design-related relationships. Although each of the stakeholder analysis models used in this research could lead to valuable findings about the attributes of the stakeholders, the network-based model especially with respect to the 'communication frequency' and 'communication topics' is deemed to be the most suitable one for the proposed evaluation package. The first reason is that not only it enables a more accurate and thorough understanding of stakeholders' relationship and involvement, but also is in line with the ultimate advocated goal of the DQI tool to facilitate stakeholders' dialogue and interactions (Dewulf and van Meel, 2004; Gann et al., 2003). In fact, the interaction between the stakeholders and their discussions with each other about the design quality were evident during the observed DQI workshops. However, it also led to the question that 'if these interactions are crucial why not to also evaluate them during the projects?'

The second reason is operational. The procedure of the network-based analysis model could more appropriately fit with the format of the current DQI tool. Both incorporate the 10 areas of design quality and involve multiple stakeholders to answer the questions. Furthermore, both could be conducted at different stages of the project lifecycle and take advantage of visualisation techniques to display the results. It should also be noted that this integration would reduce the considerable time and resources required to collect the network data, as the task could be done at once during a DQI workshop.

It is noteworthy to mention that after the completion of the fourth study, the researcher contacted the Construction Industry Council (CIC) in order to present the idea. Consequently, two presentations were given; one to the senior members of the CIC and another at an annual DQI facilitators conference. Although it was found valuable especially in the view of the senior members who showed interest to test it in a number of DQI workshops, it could not eventually go any further due to practical limitations. Therefore, a further work recommended here is to test the applicability of the proposed evaluation package in a number of projects.

A final point about the proposed holistic evaluation is the possibility to add an extra component to it, which although was not explored in this research, could be valuable in the evaluation task. This fourth component could be a knowledge repository of design quality outcomes for different stakeholder groups which is derived from EBD findings (i.e. the 'why' question in figure 2-11). The AEDET tool (section 4.4.2), which was a healthcare version of the DQI tool, benefited from an 'evidence layer' before it was terminated by the NHS. Since recently specific versions of the tool have been developed for schools (DQI for Schools) and healthcare buildings (DQI for Health) (DQI, 2015), the evidence layer could be updated and brought back to the tool for different building types. By doing so, the holistic evaluation of design quality achievement would cover all of the 'design quality research' areas identified in figure 2-11.

8.5 Reflections on overall research approach

The methodological approach and its strengths and limitations for each empirical study were discussed in the corresponding chapters. Here, the common aspects across the studies will be integrated and reviewed.

The research benefited from the employment of a wide range of data collection and analysis methods. Although literature review was predominantly used to learn about the current progress in the research area and to identify gaps in the knowledge, it was also essential in appropriately designing the studies. The facilitating materials in Study Two and the stakeholder relationship framework used in Study Four are examples for this second usage. It was noticed throughout the research that in the construction industry, the terms such as 'stakeholder' and 'quality' could be used and interpreted differently. The term 'stakeholder' seemed to be primarily used when referring to building users and 'quality' to be used interchangeably with concepts like value or outcome. Therefore, in developing the data collection instruments and in engaging with the participants, it was essential to clarify these according to the research intentions without going to much into the academic or theoretical sides of them.

Interview was a major data collection method in this research which could allow for an in-depth and compelling exploration of the participants' opinions. Different types of interview were used based on the requirements including face-to-face, video-conference and email interviews. In overall, 42 participants were interviewed in this research. The data obtained from these were thematically analysed in Study One and Two and with the help of social network analysis (SNA) in Study Four. Questionnaire survey was another data collection method that could allow for approaching a large sample of participants. As shown in Chapter 6, the survey data were analysed using various statistical techniques. To complement the methods of interview and survey, case study was also used as the third method providing comprehensiveness to the findings. As a result, the research enjoyed the employment of a whole range of methods each with specific advantages. With regard to

the SNA, since it introduces a new perspective to data collection and analysis compared to conventional methods and the point that it is not yet prevailing, the researcher attended a conference as well as a workshop run by the UKSNA[16] to ensure proper data collection and analysis. Moreover, the statistical methods and their findings were checked with an experienced independent individual.

A noteworthy strength of the research was the use of both conventional and network types of data which allowed for a better exploration of the stakeholder attributes from different perspectives. The utilisation of both types of qualitative and quantitative data in a mixed method approach was also advantageous. As described in Chapter 3, both concurrent and sequential mixed methods research were used which successfully assisted in issues such as triangulation, validation, explanation and instrument development which are among the reasons listed by Bryman (2006) for conducting mixed methods research.

It is noteworthy to mention that 'triangulation' – although sometimes is equated to 'mixed method research' (Modell, 2009), refers to a closer integration of multiple methods as part of a validation process (Johnson et al., 2007). Denzin (1978) originally defined triangulation as the "*combination of methodologies in the study of the same phenomenon*". It is argued that the convergence of findings from more than one method leads to reduced bias and more confidence in the findings and therefore, greater validity and rigor to the study (Johnson et al., 2007). In this research, triangulation with its converging capability was particularly used in a sequential mixed methods approach involving the study two and study three. A same phenomenon, i.e. identification of CSFs, was investigated and as a result, the qualitatively-found factors in study two were put into question and validated in a quantitative manner in study three. This close integration or convergence of the findings were in fact not the aim for all studies in the research. As discussed earlier, for instance, the mixed methods approach in study four brought mainly contextual qualitative

[16] UK Social Network Association

information helpful in explaining the quantitative results without a focus on data convergence.

The research also engaged with various groups of participants from expert individuals with high expertise and experience about the topic to industry professionals involved in building projects and also various stakeholders of a building project with different backgrounds. In fact, the employment of different research methods and the involvement of various groups of participants not only could bolster the research in providing better insights but also to help the researcher to develop necessary skills in conducting research studies with different requirements. An interesting observation was the fact that as a community, different groups of individuals had valuable contribution to the research topic which could be due to the essential role buildings and their design quality have on people's lives and activities.

Apart from the above, it was attempted to maintain the data quality in the empirical studies using appropriate evaluation criteria. As discussed for each study in detail, various considerations such as pilot studies and reliability checks were taken into account. The research also differentiated between assessment of quality in qualitative and quantitative research as recommended by Guba (1981) and Shenton (2004). As a result, validity, reliability and generalisability were considered for quantitative studies and credibility, dependability and transferability for qualitative ones. This also allowed to self-assess the methodological approaches taken with respect to their limitations. For instance, a common limitation of the studies that could affect the generalisability criterion was the geographical limitation (i.e. only the UK) and also the inclusion of specific building types (i.e. mainly healthcare and higher education). Therefore, it is recommended that future research could evaluate the applicability of the study methods and findings in other locations and with respect to other types of buildings.

A specific discussion about the generalisation (or external validity) of the research would be valuable here. According to Bryman et al. (2008), generalisation in its conventional form, from an investigated sample to a population, is more concerned with quantitative studies

in which an inference from sample to population with statistical accuracy is made. However, the need for generalisation depends on the study aim and objectives. They believed that a statistical (or numerical) generalisation is not necessarily an aim for a qualitative study. Instead, an analytical (or theoretical) generalisation (transferability) could be pursued (Yin, 2011). in analytical generalisation, the transferability of the findings to other contexts and compatibility of them to previously developed theories are considered (Yin, 2011).

In this research, the first and the second studies were qualitative and of exploratory nature. They did not aim for generalisation of the findings from data to population as a priority. According to Mayring (2007), explorative studies do not generalise well but develop general statements or hypotheses which can be tested for generality in the following studies. With regard to study one, the matrix technique which was employed with multiple study units (i.e. participants) was compatible with previous theories concerning the existence of multiple stakeholder groups in building projects and the fact that their level of power to influence decisions vary. This power imbalance was further observed in the third and fourth studies were other stakeholder analysis models were used. Moreover, the findings of the study one, which encompassed multiple references by the participants to critical factors for design quality achievement, implicitly indicated to the point that a list of critical success factors could be developed and serves as useful for the industry. As shown, this list was aimed for in the next steps of the research and was developed and validated through study two and three. Study two, similar to study one, was exploratory and looked for an exhaustive potential list of CSFs in a qualitative interview approach. The obtained list of 36 factors served as hypothesis for the study three where these factors were examined through a larger sample size and statistical tests to provide more confidence in their applicability. As a result, both study one and two had an analytical view to generalisation.

This analytical view was also the case with the fourth study which was conducted in the form of a single case study. Although multiple cases are desirable to better serve the generalisability purposes, it is argued in the literature that generalisation is also possible

for a single case study (Yin, 2014). As given in Chapter 7, a conceptual framework was developed based on multiple theories in the literature prior to instrument development and data collection. This theoretical framework was then applied to the case study. Moreover, according to Mayring (2007), a form of generalisation is to generalise not the results of the study but the procedures to come to the results. The SNA method used in study four provided useful insight on how it should be applied in building contexts and how to deal with its practical problems and possible pair-wise biases that could occur. This is particularly valuable when considering that the SNA method is still very new in the field of construction and more studies are needed by the next researchers, who could benefit from the learnings of this study on its procedure and application. Another noteworthy point is that, although it was a single study but came in the form of multiple networks across 5 different project stages. The network structures differed but all of them supported the more generalizable statement that network properties and stakeholders' attributes are not static in building projects and change patterns over time.

The study three was, however, a quantitative study where multiple statistical analyses were employed in order to derive meaningful results from the numerical data. According to Babbie (2014), in order for a quantitative study to provide a numerical generalisation (i.e., inference to the population), the sample needs to be representative of the population and the sample size to be adequate. For sample representativeness, a probability sampling technique which includes random selection is required. A randomly selected sample ensures that each member of the population has an equal chance to be included in the sample. A requirement for probability sampling is to have at hand the list of all members of the population to select from (Robson, 2014). Although this is desirable in quantitative research, in practice, achieving a true probability sampling is often not possible. This is especially the case with the social sciences research where the population could be inaccessible or even unlimited (Babbie, 2014). Therefore, a non-probability sampling is often used in practice. This was the case with this study (and also the other qualitative studies in this research). Moreover, non of the several previous CSFs studies which reviewed as part of this research employed a probability sampling. The drawback of non-probability

sampling is of course its limitations for numerical generalisation. However, it makes conducting the research on the phenomenon of interest possible with useful insights and also a analytical generalisation.

It is argued that a research with non-probability sampling is still valuable and worth undertaking without aiming for a firm numerical generalisation. In study three, the population was defined as professionals from architecture or client organisation in the UK with experience and knowledge in multi-stakeholder building projects. Obtaining a complete list of this population was not possible and pragmatic for the research project. However, it was attempted that those targeted directories (i.e. RIBA, NHS and HE estates as explained in chapter 6), were all entirely approached. As a result, a large number of questionnaires (i.e. 950) were in fact distributed. Notwithstanding, the outcome was a small response rate which again reflects the practical issues in achieving a representative sample in this field of research. Despite these issues, the sample size was adequate for the statistical analyses used. Both ways of 'rule of thumb' as well as mathematical/statistical tests (e.g. KMO) for sample adequacy were satisfied, as explained in chapter 6. For PCA, the communality values were high and for the MLR the difference between R and R^2 were small which as stated in chapter 6 and according to Field (2009) contributes to the cross-validity and therefore, sample representativeness. In overall, the generalisability should be considered with caution and as suggested earlier a Confirmatory Factor Analysis or another MLR study with a different sample are recommended as future research.

Besides these limitations, the research also encountered with various practical challenges and constraints in different stages. According to Gillham (2005), 'real-world' research does not take place in a controlled setting and as a result, there is a need for constant compromise and adaptation. One of the major challenges was to collect adequate responses for the questionnaire survey. As discussed in Chapter 6, the initial attempt to distribute the questionnaire via an online tool to a large extent failed. However, by mixing it with a postal paper questionnaire and also promoting materials in the next attempt, adequate

sample size was obtained. Still, the overall data collection process took more than 6 months which caused a considerable burden in terms of the research time.

Another challenging issue occurred at the time of the analysis of interrelationships between the CSFs (section 6.4.5) where a simple structure in the rotated components was not achieved in the first run. Consequently, one of the factors, i.e. 'knowledge & skills' had to be excluded from the analysis. This, however, was compensated for by successfully including it in the regression analysis (section 6.4.6) and in the CSFs framework (section 8.2.1). A compromise was also needed in the fourth study between accuracy and avoiding loss of valuable collected data. As discussed in Chapter 6, the variables of 'mode', 'medium' and 'shared understanding' had to be dropped from the analysis due to a large number of pair mismatches. Other examples could also be mentioned, e.g., not completing the matrix model in 2 of the interviews in Study One, the necessary shift from face-to-face interviews to email interviews in Study Two, and not collecting direct network data from two of the stakeholder groups in Study Four.

9 Chapter Nine

Conclusions

The research presented in this thesis aimed to improve the understanding of how design quality is achieved in building projects through an in-depth exploration of CSFs and stakeholder attributes. This chapter presents the main research outcomes with regard to the research objectives and the contributions made in relevant academic fields. The chapter closes with a few recommendations for future research.

9.1 Main research outcomes

(Preliminary Objectives)

(1) To identify key gaps in previous research on design quality and suitable methods to address them.

(2) To explore architects' perspectives on design quality in real-world building projects.

Pursuing the first preliminary objective to identify key gaps in knowledge revealed that the concept of design quality could be studied with respect to five key questions around 'design quality achievement'. Among these, the 'how to achieve design quality' question was found to be considerably unexplored and suitable to be addressed through an examination of CSFs and stakeholder attributes.

Exploring architects' perceptions about the concept of design quality and its stance in the industry (study one) revealed that their viewpoints revolved around 'design quality characteristics', 'two-way relationship between design quality and stakeholders' and 'stakeholder relationship regarding design quality'. It was discovered that achieving design quality is complex yet important and managing its stakeholders could be with many hurdles in building projects. The findings, moreover, verified that identifying CSFs and employing stakeholder analysis models are useful for enhancing the understanding about design quality achievement.

(Primary Objective A) *To explore and improve the understanding of the CSFs for design quality achievement in building projects.*

Through a sequential mixed method approach, the research unveiled 36 potential CSFs for design quality achievement in study two, 28 of which were then validated as the CSFs in study three. It was found that 'brief', 'leadership', 'communications', 'knowledge & skills' and 'construction quality' are the most important perceived CSFs for achieving design quality. Moreover, it was concluded that the two respondent groups of architects and clients did not significantly differ in perception regarding the importance of the factors except for the 'stakeholder identification' and 'POE'.

Moreover, the evaluation of the CSFs in real-world projects revealed six underlying components (i.e., grouping of the CSFs) could effectively represent the CSFs and explain the interrelationships between them. These components were 'appropriate briefing with shared vision of design quality', 'overseen design quality execution with commitment', 'appropriate design quality transition at project process interfaces', 'stakeholder interaction and working relationship', 'appropriate allocation of stakeholders' role and power', and 'pro design quality resource considerations'.

A further exploration into the relationship between the CSFs and design quality achievement in real-world projects, revealed that the CSFs could contribute differently to the achievement of various aspects of design quality. For instance, it was found that in achieving 'build quality' in the constructed building, 'overseen DQ execution with commitment' is highly influential or for a desired 'functionality', one should especially maintain two areas of 'appropriate knowledge and skills in design development' and 'stakeholder interaction and working relationship'. The findings led to the conclusion that all of the CSFs components contributed significantly to at least one aspect of design quality achievement and thus, further validation for the identified CSFs was obtained.

(Primary Objective B) *To explore and improve the understanding of the attributes and relationships of design quality stakeholders in building projects.*

Through the application of three different stakeholder analysis models, the research provided new insights into the stakeholders and their attributes with respect to design quality achievement. The first model, which was devised based on stakeholder definition, could assess and map on a matrix the degree to which stakeholders can affect design quality and the degree to which they are affected by. Through employing the model in study one, 17 stakeholders of healthcare built environments such as patients, clinicians, architects and facility managers were identified. Moreover, empirical evidence was provided leading to the conclusion that stakeholders are not necessarily able to affect design quality decisions in proportion to the level they are affected by. It was also verified that there is an imbalance in power distribution among the stakeholders.

The application of the second stakeholder model in the third study offered descriptive insights into the power, proximity and urgency attributes of key stakeholders in real-world projects. In comparison, it was found that the 'client' stakeholder held the highest power to influence design quality decisions, whereas the 'users' suffered from having the lowest power. The 'architects' enjoyed the highest proximity to design quality related activities whereas the 'facility managers' (FMs) were found on the farthest group. The FMs, similarly, attracted the lowest urgency with regard to their design quality requirements, while the highest urgency belonged to the clients. The 'contractor' stakeholder also was found to possess a moderate level in all the attributes. A separate analysis further revealed that there is a significant positive correlation between these attributes.

Contrary to the previous models, the third adopted model took a relational approach in analysing the stakeholder attributes in a case building project. By using social network analysis (SNA) and based on a developed conceptual framework of stakeholder relationships, the fourth study modelled various design quality related stakeholder networks and measured the relational attributes of 14 stakeholder groups. The networks of

stakeholder communications across project lifecycle stages and for different design topics were visualised based on which, a novel insight into stakeholders' involvement was obtained. For instance, it was discovered that 'department PM' and 'FM' were the most involved stakeholders in the project 'handover' stage. The 'primary architect' was also found to have an increasing level of involvement up to the 'construction' stage since when, it became less involved as the project progressed. With regard to different communication topics, it was found, for instance, that 'users' were most involved with regard to the 'use' of the building while the 'main contractor' was the most involved stakeholder in the 'build quality' aspects. The stakeholder analysis model also revealed an assessment about the communication effectiveness and stakeholder influence, where the 'main contractor' and its sub-contractors had the lowest effectiveness and the 'department PM' and 'primary architect' with the highest influence on design quality decisions.

9.2 Contributions to knowledge

The contributions to knowledge made in different research stages were discussed in Chapter 8. The overarching contribution of the research project could be seen as the development of the CSFs for design quality achievement (the how) and the application of stakeholder analysis techniques for this purpose (the who) as a supplementary layer in evaluating design quality (the what). A key contribution in that was the framework of CSFs components developed based on empirical data from real-world projects presented shown figure 8-2. In the following, a comprehensive list of various novelty and contributions made with respect to the academic fields of 'design quality', 'project success', 'stakeholder management' and 'social network analysis' are given.

Research contributions to the field of 'design quality':

- Classifying 'design quality research' into five fundamental areas, each associated with a key research question about design quality achievement; and addressing the 'how' question as a major gap identified (Section 2.5).

- Introducing new applications for the DQI conceptual framework: first as the success criteria for design quality achievement (i.e. building success) (Chapter 6) and second as the topics for design-related communication networks in building projects (Chapter 7). The research also made a contribution to the tool by presenting the identified CSFs as the 'enablers' of design quality which is mentioned in the DQI framework but currently not adequately addressed (section 8.4.3).

Research contributions to the field of 'project success':

- Addressing an identified gap in the existing literature of project success indicating a lack of understanding of the CSFs for design quality objective of the building projects. It was significant due to a trend in the field showing an increased attention to the 'building success' and the stated need to distinguish it from 'project management success'.

- Developing a conceptual framework of the CSFs based on seven groupings (the how) for design quality achievement, and establishing the interrelationships between them. The framework was meaningfully mapped onto the project lifecycle process and could be used as a monitoring tool in building projects. (sections 6.4.5 and 8.2.1)

- Determining the relative impact of the CSFs on the achievement of three criteria of design quality, i.e. functionality, build quality and impact. As a result, a framework establishing the relationship between the CSFs and the success criteria of design quality was obtained (section 6.4.6).

- Proposing a new framework of 'success criteria' for building projects. (section 8.4.2)

Research contributions to the fields of 'stakeholder management' and 'social network analysis':

- Devising and applying a matrix-based stakeholder analysis model through the operationalisation of Freeman's (1984) definition, contrasting the similar existing models with an 'instrumental' perspective.
- Establishing a positive correlation between the stakeholder attributes of power, proximity and urgency, which was never looked into before (section 6.4.7).

- Developing a conceptual framework of stakeholder relationships relevant to design quality. The framework classifies 8 relational variables into two categories of structure and quality of interactions (section 7.3).

- Broadening the application of the SNA in modelling and visualising construction projects both in terms of exploring new topic areas, i.e. design quality, and across project lifecycle stages – as it was called for in the literature (section 7.5.2).

9.3 Recommendations for future research

The suggestions for potential future work were discussed in the study chapters as well as Chapter 8. Here, these are outlined based on two types of recommendations.

The first type is to enhance the conducted studies with regard to their limitations. As this research produced the first systematically obtained list of CSFs for design quality, its applicability needs to be tested in other context e.g. other geographical locations and other types of buildings as well. It would be also valuable to approach more stakeholder groups (beyond clients and architects) for CSFs exploration.

The matrix model can be used in specific projects and for different stages to help the engagement and management of stakeholders. The data collection for the network model can be done in a longitudinal manner provided that time, cost and accessibility are not an issue. This would reduce the recall bias and allow for required interventions in the stakeholder management. If practically possible, multiple case studies could be used so that comparison between projects could be made.

The second type of recommendations concerns the next research step in the topic spaces discussed in sections 8.2.2. and 8.3.2:

- The identification of Key Performance Indicators (KPIs) for the identified CSFs, as the next logical step in the 'project success' topic space. These could be identified for all CSFs in an exploratory manner, or alternatively for each of the CSFs through inferential statistical models (section 8.2.2).

- An investigation into the application of the findings from stakeholder analysis models in order to improve stakeholder engagement strategies in ongoing building projects (section 8.3.2).

- Establishing the relational determinants of stakeholder 'participation'. For this purpose, the relational attributes in study four could be tested (section 8.3.2).

Research recommendation for the practice:

Having originally motivated by the DQI tool, the research wish to come to an end by making a practical recommendation for the tool. As discussed in section 8.4.3, the research proposes a holistic evaluation of design quality achievement by complementing the current DQI tool by the assessment of the CSFs and stakeholder attributes. The developed conceptual framework of CSFs could be used as a monitoring check-list and the proposed

stakeholder network model as an advanced analysis tool to ensure stakeholders are on the right track towards DQ achievement.

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Appendices

Appendix A: study one

a. Interview guide

Topic area one: design quality concept

Question 1: How do you define the concept of design quality?
Question 2: What do you consider as good design?

Topic area two: design quality in project process

- **Question 3:** How is design quality ensured in projects considering various objectives?
- **Question 4:** How are related decisions made?

Topic area three: design quality stakeholders

- **Question 5:** Who are the stakeholders of design quality?
  (definition: any individual or group who can affect or is affected by the design quality of the completed building)
- **Question 6:** To what extent they can affect or are affected by design quality? (stakeholder analysis matrix)

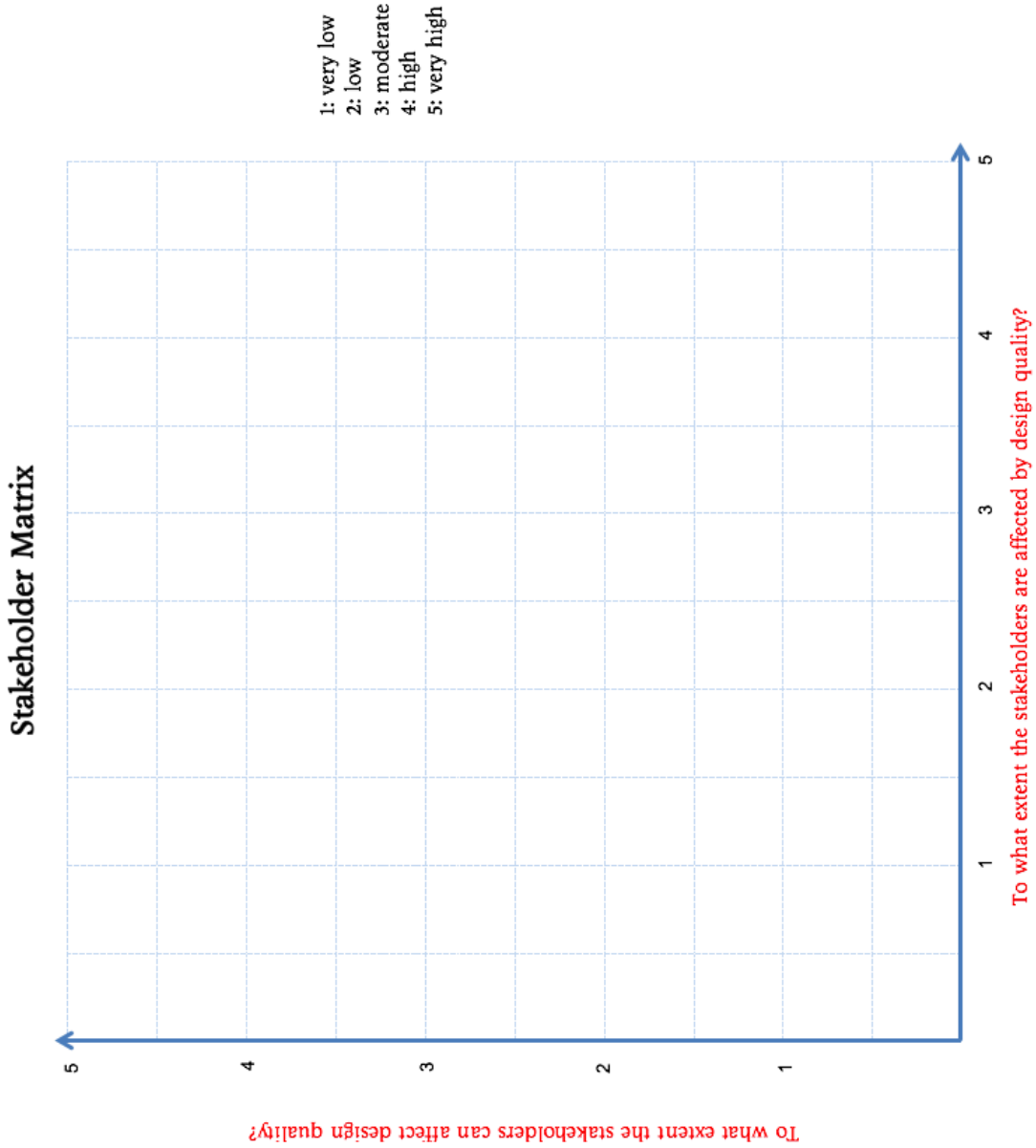
Topic area four: design quality stakeholders in project process?

- **Question 7:** How are design quality stakeholders managed in projects?
- **Question 9:** How are their requirements integrated into related decisions?
- **Question 10:** What tools are used?

Probes and Follow-ups:

- Is there any difference between healthcare and other sectors?
- Have you encountered any conflict between different design objectives? Is it possible to achieve them all?
- How do you optimise design, cost and quality constraints?
- What about stakeholder 'x'?
- Have you used the DQI in your projects?
- Are the results embedded in decisions?

b. <u>Matrix Exercise for Stakeholder Model 1</u>



c. <u>Image of one of the completed matrices (Matrix 6):</u>

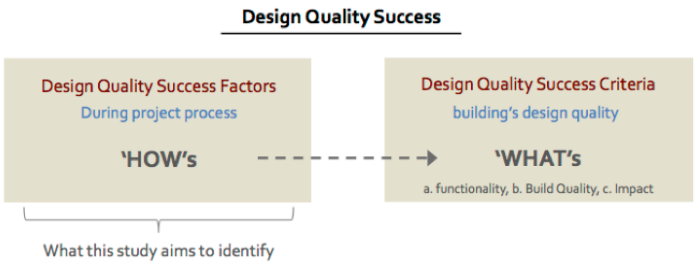
Appendix B: study two

a. Copy of the questionnaire

A. Introduction

The 'design quality achievement' is defined by two interrelated components. One is the 'design quality success criteria' or the 'WHAT's (which indicates the result areas), and the other component is the 'design quality success factors' or the 'HOW's (the areas indicating how projects can achieve the design quality criteria or the WHATs.)

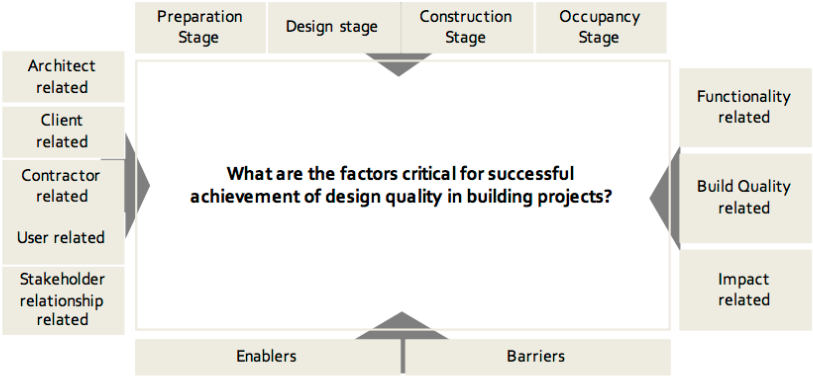
This research aims to identify the latter or to answer the question of 'how to embed design quality in the construction projects in order for it to be achieved successfully?' For the criteria – or the WHATs – the study considers the - already defined - areas of 'Functionality', 'Build Quality', and 'Impact' of the completed building as three design dimensions against which the final design quality of buildings can be assessed.



There is a table in the page 4 of this document (section C) where you can fill with your perceived factors. Desirable is a list of **15 to 25 factors** as **universal** as possible applicable to building projects with multiple stakeholders. Each factor should be **essential** for successful achievement of design quality and all factors together to be **sufficient** for that purpose - in other words, to be **collectively exhaustive**. You may go straight to the Section C but to facilitate this, there are some guidelines and hints given in section B.

B. Facilitating Materials

Part 1. In order to facilitate the process of identification, a number of categories are introduced here. These categories are described and also depicted in the figure below. Of course, the relevant factors are not limited to these categories and you may identify the factors beyond them.



- Factors related to the key **'stakeholder groups'**
  There are, of course, factors relevant to all involving parties. But, of particular interest to this research is to also identify the factors critical to each of the key stakeholder groups; i.e. architect, client, contractor and even end-users. What are the essential responsibilities or characteristics of each of these groups to make them an enabler of successful design quality? Examples could be 'minimum design change by the client' or 'Architect's ability to develop good design within budget and programme'.

- Factors related to **'interactions and relationships between stakeholder groups'**
  Examples could be 'effective communication', 'mutual trust', or 'frequent progress meetings'.

- Factors related to different **'project lifecycle stages'**:
  Some factors might be more critical to a specific stage of the construction projects. These are defined for this study as 'preparation', 'design', 'construction', or 'occupancy' stages. Examples could be 'brief-related' factors or 'post occupancy evaluation'.

- Factors related to different aspects of the **'design quality of completed building':**

  Some factors might be more critical to a specific aspect of the building's design quality. You could think of:
  - Factors critical to deliver 'functionality' successfully. (Usefulness of the design)
  - Factors critical to deliver 'build quality' successfully. (Durability of the design)
  - Factors critical to deliver 'impact/delight' successfully. (Aesthetic of the design)

- Factors which are either **'enabler'** or **'barrier'**
  We are looking for the factors which have positive influence on design quality achievement, but, thinking of the barriers or those factors having negative influence could also help identifying the factors. An example could be 'Absence of bureaucracy'.

Part 2. To further facilitate the identification process, in the table below, a number of potential critical success factors identified in similar studies are presented in brief. Although these studies have identified the factors for the overall success of the projects, you may find some of them transferrable and applicable to the 'design quality success' as well. Please choose, modify or expand on those factors you believe are critical for the achievement f design quality when filling the table next page.

Clearly defined goals	Project nature and size	Realistic Schedule/programme
Realistic Budget	Total Cost Perspective	Availability of Equipment
Type of contract; clear and detailed written contract; comprehensive contract documentation	Project feasibility	Appropriate/Transparent procurement
Availability of Materials	Appropriate stakeholder analysis	Appropriate value management/engineering
Competence of any of client/architect/contractor etc.	Experience of any of client/architect/ contractor etc.	Timely/quick decision making by any of client/architect/contractor etc.
Client's top-management support	Minimum or absence of design changes by the client	Architect's ability to develop good design within budget and programme
Effective communication	Mutual Trust	Honesty
Commitment of all parties to the project	Clear definition of responsibilities	Frequent Progress meetings among parties
involvement of users	Holding stakeholder workshops	Willingness to exchange ideas and visions
Creativity and innovation	Appropriate/up to date technologies	Passion/ Enthusiasm
Learning Climate)	Absence of bureaucracy	Reasonable fee structures for participant firms
Troubleshooting	Post Occupancy Evaluations; learning from previous experiences	Sub-contractors' involvement
Knowing what the client really wants	Proper priority settings	Agreement of briefs by all parties
Flexibility of brief to cater for changes	Adequate time for briefing	Project manager's authority
Clearly articulated needs	[Quick] conflict resolution	Organisational Structure
Leadership Quality	Construction Methods	Appropriate quality workmanship
Current state of market	Minimum or absence of commercial pressure	Appropriate site management
Appropriate risk identification and allocation	Effective monitoring and control	Appropriate planning (

C. Design Quality Critical Success Factor Table

	What are the critical success factors for the achievement of design quality in multi-stakeholder building projects? Please identify between 15 to 25 factors.
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Thank you very much for your time and kind assistance with this research. If you would like to discuss the factors further in a short face-to-face/telephone/Skype interview session (which the research would highly benefit from), please kindly let me know. (m.sadeghi@warwick.ac.uk)

b. CSFs used in the questionnaire and sources

Clearly defined goals (Toor & Ogunlana, 2008)	**Project nature and size** (Chan et al., 2004)	**Realistic Schedule/programme** (Yu et al., 2006)
Realistic Budget (Li et al, 2011)	**Total Cost Perspective** (Chen and Chen, 2007)	**Availability of Equipment** (Odeh and Battainah, 2002)
Type of contract; clear and detailed written contract; comprehensive contract documentation (Songer and Molenaar, 1997; Toor and Ogunlana, 2008, Nguyen et al., 2004)	**Project feasibility** (Khan and Spang, 2011)	**Appropriate/Transparent procurement** (Chan et al. 2011; Phua, 2004)
Availability of Materials (Hwang et al., 2013)	**Appropriate stakeholder analysis** (Yang, 2009)	**Appropriate value management/engineering** (Shen and Liu, 2003)
Competence of any of client/architect/contractor etc. (Kog and Loh, 2012)	**Experience of any of client/architect/ contractor etc.** (Hwang et al., 2013)	**Timely/quick decision making by any of client/architect/contractor etc.** (Tabish et al. 2011)
Client's top-management support (Chua et al., 1999)	**Minimum or absence of design changes by the client** (Tabish et al, 20110	**Architect's ability to develop good design within budget and programme** (Chan et al., 2001)
Effective communication (Chen and Chen, 2007)	**Mutual Trust** (Cheng and Li, 2002)	**Honesty** (Yu et al. 2006)
Commitment of all parties to the project (Iyer and Jha, 2006)	**Clear definition of responsibilities** (Chan et al. 2004)	**Frequent Progress meetings among parties** (Toor and Ogunlana, 2008)
involvement of users (Chan et al., 2004)	**Holding stakeholder workshops** (Yu et al., 2006)	**Willingness to exchange ideas and visions** (Chan et al., 2004)
Creativity and innovation (Koutsikouri et al., 2008)	**Appropriate/up to date technologies** (Nguyen et al., 2004, Koutsikouri et al., 2008)	**Passion/ Enthusiasm** (Koutsikouri et al., 2008)
Learning Climate (Cheng and Li, 2002)	**Absence of bureaucracy** (Toor and Ogunlana, 2008)	**Reasonable fee structures for participant firms** (Phua, 2004)
Troubleshooting (Li et al., 2011)	**Post Occupancy Evaluations; learning from previous experiences** (Yu et al., 2006; Toor and Ogunlana, 2008)	**Sub-contractors' involvement** (Chan et al., 2004)
Knowing what the client really wants (Toor and Ogunlana, 2008))	**Proper priority settings** (Tang et al., 2013)	**Agreement of briefs by all parties** (Tang et al., 2013)
Flexibility of brief to cater for changes (Yu et al., 2006)	**Adequate time for briefing** (Tang et al., 2013)	**Project manager's authority** (Chua et al., 1999)
Clearly articulated needs (Chan et al., 2001)	**[Quick] conflict resolution** (Tabish et al., 2011)	**Organisational Structure** (Koutsikouri, et al., 2008)
Leadership Quality (Koutsikouri et al., 2008)	**Construction Methods** (Hwang et al., 2013)	**Appropriate quality workmanship** (Toor and Ogunlana, 2008)
Current state of market (Songer and Molenaar, 1997)	**Minimum or absence of commercial pressure** (Chan et al., 2003)	**Appropriate site management** (Hwang et al., 2013)
Appropriate risk identification and allocation (Li et al., 2005)	**Effective monitoring and control** (khan and Spang, 2011)	**Appropriate planning** (Odeh and Battainah, 2002)

Appendix C: study three

a. Copy of the questionnaire

Critical Success Factors for Achieving Design Quality in Building Projects

Dear

We would like to invite you to share your valuable opinions and experiences on achieving 'design quality' in building projects by completing a short survey. This survey is part of a research project conducted in WMG at the University of Warwick funded by the Engineering & Physical Sciences Research Council in the UK (EPSRC). To participate, please complete the enclosed questionnaire and return it using the pre-paid envelope or alternatively, access the online version by visiting warwick.ac.uk/design-quality.

What is the study about?

Achieving design quality can provide positive outcomes for users and other stakeholders of built environments. Therefore, it is crucial to deepen the understanding of the factors critical to successful achievement of design quality in building projects. This research study has been developed accordingly in order to (a) identify these Critical Success Factors (CSFs), and to (b) explore their presence in recent projects. Construction industry professionals from architecture firms, client organisations, contractors and other groups involved in building projects are invited to take part.

What does the survey involve?

There are two sections in this survey. Section 1 seeks your opinion on relative importance of a list of success factors for achieving design quality. Section 2, then, asks you to evaluate a recently completed building project, in which you were involved, against these factors. Completing the survey will take between 15 to 20 minutes.

Information about your participation

Participation is voluntary and the information you provide will be treated with strict confidentiality and anonymity. The study findings will be shared with the respondents if requested. For further details about the study and your rights as a participant, please visit our webpage (warwick.ac.uk/design-quality).

If you consent to participate, please proceed to the questions and return the completed survey within two weeks of receipt. Thank you very much for your kind assistance with this research.

Contact Information

Please contact us if you have any question or would like to know more about this research study.

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WMG Innovative Solutions

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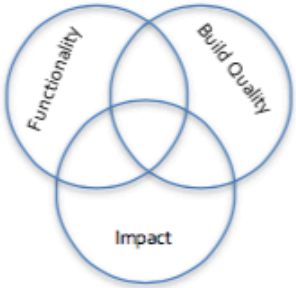
Definitions Helpful in Answering the Survey Questions

Design Quality

For this study, 'design quality' is comprised of 3 quality fields of 'functionality', 'build quality' and 'impact. Design quality is successfully delivered when these fields are achieved and work together in a synergetic way. This classification has its origin in Vitruvius' (Roman Architect) *Triad of Architecture* and is still a valid basis for building evaluation.



Functionality (or Commodity) is concerned with how well the building is designed to be useful.

It encompasses areas like accessibility & wayfinding, suitability of spaces & layout, and suitability of design to accommodate original & changing operational needs.

Build Quality (or Firmness) is concerned with how well the building and its components are constructed.

It encompasses areas like performance of environmental, engineering & control systems, energy efficiency and quality of construction, structure & materials.

Impact (or Delight) is concerned with how well the building creates a sense of place & contributes to local environment.

It encompasses areas like pleasantness of inside & outside areas, landscape, look & feel of materials & finishes, and ability to create positive image & character and contribute to new knowledge & innovation.

Design Quality Stakeholders

For this study, stakeholders are any individual or group who is affected by design quality or can affect it during the project lifecycle. (e.g. architect, contractor, client, user group, facility management team etc.)

Section One: Relative Importance of the Success Factors

Below is a list of 36 success factors for achieving design quality in building projects structured in 3 groupings. Based on your perception and experience in the construction industry, please rate these factors in terms of how important they are for the successful achievement of design quality. Please consider building projects where multiple stakeholder groups exist, e.g., healthcare or higher education.

Group One: Focus on Design Quality	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
1) Shared understanding of design quality & its indicators between stakeholders	☐	☐	☐	☐	☐
2) Recognition of the importance of design quality when defining project objectives & constraints	☐	☐	☐	☐	☐
3) Early definition & prioritisation of design quality goals & aspirations	☐	☐	☐	☐	☐
4) Appropriate method to define value of design elements & outcomes for stakeholders	☐	☐	☐	☐	☐
5) Allocation of adequate time to design & its development	☐	☐	☐	☐	☐
6) Allocation of adequate budget to design & its development	☐	☐	☐	☐	☐
7) Understanding of project whole lifecycle & design requirements over time	☐	☐	☐	☐	☐
8) Design quality oriented selection of procurement/contract method	☐	☐	☐	☐	☐
9) Design quality oriented appointment of all project participants	☐	☐	☐	☐	☐

Group Two: Design Stakeholders	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
10) Early, comprehensive identification of all stakeholders	☐	☐	☐	☐	☐
11) Appropriate method for discovering stakeholders' requirements & interests	☐	☐	☐	☐	☐
12) Appropriate method for balancing varying objectives of stakeholders	☐	☐	☐	☐	☐
13) Appropriate stakeholder engagement throughout project lifecycle	☐	☐	☐	☐	☐
14) Appropriate analysis of stakeholders' attributes (e.g. influence) & relationships	☐	☐	☐	☐	☐
15) Clearly defined roles & responsibilities of all project participants	☐	☐	☐	☐	☐
16) Appropriate knowledge & skills in design development	☐	☐	☐	☐	☐
17) Appropriate experience & track record in design development	☐	☐	☐	☐	☐
18) Effective design leadership	☐	☐	☐	☐	☐
19) Continuous commitment to design quality by all project participants	☐	☐	☐	☐	☐
20) Creativity and innovation from project participants	☐	☐	☐	☐	☐
21) Effective two-way communication & dialogue between stakeholders	☐	☐	☐	☐	☐
22) Effective inter-disciplinary collaboration between stakeholders	☐	☐	☐	☐	☐
23) Mutual trust & respect between stakeholders	☐	☐	☐	☐	☐
24) Effective resolution of conflicts & disagreements between stakeholders	☐	☐	☐	☐	☐
25) Appropriate level of power possessed by different stakeholder groups to influence design related decisions	☐	☐	☐	☐	☐

Group Three: Design/Project Process

	Not Important	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
26) Development of a clear, comprehensive brief agreed by all stakeholders	☐	☐	☐	☐	☐
27) Appropriate design/project process with agreed stages & deliverables	☐	☐	☐	☐	☐
28) Effective management & exchange of design information	☐	☐	☐	☐	☐
29) Development of clear, coordinated design drawings & specifications	☐	☐	☐	☐	☐
30) Appropriate mechanism for rigorous design modelling & simulation	☐	☐	☐	☐	☐
31) Appropriate translation of design intent into construction & operation phases	☐	☐	☐	☐	☐
32) Appropriate management of design changes	☐	☐	☐	☐	☐
33) Appropriate control & monitoring of design quality development during project process	☐	☐	☐	☐	☐
34) Appropriate method for post-project/post-occupancy evaluation	☐	☐	☐	☐	☐
35) Appropriate construction methods & quality of execution on site	☐	☐	☐	☐	☐
36) Effective learning & incorporation of feedback from similar projects	☐	☐	☐	☐	☐

Please enter any additional comments about these factors or add any other success factors critical for achieving design quality in your opinion not mentioned above.

Section Two: Exploring the Presence of Success Factors in A Specific Project

For this section, please choose a recently completed building project which:

- you were involved in and have good knowledge about its process and the achieved design quality in the constructed building;
- is preferably in 'healthcare' or 'higher education' sectors (however, other building sectors are also acceptable.);
- has been completed in the last 10 year

Part One: Information about the Chosen Project & the Respondent

1.1 Please give a brief description of the chosen project (e.g. name, aim, location, completion date etc.)

1.2 Sector of the chosen project:

☐ Healthcare ☐ Higher Education ☐ Others, please specify:

1.3 Procurement method used in the chosen project:

☐ Traditional ☐ Management Contract

☐ One-stage Design & Build ☐ Private Finance Initiative (PFI)

☐ Two-stage Design & Build ☐ Others, please specify:

1.4 Type of client:

☐ Public ☐ Private ☐ Others, please specify:

1.5 Which one of the followings best describes your organisation's role in the chosen project?

☐ Client/Client Representative (Including estate departments) ☐ Project Management Consultant

☐ Builder Contractor ☐ Engineering Consultant

☐ Architectural/Design Consultant ☐ Others, please specify:

1.6 Your role in the chosen project:

1.7 Your position in your organisation:

1.8 Your experience in the construction industry:

☐ Under 5 years ☐ 15 to 20 years

☐ 5 to 9 years ☐ Over 20

☐ 10 to 14 years

Part Two: Outcomes of the Chosen Project

2.1 To the best of your knowledge, please rate the level of design quality achieved in the constructed building of the chosen project in terms of its ability to match set expectations. Please refer to page 2 for the description of each quality field.

	Far short of expectations	*Short of expectations*	*Somewhat short of expectations*	*Equals expectations*	*Somewhat exceeds expectations*	*Exceeds expectations*	*Far exceeds expectation*	*Don't Know*
Functionality	☐	☐	☐	☐	☐	☐	☐	☐
Build Quality	☐	☐	☐	☐	☐	☐	☐	☐
Impact	☐	☐	☐	☐	☐	☐	☐	☐

2.2 **'Time performance'** of the chosen project:

☐ Behind schedule by over 10% ☐ Behind schedule by 5-10% ☐ Behind schedule by below 5% ☐ On schedule ☐ Ahead of schedule by below 5% ☐ Ahead of schedule by 5-10% ☐ Ahead of schedule by over 10% ☐ Don't Know

2.3 **'Cost performance'** of the chosen project:

☐ Overrun budget by over 10% ☐ Overrun budget by 5-10% ☐ Overrun budget by below 5% ☐ On budget ☐ Below budget by below 5% ☐ Below budget by 5-10% ☐ Below Budget by over 10% ☐ Don't Know

Please enter any additional comments about part two here, including any specific reasons for the indicated outcomes. Please also mention any specific tool or method used for design quality evaluation/achievement.

Part Three: Presence of the Success Factors in the Chosen Project

Below is the same list of success factors given in section one. To the best of your knowledge, please indicate your level of agreement on the presence of each of these factors in your chosen project.

Group One: Focus on Design Quality	*Strongly Disagree*	*Disagree*	*Somewhat Disagree*	*Neutral*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Don't Know*
1) Shared understanding of design quality & its indicators between stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
2) Recognition of the importance of design quality when defining project objectives & constraints	☐	☐	☐	☐	☐	☐	☐	☐
3) Early definition & prioritisation of design quality goals & aspirations	☐	☐	☐	☐	☐	☐	☐	☐
4) Appropriate method to define value of design elements & outcomes for stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
5) Allocation of adequate time to design & its development	☐	☐	☐	☐	☐	☐	☐	☐
6) Allocation of adequate budget to design & its development	☐	☐	☐	☐	☐	☐	☐	☐
7) Understanding of project whole lifecycle & design requirements over time	☐	☐	☐	☐	☐	☐	☐	☐
8) Design quality oriented selection of procurement/contract method	☐	☐	☐	☐	☐	☐	☐	☐
9) Design quality oriented appointment of all project participants	☐	☐	☐	☐	☐	☐	☐	☐

Group Two: Design Stakeholders	*Strongly Disagree*	*Disagree*	*Somewhat Disagree*	*Neutral*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Don't Know*
10) Early, comprehensive identification of all stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
11) Appropriate method for discovering stakeholders' requirements & interests	☐	☐	☐	☐	☐	☐	☐	☐
12) Appropriate method for balancing varying objectives of stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
13) Appropriate stakeholder engagement throughout project lifecycle	☐	☐	☐	☐	☐	☐	☐	☐
14) Appropriate analysis of stakeholders' attributes (e.g. power) & relationships	☐	☐	☐	☐	☐	☐	☐	☐
15) Clearly defined roles & responsibilities of all project participants	☐	☐	☐	☐	☐	☐	☐	☐
16) Appropriate knowledge & skills in design development	☐	☐	☐	☐	☐	☐	☐	☐
17) Appropriate experience & track record in design development	☐	☐	☐	☐	☐	☐	☐	☐
18) Effective design leadership	☐	☐	☐	☐	☐	☐	☐	☐
19) Continuous commitment to design quality by all project participants	☐	☐	☐	☐	☐	☐	☐	☐
20) Creativity and innovation from project participants	☐	☐	☐	☐	☐	☐	☐	☐
21) Effective two-way communication & dialogue between stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
22) Effective inter-disciplinary collaboration between stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
23) Mutual trust & respect between stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
24) Effective resolution of conflicts & disagreements between stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
25) Appropriate level of power possessed by various stakeholder groups to influence design related decisions	☐	☐	☐	☐	☐	☐	☐	☐

Group Three: Design/Project Process	*Strongly Disagree*	*Disagree*	*Somewhat Disagree*	*Neutral*	*Somewhat Agree*	*Agree*	*Strongly Agree*	*Don't Know*
26) Development of a clear, comprehensive brief agreed by all stakeholders	☐	☐	☐	☐	☐	☐	☐	☐
27) Appropriate design/project process with agreed stages & deliverables	☐	☐	☐	☐	☐	☐	☐	☐
28) Effective management & exchange of design information	☐	☐	☐	☐	☐	☐	☐	☐
29) Development of clear, coordinated design drawings & specifications	☐	☐	☐	☐	☐	☐	☐	☐
30) Appropriate mechanism for rigorous design modelling & simulation	☐	☐	☐	☐	☐	☐	☐	☐
31) Appropriate translation of 'design intent' into construction & operation phases	☐	☐	☐	☐	☐	☐	☐	☐
32) Appropriate management of design changes	☐	☐	☐	☐	☐	☐	☐	☐
33) Appropriate control & monitoring of design quality development during project process	☐	☐	☐	☐	☐	☐	☐	☐
34) Appropriate method for post-project/post-occupancy evaluation	☐	☐	☐	☐	☐	☐	☐	☐
35) Appropriate construction methods & quality of execution on site	☐	☐	☐	☐	☐	☐	☐	☐
36) Effective learning & incorporation of feedback from similar projects	☐	☐	☐	☐	☐	☐	☐	☐

Please enter any additional comments about part three here.

Part Four: Attributes of Key Stakeholder Groups in the Chosen Project

Please rate the following key stakeholder groups (or their key person) in the chosen project in terms of:

- **Power:** The level they had power to influence or change design quality decisions;
- **Proximity:** The level they were involved in design quality decision-making processes;
- **Urgency** The level their design quality-related interests/preferences were considered as critical and of high-priority.

		Very Low	*Low*	*Somewhat Low*	*Neutral*	*Somewhat High*	*High*	*Very High*	*Don't Know*
Architect/Designer Consultant	*Power:*	☐	☐	☐	☐	☐	☐	☐	☐
	Proximity	☐	☐	☐	☐	☐	☐	☐	☐
	Urgency	☐	☐	☐	☐	☐	☐	☐	☐
Client Organisation/ Representative	*Power:*	☐	☐	☐	☐	☐	☐	☐	☐
	Proximity	☐	☐	☐	☐	☐	☐	☐	☐
	Urgency	☐	☐	☐	☐	☐	☐	☐	☐
Builder Contractor	*Power:*	☐	☐	☐	☐	☐	☐	☐	☐
	Proximity	☐	☐	☐	☐	☐	☐	☐	☐
	Urgency	☐	☐	☐	☐	☐	☐	☐	☐
User Group	*Power:*	☐	☐	☐	☐	☐	☐	☐	☐
	Proximity	☐	☐	☐	☐	☐	☐	☐	☐
	Urgency	☐	☐	☐	☐	☐	☐	☐	☐
Facility Management Team	*Power:*	☐	☐	☐	☐	☐	☐	☐	☐
	Proximity	☐	☐	☐	☐	☐	☐	☐	☐
	Urgency	☐	☐	☐	☐	☐	☐	☐	☐
Any Other Key Stakeholder:	*Power:*	☐	☐	☐	☐	☐	☐	☐	☐
	Proximity	☐	☐	☐	☐	☐	☐	☐	☐
	Urgency	☐	☐	☐	☐	☐	☐	☐	☐

Please enter any additional comments about part four and the overall survey here.

This is the end of the survey. Thank you for your valuable contribution.

- Please return your completed survey using the enclosed pre-paid envelope or email it to M.Sadeghi@Warwick.ac.uk.
- It would be highly appreciated if you could share the survey link (warwick.ac.uk/design-quality) with other potential respondents in your firm or other organisations involved in building projects.
- If you would like to be notified of the study findings, please leave your email address below.

b. **Study Webpage** (www.warwick.com/design-quality)

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Shaping the future with WMG

About WMG | Study | Research | Business | Our People

Experiential Engineering » Projects » Achieving Design Quality in Building Projects

Achieving Design Quality in Building Projects

Achieving design quality is increasingly important for building projects. There is a growing body of research showing the impact of design attributes of built environments on users and other stakeholder groups. For instance, better design can help patients to recover faster, improve students' performance in a library and increase productivity in a workplace. It can also reduce lifecycle costs and provide a favourable return on investment.

The construction industry has been therefore called for more attention to design quality acheivement (which has been inadequate for many years compared to other project objectives like cost and time). Similarly, there are opportunities for the academic community to look into this less-researched yet important topic.

Here in WMG, a research project has been set to study design quality from a new perspective, that is, its development during the project lifecycle - as opposed to more common viewpoint of design quality evaluation after project completion. This research project is part of the PHEE programme and is carried out at the Experiential Engineering research group.

This ongoing project consists of two main streams:

- Identifying Critical Success Factors for achieving design quality in building projects, and
- Evaluating design quality related interactions between stakeholders during project lifecycle

Survey: Critical Success Factors for Achieving Design Quality in Building Projects

If you are a construction industry professional from an architecture firm, client organisation, contractor or other groups involved in building projects, we would like to invite you to take part in a short survey.

To access the **online version**, please click here.

If you prefer the **paper-based version**, please click here.

For information on your rights as a participant, please have a look at the participant information sheet.

c. Cover page for the identical online version of the questionnaire

Critical Success Factors for Achieving Design Quality in Building Projects

Thank you very much for agreeing to share your valuable opinions and experiences on achieving 'design quality' in building projects by completing a short survey. This survey is part of a research project conducted in WMG at the University of Warwick funded by the Engineering and Physical Sciences Research Council in the UK (EPSRC).

What is the study about?

Achieving design quality can provide positive outcomes for users and other stakeholders of built environments. Therefore, it is crucial to deepen the understanding of the factors critical to successful achievement of design quality in building projects. This research study has been developed accordingly in order to (a) identify these Critical Success Factors (CSFs), and to (b) explore their presence in recent projects. Construction industry professionals from architecture firms, client organisations, contractors and other groups involved in building projects are invited to take part.

What does the survey involve?

There are two sections in this survey. Section 1 seeks your opinion on relative importance of a list of success factors for achieving design quality. Section 2, then, asks you to evaluate a recently completed building project, in which you were involved, against these factors. Completing the survey will take between 15 to 20 minutes.

Information about your participation

Participation is voluntary and the information you provide will be treated with strict confidentiality and anonymity. The study findings will be shared with the respondents if requested. For further details about the study and your rights as a participant, please visit our webpage at warwick.ac.uk/design-quality.

If you consent to participate in the study, please proceed to the questions by clicking on the 'Next' button.

(Please note that the survey tool is optimised for desktops and laptops; please do not use phones or tablets to complete it. Switching pages will automatically save your responses, so you may leave and continue at a later time.)

Mahdad Sadeghi,
Doctoral Researcher
International Digital Laboratory
WMG, University of Warwick
M.Sadeghi@Warwick.ac.uk

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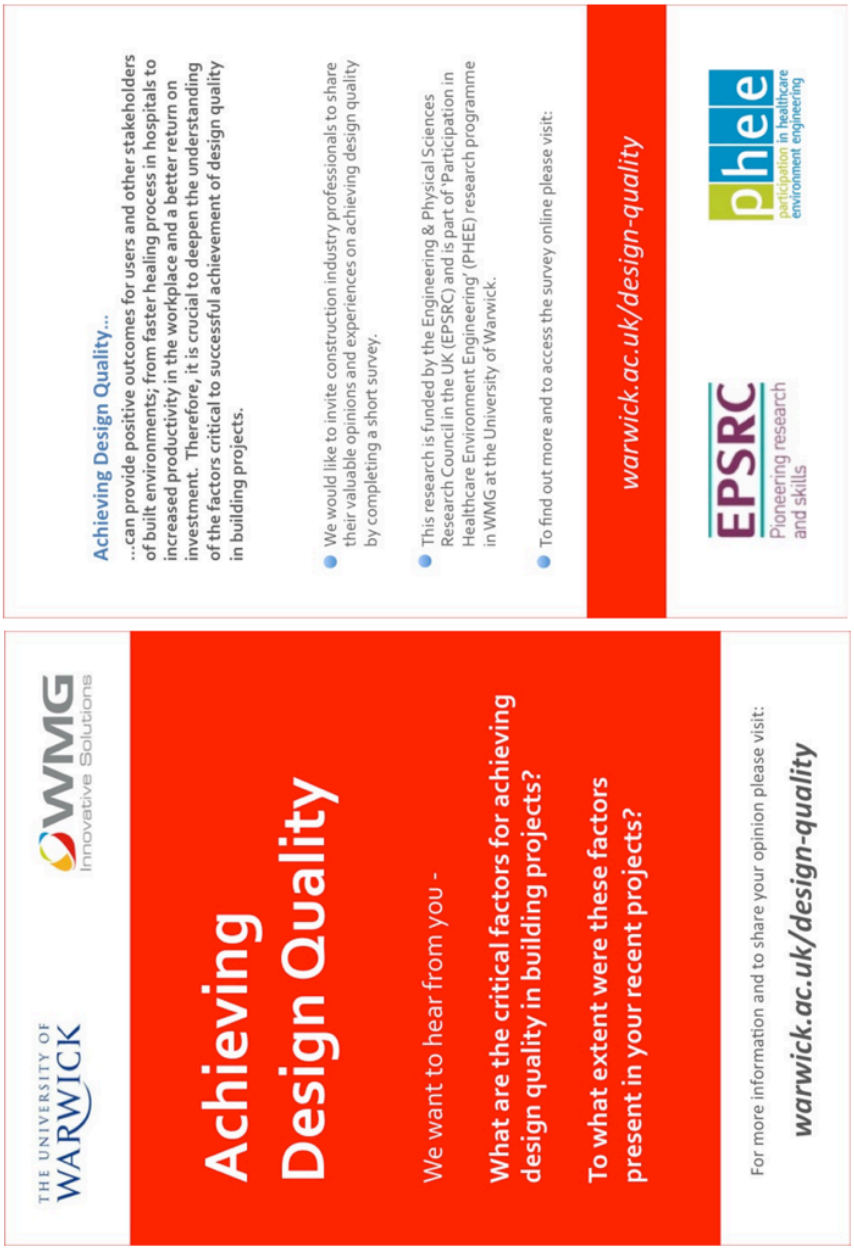
Next

d. Study leaflet and other materials



THE UNIVERSITY OF WARWICK

WMG Innovative Solutions

Achieving Design Quality

We want to hear from you -

What are the critical factors for achieving design quality in building projects?

To what extent were these factors present in your recent projects?

For more information and to share your opinion please visit:

warwick.ac.uk/design-quality

Achieving Design Quality...

...can provide positive outcomes for users and other stakeholders of built environments; from faster healing process in hospitals to increased productivity in the workplace and a better return on investment. Therefore, it is crucial to deepen the understanding of the factors critical to successful achievement of design quality in building projects.

- We would like to invite construction industry professionals to share their valuable opinions and experiences on achieving design quality by completing a short survey.
- This research is funded by the Engineering & Physical Sciences Research Council in the UK (EPSRC) and is part of 'Participation in Healthcare Environment Engineering' (PHEE) research programme in WMG at the University of Warwick.
- To find out more and to access the survey online please visit:

warwick.ac.uk/design-quality

EPSRC Pioneering research and skills

phee participation in healthcare environment engineering

Critical Success Factors for Achieving Design Quality in Building Projects

Dear

We would like to invite you to share your valuable opinions and experiences on achieving 'design quality' in building projects by completing a short survey. This survey is part of a research project conducted in WMG at the University of Warwick funded by the Engineering & Physical Sciences Research Council in the UK (EPSRC). To participate, please complete the enclosed questionnaire and return it using the pre-paid envelope or alternatively, access the online version by visiting warwick.ac.uk/design-quality

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Information about your participation
Participation is voluntary and the information you prov
anonymity. The study findings will be shared with the
the study and your rights as a participant, please visit

If you consent to participate, please proceed to the qu
weeks of receipt. Thank you very much for your kind a

Contact Information
Please contact us if you have any question or would lik

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Achieving Design Quality

We want to hear from you -

What are the critical factors for achieving design quality in building projects?

To what extent were these factors present in your recent projects?

For more information and to share your opinion please visit:

warwick.ac.uk/design-quality

To:

UK

warwick.ac.uk/design-quality

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Mahdad Sadeghi
International Digital Laboratory
WMG, University of Warwick
Gibbet Hill Road
Coventry
CV4 7AL

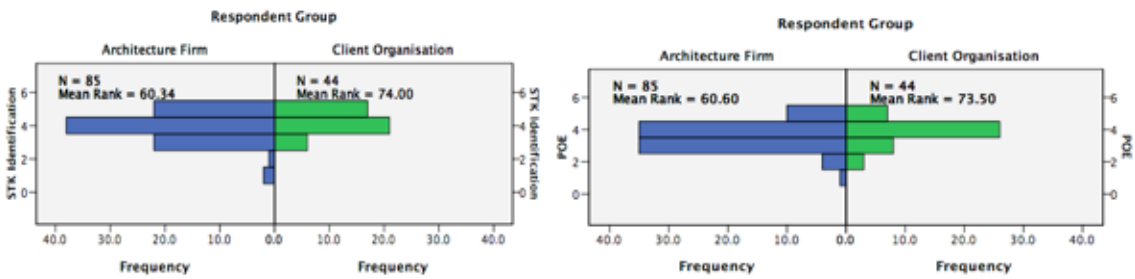
e. Additional analysis material:

Mann-Whitney t-test (section 6.4.3):

Table of asymptotic significance values:

ID	factors	Asymp. Sig.	ID	factors	Asymp. Sig.
1	DQ criteria appreciation	0.299	19	Commitment	0.609
2	DQ Importance	0.662	20	Creativity	0.397
3	DQ Objectives	0.062	21	Communications	0.754
4	DQ Value analysis	0.338	22	Collaboration	0.488
5	DQ Time	0.178	23	Trust	0.885
6	DQ Budget	0.153	24	Conflict management	0.868
7	Whole-life View	0.263	25	Stk-Power distribution	0.831
8	Procurement	0.466	26	Brief	0.365
9	Appointments	0.180	27	Phased-Process	0.772
10	Stk-Identification	**0.035**	28	Information-management	0.620
11	Stk-Requir-discovery	0.856	29	Drawings & Specifications	0.169
12	Stk-Balancing-objectives	0.053	30	Simulations	0.335
13	Stk-Engagement	0.161	31	Design-translation	0.947
14	Stk-Analysis	0.461	32	Change-management	0.816
15	Roles & Responsibilities	0.334	33	DQ-Monitoring	0.862
16	Knowledge & Skills	0.934	34	POE	**0.044**
17	Experience	0.593	35	Construction-Quality	0.919
18	Leadership	0.433	36	Feedback	0.668

Populated pyramids histogram showing the differences in distribution between two sub-respondents for 'STK identification' and 'POE':



Mean values for factors and success criteria (section 6.4.4):

ID	factors	Mean	ID	factors	Mean
1	DQ Criteria appreciation	5.127	19	Commitment	5.024
2	DQ Importance	5.294	20	Creativity	4.976
3	DQ Objectives	5.20	21	Communications	5.413
4	DQ Value analysis	4.667	22	Collaboration	5.087
5	DQ Time	4.921	23	Trust	5.484
6	DQ Budget	4.841	24	Conflict-management	4.937
7	Whole-life View	4.79	25	Stk-Power distribution	5
8	Procurement	4.802	26	Brief	5.22
9	Appointments	5.063	27	Phased-Process	5.54
10	Stk-Identification	5.143	28	Information-management	5.41
11	Stk-Require-discovery	5.349	29	Drawings & Specifications	5.60
12	Stk-Balancing-objectives	4.897	30	Modelling & Simulations	4.80
13	Stk-Engagement	5.103	31	Design-translation	5.32
14	Stk-Analysis	4.659	32	Change-management	5.111
15	Roles & Responsibilities	5.167	33	DQ-Monitoring	5.111
16	Knowledge & Skills	5.75	34	POE	4.40
17	Experience	5.37	35	Construction-Quality	5.286
18	Leadership	5.42	36	Feedback	4.992

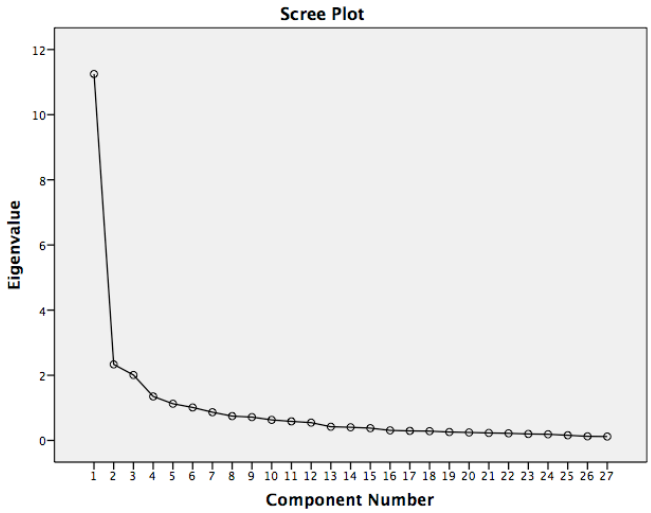
	DQ Success Criteria	Mean
	Functionality	4.857
	Build Quality	4.310
	Impact	4.667

Principal Component Analysis (section 6.4.5):

Total variance explained table and scree plot in the second run:

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.249	41.664	41.664	11.249	41.664	41.664	5.285	19.573	19.573
2	2.335	8.647	50.310	2.335	8.647	50.310	3.389	12.552	32.125
3	2.009	7.440	57.750	2.009	7.440	57.750	3.078	11.400	43.525
4	1.351	5.003	62.753	1.351	5.003	62.753	3.008	11.142	54.666
5	1.126	4.171	66.923	1.126	4.171	66.923	2.219	8.219	62.885
6	1.012	3.749	70.673	1.012	3.749	70.673	2.103	7.788	70.673
7	.866	3.208	73.881						
8	.746	2.765	76.645						
9	.716	2.652	79.297						
10	.630	2.335	81.632						
11	.585	2.165	83.798						
12	.546	2.023	85.821						
13	.420	1.555	87.376						
14	.404	1.496	88.872						
15	.377	1.396	90.268						
16	.308	1.142	91.410						
17	.292	1.083	92.493						
18	.285	1.055	93.548						
19	.258	.954	94.502						
20	.245	.907	95.409						
21	.230	.851	96.260						
22	.218	.808	97.068						
23	.199	.737	97.805						
24	.189	.699	98.504						
25	.159	.587	99.091						
26	.126	.465	99.556						
27	.120	.444	100.000						

Extraction Method: Principal Component Analysis.



Regression analysis (section 6.4.6)

Assumption for Ordinal regression: for the assumption of proportional odds to be met, the difference in model fit (the Chi-square column) between these two models is expected to be small and not statistically significant (p>.05). As it can be seen, the assumption is violated for all three dependent variables.

Functionality:

Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	319.307			
General	251.464[b]	67.843[c]	35	.001

Build quality:

Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	366.274			
General	286.445[b]	79.829[c]	35	.000

Impact:

Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	366.274			
General	286.445[b]	79.829[c]	35	.000

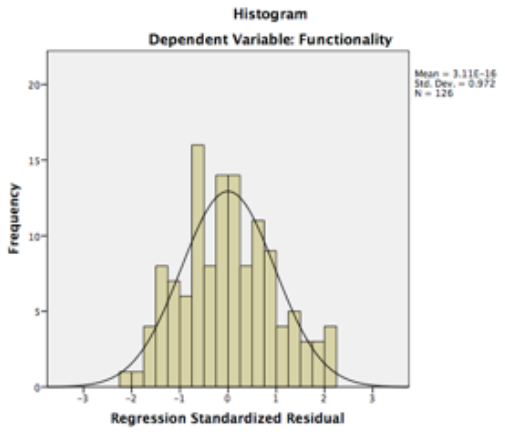
Testing of assumptions for the multiple linear regression models:

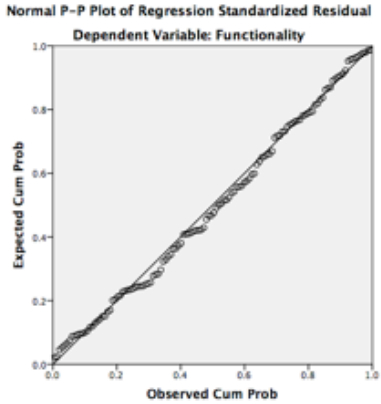
Test of normality:

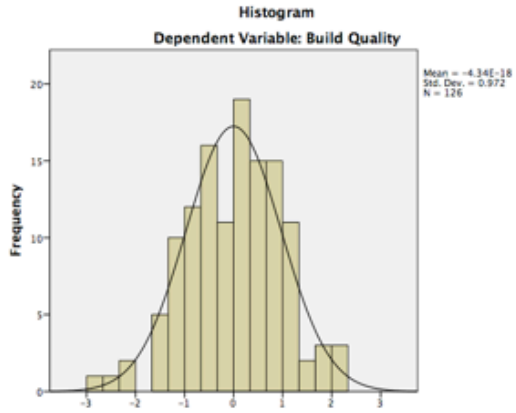
This test requires the errors in the residuals to be approximately normally distributed. Both numerical and graphical techniques are used. For numerical, the z-scores based on skewness and kurtosis values are calculated. The value of z-scores should be within ± 1.96.

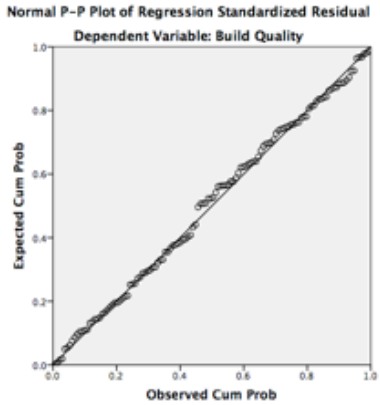
$Z_{Skewness} = \frac{Skewness}{Std.Error_{skewness}}$	**Functionality:**	
	$Z_{Skewness}$= -1.41	$Z_{Kurtosis}$= 0.47
	Build Quality:	
$Z_{Kurtosis} = \frac{Kurtosis}{Std.Error_{kurtosis}}$	$Z_{Skewness}$= -1.1	$Z_{Kurtosis}$= -0.21
	Impact:	
	$Z_{Skewness}$= -0.99	$Z_{Kurtosis}$= -1.27

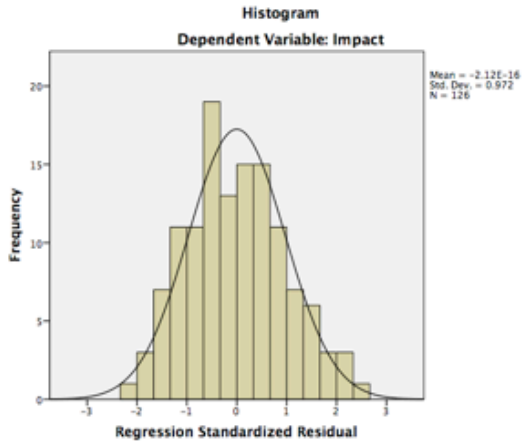
For graphical assessment, histograms and P-P plots are used. In case of normality, the data points should be located approximately on the diagonal line, on the P-P plots. As it can be seen the normality test is also met by graphical technique.

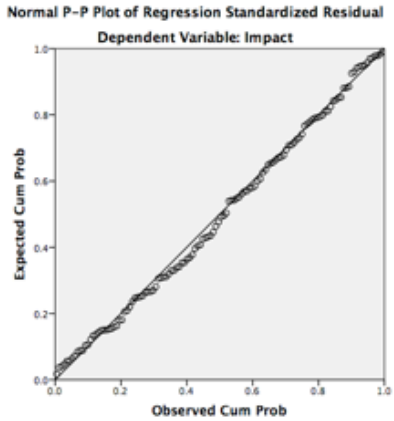












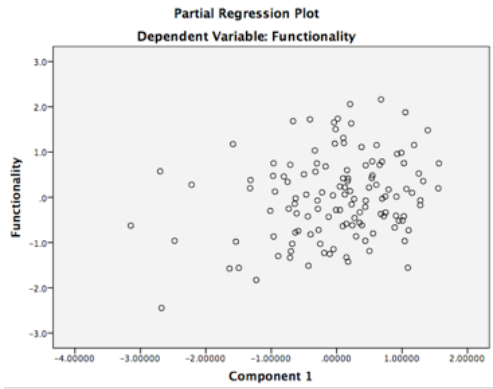
Test of independence of observation:

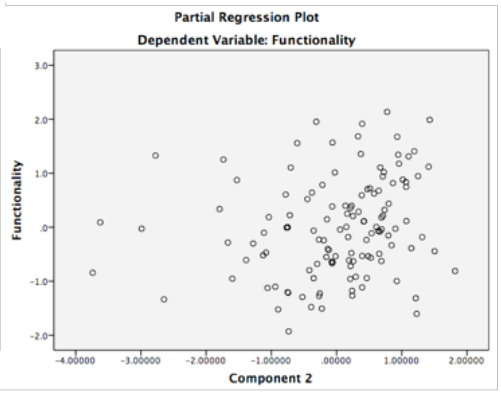
This can be assessed by Durbin-Watson measure given in the 'model summary' table. For this assumption to be met, this value should be close to 2 and between 1 and 3.

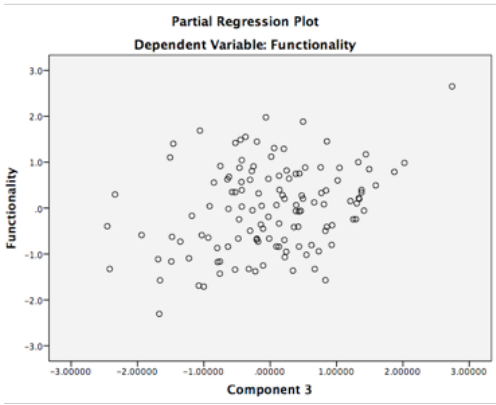
- Functionality: 1.760
- Build quality: 1.772
- Impact: 1.689

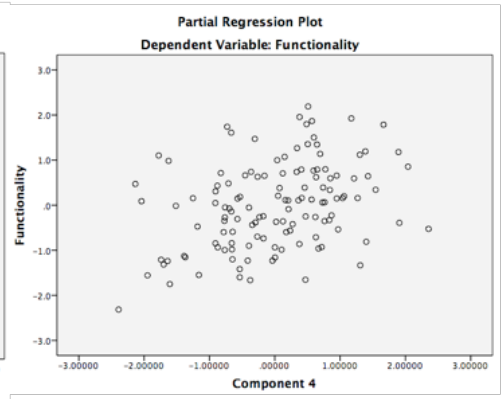
Test of linearity and homoscedasticity:

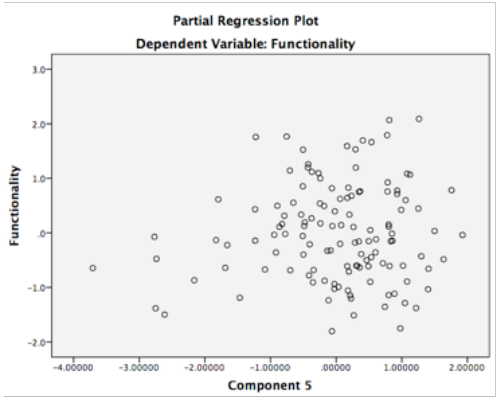
Functionality:

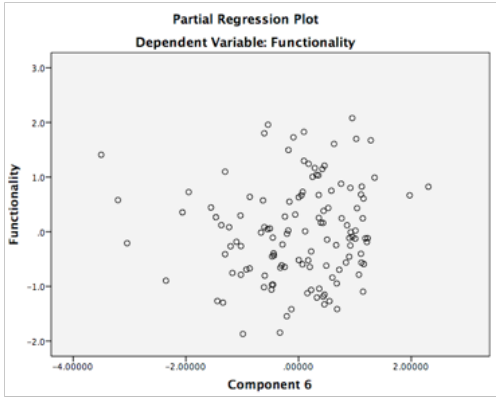


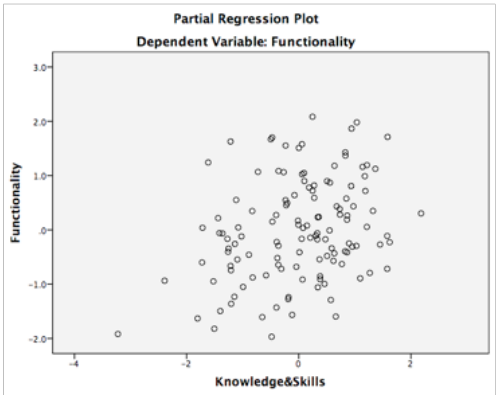




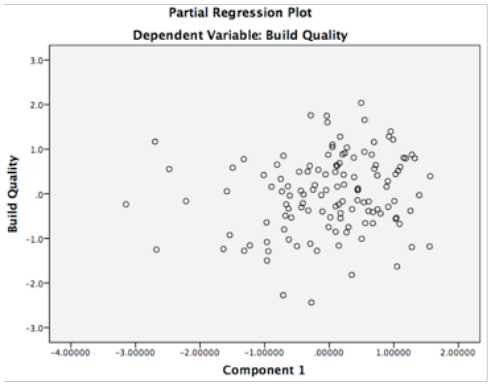


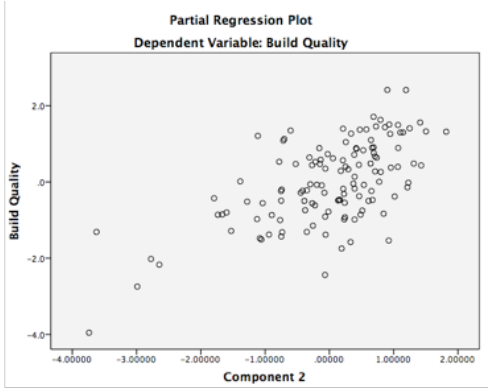


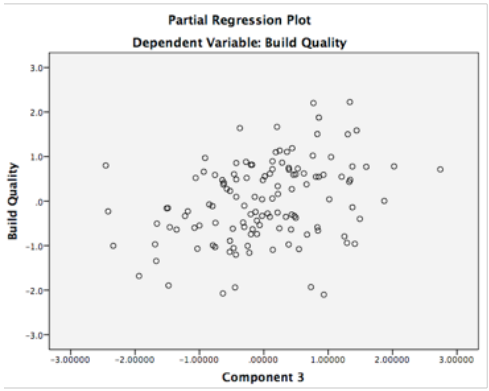


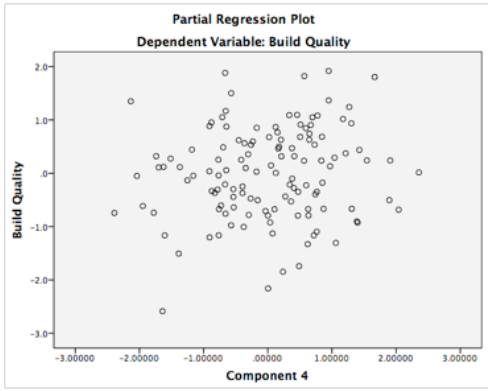


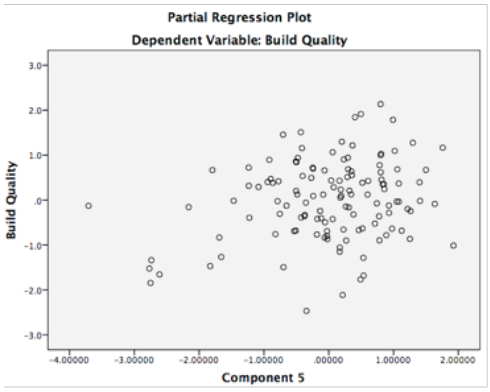
Build Quality:

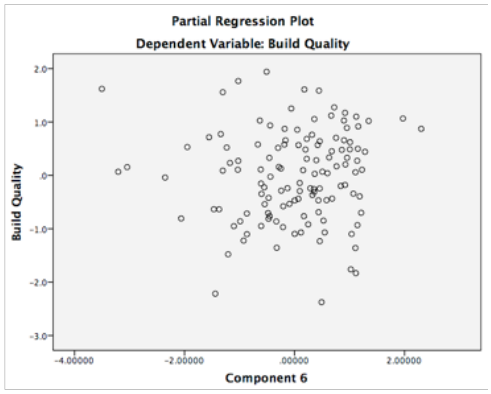


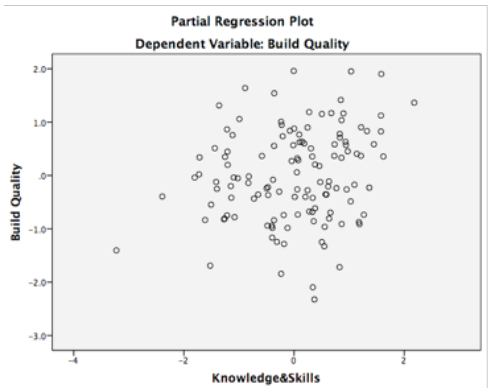




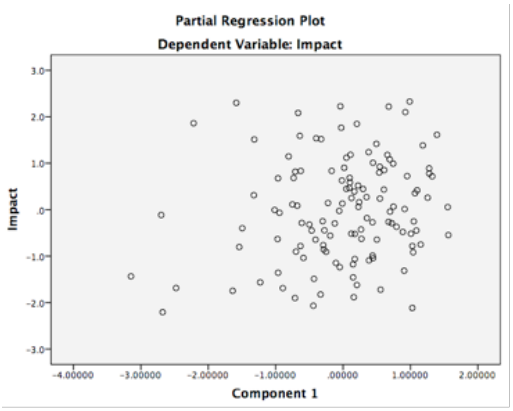


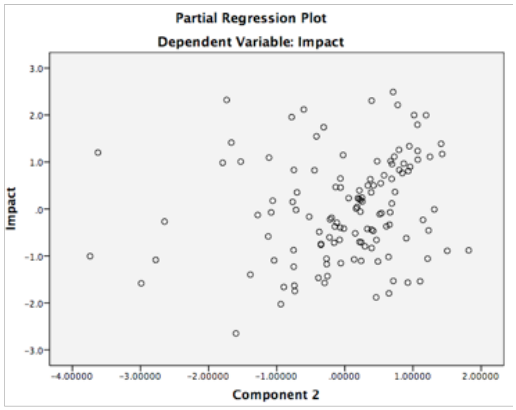






Impact:


Partial Regression Plot
Dependent Variable: Impact
Impact
Component 1


Partial Regression Plot
Dependent Variable: Impact
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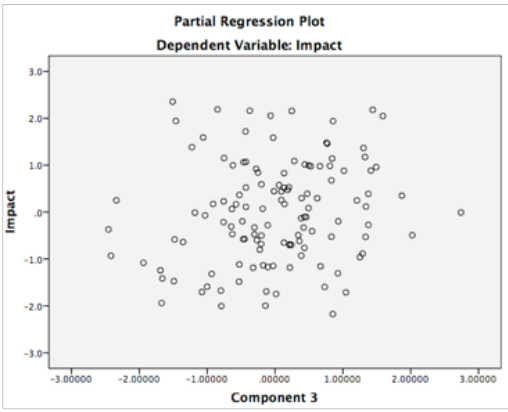
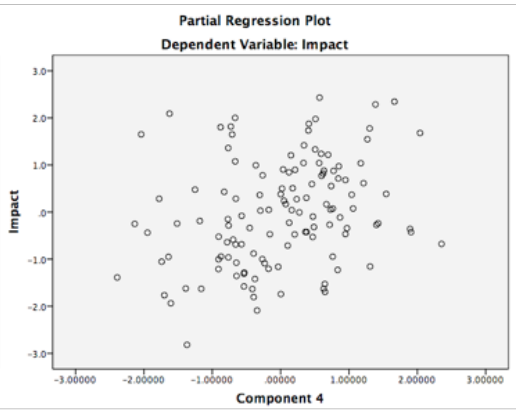
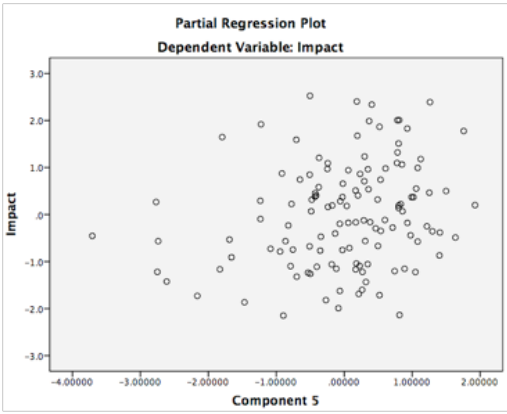
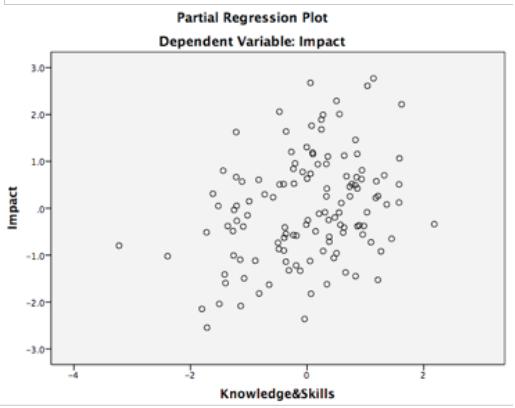
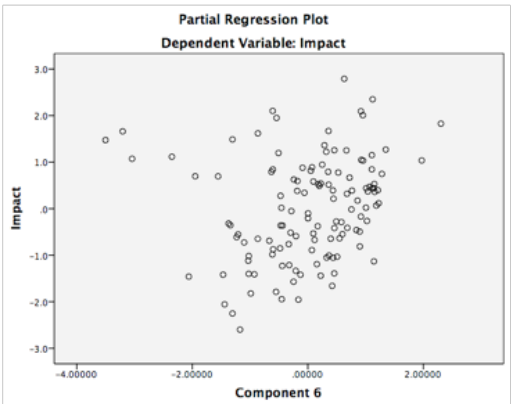
Component 2


Partial Regression Plot
Dependent Variable: Impact
Impact
Component 3


Partial Regression Plot
Dependent Variable: Impact
Impact
Component 4


Partial Regression Plot
Dependent Variable: Impact
Impact
Component 5


Partial Regression Plot
Dependent Variable: Impact
Impact
Knowledge&Skills


Partial Regression Plot
Dependent Variable: Impact
Impact
Component 6

Checking for multicollinearity:

Functionality: none of the independent variables have correlations greater than 0.7.

Correlations

		Functionality	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6	Knowledge&Skills
Pearson Correlation	Functionality	1.000	.319	.148	.340	.374	.046	.079	.522
	Component 1	.319	1.000	.000	.000	.000	.000	.000	.387
	Component 2	.148	.000	1.000	.000	.000	.000	.000	-.007
	Component 3	.340	.000	.000	1.000	.000	.000	.000	.284
	Component 4	.374	.000	.000	.000	1.000	.000	.000	.253
	Component 5	.046	.000	.000	.000	.000	1.000	.000	-.052
	Component 6	.079	.000	.000	.000	.000	.000	1.000	.057
	Knowledge&Skills	.522	.387	-.007	.284	.253	-.052	.057	1.000
Sig. (1-tailed)	Functionality	.	.000	.049	.000	.000	.306	.191	.000
	Component 1	.000	.	.500	.500	.500	.500	.500	.000
	Component 2	.049	.500	.	.500	.500	.500	.500	.470
	Component 3	.000	.500	.500	.	.500	.500	.500	.001
	Component 4	.000	.500	.500	.500	.	.500	.500	.002
	Component 5	.306	.500	.500	.500	.500	.	.500	.280
	Component 6	.191	.500	.500	.500	.500	.500	.	.263
	Knowledge&Skills	.000	.000	.470	.001	.002	.280	.263	.
N	Functionality	126	126	126	126	126	126	126	126
	Component 1	126	126	126	126	126	126	126	126
	Component 2	126	126	126	126	126	126	126	126
	Component 3	126	126	126	126	126	126	126	126
	Component 4	126	126	126	126	126	126	126	126
	Component 5	126	126	126	126	126	126	126	126
	Component 6	126	126	126	126	126	126	126	126
	Knowledge&Skills	126	126	126	126	126	126	126	126

Collinearity Statistics	
Tolerance	VIF
.823	1.215
1.000	1.000
.897	1.115
.916	1.091
.996	1.004
.995	1.005
.699	1.430

Build quality:

Correlations

		Build Quality	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6	Knowledge&Skills
Pearson Correlation	Build Quality	1.000	.201	.554	.308	.142	.169	.042	.315
	Component 1	.201	1.000	.000	.000	.000	.000	.000	.387
	Component 2	.554	.000	1.000	.000	.000	.000	.000	-.007
	Component 3	.308	.000	.000	1.000	.000	.000	.000	.284
	Component 4	.142	.000	.000	.000	1.000	.000	.000	.253
	Component 5	.169	.000	.000	.000	.000	1.000	.000	-.052
	Component 6	.042	.000	.000	.000	.000	.000	1.000	.057
	Knowledge&Skills	.315	.387	-.007	.284	.253	-.052	.057	1.000
Sig. (1-tailed)	Build Quality	.	.012	.000	.000	.056	.029	.321	.000
	Component 1	.012	.	.500	.500	.500	.500	.500	.000
	Component 2	.000	.500	.	.500	.500	.500	.500	.470
	Component 3	.000	.500	.500	.	.500	.500	.500	.001
	Component 4	.056	.500	.500	.500	.	.500	.500	.002
	Component 5	.029	.500	.500	.500	.500	.	.500	.280
	Component 6	.321	.500	.500	.500	.500	.500	.	.263
	Knowledge&Skills	.000	.000	.470	.001	.002	.280	.263	.
N	Build Quality	126	126	126	126	126	126	126	126
	Component 1	126	126	126	126	126	126	126	126
	Component 2	126	126	126	126	126	126	126	126
	Component 3	126	126	126	126	126	126	126	126
	Component 4	126	126	126	126	126	126	126	126
	Component 5	126	126	126	126	126	126	126	126
	Component 6	126	126	126	126	126	126	126	126
	Knowledge&Skills	126	126	126	126	126	126	126	126

Collinearity Statistics	
Tolerance	VIF
.823	1.215
1.000	1.000
.897	1.115
.916	1.091
.996	1.004
.995	1.005
.699	1.430

Impact:

Correlations

		Impact	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6	Knowledge&Skills
Pearson Correlation	Impact	1.000	.281	.137	.232	.330	.171	.176	.472
	Component 1	.281	1.000	.000	.000	.000	.000	.000	.387
	Component 2	.137	.000	1.000	.000	.000	.000	.000	-.007
	Component 3	.232	.000	.000	1.000	.000	.000	.000	.284
	Component 4	.330	.000	.000	.000	1.000	.000	.000	.253
	Component 5	.171	.000	.000	.000	.000	1.000	.000	-.052
	Component 6	.176	.000	.000	.000	.000	.000	1.000	.057
	Knowledge&Skills	.472	.387	-.007	.284	.253	-.052	.057	1.000
Sig. (1-tailed)	Impact	.	.001	.062	.005	.000	.028	.024	.000
	Component 1	.001	.	.500	.500	.500	.500	.500	.000
	Component 2	.062	.500	.	.500	.500	.500	.500	.470
	Component 3	.005	.500	.500	.	.500	.500	.500	.001
	Component 4	.000	.500	.500	.500	.	.500	.500	.002
	Component 5	.028	.500	.500	.500	.500	.	.500	.280
	Component 6	.024	.500	.500	.500	.500	.500	.	.263
	Knowledge&Skills	.000	.000	.470	.001	.002	.280	.263	.
N	Impact	126	126	126	126	126	126	126	126
	Component 1	126	126	126	126	126	126	126	126
	Component 2	126	126	126	126	126	126	126	126
	Component 3	126	126	126	126	126	126	126	126
	Component 4	126	126	126	126	126	126	126	126
	Component 5	126	126	126	126	126	126	126	126
	Component 6	126	126	126	126	126	126	126	126
	Knowledge&Skills	126	126	126	126	126	126	126	126

Collinearity Statistics	
Tolerance	VIF
.823	1.215
1.000	1.000
.897	1.115
.916	1.091
.996	1.004
.995	1.005
.699	1.430

Appendix D: study four

Questionnaire:

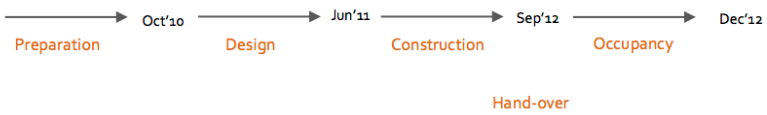
Inter-Organisational Design Communication in Construction: A network Approach
Mahdad Sadeghi

Interview Questionnaire & Guide

Name of the organisation/stakeholder group:
Your role in the organisation:
Your organisation's role in the project:

a. Project Stages

This study considers 5 high-level stages in the project lifecycle. In which of the project stages your organisation was involved/had interaction with other project parties/stakeholders?



b. Project Stakeholders

Multiple different stakeholder groups were involved in the project - in some or all of the project stages. With which of these groups did your organisation have interactions/communications? Please use the table below to identify specific firms/groups/individuals. Please identify any non-mentioned groups.

Main Groups	Sub-Groups	Main Groups	Sub-Groups
Client Body	• Department PM • Estate PM • FM • IT Services	***Sub-Contractor***	• Contractor Architect • M&E Contractor
User Groups	• SME Team • Research Team: Digital • Research Team: Material • Research Team: User-centred	***Suppliers***	• Audio/Visual provider • Furniture Provider
Design Consultants	• Primary Architect • Engineering designer	***Authorities***	• Building Control • Planning Authorities
Main Contractor	• Builder Contractor	***Others, if any?***	

c. Relations Questions

Please respond with regard to each identified stakeholder group in the last section. 'Question statements' and the 'response scale' is given in the lower part of the table below.

Stakeholders	Information Exchange					Medium			Mode		Communication Topic	Effectiveness			Influence	Shared Understanding
	Prep	Design	Construction	Hand-over	In-Use	Verbal	Written	Visual	Formal	Informal		Accuracy	Timeliness	Completeness		
1.																
2.																
3.																
4.																
5.																
6.																
7.																
8.																
9.																
10.																

Information Exchange
How frequently did you exchange design-related information with the other stakeholders? Never (0), Monthly (1), Biweekly (2), Weekly (3), Daily (4), Several times per day (5)

Medium
What percentage of the total design related communications occurred verbally, written, and/or visually between you and other stakeholders?

Mode
What percentage of the total design related communications occurred formally or/and informally between you and other stakeholders?

Design Topic
Which aspects of design were the topics of communication between you and the other stakeholders? (Choose from the 10 design aspects given at the bottom of this page; further explanations are given about each in next page)

Communication Effectiveness
Please rate the accuracy, timeliness, and completeness of the received design-related information (Scale from 0 to 10)

Influence
To what extent the other stakeholders could influence your design related decisions or activities? (Scale from 0 to 10)

Shared Understanding
To what extent did agreement exist between you and the other stakeholders regarding the priority of design quality & project objectives? (scale from 0 to 10)

Functionality			Build Quality			Impact			
Access (A)	**Space** (S)	**Use** (U)	**Performance** (P)	**Engineering** (E)	**Construction** (Co)	**Urban & Social Integration** (Ur)	**Internal Environment** (I)	**Form and Material** (F)	**Character & Innovation** (Ch)

To help clarifying design quality areas (based on the DQI tool):

Functionality	**Access**	Access for everyone including disables in & around, public transport, parking, wayfinding & signage
	Space	Size, layout & relationship and connectivities of rooms & circulation spaces, ratio of usable space, privacy (private/communal balance), storage
	Use	Functions for all users, organisational efficiency & productivity, flexibility & adaptability, security
Build Quality	**Performance**	Maintenance & repair, tears & wears, durability, cleaning, replacement of components, lighting (natural & artificial), acoustics, temperature, safety and healthy to use
	Engineering	Building Control Systems, Engineering systems (heat, light, plumping etc.), energy & water usage, Emissions, Mechanical ventilation
	Construction	Construction methods/sequences, Material, Integration in layout, structure, fittings & finishes, sustainability, construction safety
Impact	**Urban & Social Integration**	Contribution to neighbourhood, local environment, landscape, pleasant outside area
	Internal Environment	Pleasant inside area, spatial quality, personal control, pleasantness of lighting, thermal climate, acoustics, indoor air, comfortable environment
	Form & Material	Overall form and shape of the building, visually pleasantness, look & feel of the materials, colour & texture, external material, locality
	Character & Innovation	Uplifting, reinforcing the image of the organisation, vision, character & personality, new knowledge aiding future design

d. Additional Questions

- How do you evaluate your participation/involvement in the project? What could improve it?
- How much satisfied are you of the final design quality achieved? (In overall, or specific areas)
- Is there any link between participation and design quality?

Additional Findings:

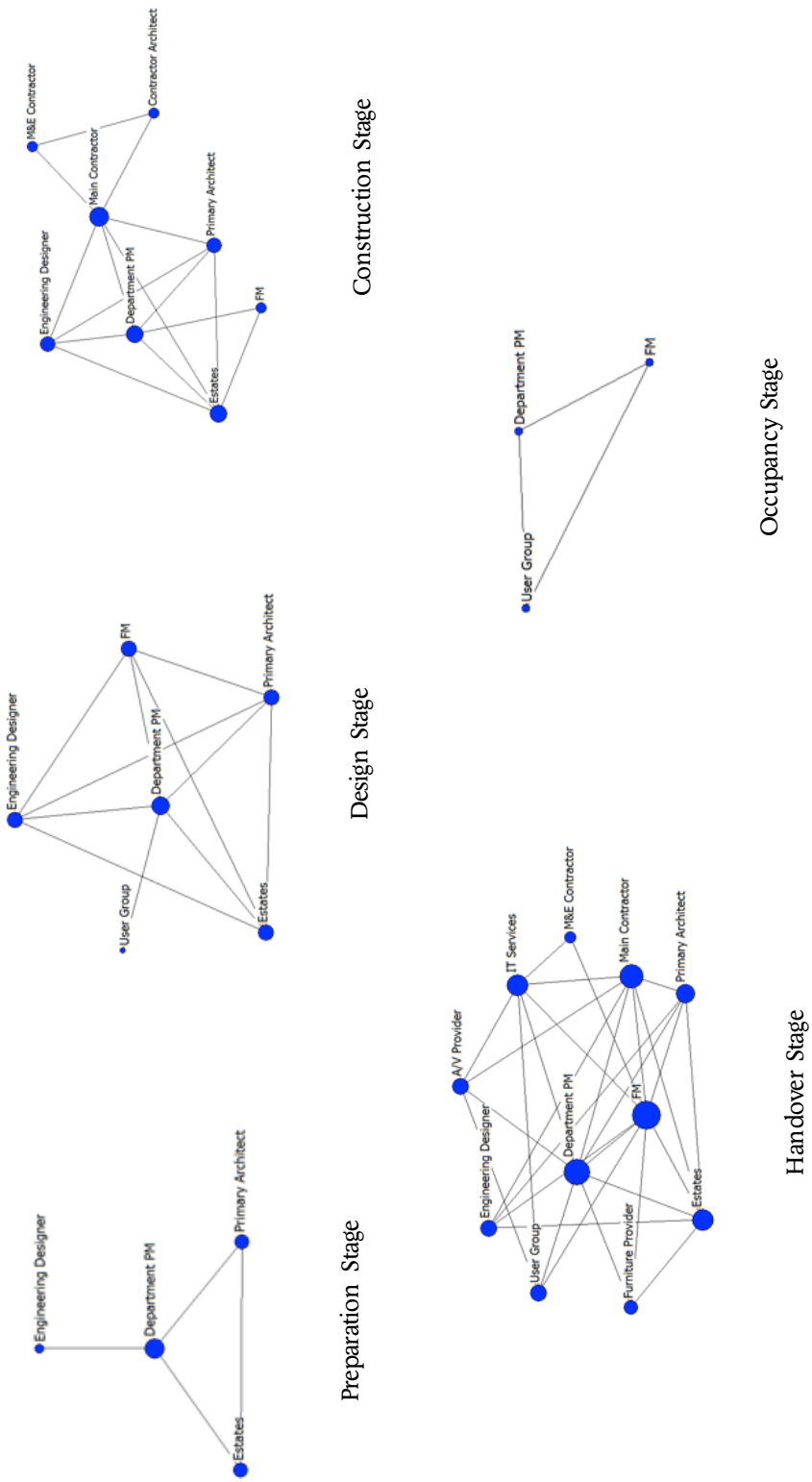
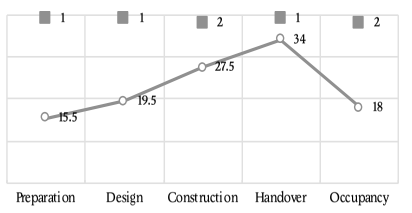
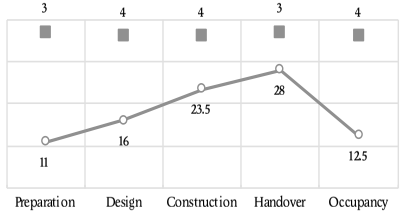


Figure 1 – Design Communication Networks throughout Project Lifecycle Stages (dichotomised at cut-off=weekly

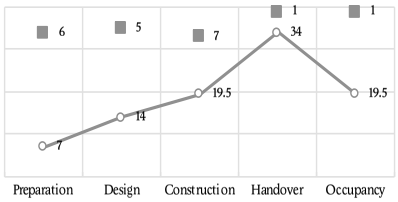
Department PM



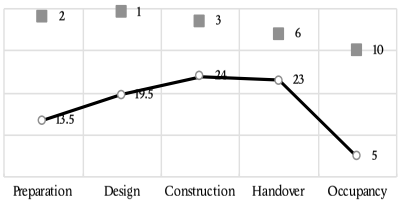
Estates



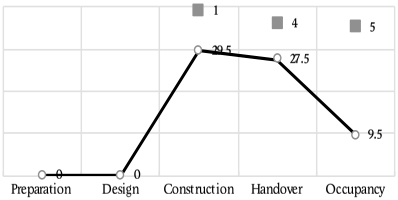
FM



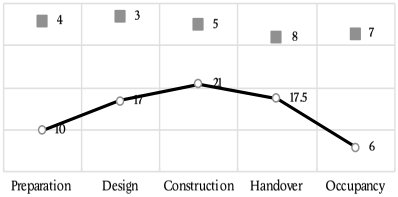
Primary Architect



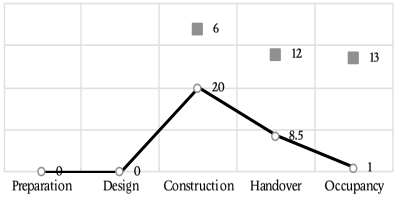
Main Contractor



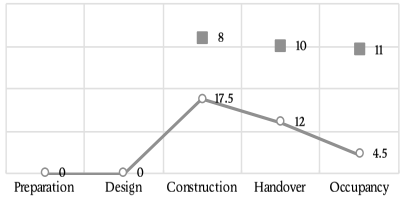
Engineering Designer



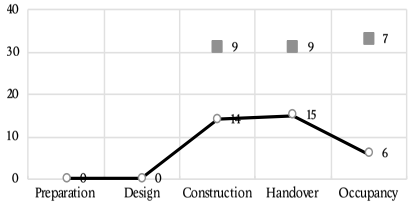
Contractor Architect



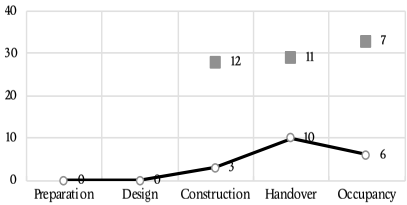
M&E Contractor



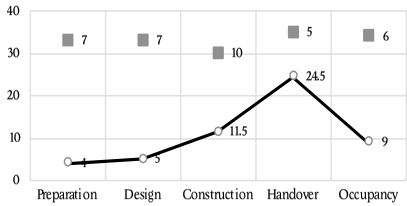
A/V Provider



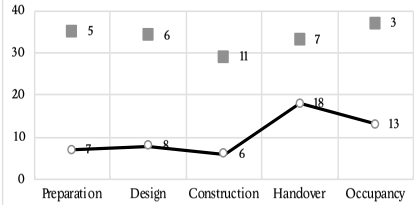
Furniture Provider



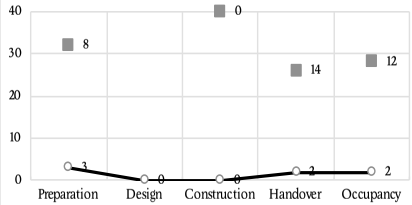
IT Services



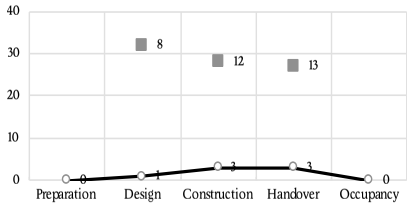
User Group



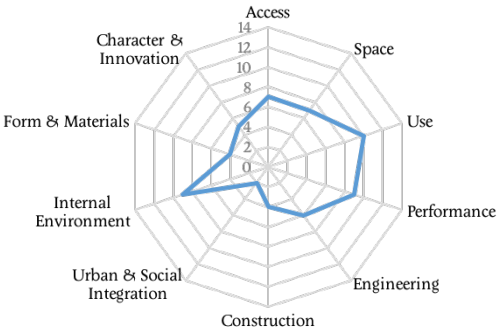
Visitors



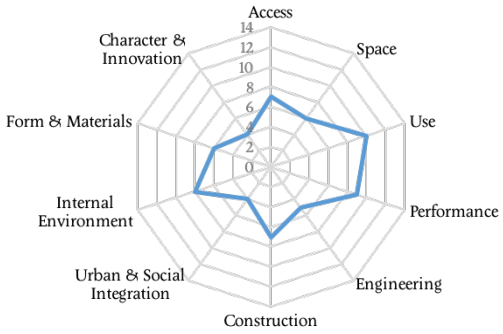
Statutory Bodies



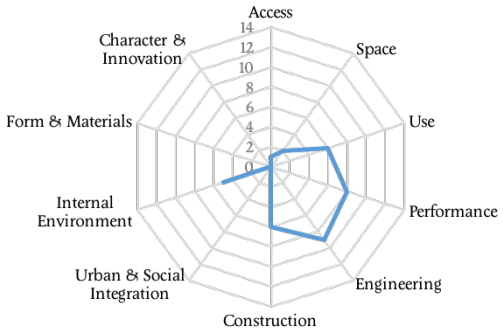
FM



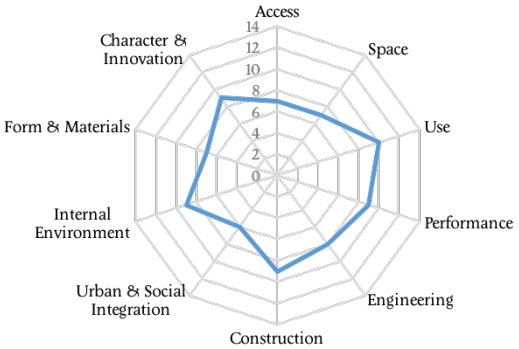
Contractor Architect



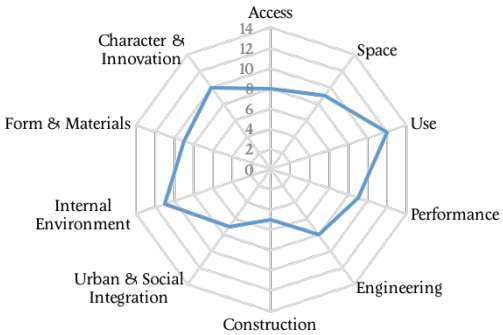
M&E Contractor



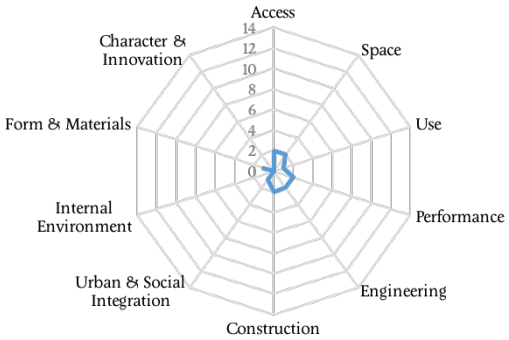
Estates



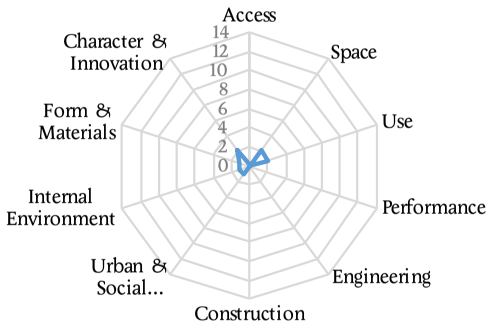
Department PM



Statutory Bodies



Visitors



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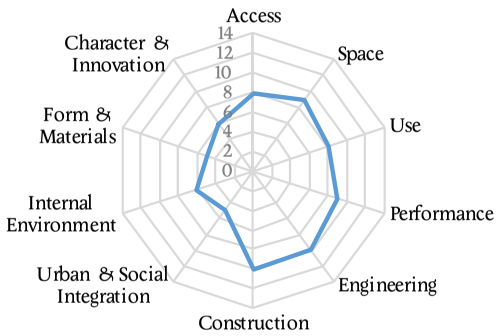
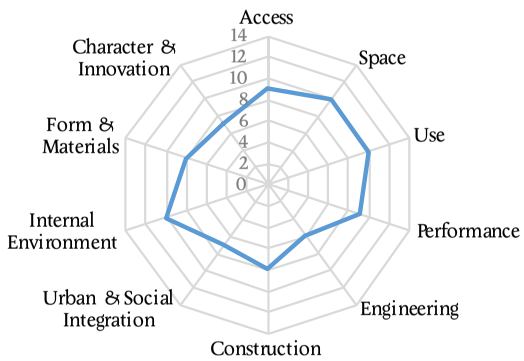
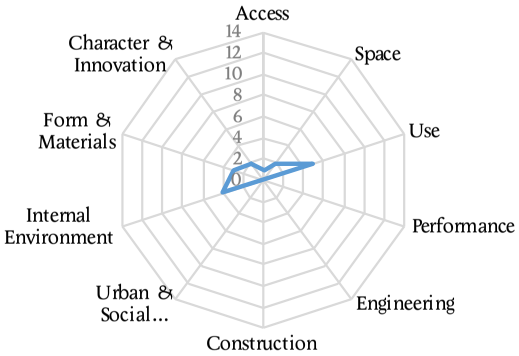


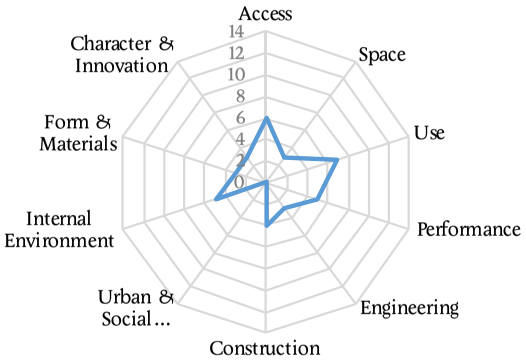
Primary Architect



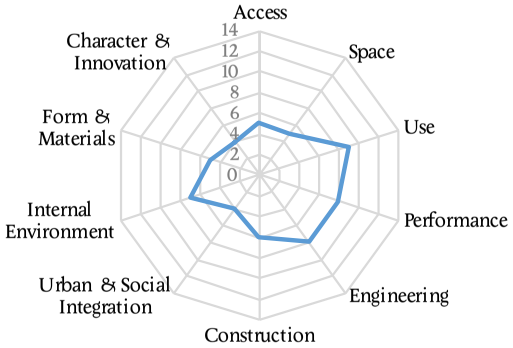
Furniture Provider



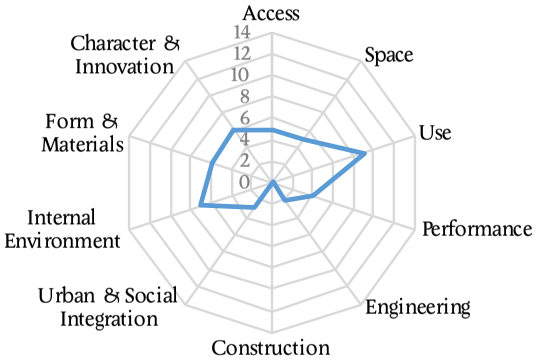
A/V Provider



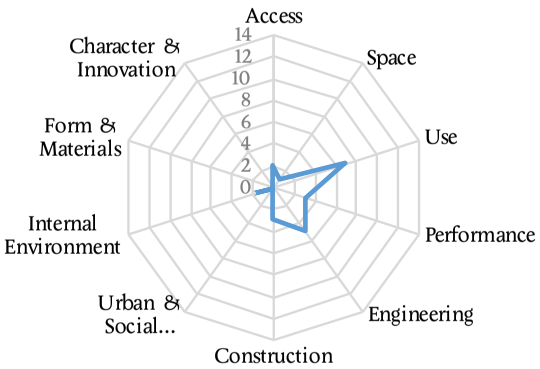
Engineering Designer



User Group



IT Services



Appendix E: ethics

a. **Full ethical approval letter:** (The title of the research and the studies changed during the research process)

Tuesday 20th November 2012

Warwick
Medical School

PRIVATE

Dear Mahdad,

Study Title and BSREC Reference: *Design quality and stakeholders interactions in Healthcare Construction: Expert Perspective- 235-07-2012*

Thank you for submitting your revisions to the above-named project to the University of Warwick Biomedical and Scientific Research Ethics Sub-Committee for Chair's Approval.

I am pleased to confirm that I am satisfied that you have met all of the conditions and your application meets the required standard, which means that full approval is granted and your study may commence.

I take this opportunity to wish you success with the study and to remind you any substantial amendments require approval from the committee before they can be made. Please keep a copy of the signed version of this letter with your study documentation. The committee also requires you to complete an End of Study Declaration Form when you reach the end of your study: this form has been e-mailed to you.

Yours sincerely,

Professor Jane Barlow
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Copy:
File
Name of academic supervisor
Professor Paul Jennings
Dr Rebecca Cain

Biomedical and Scientific
Research Ethics Subcommittee
Enquiries: BSREC Administrator
B032 Medical School Building
Warwick Medical School,
Coventry, CV4 7AL.
Tel: 02476-528207
Email: bsrec@warwick.ac.uk

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b. Information sheet and consent form for Study One:

Participant Information Sheet

Study title: Design Quality in Healthcare Built Environments: Interview study
Investigator: Mahdad Sadeghi, Doctoral Researcher

You are being invited to participate in a research study conducted by Mahdad Sadeghi from Warwick Manufacturing Group (WMG) at the University of Warwick. Before you decide, it is important to understand why the research is being done and what it will involve. Please take your time to read the following information carefully.

What is the purpose of this research?
The interview study is part of a doctoral research project aimed to investigate the concept of design quality in healthcare built environments. Through the interview study, it is attempted to gain an understanding of design quality and its stakeholders in projects.

Why have I been invited to participate?
The study seeks to explore the perceptions and experiences of architects involved in design quality decision makings for healthcare built environments. Participation in the study is entirely voluntary and it is up to you to decide whether or not to participate. You can withdraw from the interview at any time without giving a reason and you may also ask for your data to be withdrawn.

What would be involved?
The interview will consist of a series of questions around topic areas of design quality concept, design quality in project process, design quality stakeholders and design quality stakeholders in project process. The interview will take approximately one hour. To ensure the accuracy of your input, I would like to audio-record the interview and transcribe it. I will not record this interview without your permission. If you grant permission for this, you have the right to revoke recording permission and/or end the interview at any time.

Will my information be kept confidential?
Anonymity and confidentiality will be maintained in the collection, storage and publication of study materials. The information you provide will be coded with a study number so you cannot be identified from it. All interview recordings will be stored in a secure work place until the end of this research. your name and the name of your organisation will not appear in any thesis or any publication resulting from this study unless you give me permission to do that.

What will happen to the results of the study?
The results of this study will be used in my doctoral thesis and may be used as the basis for publications and presentations. If you want a summary of the study findings, I will send it to you when it is finished and you will be informed of any publication arising from the study.

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Who is conducting and funding the research?

This research is conducted by doctoral student Mahdad Sadeghi as part of the Participation in Healthcare Environment Engineering programme funded by the Engineering and Physical Sciences Research Council (EPSRC). More information about this programme can be obtained from http://tinyurl.com/pheeproject.

Contact for more information

If you have any question or wish to discuss further about this research, please contact either me or the research supervisors, Dr Rebecca Cain and Professor Paul Jennings.

Mahdad Sadeghi
M: 07850761406
M.Sadeghi@warwick.ac.uk
WMG, University of Warwick,
Coventry, CV4 7AL

Dr Rebecca Cain
T: 02476575951
R.Cain.1@warwick.ac.uk
WMG, University of Warwick
Coventry, CV4 7AL

Prof Paul Jennings
T: 02476523646
Paul.Jennings@Warwick.ac.uk
WMG, University of Warwick,
Coventry, CV4 7AL

Thank you for taking time to read this information sheet.

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Participant Consent form

Study title: Design Quality in Healthcare Built Environments: Interview study
Investigator: Mahdad Sadeghi, Doctoral Researcher

Please initial the boxes you agree with.

1. I confirm that I have read and understand the attached information sheet for the project named above. I have had the opportunity to consider the information and ask questions, and have had these answered satisfactorily. ☐
2. I understand that my participation in this research is voluntary and that I am free to withdraw at any time without giving any reason. ☐
3. I agree to take part in this research study. ☐
4. I agree to the interview being audio-recorded and transcribed to help the academic research analysis. ☐
5. I agree to the use of anonymous quotations in any thesis or publication that comes of this research. ☐

Name of Participant	Signature	Date
Name of Researcher	Signature	Date

One copy will be kept by the researcher and one by the participant, if so desired.

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c. Information sheet and consent form for Study two:

Participant Information Sheet

Study Title: **Identifying the Critical Success Factors for Design Quality Achievement in Construction**

Investigator: **Mahdad Sadeghi, University of Warwick**

Introduction

You are invited to participate in a research study conducted by doctoral researcher Mahdad Sadeghi from Warwick Manufacturing Group (WMG) at the University of Warwick. The overall doctoral research investigates 'the development of design quality in construction projects by taking a multi-stakeholder analysis approach'.

What is this study about?

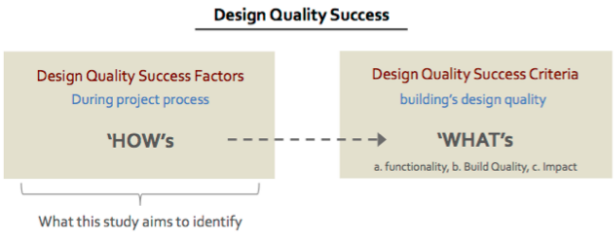
This particular study aims to identify a list of factors critical to the successful achievement of 'design quality' in UK building projects. Critical Success Factor (CSF) approach is an established methodology in the area of project and construction management. There exist more than 50 previous works attempting to identify the CSFs for the success of construction projects. While these are mainly concerned with the overall success of construction projects, there is no work yet to identify the CSFs for the achievement of 'design quality' in specific, as an increasingly important objective of projects.

Hence, this study is developed with a focus on the success of the end product of the construction projects, i.e., the completed building and its design quality - and not other objectives like time or cost. The study attempts to identify a 'limited' number of areas of activity with high influence on the building's design quality, which if properly managed and maintained, will ensure its successful delivery.

Considering the complexity of construction projects and also the debatable and subjective nature of design quality, the identification of CSFs could provide practical knowledge and aid industry practitioners to deepen their understanding of the 'predominant areas' to focus on and also could serve as a 'checklist' when monitoring and assessing project 'design quality' performance.

The 'design quality achievement' of projects is defined by two interrelated components. One is the 'design quality success criteria' or the 'WHAT's (which indicates the result areas), and the other component is the 'design quality success factors' or the 'HOW's (the areas indicating how projects can achieve the design quality criteria or the WHATs.)

This research aims to identify the latter or to answer the question of 'how to embed design quality in the building projects in order for it to be achieved successfully?' For the criteria – or the WHATs – the study



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considers the already identified areas of 'Functionality', 'Build Quality', and 'Impact' of the completed building against which the final design quality of buildings can be assessed.

Why have I been invited?
The study approaches individuals in the construction industry with high expertise and experience about the concept of design quality and its achievement in building projects with multiple stakeholders.

Do I have to take part?
Participation in this study is entirely voluntary and it is up to you to decide whether or not to participate. If you agree to take part, you will be asked to sign a consent form to confirm that you have agreed to participate. You will be free to withdraw at any time, without giving a reason.

If I take part, what will it involve?
The study seeks to identify the critical success factors (CSFs) for design quality achievement from the viewpoint of the participants. You will be asked to identify between 15 to 25 factors that you perceive as critical for design quality achievement. If you grant permission, I would like to audio-record the interview to ensure the accuracy of your input. The interview will take approximately an hour.

Will my taking part be kept confidential?
Anonymity and confidentiality will be maintained in the collection, storage and publication of study materials. The information you provide will be coded with a study number so you cannot be identified from it. Your name and the name of your organisation will not appear in any thesis or any publication resulting from this study. Interview recordings and material will be stored in a secured place and only the researcher and the academic supervisors have access to. According to the University's policy, these will be kept for 10 years and then will be destroyed.

What will happen to the results of the study?
The results of this study will be used within my PhD thesis, and may be also used as the basis for publications and presentations. If you want a summary of the study findings, I will send it to you when it is finished and you will be informed of any publication arising from the study.

Expenses and Payments
There are no expenses or payments associated with being involved in the research.

Who has reviewed the study?
This study has been reviewed and given favourable opinion by the University of Warwick's Biomedical and Scientific Research Ethics Committee (BSREC); (Reference number: 235-07-2012).

Whom should I contact if I wish to complain or if there is a problem?
In case of any problem, please address your complaint to the person below, who is a Senior University of Warwick Official entirely independent of this study:

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Jo Horsburgh
Deputy Registrar, Deputy Registrar's Office
University of Warwick, , Coventry, UK, CV4 8UW
T: 0044 (0) 2476 522 713, Nicola.Owen@warwick.ac.uk

What if I want more information about the study?

If you have any question or wish to discuss further the study or your participation, please contact either the researcher or the academic supervisors:

Mahdad Sadeghi
M: 07850761406
WMG, University of Warwick,
Coventry, CV4 7AL
M.Sadeghi@warwick.ac.uk

Dr Rebecca Cain
T: 02476575951
WMG, University of Warwick
Coventry, CV4 7AL
R.Cain.1@warwick.ac.uk

Prof Paul Jennings
T: 02476523646
WMG University of Warwick
Coventry, CV4 7AL
Paul.Jennings@Warwick.ac.uk

Thank you for taking time to read this participant information leaflet.

WMG Innovative Solutions

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Participant Information Sheet

Study Title: **Identifying the Critical Success Factors for Design Quality Achievement in Construction**

Investigator: **Mahdad Sadeghi, University of Warwick**

Please initial the boxes you agree with.

1. I confirm that I have read and understand the attached information sheet for the above study (reference 235-07-2012). I have had the opportunity to consider the information and ask questions, and have had these answered satisfactorily. ☐

2. I understand that my participation in this research is voluntary and that I am free to withdraw at any time without giving any reason. ☐

3. I agree to take part in this research study. ☐

4. I agree to the interview being audio-recorded and transcribed to help the academic research analysis. ☐

5. I agree to the use of anonymous quotations in any thesis or publication that comes of this research. ☐

Name of Participant	Signature	Date
Name of Researcher	Signature	Date

One copy will be kept by the researcher and one by the participant, if so desired.

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d. Information sheet for Study three:

THE UNIVERSITY OF WARWICK

Participant Information Sheet

Study Title: **Identification and Evaluation of Critical Success Factors for Successful Achievement of Design Quality in Building Projects**

Investigator: **Mahdad Sadeghi, Doctoral Researcher**

Introduction

You are invited to participate in a research study. This document provides information about why the research is being done and what it would involve for the participants. Please take the time to read the following information.

What is this study about?

There is an increasing amount of evidence indicating the value of design and its outcome for users and other stakeholders of built environments. Therefore, it is crucial to deepen the understanding of the factors critical to successful achievement of design quality in building construction projects. This study, accordingly, has two main objectives:

(1) To identify and validate a limited list of critical success factors (CSFs), which if properly managed and maintained, will ensure successful achievement of design quality in building projects; and,

(2) To evaluate the performance of multiple building projects, especially in healthcare and higher education, against these CSFs.

Considering the complexity of construction projects and also the debatable and subjective nature of design quality, the findings could provide practical knowledge and aid industry practitioners to deepen their understanding of the 'predominant areas' to focus on and also of what areas the industry is currently lacking.

Why have I been invited?

The study approaches construction industry professionals, like yourself, from various organisations involved in building projects, e.g., architects/designers, client representatives, project managers, contractors, consultants etc. It is believed that the combined perception and experience of industry professionals could contribute substantially to the study objectives.

Do I have to take part?

Participation in this study is entirely voluntary and it is up to you to decide whether or not to participate. If you consent to participate and for the information you have provided to be used in this study, please proceed to the questions and complete the survey. You will be free to withdraw at any time, without giving a reason.

If I take part, what will it involve?

The survey consists of two sections of questions. The first section seeks your opinion on relative importance of a list of success factors extracted from academic literature and expert interviews. The second section, then, asks you to evaluate a recently completed building project, in which you were involved, against these factors. Completing the questionnaire will take between 15 to 20 minutes.

Will my taking part be kept confidential?

Anonymity and confidentiality will be maintained in data collection, storage and publication of this study. Your name and project title (if provided) as well as the information you provide with regards to the questions will be coded and anonymised so you and your organisation cannot be identified from it. All the material of the study will be stored in a secured place and only the researcher and his academic supervisors have access to it. According to the University's policy, these will be kept for 10 years and then will be destroyed.

What will happen to the results of the study?

The results of this study will be used within my PhD thesis, and may be also used as the basis for publications and

presentations. If you want a summary of the study findings, I will send it to you when it is finished and you will be informed of any publication arising from the study.

What are the possible advantages and disadvantages of taking part in this study?

The advantages are that you will be involved in a research that attempts to raise insight and understanding about design quality and also the critical factors contributing to its successful achievement in building projects. It is hoped that you find the study useful and interesting. There is no risk associated with the research and the main burden is that it will take up to 20 minutes of your time.

Who has reviewed the study?

The research has been reviewed and given favourable opinion by the University of Warwick's Biomedical and Scientific Research Ethics Committee (BSREC); (Reference number: 235-07-2012).

Expenses and Payments

There are no expenses associated with being involved in the research.

Whom should I contact if I wish to make a complaint or if there is a problem?

Please contact the Deputy Registrar, on +44 (0) 24 7652 2713 or via email deputyregistrar@warwick.ac.uk in case of any problem or complaint.

What if I want more information about the study?

If you have any question or wish to discuss further the study or your participation, please contact either the researcher or the academic supervisors:

Mahdad Sadeghi
M.Sadeghi@warwick.ac.uk
T: 024765 74772
M: 07850761406
IIPSI, WMG, University of Warwick,
Coventry, CV4 7AL

Dr Rebecca Cain
R.Cain.1@warwick.ac.uk
T: 02476575951
IIPSI, WMG, University of Warwick,
Coventry, CV4 7AL

Prof Paul Jennings
Paul.Jennings@Warwick.ac.uk
T: 02476523646
IIPSI, WMG, University of Warwick
Coventry, CV4 7AL

Thank you for taking time to read this participant information leaflet.

e. Information sheet and consent form for Study four:

Participant Information Sheet

Study title: Inter-organisational Design Communications in Construction: A Network Approach
Investigator: Mahdad Sadeghi, Doctoral Researcher

Introduction

You are invited to take part in a research study conducted by Mahdad Sadeghi from Warwick Manufacturing Group (WMG) at the University of Warwick. Before you decide, it is important to understand why the research is being done and what it would involve for you. Please take the time to read the following information carefully and ask if there is anything that is not clear or if you would like more information.

What is the study about?

The communications occurred amongst different parties in a building project can highly impact on the performance and the outcome of it. Design-related communications contribute to a large amount of the total project communications and how to convey design information is considered as a particularly challenging aspect of construction projects.

This study, as part of my doctoral research, aims to investigate this type of communications through the perceptions of the project stakeholder groups. Stakeholders for this study are defined as individuals or groups who are affected by the design quality or who can affect it. Structured interviews with representatives of the main stakeholder groups are used for data collection. The project chosen for this study is the recently finished 'International Institute for Product and Service Innovations' (IIPSI) at the University of Warwick.

Why have I been invited?

The study approaches the representatives of the main stakeholder groups in the IIPSI project; those aware of the occurred design communications and who were the points of contact for other groups. The stakeholder groups include the client body, user groups, design team, construction team, facility management, suppliers, authorities etc. The study, in order to be complete, needs to collect data from all of the main stakeholder groups.

Do I have to take part?

Participation in this study is entirely voluntary and it is up to you to decide whether or not to participate. If you agree to take part, you will be asked to sign a consent form to confirm that you have agreed to participate. You will be free to withdraw at any time, without giving a reason.

If I take part, what will it involve?

The interview consists of a series of questions mainly regarding the design-related communications

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occurred with other groups, such as the frequency of information exchange, topic and its effectiveness. If you grant permission, I would like to audio-record the interview to ensure the accuracy of your input. The interview duration can vary based on the number of groups the participant had interaction but will not take more than an hour.

What are the possible advantages and disadvantages of taking part in this study?

The advantages are that you will be involved in a research that attempts to raise attention and insight about the design quality in construction projects and also the interactions of stakeholders with regard to it. The findings from this study will also support the development of a tool for evaluation of stakeholder interactions in ongoing projects and visualise them in a network structure. It is hoped that you find the interview topics useful and interesting.

There is no risk associated with the research and the main burden is that it will take up to 60 minutes of your time.

What will happen if I do not want to carry on being part of the study?

You can withdraw from the interview at any time without giving a reason and you may also ask for your data to be withdrawn.

Will my taking part be kept confidential?

Anonymity and confidentiality will be maintained in this study. The project name and the information you provide will be coded and anonymised so you and your organisation cannot be identified from it. Interview recordings and material will be stored in a secured place and only the researcher and the academic supervisors have access to. According to the University's policy, these will be kept for 10 years and then will be destroyed.

What will happen to the results of the study?

The results of this study will be used within my PhD thesis, and may be also used as the basis for publications and presentations. If you want a summary of the study findings, I will send it to you when it is finished and you will be informed of any publication arising from the study.

Who has reviewed the study?

This study has been reviewed and given favourable opinion by the University of Warwick's Biomedical and Scientific Research Ethics Committee (BSREC); (Reference number: 235-07-2012).

Expenses and Payments

There are no expenses or payments associated with being involved in the research.

Who should I contact if I wish to make a complaint of if there is a problem?

In case of any problem, the study is covered by the University of Warwick's insurance and indemnity cover. Any complaint about the way you have been dealt with during the study or any possible harm

you might have suffered will be addressed. Please address your complaint to the person below, who is a Senior University of Warwick Official entirely independent of this study:

Jo Horsburgh Deputy Registrar Deputy Registrar's Office University of Warwick, Coventry, UK, CV4 8UW T: 0044 (0) 2476 522 713 Nicola.Owen@warwick.ac.uk

What if I want more information about the study?

If you have any question or wish to discuss further the study or your participation, please contact either me or my academic supervisors:

Mahdad Sadeghi
M: 07850761406
M.Sadeghi@warwick.ac.uk
WMG, University of Warwick,
Coventry, CV4 7AL

Dr Rebecca Cain
T: 02476575951
R.Cain.1@warwick.ac.uk
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Participant Consent Form

Study title: Inter-organisational Design Communications in Construction: A Network Approach
Investigator: Mahdad Sadeghi, Doctoral Researcher

Please initial the boxes you agree with.

1. I confirm that I have read and understand the attached information sheet for the above study (reference 235-07-2012). I have had the opportunity to consider the information and ask questions, and have had these answered satisfactorily. ☐

2. I understand that my participation in this research is voluntary and that I am free to withdraw at any time without giving any reason. ☐

3. I agree to take part in this research study. ☐

4. I agree to the interview being audio-recorded and transcribed to help the academic research analysis. ☐

5. I agree to the use of anonymous quotations in any thesis or publication that comes of this research. ☐

Name of Participant	Signature	Date
Name of Researcher	Signature	Date

One copy will be kept by the researcher and one by the participant, if so desired.

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