A STRATEGIC APPROACH TO EXPLOITING BIM, BIG DATA ANALYTICS, AND INTERNET OF THINGS (BBI) FOR COMPETITIVE ADVANTAGE IN THE CONSTRUCTION INDUSTRY: AN OVERVIEW OF THEORETICAL UNDERPINNING

Besides the productivity and profitability hindering, the government of UK admits that the construction industry is lagging behind other industries in terms of fully utilizing digital technology. As an innovative solution to this end, consideration is now being given to exploring the possibilities of improving the utilisation of digital technologies via integrating BIM, Big Data Analytics, and Internet of things (together aka BBI)which gives organisations the long-awaited competitive advantage. Many studies have provided different levels of insight into the achievement of competitive advantage. However, this study pitches organisational level (construction firms) as the unit of analysis and as the level of competitiveness. Given the role played by the construction industry in UK economies; as a GDP contributor, job-creator, shaper of the built environment and resource-consumer, the competitiveness of the construction industry is of interest majorly into firms. Hence, this study aims to unfold the theoretical underpinning of an on-going PhD study: investigating the impact of organisational size, culture and structures on effective implementation and exploitation of BBI in construction organisations. The study follows a mixed methodological approach which leads to investigate the critical factors that impact on effective implementation and exploitation of BBI for competitive advantage and thereby develop a strategic framework for improved understanding of such critical factors at play. These factors fall into four main themes inter alia; organisational size, culture, structure and skills-knowledge-training needs. The latter will be demonstrated as a separate skill-knowledge-Inventory (SKI). The philosophical stance is a combination of interpretive and positivism. The approach holds a mixture of inductive and deductive means in different stages as the study starts from literature review to develop the strategic framework consisting of critical factors. Data collection methods adopted in this study will be semi-structured interviews in pilot study phase and questionnaire surveys in the main study phase. Focus group approach is intended to be employed to validate the framework and SKI.

Keywords: Big Data Analytics, Building Information Modelling, Competitiveness, technology exploitation, Internet of Things, theoretical underpinning

INTRODUCTION

The construction industry in the UK is currently facing uncertain market prospects between the political and economic conflict following the EU referendum vote (HM Government, 2017). The latest set of KPIs established by HM Government provides a valuable assessment of the industry's recent performance, its strengths and weaknesses, and its ability to

accommodate evolving market conditions and improve compared to other sectors over the next few years (ONS, 2016).

Notwithstanding, the problem appeared to be common in the global context as well. The construction industry is one of the world economy's largest sectors that employ about 7 percent of the world's working-age population with $10 trillion spent on construction-related goods and services annually (Economist Intelligence Unit, 2015). Despite the large share acquired in the world economy, the industry itself is facing intractable productivity problems being unable to withstand the dynamic changing climates of the global economic environment. Admittedly, 'infusing digital technology' has now been a widely accepted strategy to boost productivity and maximise the competitive edge (Chevin, 2017; Construction Excellence, 2016; Eriksson et al., 2017; Ive et al., 2004; PWC, 2015; Robson et al., 2016). It has now been hype that BIM (Building Information Modelling), BDA (Big Data Analytics) and IOT (Internet of Things) enabled strategy does have a significant impact on construction organisations competitiveness (Flanagan et al., 2007; Henricsson et al., 2004). Thus, this research seeks to answer the construction industry problems, considering BBI as strategic tools that enhance organisational competitiveness. Albeit there are benefits and challenges/ barriers that enable or impede their pursuance, it has now widely accepted that depending various conditions (i.e firm size, technological capacity, firm culture-structure setting, etc.) implementation and exploitation of BBI (collectively or individually) has the potential to offer firms with advantages towards competitiveness (Lu, 2006; Betts et al., 1991; Betts and Ofori, 1994).

The research itself introduces a conceptual framework initially with the findings of existing literature, encompassing the factors that highly impact on organisations ability to exploit BBI to maximise competitive advantage (Please Appendix-B) and establishes a range of hypotheses to test. These hypotheses emerge from reviewing the literature on the dynamism of technology in construction, competitive advantage of BIM/BDA/IOT and transformation power of digital technology (Alaka et al., 2015; Bilal et al., 2016; BIS, 2013; Etkin, 2016; Oyedele, 2016; PWC, 2015; Rathorea et al., 2016; Shah et al., 2015; WEF, 2016).

AIM OF THE RESEARCH

To develop a framework for improved understanding and exploitation of BIM, Big Data Analytics and Internet of Things as strategic tools for competitive advantage in construction.

OBJECTIVES OF THE RESEARCH

Table 1: Nature of objectives

Research Objectives	Objective type	Type of data	Type of analysis	Method
1.To critically review the state of the art in BIM, Big Data Analytics, and Internet of Things in the construction industry.	Qual & Quan	Qual & Quan	Qual & Quan	Review of literature
2.To investigate the extent of use, exploitation, benefits, and challenges associated with BBI in construction supply chains	Qual & Quan	Qual & Quan	Quan	Semi structured interviews, Surveys
3.Ascertain the impact of organizational size, culture, and structure on effective exploitation and implementation of BBI construction supply chains and the construction sector generally.	Qual	Qual + Quan	Quan	Semi structured interviews, Surveys
4.Investigate the extent to which BBI are employed as competitive tools in other sectors (including Retail and manufacturing), and explore possible lessons for the construction industry.	Qual	Qual	Quan	Semi structured interviews
5.To explore skills and training needs for effective exploitation and implementation of BBI for competitive advantage and, in this regard, develop skills and knowledge inventory (SKI).	Qual & Quan	Qual & Quan	Quan	Semi structured interviews, Surveys, desk study
6.To develop and validate a framework for improved awareness and understanding of the critical factors at play in the exploitation and implementation of BBI for competitive advantage in construction	Qual & Quan	Qual & Quan	Qual & Quan	desk study

Research Questions

1. What factors impact on a construction organisation's ability to exploit BIM, BDA, and IOT for competitive advantage?- Require QUAL data (explore factors)
2. In what different and complex ways do construction organisations maximise competitive advantage through the exploitation and implementation of BIM, BDA and IOT?- require QUAN and QUAL data (investigate the correlations between factors and confirm the hypotheses)

RESEARCH METHODOLOGY

Suppositionally, research methodology is the entire research process explained with justifications. This includes the assumptions of worldviews, research design, approaches employed, the strategy of inquiry, research methods, and validation techniques.

Theoretical perspective

Howe, 1988, 1992 explains that linkage between research paradigm and research methods is neither sacrosanct nor necessary. Nevertheless, this research carries some linkage between paradigms and the choice of research methods. Brannen (2005) introduces 'three Ps': paradigms, pragmatics and politics as the foremost attention required philosophies, for a correct understanding of these shape a researcher's choice of method.

Paradigms and Philosophical assumptions

Paradigm and philosophical positions define the limits the frame which the research or the researcher's frame of reference (philosophical assumptions- ontological and epistemological). The philosophical position is basically linked with ideas and their origins, in the ideas which drive the research and the ideals upon which research should be founded. Researcher's choice of methods is chiefly driven by these three Ps. Authors often mention the complexity and ambiguity of this paradigm as 'paradigm wars'. The philosophical positions for qualitative-quantitative strategies are said to be different.

Philosophical Assumptions

A research question is often framed by epistemological assumptions influenced by the need to find theory that 'fits' a specific set of cases or contexts. In general, the two most dominating philosophical traditions for mixed method research are positivism and interpretivism. Qualitative researchers typically locate themselves within an interpretive tradition. However, there are times that they also hold realist assumptions about the world and the contextual conditions that form the perspectives of their study. In contrast, quantitative research is aligned to positivism, often by those defining themselves as qualitative researchers. Bryman (1988) rationalises this as most of the quantitative research does not pay much attention to epistemological and ontological assumptions in discussing their research. Moreover, the literature suggests another dimension of paradigms related to the transcendence of paradigms-micro and macro level perspective. Micro-level studies seek subjective interpretations while macro-level studies attempt at making structural explanations on larger scale patterns and trends and seek to pose structural explanations. However, it is likely that a researcher's choice of methods is highly ruled by the philosophical choices initially. Nevertheless, there is no agreement that the entire research process and context need to be governed by the pre-selected philosophical stance as the research unfolds (Brannen, 2005).

The researcher initially sees the problem need to be addressed in this research is an ideology between society and technology (Science). The society is either regulatory or subjected to radical change. In regulatory view, the status quo has framed the society to behave in such a manner regulated by a third party (i.e. Government, religion etc) and evolvement of the society is too often justifiable by logical means. To that end, every human is considered to be uniform and cohesive (modernism). In radical view, a constant conflict is seen as humans attempt to live a preferred life free from the domination of societal structures (post-modernism). On the other hand, the evolvement of technological science can be either a subjective or an objective approach to research.

Epistemological perspective (how knowledge is constructed)

The research explores the existing body of knowledge (theories related to competitiveness, strategic management, organisational culture, organisational structure, innovation and change management). By comparing and contrasting each theory, the researcher identifies the combination of theories that best suits the research context (innovative technology exploitation). The technological science is viewed in both subjectivism and objectivism. The qualitative data collection (interviews) seeks to explore the subjective side of real human perspectives being more interpretivists while the quantitative data collection seeks straightforward scientific decisions being more positivists. Therefore this research is viewed in both positivistic and interpretive lenses. Interpretive worldview helps the researcher to understand the role of people, technology and their interrelationships within construction organisational contexts. Researchers focus on the socially constructed nature of reality and the situational constraints of the contribution of digital infusion to firms' competitiveness. Hence, this research follows a qualitative approach based on interpretivist epistemology. Qualitative data collected are considered as subjectivist, and corresponds to 'ecological validity', which stresses on understanding how different realities are constituted in a localised context (Dainty, 2007). Through the positivist worldview, the researcher attempts to reduce the field of inquiry, focusing on some specific areas to gather quantifiable data. A series of questions were asked from sample population inter-alia the factors that impact on firms ability to exploit BBI, skills and training need related to BBI etc. Moreover, casual relationships are discovered such as the relationship between a managers' experience and the skills/knowledge dimension that he thinks as important. The [positivist worldview allows the researcher to derive quantifiable measures of variables by testing the hypotheses and draw inferences about a phenomenon from the sample to a stated population.

Ontological perspective (conception of reality)

The nature of reality (ontology) in this research is considered to be an existence relative to the theorised parameters. For example, the researcher believes 'competition' among organisations actually exits; only if it is viewed against the benchmarks (national productivity measures, etc). The researcher seeks to explore what makes some firms to perform better than others. On the contrary, the researcher believes the reality is also objective and ''out there" waiting to be discovered, which exactly the main purpose of this research (unfold the secrets of success from big players and help/ guide the majority of SMEs to reach the competitive edge). Knowledge captured by the industry professionals are stored, analysed and communicated by converting the knowledge into understand format. The researcher believes a human as the controller for everything. Even though we see employees are controlled and confined by a structured set of rules, the rules itself are also defined by a human. Therefore, the research strongly believes the dynamic capabilities and core competencies of human as the basis for this research. Moreover, this study complements constructivist ontology (or subjective) believing that objects of thought/social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence. The researcher sees the concept of 'competitiveness' would not exist without the social interaction and therefore in a constant state of revision with the involvement of key players/ actors in it.

It is manifesting the consideration of multiple realities in this study. Since the epistemological perception is inextricably linked to ontological perspective, the positivist epistemology is linked to the objectivist ontology whilst the interpretive epistemology is linked to the constructivist ontology. This re-justifies the need for the mixed methodological approach.

Axiological Position (domain of values and ethics)
Value of knowledge is achieved by testing the value it creates to humans and to the world viewed as environmental settings. Since the unit of analysis is 'firms', this is achieved by investigating end users' views and opinions through qualitative and or quantitative means to better assess the value of the stated dynamic digital capabilities (BBI) viewed as a collection of assets, processes, and performances (APP approach by Momaya and Selby, 1998).

Pragmatics
Bryman (1988) suggest that researchers need to be underpinned by pragmatism as much as it is underpinned by philosophical assumption if they are meant to apply in practice. This implies that for research question formulation pragmatism is equally important as philosophical assumptions. Unlike in paradigms, the pragmatist is more to open up the world to social inquiry and the practicality of the research to meet practical and policy ends. Thus, the pragmatist is less-purist in terms of methods and preconceptions (about theory and method). Pragmatism entails current meaning or instrumental or provisional truth value of an expression is to be determined by the experiences or practical consequences of belief in or use of the expression in the world (Durkheim and Murphy, 1985).

In this research, organisational behaviours- which are generally positioned in complex and pluralistic social contexts demand analysis that is informed by multiple and diverse perspectives. Therefore, it can be rationalised that mixed methodological strategy was selected for the sake of strengthening the inferences. Moreover, to answer the research questions it requires a breadth of vision, tolerance and a willingness to accept different approaches and objectives instead of conformity. This attributes that there is no one correct method of finding what makes firms more competitive but many methods. Pragmatic rational for the research also can be discoursed by the resources available to researchers and the selection of questions required to be asked and the way they are framed. Because the actual cultural setting within a construction firm is impractical to observe, the researcher decides to use self-completion questionnaire surveys. Pragmatism is also associated with the level of the feasibility of particular methods. This research intends to employ semi-structured interviews with senior managers who generally considered to be the strategic decision makers of a firm. The senior managers are usually in powerful positions within a firm and their perspectives are likely to be (or be believed to be) unique within an organisation. For this reason it is pragmatically justifiable to use semi-structured interviews to capture their perception.

Politics
The politics of a researcher often explores the forms of knowledge and to whom that knowledge targeted on. In this case, views and perceptions of organisation managers are studied. Therefore one target audience is 'senior managers' who make strategic decisions. Moreover, up and coming scholars and educational leaders may also benefit from the implications. It is an ongoing debate that knowledge cannot be easily accessed and captured in terms of views, perceptions, and attitudes, albeit attempts are made through interviews and questionnaire surveys (mixed methods) assuming that the collected data are a true reflection of them. Moreover, since the area concerned in this research is relatively under-researched and that makes the political rationale to explore the managerial views through explorative

qualitative methods while choosing surveys to confirm the relationship between several cultural norms and their ability to maximise competitive edge.

Research Strategy/ design

According to the **Error! Reference source not found.**, the research objectives manifest both qualitative and quantitative natures and in order to fulfill the objectives, both qualitative and quantitative data need to be collected. Further, inspecting the two research questions it is also apparent that both QUAL and QUAN data are required to answer the two reserve questions. Subsequently, considering the outcomes of each objective, they are required to be analysed in both qualitative and quantitative methods are employed in this research. Teddlie and Tashakkori (2006) asserts research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry are 'mixed method research'. Therefore this research follows a mixed-methodological (MM) approach as the main strategy. This is also referred to as multi-strategy research (Bryman, 2001).

The basic reasoning behind the selection of mixed-methodological approach is as follows: According to the research aim, it is required to develop a framework for improved understanding of the subject area. In order to develop a framework, it is required to have a finite number of factors systematically selected. To derive the factors (impact factors-independent variables and implementation/exploitation factors, competitiveness factors-dependent factors) it is imperative to explore and understand how BBI is used (if at all) in the context of construction firms- the unit of study. In this study, the aforementioned three technological innovations (BBI) are treated as dynamic digital capabilities comprise with a collection of assets, processes, and performances (according to APP approach suggested by Momaya and Selby, 1998). The social problem investigated here is 'how construction firms achieve competitive advantage through the exploitation of BIM, BDA, and IOT''. How individuals or groups ascribe to this social problem is explored qualitatively. These qualitative data is typically collected in the participant's setting where collected data are inductively attributed from particulars to general themes while the researcher making interpretations of the meaning of the data. This approach allows the researcher to be more flexible with the stories heard from individuals to honour an inductive style, a focus on individual meaning, and the importance of rendering the complexity of the situation. The researcher intends to gather critical factors qualitatively to aid quantitative study. The reason why these factors solely obtained from a review of literature is that the subject area studies here is new and the paucity of already published empirical data. Therefore, exploring the problem in the current context is a prerequisite for producing the quantitative information.

The main purpose of the quantitative study is testing objective theories by examining the relationship between variables. Once the general themes are finalised through the qualitative study, it aids to develop the quantitative study with a set of finite variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures. This approach involves assumptions about testing theories deductively, building in protections against bias, controlling for alternative explanations, and being able to generalize and replicate the findings (Creswell, 2009).

A major advantage of MM research is that it enables researchers simultaneously to ask confirmatory and exploratory questions, and therefore verify and generate theory in the same

study. MM strategy also encourages thinking 'outside the box' (Brannen, 2005) as well as generate new perspectives and innovative insights. It allows to fit with the political currency accorded to 'practical inquiry' that speaks to policy and policymakers and that informs practice (Hammersley, 2000). In receiver's perspective, MM strategy allows a researcher to speak to the audience in more than one language. Considering the emphasis of dissemination, it is vital to speak in multiple languages in a society where a growth of strategic and practically oriented research which meets the needs of users is at hype. This may be technical language that pitches the experts and a language that is easily communicated as well as easily understandable by the general public. On the other hand, words and numbers for everyone. According to Teddlie and Tashakkori (2006), it is important that the researcher must select a suitable typology specifically in Mixed Methods Designs. Because typologies help the researcher to decide the ideal path to accomplish the goals of the study among a variety of alternative paths when designing MM studies. The subsequent paragraphs describe the seven criteria that have been used by many authors in deciding typologies in MM design.

Research methods

Empirical data was gathered through the following research methods/techniques:

1. Documentation analysis such as BIM/BDA/IOT implementation strategy documents, written policies and procedures, and project documents, systematic reviews of scholarly articles.
2. Semi-structured interviews with different stakeholders (predominantly strategic managers in firms of four sectors according to SIC-2007 industry classification)-Those interviews are recorded and transcribed
3. Questionnaire survey targeted managers of three levels (strategic, middle and junior level) construction firms (according to SIC-2007 industry classification)

Logic of inquiry (research approach)

In general, surveys are meant to associate with inductive and deductive logic while qualitative methods are most often elaborated with a grounded theory where ideas are tested as well as generated. In this study, both deductive and inductive approaches are used for different stages.

The research starts with a comprehensive literature review to explore the existing theories. A broader view of general theories helps to narrow down to more specific hypotheses. This shows deductive nature in the first stage. In the second stage, the research holds more inductive nature as it moves from specific observation to broader generalisation and theories. Data collection starts with qualitative interviews, which shows the inductive nature of identifying concepts. The correlations between factors identified from the broader literature are further explored to establish a theory. Further, it uses identified concepts and investigates relationships; which deductive. The theories built are interpreted as a strategic framework and a Skill Knowledge Inventory (SKI). The relationships between concepts (the proposed theory) are tested by looking for facts that support or deny the suggested relationship (deductive)
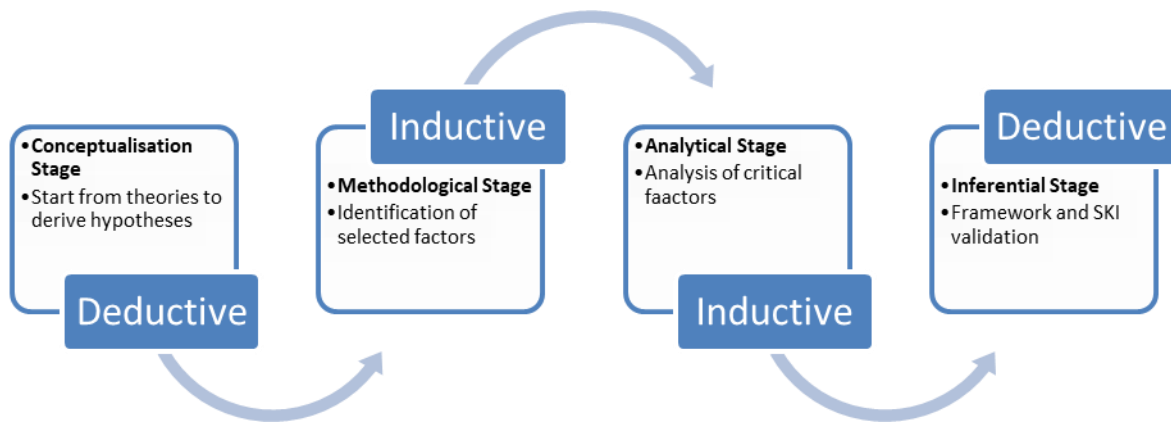
Figure 1: Deductive/ inductive approach

Number of methodological approaches used

To more specifically locate the MM design related to this research within the larger framework of a general typology of research, two methodological approaches are used. One Qualitative and one quantitative method are used. Hence, this research shows characteristics of a mixed-method design where QUAL and QUAN approaches are mixed across the stages of a study.

Number of strands or phases

A strand of a research design is a phase of a study that includes three stages: the conceptualization stage, the experiential stage methodological/analytical), and the inferential stage (Teddlie and Tashakkori, 2006). Considering the nature of research objectives, the research needs to be conducted in two phases for each method (QUAL and QUAN). Each encompasses all of the stages from conceptualization through inference. Therefore, Multi-strand Design is the approach selected.

Type of implementation process

It is apparent that some of the data collected from the qualitative method are required to be converted and fed into a quantitative method. Therefore, both methods occur in chronological order with one strand emerging from the other. Hence, it is a sequential design consisting of two strands for each QUAL and QUAN methods. The conclusions made as a result of the first strand lead to the formulation of questions, hypotheses, data collection, and data analysis for the next strand. The final inferences are based on the results of both strands of the study. The second strand of the study is conducted to confirm/disconfirm the inferences of the first strand. Moreover, each strand is further used to provide an explanation for findings derived from each opposing strand.
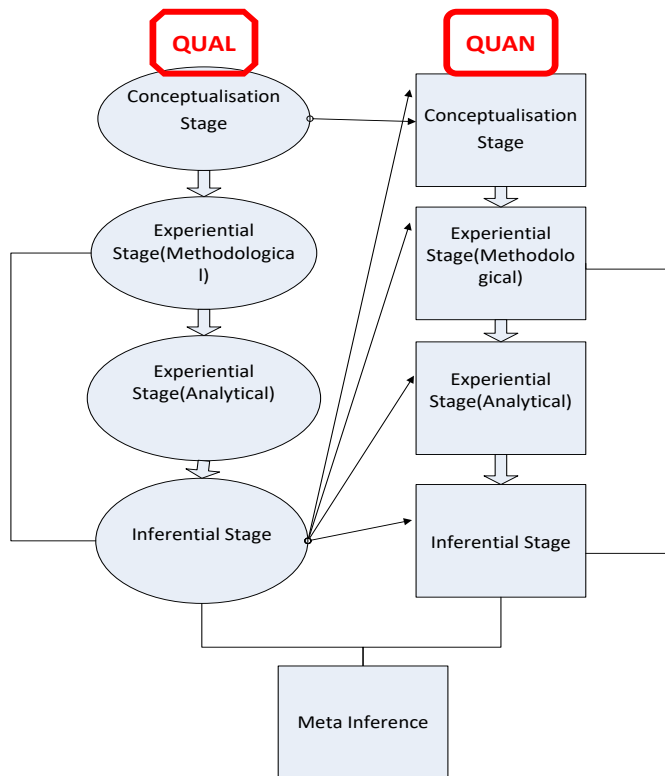
Figure 2: QUAL-QUAN strands and integration

In light of this research, qualitative study is intended to precede (conducted first) as semi-structured interviews. Results from these interviews are then used to generate a series of hypotheses related to this phenomenon. The semi-structured interviews in the first part of the study that examined several research questions. The resultant data are analysed using grounded theory techniques and derived set of hypotheses and critical determinants of several key impact factors. Based on these analyses, a series of 12 hypotheses were developed and tested using a 75-item questionnaire generated for the purposes of this study. Hypothesis testing involved both correlational and analysis of variance techniques.

It is said to be less common for qualitative research to be done as a follow- up to quantitative study (Ritchie and Lewis, 2003; Sieber, 1973). For highly resourced quantitative methods to initiate first, there should be a good and strong justification (Neuman, 2011). Hence, in this study qualitative method (secondary- less resourced) is conducted first and the quantitative method is conducted secondly (main-highly resourced) [qual > QUAN]. The level of dominance is explained in subsequent paragraphs.

Stage of integration of approaches

Collected QUAN and QUAL data are integrated into several stages. Therefore it is partial integration (not full integration at every stage). The results derived from QUAL study is transferred into every stage in QUAN study (Conceptualisation, methodological, analytical and inferential). Moreover, during the conceptualisation stage of QUAL study, the formulation of the QUAL oriented questions informed the formulation of the QUAN oriented questions.

Priority of methodological approach

In this research, QUAN method is treated to be dominant (main) while QUAL method is treated as secondary. Therefore lesser resources of time are being devoted to the QUAL method in terms of data collection and also in the analysis phase and the writing up while much resources are dedicated to QUAN research data collection, analysis and writing up. (qual > QUAN). The qualitative method also partially acts as a 'pilot 'questioning to develop coded questions for use in a survey. However, it is inevitable that the plans made at original design may subject to many changes with the progress. Therefore the research design counts not only the initial plans but also the changes to be made in the course of the study.

Function of the research study

Triangulation is when different bearings are taken in to research design where each complements each other in order to arrive at a precise physical location. The second bearing is not used to check or verify the first bearing (Brannen, 2005), This is also termed as a check, validate or corroborate one another in many research. This necessarily does not need to be combing different methods, rather can be using same observation (same method) in different settings or different vantage points (investigator, location, target group).

Complementarity is carried out when qualitative and quantitative results act as enhancers for each other while they are treated as different beasts. Ultimately, the data analyses from both beasts are juxtaposed and generate complementary insights that together create a bigger picture.

Initiation is used when the main function of the first method is to emerge new hypotheses, critical variables or research questions that can be pursued using a different method. This research uses initiation as of the first method (QUAL) method is used to identify and define critical variables that are continued to pursue the criticality in QUAN method. This is also termed as development by some researchers as the analysis of first method sparks the development of second method.

Elaboration or expansion is often employed when there is a requirement for the data analysis of one method to exemplify the data analysis of other. Further clarified, it is one type of data analysis adds to the understanding being gained by another. In this research elaboration and expansion in QUAL analysis is also used to elaborate how patterns/trends based on quantitative data analysis apply in particular cases (firms).

Contradictions are applied when qualitative and quantitative data findings conflict. Scrutinising the contradictions between different types of data that are investigated to examine the same phenomenon is often interrogated with each other and one method is discounted in favour of another (in terms of assessments of validity or reliability).

Even though the exact function of the research is hard to assume at the first place of designing the research, it is presumed that the function of QUAL method is basically initiation/ development and elaboration and expansion, while the function of QUAN method is to confirm or reject the hypotheses and lead to framework and SKI (Skill and Knowledge Inventory) development.

Considering the typologies explicated above, this research follows a mixed-method, multi-strand, sequential methodological approach with partial integration where QUAN method

dominate over qual method and qual method is conducted first while QUAN follows up. (qual > QUAN).

Contextualisation

The research topic does not specifically state that question intended to answer through this research is in the context of United Kingdom. In fact, the problem investigated here is common to global; therefore the inferences and implication made in the conclusion may be applied in different contexts in terms of nations. However, for the feasibility and viability selections, the researcher selects the United Kingdom as the context of data collection and construction organisations (generally) in United Kingdom as the 'unit of analysis'. Nevertheless, the researcher, through this research makes attempts to 'conceptualise' a phenomenon within a pre-defined context (UK) that can be applied to a wider context other than which the study is investigated.

Credibility and validity of research

The research employs focus group method to validate the strategic framework and Skill Knowledge Inventory.

Quantitative and Qualitative studies used in this study further explained

Purpose of less resourced (secondary but firstly conducted) qualitative study (qual)

Threw up hypotheses

- Threw up hypotheses
- Way of establishing significant variables for isolation and examination (See Appendix A)
- Resource area is under-researched, hence explorative
- Act as a 'mapping' exercise to inform the research design and implement the quantitative part of the study.
- Strengthen some interpretations in the inferential stage.
- Describe, in rich detail, phenomena as they are situated and embedded in local contexts.
- Identify contextual and setting factors as they relate to the phenomenon of interest
- Determine how participants interpret "constructs'' (variables) and allocate them according to the priority given by them.

Purpose of high resourced (main but secondly conducted) quantitative study (QUAN)

- QUAN tradition is employed with hypotheses predicting via significant relationships between several predictor variables.
- Reject or confirm the qualitative evidence.

- Testing and validating already constructed theories and hypotheses about how (and to a lesser degree, why) phenomena occur- How construction organisations maximise their competitive advantage by exploiting BIM, Big data Analytics and Internet of things as strategic tools.
- Generalise research findings when the data are based on random samples of sufficient size- the organisations that are good at BIM may not be good at BDA or IOT. Thus, random sampling can be justified.
- Elaborate the cause-and-effect relationships- the research investigates the level of impact of impact factors for competitive advantage using BBI as strategic tools that drives competitive advantage.

CONCLUSIONS

This paper summarised the research methodology along with the theoretical underpinning for an on-going PhD study. The paper highlighted the philosophical foundation of the research and the choices made with regards to research approach and methods of enquiry. The research views the subject of investigation (BBI) as a dynamic digital capability that can be considered as a collection of assets, processes and performances according to an established seminal theory. Having that established the researcher views both in positivists and interpretivists epistemological world views in order to capture the knowledge base both from qualitative and quantitative means. The ontology of this research is more biased to be subjective, but objective characteristics are also manifested considering the characteristics of data collected. The research stages, data collection protocols and analysis strategies were then presented orderly. The study follows an abductive research approach, which stresses the importance of analysing multiple and interconnected levels of contexts in research design. This approach expands understanding of both theory and the empirical phenomenon under investigation by calling for sequential data collection techniques in which one aids the other. The research design is primarily three phase: preliminary framework development, development of improved framework and knowledge/skill inventory (SKI) through the findings of the exploratory studies and finally the validation of both products. Such multidimensional construct/variable implications require mixed methodological approach and are considered to be critical for breaking the more linear view on relations between empirical data and theory development. The theoretical underpinning applied to this particular on-going PhD study would benefit up and coming researchers to gain insight on the applicability of theories practically when conducting a research.

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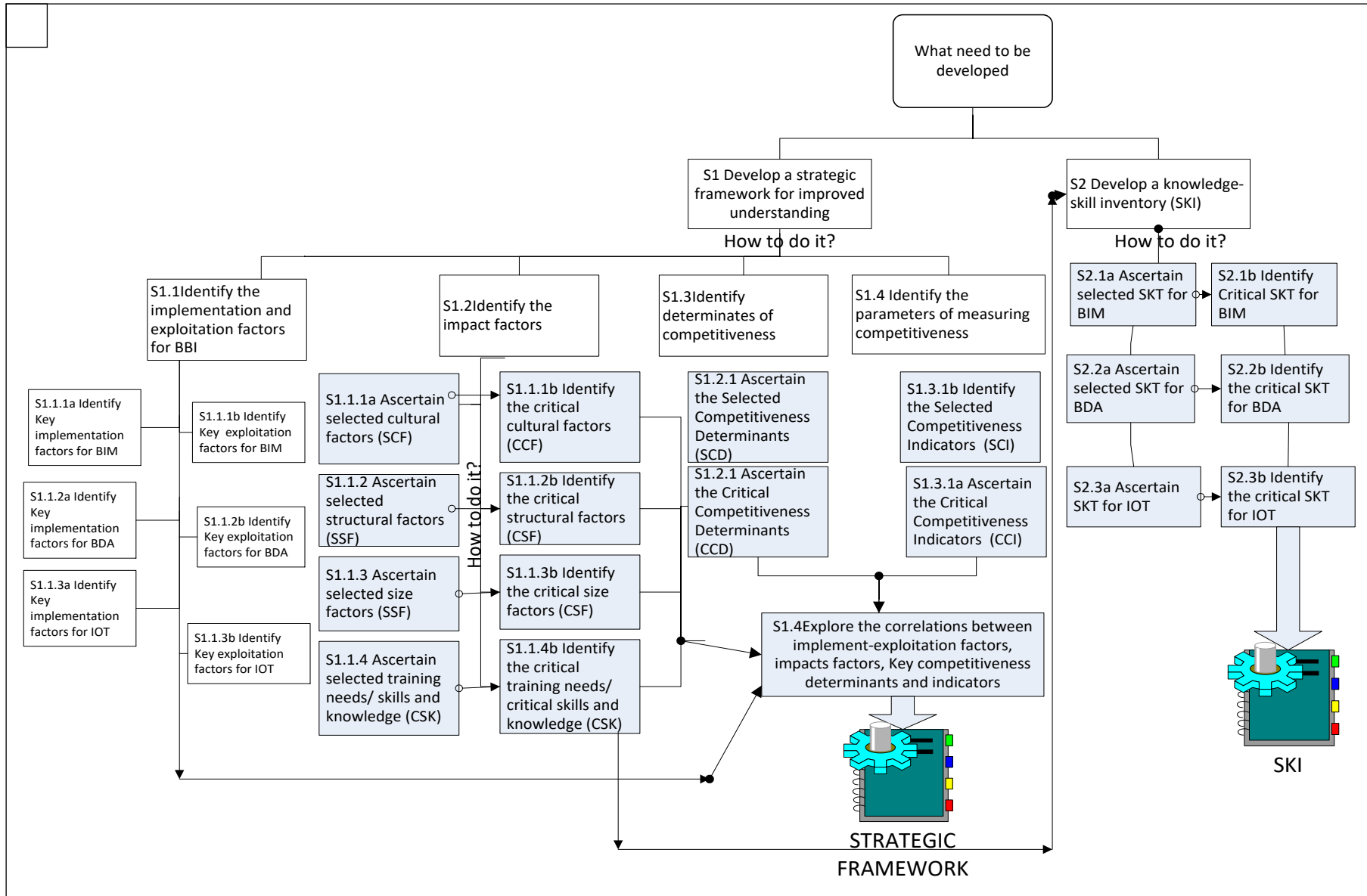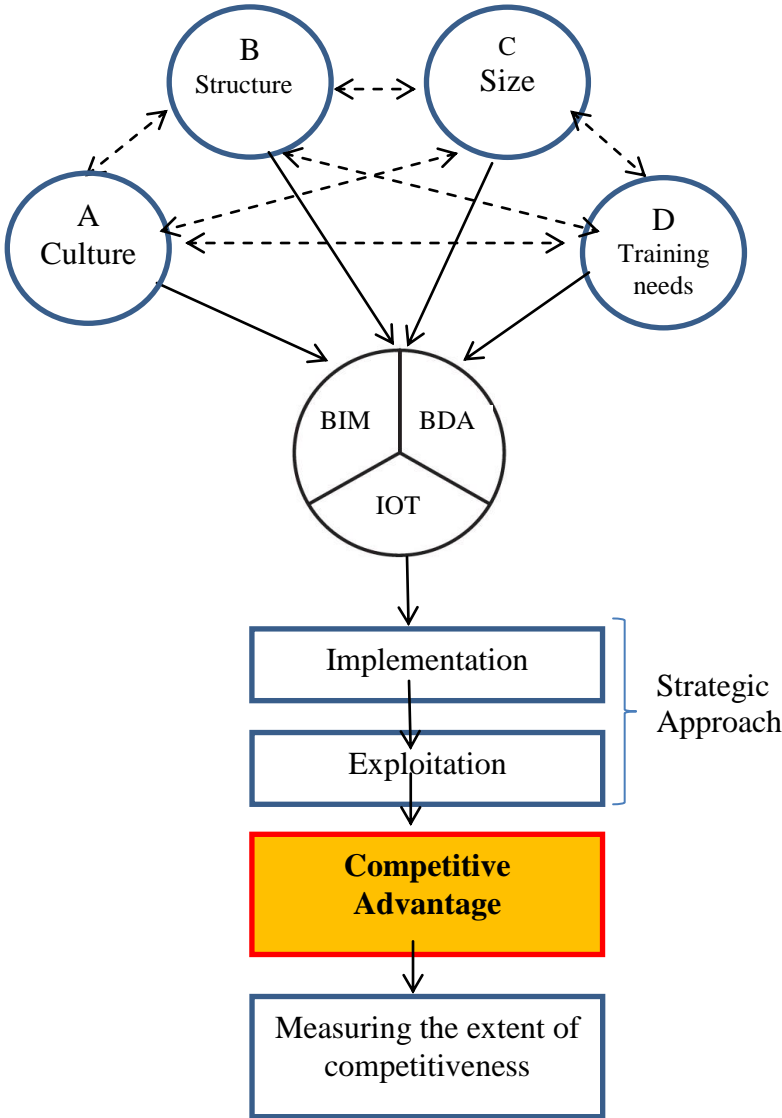WEF (2016) Shaping the Future of Construction A Breakthrough in Mindset and Technology. Available from: www.weforum.org

Figure 1- Research Activity diagram

Figure 2- Conceptual Framework