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A FRAMEWORK FOR COLLABORATIVE COSTING IN THE UK CONSTRUCTION INDUSTRY

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BSc. (Hons), MSc

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Copyright Statement

Declaration

I hereby, declare that this dissertation has not been submitted in part or in whole as paperwork for a degree at any other university. I hereby declare that this dissertation is entirely my own work and that all parts and thoughts, which have been taken from other persons, are marked and identified by reference.

Signature………………………….

Date………………………………

Abstracts

Although collaboration has been recognised as a necessary component of success in the modern construction industry, concepts like building information modelling (BIM), integrated project delivery (IPD) and target value design (TVD) are still emerging in the construction landscape. However, collaborative working (CW) is reported to be fading within the UK construction industry, largely because of commercial behaviours. These behaviours are reinforced by the dominant procurement arrangements and 'institutional' factors, which surrounds project delivery approach in construction. Consequently, construction clients and supply chain organisations struggles to realise the full benefits of CW. In fact, these commercial behaviours create costing approaches marred with irregularities and uncertainties with little shared understanding amongst stakeholders. Invariably, the prevailing approach mainly follows the RIBA Plan of Work, which is discrete, sequential and favours competitive tendering. This guides stakeholders within a narrow view to consider costing and design activities as separate functions. Conversely, the integration of design and construction creates opportunity for commercial actors to be more deeply included in CW approaches thus removing a major barrier to the performance improvements demanded in successive UK government reports.

In view of these problems, this study was undertaken to shed light on the current costing practice and CW in the UK construction industry, with the intention of developing a framework that would guide stakeholders to cost projects collaboratively. Qualitative research design strategy was adopted, which gathered data from construction and infrastructure sectors in the UK. A total of 50 interviews was conducted with three case study examination. The study found attributes like target costing, optioneering, and integrated value engineering, as core constituents of costing in collaboration. In light of this, the study proposed the notion of 'costing collaboratively' (CC), as a process that integrates stakeholders (upstream and downstream) around a wider scheme budget, creating a sense of ownership which drives positive behaviours to achieve desired cost outcomes. However, the analysis showed that the current practice differs from this description and does not support wider CW, particularly within commercial activities. Although, the findings revealed

some progress, and glimpses of CW emerging from multidisciplinary setting, however, costing process is still driven by price, and the limited understanding continues to affect the wider practice of collaboration in the UK construction industry.

The implication of this to industry, and practice is that costing approaches need to shift from the traditional standpoint to a more social-based approach, incorporating commercial actors, to heighten ‘flow’ and ‘value’ perspectives for the smooth running of production activities. This is primarily because the findings revealed that, without properly aligning commercial actors and their interests in a ‘collaborative production’ fashion, most of the barriers found to unsettle CW would remain, regardless of the environment. Thus, whilst this implication remains, efforts to sustain an integrated practice and other construction reforms in the UK will continue to stall. Hence, the study developed a simple but effective framework to guide stakeholders through the necessary steps to costs projects collaboratively in practice.

Dedication

This thesis is dedicated to my entire family, especially my loving wife Nafisat Umar for all her immeasurable support and to my adoring children Abdallah and Rayyan for the joy they brought into our family.

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List of Abbreviations

Allowable Cost (AC)

Architecture Engineering Construction (AEC)

Asset Management Programmes (AMPs)

American Institute of Architects (AIA)

Building Information Modelling (BIM)

Choosing by Advantages (CBA)

Collaboration/Collaborative working (CW)

Commercial Management Practices (CMP)

Costing Collaboratively (CC)

Design-Build (DB)

Expected Cost (EC)

Integrated Project Delivery (IPD)

International Group for Lean Construction (IGLC)

Literature Review (LR)

Market Cost (MC)

Nottingham Trent University (NTU)

Plan-do-check-act (PCDA)

Project Delivery System (PDS)

Quantity Surveying Practice (QSP)

Quantity Surveyors (QSs)

Set Based Design (SBD)

Supply Chain Groups (SCGs)

Target Costing (TC)

Target Value Design (TVD)

Toyota Production System (TPS)

Transformation Flow Value (TFV)

CHAPTER 1 INTRODUCTION

This chapter begins with an introduction to the study context, rationale and the current knowledge gap. It further presents the overview of the work done, the adopted methodology, and the study's contribution to knowledge. Accordingly, it is divided into eight sub-sections. These are background and rationale, statement of the research problem, aim, objectives and research questions, outline of the work done, and finally the summary.

1.1 Background and Rationale of the Study

The importance of the construction industry cannot be overemphasized. In the United Kingdom (UK), it contributes to *circa* 10% of the whole nation's gross domestic product (GDP) and employment (Department of Trade and Industry, 2003), which equates to £110 billion and more than 280,000 businesses (Cabinet Office, 2011). The sector is considered broad and diverse: from design, construction and infrastructural development, through to the maintenance of buildings and their disposal (NCC Strategy, 2018). However, the industry has long been criticized for its lack of efficiency and innovation (Koskela *et al.*, 2002; Koskela and Howell, 2008; Farmer, 2016). These challenges have held back the sector's productivity potential, which has performed on average of 21% less well than the wider economy since 1997 (ONS, 2018). Part of this is linked to fragmentation (HM Government 2013), a common practice where in constructions teams are formed and reformed for each new project (RICS, 2013). This sort of arrangement makes projects susceptible to problems such as cost-overruns, opportunistic behaviours, and sub-optimal performance (Savio *et al.,* 2013; Koskela *et al.;* 2018).

These issues have for a long time steered different government-led reports in the past. For instance, the seminal work of Latham (1994) and Egan (2002) branded the UK construction industry as 'non-value adding'; they recommended that the sector needs to reflect the best practices of manufacturing to provide satisfactory products and meet customer needs. Consequently, they advocated for a change to collaborative relationships for construction development. Despite these recommendations, study reports still indicate that the industry's shortcomings are not fading. The Farmer Review (2016), the Building Regulations & Fire Safety Review (2018), liquidation of Carillion (Conway & Mor, 2018), and excessive cost overruns in capital projects e.g. GWR mainline electrification (Topham, 2017). These growing trends have left many within the industry calling for modernization (Construction 2025 Strategy 2013; Industrial Strategy 2017; Farmer Report, 2016; HM Govt, 2018).

After the economic recession periods, Construction 2025 Report (2013) called for partnership at all levels amongst stakeholders to reduce costs by 33%, and speed up time by 50%. This was followed by the Farmer Report (2016), which advocated for the adoption of manufacturing advances e.g., lean construction, Building Information Modelling (BIM), and off-site production strategies for performance improvement. It seems as though galvanizing these concepts to achieve the necessary improvement would require comprehensive collaborative working (CW) relationships in the industry. However, studies have shown that CW within the UK construction industry is fading, largely because of commercial behaviours (Challender, *et al;* 2016); these behaviours are reinforced by the prevailing procurement protocols and 'institutionalised' factors that surround the usual project delivery approach (Sarhan *et al.,* 2017).

Consequently, construction clients and supply chain organisations are struggling to realise the full benefits of CW. In addition, these behaviours create costing approaches marred by irregularities and uncertainties, with little shared understanding amongst stakeholders. Accordingly, the prevailing approach still follows the Royal Institute of British Architects (RIBA) Plan of Work, which is discrete, sequential and favours competitive tendering. This guides stakeholders with a narrow view that considers costing and design activities as separate functions. However, this view remains despite scholars assertions that collaboration especially during early costing stages can shift the customary approach (Laryea & Watermeyer, 2010; Jung *et al.,* 2012; Ballard & Pennanen, 2013; Love *et al.,* 2017; Shalpegin *et al.,* 2018).

Despite this lack of integration in construction practices, hierarchical arrangements and commercial misalignment have been highlighted as issues impeding collaboration in the UK construction industry (Namadi *et al.,* 2018; Sarhan *et al.,* 2018). This is because the current delivery model deters clients and professional consultants from collaborating with suppliers at conceptual stages, on the basis that it limits competition (ICE, 2018). This creates more transactional characteristics, given that commercial activities are carried out in isolation (Nicolini, *et al.,* 2000), instead of being integrated and part of production, as advocated in a 'lean' system. Evidence shows that these practices are encouraged by 'institutionalised' factors that outline the governance mechanism for managing and delivering construction facilities (Sarhan, 2018), thus, characterising the prevailing UK construction model (Pasquire *et al*, 2015; Gottlieb and Haugbølle, 2013). Notably, the model seems to comprise of two separate streams: one focused on actual production (building the project to completion), and the other institutionalised separate roles mainly concerned with overcoming transactional governance using opportunistic behaviours around risk as a criterion to influence construction practices (Pasquire *et al,* 2015; Sarhan *et al,* 2014). The problem with this is that commercial activities such as costing, design, and procurement, are ill-prepared, which indicates that stakeholders performing these functions are not integrated or working in collaboration (Zimina *et al.,* 2012). Among others, these actors include: professional consultants, quantity surveyors (QSs), estimators, and members of the supply chain groups.

In response to these issues, the UK government launched a construction strategy in 2012 that attempted to modernise the procurement model; this led to the introduction of newer approaches like cost-led procurement, integrated project insurance and a two-stage open book (Cabinet Office, 2014). Nonetheless, these advances were only seen at the level of trial projects. A follow-up report by Farmer (2016), sparked a timely debate on this, and some of the critiques revealed a lack of collaboration and value creation, particularly within commercial practices. Unsurprisingly, these issues raised were still linked to fragmentation, which has left stakeholders in charge of commercial activities isolated from 'production' processes, thus allowing waste in construction (Cox & Thompson, 1997; Eriksson & Laan, 2007; Ghassemi & Becerik-Gerber, 2011). Accordingly, the traditional roles of cost consultants within these activities (QSs, PQSs etc.) involved advising clients on cost and risk management matters: an efforts that are also carried out in isolation, encouraging opportunistic behaviours, which creates other issues in the system, widely known but unacknowledged (Love, *et al.,* 2010). Ironically, fragmentation within the UK model not only seems to affect commercial practices, but also stifles CW and innovation (Doloi, 2011).

Whilst the construction environment is highly competitive, fragmentation within the delivery model is now more evident (Bertoni, *et al.,* 2015), as opportunistic practices continued to prevail over partnering (Challender *et al.*, 2014). This has left clients embracing safeguarding approaches as a mechanism to 'bully' contractors, largely through contractual interpretations to maximize their own profits (Pasquire *et al.,* 2015). This lack of shared understanding is seen amongst stakeholders during costing and design activities. Marchesan and Formoso (2001) mentioned that this stems from the narrow view where stakeholders consider costing and design activities as separate functions, thus invariably work in isolation, which in turn affects the dynamism of collaboration (Zimina *et al.,* 2012). Consequently, scholars argued that a paradigm shift is required from the traditional view to systemic thinking, where construction is seen as a 'collaborative production' system (Koskela *et al.,* 2002; Koskela & Ballard, 2012; Mossman, 2009).

In this line of thinking, lean construction is generally considered to have new philosophical approaches that embodied several managerial practices that pursues improvement in construction, thus encourage CW. These practices include integrated project delivery (IPD), Building Information Modelling (BIM) and Target Value Design (TVD) among others. Accordingly, IPD promotes better commercial alignment and incentivize stakeholders in construction (Matthews & Howell, 2005); BIM enables stakeholders to work in collaboration on highly technical models using parametric design components visualising design (Sunil *et al.*, 2011), and TVD steers design and construction processes for client value maximization (Ballard, 2012; Ballard & Reiser, 2004). All these enriched concepts support collaboration where project teams planned, managed and delivered customer's value in a setting where risks and rewards are shared.

It is claimed that TVD transforms costing approach with a more predictability that hence, minimises waste during conceptual stages (Rubrich, 2012). It also has principles that encourage CW amongst stakeholders (upstream to downstream players), where clients tend to have early dialogue over costing, making the final product more competitive (Do *et al.*, 2015). Furthermore, this new approach tied costing and design options with business delivery objectives, through credible validation studies, thereby assisting owners to get what they need within their affordability portfolios, while service providers (e.g., QSs) earn more when they contribute to value realisation (Ballard, 2012). Indeed, TVD practice promote collaboration and increase the level of shared understanding (Russell-Smith & Lepech, 2015) amongst stakeholders.

Arguably, the above described managerial practices have the requisite recipes to address some of the commercial issues earlier raised (costing, design and procurement) within the UK setting, as they seems to have the potential to channels for value creation and shared understanding amongst stakeholders in practice (Lloyd-walker, Mills, & Walker, 2014). Whilst the adoption of these lean concepts is gaining prominence in the global construction landscape, their impact on construction process improvement continues to grow (Daniel *et al.,* 2014; Akintan *et al.*, 2013; 'Motivation and Means, 2016). This is why scholars argued that lean principles are now transforming construction practices; more importantly, providing platforms for CW where clients and stakeholders are involved in value creation (Alarcon, Mesa, & Howell, 2013; Ballard, 2008; Howell & Ballard, 1996). However, in the UK, these practices are less favoured, as examples of poor behavioural relationships in commercial practices still remain (Akintan *et al.,* 2013).

In conclusion, the rationale for this study is summarised in the following way: the importance of CW remains crucial for the UK construction industry reforms. This has been emphasised in 'lean' and project management literature. The above-mentioned lean concepts seems to provide new thinking on collaborative practices. Remarkably, Bertelsen and Koskela (2002) stated that the 'identification of value continuum for customers are not clearly visible at the start in the traditional systems nor their realizations being examined systematically in projects'. This is obvious, given that fragmentation has left commercial and production domains separated within the prevailing system, which is making it difficult to achieve true collaboration in practice. Moreover, the established system still supports the status quo; consequently, cost driven behaviours and wasteful practices continue to spread.

1.2 Problem Statement

The previous section has discussed the study's rationale, this section will build on that looking at the current costing practices, prevailing challenges and their implications in practice. Costing is a commercial function in construction, which focus on providing reliable, accurate, and operational cost information usable for investment and project control. However, the approach has often been criticized in literature. Cited in (Isatto & Formoso, 1998) Johnson & Kaplan (1987) observed that costing information tends to be too late, and distorted to be relevant for production planning and control. Therefore, this becomes past-oriented and too aggregated to be useful in making cost informed decisions. Similarly, Marchesan and Formoso (2001) alluded that early activities in costing is failing to inspire decisions that would improve the overall production results; they maintained that it is mostly developed to satisfy fiscal and financial needs. This point to a lack of sufficient detail at conceptual stages, which continues to permeate uncertainty in the process.

Inconsistency and uncertainty are some of the common themes associated with the traditional costing practice in construction. Elfving *et al.,* (2005) remarked that, uncertainty is the main concern during early design development, as it often leads to unwanted changes, causing considerable amount of waste in projects. Flyvbjerg *et al.,* (2003) reports on the impact of uncertainty during cost estimation, and thus revealed the 'dark side of forecasting'. Elfving *et al.,* (2005) concurred with Flyvbjerg *et al.;* (2003) and maintained that uncertainty during early design increased variability that leads to suboptimal solutions in the process. Despite these empirical evidences, professionals performing these activities (designers, cost consultants, and QSs/estimators etc.) seems to not acknowledge this, and thus proceed despite the imprecisions in the process. Additionally, most of the costs data used in this stage are taken from previous projects, which inherit waste (Pennanen & Ballard, 2008), and, more commonly, owners at this stage often make decisions with these limited data information.

Similarly, authors such as (Kern and Formoso, 2004; Hanid *et al.*, 2011; Ashworth *et al.*, 2013), lamented on these issues. They mentioned design liability, lack of collaboration, isolated decision-making, and limited understanding of costing techniques. Relatedly, Kirkham (2007) pointed out that the classical 'cost planning' technique, which is a key process in cost management in the UK, still follows the conventional process outlined by the RIBA Plan of Work. Consequently, this same approach drives the initial budget setting process through to the eventual production costs; yet, it favours competitive tendering, which allows the iterative cycles of 'design-estimate-redesign' in practice. Evidently, this is where the practice focus more on costing the detailed design instead of establishing a detailed estimate first. Akintoye & Fitzgerald (2000), reported that the current cost management practice still lacks proper communication and feedback channels, as most times, it leads to ferocious competition, with lack of trust and data sharing amongst stakeholders, that ultimately yields increased project cost (Eastman *et al.,* 2011). Cartlidge (2006) affirmed that this growing trend indicates a low level of collaboration amongst stakeholders, which also reveals the lack of interest to develop communication and shared understanding in practice.

Equally, other authors (Nicolini *et al.*, (2000); Marchesan and Formoso (2001); Kern and Formoso (2004); Ballard (2006); & Ballard and Pennanen, 2013) have all reviewed the costing practices in construction. Nicolini *et al.*, (2000) ascertained that the main barrier to the adoption of a 'fully-fledged' version of TC (a concept developed in manufacturing) in construction stems from the extant commercial practices in the UK construction industry. This continue to support fragmentation among stakeholders, especially among contractors, who mostly operate without fully understanding costs across their supply chain. The norm within the costing approaches has often been to develop designs first, and then invite prices from suppliers who are not involved during early design development. The result is usually a series of prices based on commercial judgments, instead of true costs. Costs, as opposed to prices, are rarely investigated, thus margins are dependent upon expediency. Similarly, Laryea (2010) examined the reliability of estimated costs provided for projects in Ghana, and reported that projects estimated by consultants, experienced an average cost overrun of 40% and time overrun of 62%, however projects priced by contractors, experienced an average cost overrun of 6% and time overrun of 41%. This seems to show that contractors have some understanding of actual costs, but, when consultants are involved, up to 40% of estimated cost is added as margin for imprecision. These statistics are alarming, and even though the study was reported from a developing country, it still highlights the inconsistencies and the lack of shared understanding in practice.

Over the years, cost overruns have grown in projects and become the norm rather than the exception, particularly in infrastructure projects (Love *et al.*, 2017). Owusu-Manu *et al.*, (2016) suggested that the issues of cost overruns are not prevalent because projects do not go according to cost plans (budgets), but rather because these plans do not represent the project. This is not surprising, given that collaborative discussions during these processes are often non-existent at the feasibility stage, and more because costing and design are not considered as integrated and part of 'production' system. Thus, the challenge in predicting future uncertainty in construction cost management, presents substantial aspect of 'guess-estimation' (Ballard, 2006).

This often yields significant disparity between initial budget forecast and the actual construction cost of projects (Raisbeck & Aibinu, 2010). Similarly, projected costs for many large construction and infrastructure schemes often escalates during these early stages; these are due to the high disparity in procurement strategies deployed, which presents risk and uncertainty (Owusu-Manu *et al.,* 2016). As usual, this results in too much fire-fighting during project delivery, dealing with cost uncertainty and managing the consequences of changes to brief and project scope (Laryea, 2010). Likewise, previous explanations such as optimism bias and strategic misinterpretation (Flyvbjerg &

Holm, 2002) do not enabled us to understand the wider underlying conditions that contribute to poor costing practice (Love *et al.,* 2011). Empirical evidence shows that most of the common problems of cost management are 'institutional' and due to organisational cultures, rather than inherent in project-work (Wearne, 2014). Thus, this shows that examining the interactions of stakeholders during early costing activities in a bid to improve the accuracy and reliability in the process remains critical.

Attempts to explain these concerns have led to a growing body of research stressing the need to improve collaboration during early costing phase in construction. For example, the study of Shalpegin *et al.,* (2018), examined collaborative prototyping scenarios where manufacturers involved suppliers in the detailed design process, revealed that it had significant influence on the manufacturer's optimal decisions. The authors recommended that such approach needed adjustment to capture suppliers at conceptual stages, as this tends to reduce commercial friction. This was also seen in the study of Ballard (2006), who cited that industrial sectors are more disciplined in this regard than the general building sector, and stressed on the importance of shifting the construction industry's focus from prices to costs.

A subsequent study (Pennanen and Ballard, 2010), which was based on descriptive research, discovered that the use of the TVD system to define and deliver scope (what is wanted) within client constraints (cost, time, location, etc.) improves accuracy of conceptual estimating process. Similarly, the study of (Afonso, 2012), that examined the conditioning factors required for strategic collaborations amongst firms, revealed that mutual dependence, trust, and extensive information sharing were the key prerequisite factors for better buyer-supplier interdependence and involvement, as well as on the overall benefit of supply-chain integration. The author further added that the practices of target and kaizen costing, value engineering, and design-to-cost were perceived to have a remarkable positive effect on the internal/external organizational boundaries.

Furthermore, (Jacomit & Granja, 2011) examined various literature that captured the application of TVD in construction, and added that improvement is required in the context of construction, as target and production cost breakdown needs major attention, mainly through the development of specific inter-organizational cost-management systems. Similarly, Jung *et al.*, (2012) who used the game theory concept to compared design-build delivery systems with IPD using TVD, considered collaborative design alignment, illustrates how target-costing strategies shifted the traditionally dominant behaviour to cooperative management practice. According to the authors, this kind of economic approach is expected to give more depth in understanding collaborative practices, which might suggest what level of target cost is appropriate and how risks and rewards need to be shared to encourage wider collaboration. Other studies that suggested the use of collaborative approaches in costing and procurement include: Laryea (2010), Love *et al.*, (2017) and Tillmann, Do and Ballard (2017). Indeed, these findings showed a growing trend, which indicates that collaboration is an integral component required to transform the traditional costing approach in construction, which means developing an approach to support such needed transition on the current practice is essential.

To date, studies that examined commercial practices have focused mainly on BIM application (Kehily & Underwood, 2017; Smith, 2014; Turk *et al.,* 2014), whilst others addressed specific organisational and contracting issues (Matipa and Keane, 2008; Sadreddini, 2012; Akintan *et al.*, 2013; Bashir *et al.*, 2015). On the same continuum, studies that examined collaborative practices and innovation still emphasize the need for better efforts to improve stakeholders integration and process management (Brien, Mbachu, & Lomax, 2014; Eriksson & Westerberg, 2011; Nagalingam, Jayasena, & Ranadewa, 2013; Ofori & Toor, 2009; Rogage & Gledson, 2018; Zimina *et al.,* 2012; Zimina & Pasquire, 2011). Therefore, the foregoing discussions indicate that commercial practices (costing, design, and procurement) need aligning with production activities to underpin industry-wide CW. In light of these problems, this study will explore on how stakeholders can collaborate over costing within the UK construction industry. This is important, as it will inform the development of a framework, that would guide stakeholders to 'costs projects collaboratively' thus creating opportunity for commercial actors to be deeply involved in CW practices.

1.3 Research Questions

Based on the forgoing discussions, the following research questions have been developed:

RQ1. What does 'costing collaboratively' mean?

RQ2. What are the factors affecting CW that drive commercial behaviours?

RQ3. How would the integration of commercial actors improve CC approaches in the UK construction industry?

1.4 Research Aim

The aim of this study is to develop a framework that would guide stakeholders to 'costs projects collaboratively', creating opportunities for commercial actors to be deeply involved in collaborative practices within the UK construction industry.

1.5 Research Objectives

1. To critically review commercial practices within the prevailing UK construction system.
2. To explore the notion of 'costing collaboratively' in construction practices.
3. To investigate the perceptions of 'costing collaboratively' in the UK construction industry using TVD as guiding lens.
4. To examine commercial practices in traditional and multidisciplinary settings, identifying factors that affect CW in the UK construction industry.
5. To develop and evaluate a framework that would guide stakeholders 'cost projects collaboratively' in the UK construction industry.

1.6 Overview of Work Done

The study is intersected within costing/commercial practices, collaborative working and lean thinking concepts in construction. Accordingly, the idea of 'costing collaboratively' (CC) was explored within the UK construction industry. Firstly, the study reviewed Koskela's production theory of transformation-flow-value (TFV) as a widely acclaimed concept in lean construction practice, which provides a deeper understanding of flow and value in construction. In addition, integrated project delivery (IPD) system was contrasted with the UK prevailing delivery routes in construction to grasp the full depth and understanding of 'collaborative production' (Howell & Koskela, 2000). Therefore, this research is placed in the intersection of commercial practices; lean and collaborative working approaches (Figure 1-1).

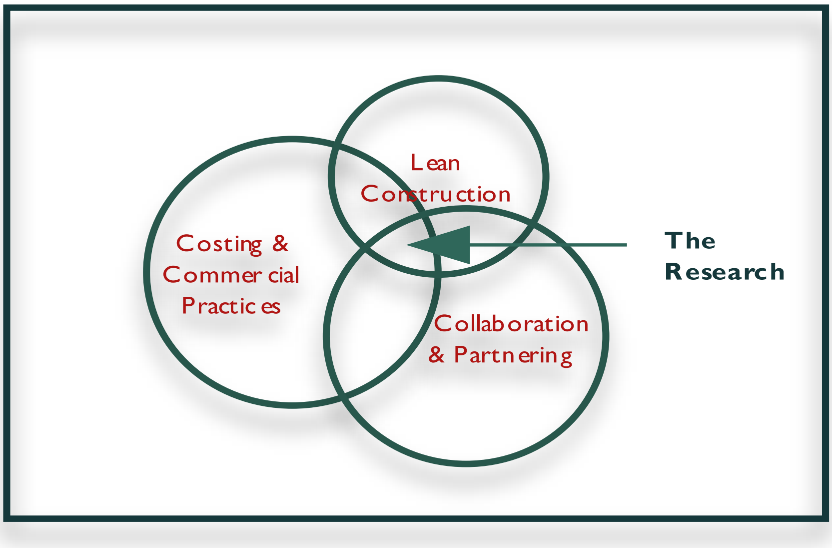


Figure 1-1: The position of the research within existing knowledge.

Furthermore, institutional theory concept was also considered in this study as part of the theoretical lens, shedding light on cultural and behavioural theories.

The scope of this study embraced the description and definition of CC in construction, identifying issues and challenges. It also reflects on commercial practices and collaborative working. These explorations examined the adaptation of target costing approach and its influence on CW. The literature review established the current state of knowledge in this areas, where accordingly the research gap was identified. The review structure adopts the funnelling approach (Wellington, 2005) as illustrated in Figure 1-2. This indicates how each chapter began with its introduction, overview and discussions. Further, pertinent issues were highlighted and narrowed down to the main discussion on the existing knowledge where conclusions were drawn.

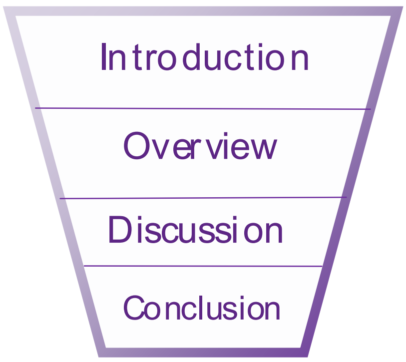


Figure 1-2: Structure of literature review chapters.

Accordingly, critical literature review was conducted, which strengthens the philosophical position of this research, and accordingly a suitable method was selected. Initially, the study began with a semi-structured interview of 25 industry practitioners. This allowed the researcher to consolidate findings and restructure the study focus. Subsequently, three multiple case studies were conducted using semi-structured interviews and documentary analysis to gather further research evidence. The sections below explained the process and the stages of the work done.

1.7 Overview of the Research Methodology

Methodology is primarily the approach to discover new knowledge, with several techniques to achieve a research aim and objectives. Therefore, it is important to identify a suitable strategy for adoption, given that methodological choices are influenced by philosophy and paradigms. Hence, from an ontological position, this study leans towards a social constructivist view, which holds that realities are co-construction of the world. This view centres on subjectivity with social interactions and textual phenomenon, thus inclining towards interpretivist epistemology.

This study is exploratory in nature, as a result, five research strategies were considered to address the study's objectives as suggested by Hunter and Kelly (2008). These include: action research, grounded theory, qualitative interviews, case study and ethnography. All the above-mentioned strategies have their advantages and disadvantages. The purpose of selecting a suitable design is not only to support and answer the questions, but also to fulfil its practical limitations. As such, interview and case study were considered appropriate for this study. This is because authors like Bryamn and Bell (2011) and Fellow and Liu (1997) maintained on the importance of using qualitative research designs to explore real-life issues compared to other strategies like survey. Therefore, qualitative interviews and case study strategies were adopted, given that the study intent to explore the practical understanding of 'costing collaboratively', in order to broaden the perceptions of collaboration in the UK construction industry. The overview of the research stages are highlighted below.

1.8 Overview of Research Process

The following are brief descriptions of the research process.

Stage 1: Literature review

The literature review began with the evaluation of the UK construction industry activities, its characteristics and significance to the economy. This was followed with an examination of the construction business model, project delivery approaches and commercial practices, all in line with the CW practices in the construction industry. Lean construction system approach was reviewed as basis for comparison, as its gaining much traction in construction, and reshaping project delivery practices.

Furthermore, the study reviewed the concept of CW in the construction domain, and the interconnections with costing practice. Through this, the idea of CC was described in theory and then probed in practice. The review used the TVD concept as a guiding lens, which enabled the extent of collaboration within the current costing practices in the UK to be explored. The procedure was carried out through systematic literature review as described by (Kitchenham and Charters 2007). This is usually applicable when there is minimal empirical or when the research area is too broad at the point of initial exploration. Thus, the review started by identifying search terms and definitions. This was accomplished through a database selection from scholarly journals, technical reports, conference proceedings, textbooks google scholar as well as Nottingham Trent University (NTU) database.

Stage 2: Exploratory Semi-Structured Interview Process

After the literature review, stage two was set out to develop the research instrument to investigate the perceptions on CC across the UK construction industry. This was achieved using exploratory interviews (see appendix 1 for copy), which involves project managers, lean construction practitioners, designers, commercial directors senior QSs and main contractors. The participants were drawn from building, construction, and infrastructure backgrounds in the UK construction industry. 25 in-depth interviews were conducted over a 14-month period. This guided the author to the ascribed definition and perceptions on CC and more importantly, restructured the research to identify other essential areas of interest while examining CC in practice.

Stage 3: Multiple Case Study

The case study investigation commenced after the research instrument was developed. This process mainly used documentary review and semi-structured interviews as the main tool for data collection. Documentary evidence is important, as it corroborates the data obtained from a case (Knight and Ruddock, 2008). The main purpose of the case study was to further understand the perceptions of CC amongst stakeholders and see how it's progressing in practice. Equally, the study embark on finding how commercial actors are aligned in multidisciplinary setting, as well as to understand the factors influencing their behaviours. The case studies were conducted over a 12-month period. All the three case studies were from the infrastructure sector.

Stage 4: Development and Evaluation of Framework for CC

Following the activities in stages 1 to 4, a framework was devised to guide stakeholders 'cost projects collaboratively' in the UK construction industry. The proposed framework is known as 'costing collaboratively' (CC), which comprised of two components: organisational commitment factors and early costing interactions. To determine its functionality, six construction industry practitioners evaluated the framework. In addition, a guidance note description was developed, which provides detailed explanation.

1.9 Contribution to Knowledge

The contribution of this research emerged after revealing the disconnect and lack of collaborative working in commercial functions (costing & design) with production activities within the UK prevailing construction model. This study has contributed to knowledge on how collaborative costing can be achieved in construction. Accordingly, shed light on wider factors affecting collaborative working approaches, which informed the development of framework that aimed to guide stakeholders (client, designers, contractors, cost consultants & supply chain groups) cost projects in collaboration.

1.10 Thesis Structure

Figure 1-3 presented the structure of the thesis. It consists of eight chapters; these are briefly presented below.

Chapter One: Introduction to the Study

This chapter introduced the study context, which discussed the background, rationale, and statement of the research problems. It identified the research aim, objectives and the research questions. It also presents the study rationale and justification. Furthermore, it concludes with an overview of the work done, the contribution to knowledge and the thesis structure.

Chapter Two: The UK Prevailing Construction Model

The chapter presents the nature and characteristics of the UK construction industry. It then examined and discussed commercial practices and the implications of separating commercial activities from production system. The chapter highlight 'institutionalised' factors as the main barrier influencing commercial practices. The chapter concluded by exploring concepts within the lean system such as: LPD, and IPD, and their relationships with CW in construction.

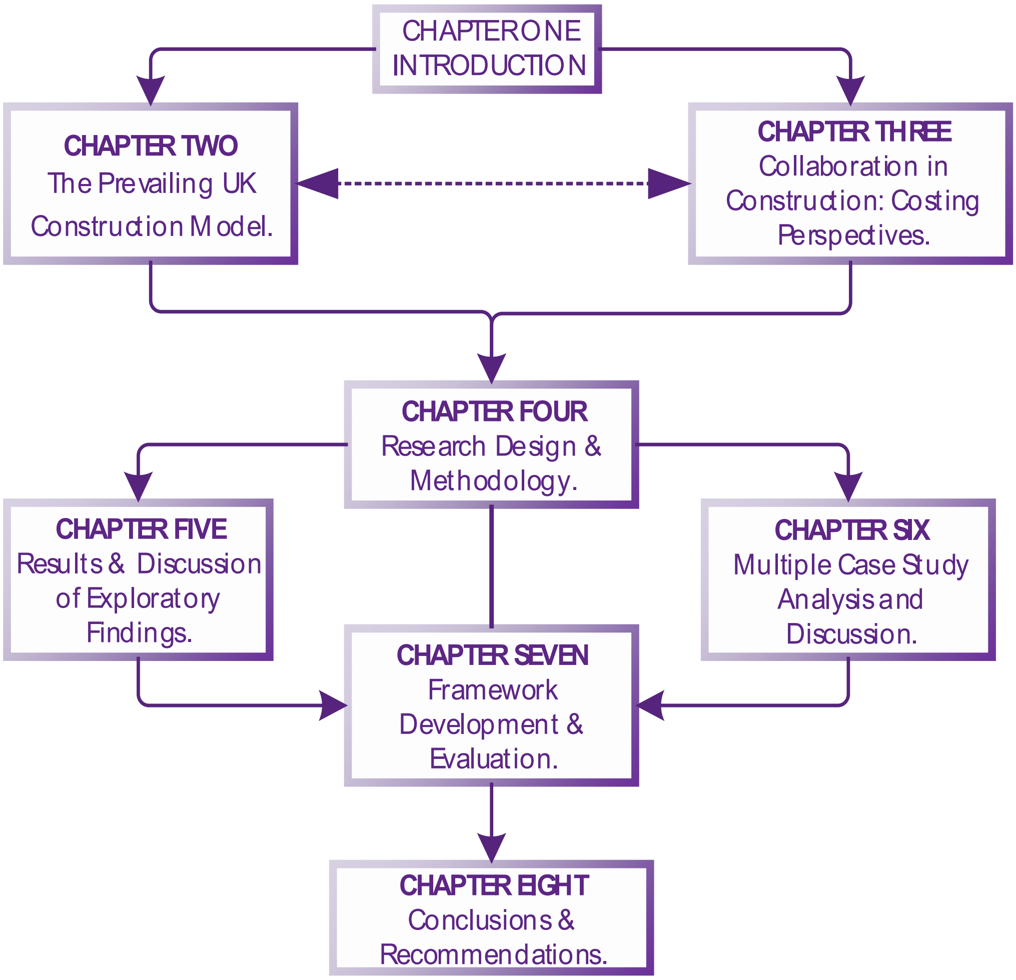


Figure 1-3: Thesis Structure

Chapter Three: Collaboration in Construction: Costing Perspectives

This chapter presents the wider outlook of collaboration, and concepts that support early stakeholders' engagement during costing practices both in manufacturing and construction industry. The chapter reviewed TC approach and the development of TVD as a matured system in the construction. This was then compared with the UK costing model, which reveals implications, differences, and areas for improvement. The literature review process was conducted through systematic review of the International Group for Lean Construction (IGLC) papers on TC and TVD development and applications.

Chapter Four: Research Design and Methodology

The chapter provided detailed account on the research strategy, and methods used to gather information, thus addressed the proposed aim and objectives mentioned in chapter one. The research methodology and design used were also justified in this chapter.

Chapter Five: Results and Discussion of Exploratory Semi-Structured Interviews

This chapter presents and discusses findings from the semi-structured interviews. The chapter discussed the current perceptions of CC and its progress within the UK construction industry. It also discussed factors that influence commercial behaviours and the wider practice of collaboration in the UK construction industry.

Chapter Six: Multiple Case Study Analysis and Discussions

The chapter analysed, presents and discussed findings from the three case studied. It also presents the cross-case study findings.

Chapter Seven: Framework for 'Costing Collaboratively'

Chapter 7 presents the framework developed based on the data gathered from stages 1, 2, 3 and 4. It also presents the qualitative evaluation feedbacks on CC received from industry practitioners.

Chapter Eight: Conclusions and Recommendations

Chapter 8 discussed the main conclusions and recommendations of the study. It presents the conclusion of the research questions, and the original contribution to knowledge; as well as the study's limitations and recommendations for further research work.

1.11 Chapter Summary

The first chapter provided a high-level overview of the research process and the contribution to knowledge. The next chapter will present a review of literature on the prevailing UK construction model in construction.

CHAPTER 2 THE PREVAILING UK CONSTRUCTION MODEL

2.1 Introduction

Chapter 1 introduced the research background, knowledge gaps, and rationale for the study. This chapter reviews the prevailing UK construction model, and the separation of commercial functions from production systems, thus highlighting implications for CW. Firstly, the chapter presents an overview of the UK construction industry. This includes its definition, characteristics, and significance for socio-economic development. Furthermore, the chapter identifies and discusses the main project delivery routes that dictate working relationships in practice, which are then contrasted with the emerging lean concept - integrated project delivery (IPD). In addition, the chapter highlights some misunderstandings of the term ‘lean production’ from the traditional view. Chapter 2 fulfils objective one of this research study, and thus sets the foundation for further exploration into collaborative practices within the UK construction industry.

2.2 Definition & Description of the UK Construction Industry

The Architecture, Engineering and Construction (AEC) sector, remains significant to the UK economy, contributing an average of 8% of the national GDP. The industry is diverse and complex, covering a wide range of business interests. This brings together the common usage of land for infrastructure development (Ashworth *et al.,* 2013). The sector is dynamic with increased advancements in technology, financial management, and process development (Chan *et al.,* 2004). This composition brings together stakeholders such as contractors, consultants, and product producers (ONS, 2017; Pearce, 2003), offering a wide range of services and innovations.

Accordingly, as the scope of the industry has developed, its description has also changed. Pearce (2003) asserts that the environment covers several activities: from those involved with in-situ construction, repair and maintenance of buildings or engineering works, to those who manufacture and sell materials, professional services, household repairs, construction works and other non-contracting organisations. From this, the industry can be seen as: (a) a construction contracting industry; (b) an industry that provides professional services; and (c) a sector that offers construction products and materials (Cabinet Office, 2014). Therefore, the sector seems to cover general construction and demolition, construction and repair of buildings, civil engineering, installation of fixtures and fittings, and building completion such as painting, glazing and plastering (Morton, 2002). This means that it entails wider human artistry, the business of construction, and a comprehensive project cycle, in addition to the site level activity, which implies that construction in the UK transcends site level activity.

However, these definitions and descriptions are often blurred (Ashworth, 2010). Murdoch and Hughes (2008) observed that people often view construction from their professional viewpoint. Thus, most descriptions of the industry seems to come from these views. Nonetheless, construction activities within the sector often include erection, repair and demolition of products as diverse as houses, offices, shops, dams, bridges, motorways, home extensions, chimneys, factories, and airports. However, several organisations within the sector engages in some form of specialist work, and very few are confined to a single building or technology. Therefore, to grasp the full knowledge and understanding of the UK construction industry, Barrie and Paulson (1992) added that one must be familiar with its scope and the professionals that contribute towards delivering these final products.

Contracting 2,030,000 jobs 234,000 businesses £63 billion GVA.	Services 850,000 jobs 30,000 businesses £14 billion GVA	Products 310,000 jobs 18,000 businesses £13 billion GVA
• Construction of buildings e.g. commercial, residential • Civil engineering e.g. roads, tunnels, bridges, utilities • Specialised construction activities e.g. electrical and plumbing installation, demolition and site preparation, plastering, painting, roofing etc.	• Architectural & quantity surveying activities • Wholesale of wood, construction & materials • Wholesale of hardware, plumbing & heating equipment. • Renting & leasing of construction equipment etc.	• Manufacture of construction products & materials: • E.g. bricks, tiles, cement, concrete products and plaster • Metal structures, doors and windows of metal, carpentry and joinery etc. • Wiring devices, electric lighting equipment etc.

Figure 2-1: Composition of the UK construction sector (Source: ONS Annual Business Survey, 2013).

In view of this, Myers (2005) described the range of actors who are included in the broad definition of construction as encompassing: suppliers, manufacturers, site operatives, project managers, surveyors, developers and architects, and facilities managers as grouped in figure 2-1. These actors provide a range of services such as supplying of basic materials, equipment manufacture, coordination of overall assembly, designing and maintaining of new products, and provision of logistics. Thus, it is important for this study to clarify how the UK construction industry is viewed. Therefore, this study considers the UK construction industry to encompass all of the above-mentioned descriptions. In other words, a broader definition of construction, as grouped in Figure 2-1 (types of activities and product services offered by actors in terms of gross value and employment).

2.2.1 Significance of the UK Construction Industry

Research statistics have shown that, in terms of output and contribution to the economy, the UK construction industry is enormous. The sector is dominated by small and medium-sized enterprises (SMEs), ranging from contracting and provision of construction related professional services, through to the construction of products and materials (Ukces, 2013). According to the Office for National Statistics (ONS) UK (2017), the sector had a turnover of £370bn in 2016 (adding £138bn to the UK economy (9%) in value added) and comprised of over 280,000 businesses covering some 3 million jobs, which is equivalent to about 10% of total UK employment. The contracting part of the industry accounted for about 70% of the total benefit generated by the UK construction, and almost 70% of the sector's jobs (ONS Employment and labour, 2018). In addition, there are other wider benefits that construction offers to the industry. These include creating, building and maintaining construction businesses, with economic infrastructures that keeps the nation connected; with schools and hospitals services, which the society needs.

The above shows that, the continued growth of the industry is important for socio-economic development in the UK. However, clients and stakeholders continue to demand that the industry's products are delivered on time and budget, and within acceptable quality limits. These expectations have put increasing pressure on construction actors to improve efficiency in practice. However, the implication for the industry on this is that various teams would have to work together to harness their resources more efficiently. Importantly, this puts the idea of integration at the heart of the government's agenda for sustainable delivery of construction. Therefore, given the enormous scale of the construction industry and its impact on the environment, it is obvious that any incremental improvement in innovation would have a significant impact on the economy.

2.2.2 Characteristics of the UK Construction Industry

The UK construction industry is under tremendous pressure to modernise and become more sustainable in terms of delivering higher quality projects at lower cost (HM

Government, 2013; ONS, 2017). However, a decline in construction productivity has been a long-standing issue in the sector. Over the years, the industry has continued to see reports and publications from government, stakeholders and within academia, lamenting about projects dissatisfactions (Farmer, 2016). More recently, studies have cited on low productivity and structural fragmentation as attributes of the UK construction environment.

Figure 2-2 and Figure 2-3 revealed the upturns in UK productivity in construction, which coincides with economic slowdowns. This shows that, in high output periods, less productive workers entered the industry, diluting the overall productivity (Farmer, 2016). This was noticeable in construction, due to labour still being the dominant factor in overall unit productivity, whereas in other industries, automation effectiveness is much more significant. Savio *et al.*, (2014) and Cha *et al.*, (2015) suggested that over 57% of construction efforts are wasted because of non-value adding transactions. Crotty (2012) indicated that 50% of projects in the UK suffers both cost and time overruns. Farmer (2016) added that these numerous failures that have adversely affected the UK industry stems from: poor productivity, fragmentation, commercial behaviours, lack of early well-defined client briefs, and the tendency of clients to change their requirements late during the costing/design/procurement/construction phases, thus resulting into large-scale re-works and defects rectification.

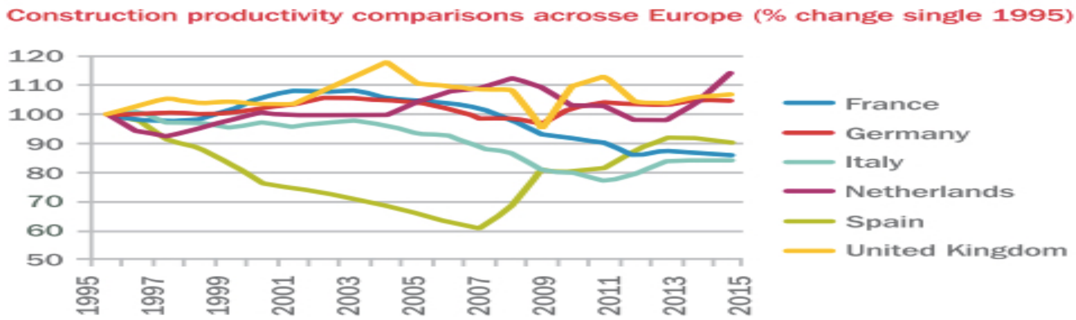


Figure 2-2: Productivity index output (Source: ONS Labour Productivity, 2015).

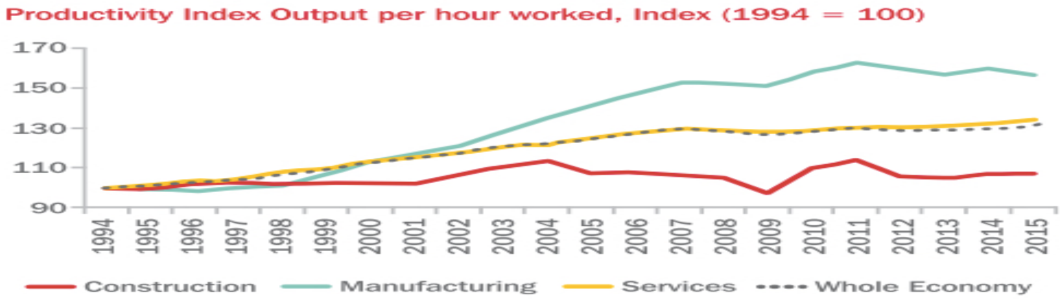


Figure 2-3 Construction productivity comparisons across Europe (Source: OECD Productivity and ULC by main economic activity 2015).

This correlates with what Kirkham (2007) mentioned: that the inherent nature of the industry and the environment in which it operates are suited to today's high intensity innovations, because most projects have multiple stakeholders and carry greater risks and uncertainties. This matched what Anumba *et al.,* (1998), suggested that most of the industry's drawbacks can still be attributed to the fact that construction is functionally organised. Herein, information flows sequentially to each party, from the client to the suppliers, as seen in Figure 2-4. Each step has associated handling and processing costs, time implications, delays and potential for error. This indicates that teams have been working in isolation with little or no concurrence.

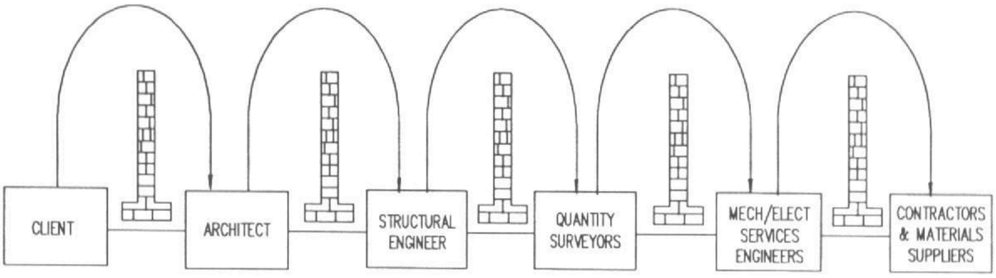


Figure 2-4: Functional orientation within the AEC sector (Evbuomwan and Anumba, 1998).

That said, Fellows *et al.,* (2003) suggested that new concepts have now emerged, which increasingly being adopted in the UK, albeit incrementally, in a bid to change the current status quo towards more simultaneous approaches. Amongst others, these practices include: collaboration/partnering initiatives, and integrated concepts e.g., lean construction, and BIM.

2.2.3 Demands for Performance Improvement in the UK Construction Industry

Traditionally, the UK construction industry is widely known for its risk-averse style, inefficiencies, lack of trust, and failure to modernise (Eriksson & Laan, 2007; Gohil *et al.,* 2011; Koskela, 1992). Over the past 70 years, there have been repeated government/client-initiated reports and academic research papers, all aiming towards performance improvement. These publications highlighted several areas of concerns and recommended means for improvement. Specifically, Latham and Egan's reports called for the integration of processes and teams around the product as an improvement strategy. The Wolstenholme (2009) report and the Government construction strategy (Cabinet Office, 2011) followed, and built upon the earlier reports, but hardly anything changed. For instance, it is evident that partnering and framework arrangements continue to lose ground, in the face of lowest price tendering. In 2013, the construction 2025 report further stressed that the industry has lost opportunities for innovation due to the lack of process integration, and challenged the industry to improve by integrating stakeholders early on during projects.

However, the successive demands for collaborative practices show that these calls have not been fully listen to by the UK construction industry, primarily because the industry has now adopted a 'survivalist' mentality, wherein surviving has become the commercial imperative (Farmer, 2016). This is evident, as clients currently prefer the conventional project delivery routes; this fortifies the traditional procurement protocols, entrenching deep-seated cultural attitudes that across all boundaries, thus resisting change (Farmer, 2016). With this growing mentality, Farmer, in his report (*Modernise or Die, 2016*), emphatically suggested on adopting manufacture-led advances in the UK construction industry, and stressed that delivering construction in a more ‘collaborative production’ fashion is desired. This supports other views that criticize the prevailing UK construction model as incoherent and entrenching wastefulness, despite the substantial attempts to address the recognised inadequacies (Sarhan *et al.*, 2014).

Concurrent engineering as a manufacturing advancement emerged in the early 1990s, through the Toyota’s principles of set-based design. This has addressed the failures in construction, transforming delivery approach from activity-thinking to a systemic approach (Liker, 2004). This integrated way of working is less costly and results into more expedient product development, ensuring that the right people are involved at the right time during product development (Tezel, Koskela, & Aziz, 2018). This is contrary to the prevailing UK construction system, where teams are functionally organised, with lack of communication or forward ways of thinking. Zeeshan (2011) added that integrated systems allow independent tasks during product development to be carried out simultaneously rather than sequentially during product development. For instance, if planning and product design (costing and design activities) in manufacturing are carried out side-by-side, the interactivity leads to early problem identification. Key principles of these approaches include: simultaneous working, focusing on process rather than function and conversion of organisations into cross-functional teams (Ballard, Koskela, Howell, & Zabelle, 2001).

Accordingly, these changes gave rise to the lean production movement that is now gaining much prominence in various construction industries and reshaping project delivery approaches. The lean concepts focus on adapting the manufacturing principles to improve efficiency in processes and performance among stakeholders in the construction industry (Bertelsen & Koskela, 2002). However, this new philosophy is not much favoured within the UK construction landscape (Common *et al.,* 2000), as fragmented roles and hierarchical arrangements continue to dominate project delivery systems (Baiden *et al.,* 2006). Thus, to understand these inadequacies within the UK construction model, it is equally important to evaluate the role of commercial actors within the delivery model, and to unpack the cultural antecedents that are preventing CW and performance improvement.

2.3 Project Delivery Routes within the UK Construction Industry

Contractual arrangements dictates the relationships between various stakeholders and characterise how they intend to deliver project end-values. These arrangements preserve the traditional procurement system, which is often used to deliver construction projects (Baiden, 2006). Hence, Masterman (2002) remarked that the procurement strategy adopted also influences several contractual behaviours in practice. Accordingly, these contractual strategies are widely used within the UK system, although, the definitions of project delivery systems (PDS) in construction differs. According to ASCE (2000), PDS describes how participants are organised to interact, and transform the owner's goals and objectives into a finished project (Chen *et al*., 2011).

Kenig (2011) added that PDS it is a comprehensive process of assigning contractual responsibilities for the design and construction of a project. AIA described it as a method for selecting and allocating roles, responsibilities, risks and rewards, among the party's task of undertaking design, preparation of construction documents, and management of construction projects (CSI, 2011). Consistent elements within these definitions are the 'relationships of project participants' and the 'timing of engagement' (Konchar & Sanvido, 1998). In other words, PDS is seen as a delivery approach that highlights relationships between various project stakeholders and their timing of engagement to provide a built facility (El Asmar *et al.,* 2013). From these descriptions, four basic project delivery strategies have emerged, which are commonly adopted in the UK (Harris & McCaffer, 2003; Masterman, 2002). These include:

1. Traditional delivery system or Design-Bid-Build
2. Design-Build
3. Management Oriented Methods and
4. The Non-Conventional Techniques (partnering, alliancing, PPP/PFI etc.)

These methods clearly vary, starting with the traditional that sees clients engaging designers early and later inviting contractors to submit prices for competitive quotes, and others that require contractors to provide both the design and construction services. Other methods, such as the two-stage tendering, allow early engagement using a fast track system, helping contractors to finish early via the traditional means. There are also some emerging methods that are in use now, which include private finance initiative (PFI), public private partnership (PPP), joint venture and build operate and transfer (BOT). Nonetheless, the most common methods used in the UK are the DBB, D&B, Management methods, and occasionally the partnering techniques.

2.3.1 Design Bid Build Approach (DBB)

The traditional method, also known as DBB, is one of the commonly adopted project delivery systems in the UK. It is popular because of its simplicity, with a rigid separation between design and construction phases, which it easier for bidders to have a perfect understanding of project scope (Kantola & Saari, 2016). In this system, clients have separate contracts with the designer and the constructor. Detailed drawings, specifications and Bill of quantities (BOQ) are prepared by the design team that leads to tender preparation, and the contract being awarded to constructors, usually on the lowest bid (Potts and Ankrah, 2013). The basis of reimbursement is a set of price exchange for a scope of work, and the client, designer and the constructor manage their risks separately (Mesa *et al*., 2016). Key benefits of this approach include flexibility during construction; it also allows competitive bidding and fixed price, which ensure equitable criteria for bidding the job specifications.

However, the system has been highly criticised. It has been embraced since the 1940s, shaping public procurement policies and widely used for project delivery in the united states (US) and UK (Becerik-gerber & Kent, 2010). Egan (1998) remarked that it forms multiple subcultures and stereotypes within the sector, causing fragmentation and intra-team boundaries (Moore and Dainty, 2001); it restricts designers, leaving bidders with no room for innovation, and drives sub-optimal performance in practice (Xue *et al.,* 2005; Col Debella and Ries, 2006). The approach often results in a sequential construction process, where some parties are temporarily engaged at certain stages, which encourages 'one-piece' optimisation instead of the whole project (Osipova & Eriksson, 2011). Of interest, integrating consultants (e.g., QSs) within this approach is a challenge, as consultants in general are marginalised during early design and construction development. A good example is the typical position that cost consultants (QSs etc.) occupied during costing activities with their counterparts (Johansen *et al.,* 2004). Consequently, the role of a contract in this arrangement is to buttress the state-of-affairs by shifting blame, which encourages confrontation (Klein, 2004). This system has now become less popular, as clients are aware of its high associated risks, coupled with the fact that, in 2003, the UK government stressed that (non-integrated) strategies should no longer be used, unless they represented the best value for money (OGC, 2003). However, several studies and the UK wide-industry reports indicate that the traditional approach is still adopted by many organisations, despite not being approved by the UK government (CIOB, 2010; Eadie *et al.,* 2013; Oyegoke, *et al.,* 2010). Hence, this delivery approach further highlights fragmentation and professional hierarchy, which is stifling CW. This is despite it being suggested that aligning stakeholders' objectives ensures project success, and in turn prevents conflict (Bennett *et al.,* 1995; Meng *et al.,* 2011).

These points raise the question of why this method has so much traction in construction and is still commonly used in various countries, offering little room for collaboration amongst stakeholders? Indeed, this situation is fits well with commercial actors like QSs, PMs etc.; (Johansen *et al.,* 2004), hence, the increase in project costs and conflicts remains. Besides, most consultants in this arrangement are paid on professional fees, which makes it hard to align their interests with the overall project goal.

2.3.2 Design-Build Approach (DB)

The Design-Build (DB) delivery approach is a well-known and established system, and the most popular route in the UK construction industry (Potts and Nii, 2013). O'Brien (2007) reported that the system was first introduced in the 1960s to coincide with the need for faster project delivery and completion times in construction. However, it was not until the 1990s that it was developed in the UK (Kent, and Becerik-Gerber, 2010). DB has been used as an integrated way to deliver projects, which highlights the overlaps of the design and construction phases, so that early stages of construction can commence before design is completed (Masterman, 2002). In this system, the owner has one contract with a design-builder: a single entity that performs both design and construction work (Mesa *et al,* 2016).

Within DB, a single contractor assumes the risks and responsibilities for designing and constructing the project, usually in return for a fixed-price lump sum (RICS, 2010). Clients sometimes appoint a project manager (PM) or Quantity Surveyors (QS) to safeguard their interests, but the contractor normally withstands the risks associated with design and construction, which gives clients greater protection (Potts and Nii, 2013). The system has a single contractual relationship that is borne between the client and the contractor; whilst the amount of time saved can be as much as 30-50 percent, the cost of the project remains unaffected (Ibbs et al., 2003; O'Brien, 2007). The contractor also enters into an agreement with sub-contractors, consultants, and suppliers, to deliver the project in accordance with the earlier pre-agreed specifications. The DB system has been reported to improve project costs, schedules and quality performance, partly because of the integration of the design and construction teams, which also revealed pain/gain sharing between designers and constructors (Mesa et al., 2016b). The organisational structure of this system is an improvement over the DBB method; communication, team building, trust and integration are strong elements in this system (Chan *et al.,* 2010).

However, some authors have reported that DB is subject to significant challenges associated with its usage in the public sector. This stems from the concerns regarding the manner of justifying the evaluation process to the public (Koushki, *et al.,* 2005), and the sheer expense in complying with the tender and prequalification procedures (Hughes *et al.,* 2001). It provides little flexibility for the owner to make changes after the initial design has been approved and when the contract amount is established (Jackson, 2011).

This approach does not overly differ from the traditional methods, as designs are outsourced to external consultants with little or no team scrutiny (Sarhan & Fox, 2013). Similarly, it reduces cost management, where clients make a full commitment prior to design completion and price often dictates the project at the expense of quality (Ashworth *et al.,* 2013; Cooke, 2004). DB also has other arrangements, such as design-novation, where (after developing the project brief), a consultant (architect) and a contractor are selected to complete the post-contract design work (Griffith and King, 2003; Konchar, 1997). Furthermore, Griffith and King (2003) identified that various flaws exist within this approach, which are detrimental to project outcomes. These include increased contingencies in contractors' bids because of unfair risk allocation, biased contractor-selection decisions, and 'no-scheme-no-fee' basis payment systems for pre-novated architects, and dual loyalties on architects' post-contract designs and communication routes. Thus, Masterman (2002) added that working relationships between the novated design team and the DB contractor can become strained because of the imposition on the design team by the client. Despite the benefits of DB with novation and its increasing popularity, Griffith and King (2003) added that it potentially creates fragmentation and value-loss within the supposedly integrated approach; hence they regarded it as imperfect solution to overcoming the issues associated with fragmentation and professional hierarchies in procurement practices.

2.3.3 Construction Management at Risk (CM@R)

Construction management at risk (CM@R) project delivery, is a method where the owner retains a designer to furnish a design service, and retains a construction manager to provide construction management services for a project throughout the preconstruction and construction stages (Harris & McCaffer, 2003; Masterman, 2002). These services may include preparation and coordination of bid packages, scheduling, cost control, value engineering, and construction administration. The construction manager is usually a licensed general contractor and guarantees the cost of the project (guaranteed maximum price or GMP). The owner is responsible for the design before a GMP can be set (Mesa *et al.,* 2016). Unlike DBB, CM@R brings the constructor into the design process at a stage where they can have definitive input. The value of the delivery method stems from the early involvement of the contractor and the reduced liability of the owner for cost overruns.

It has been reported that the CM@R structure promotes more trust amongst project participants than the DBB method, partly due to the benefits realised through collaborative working relationships (Jackson, 2011). Accordingly, the system has allowed owners to determine what is best for their project, while the pricing structure reduces the risk the owner bears. In this system, the project is categorised into sub-packages and executed by the sub-contractors, saving costs and time. The system also encourages the integration and management of multiple contractors (Harris & McCaffer, 2003; Masterman, 2002). Oyegoke *et al.,* (2010) reported that the CM@R system became fully developed in the UK in the 1970s because of the economic recession at that time, and since then has been used as a driver to anchor value for money.

Nonetheless, the system has not explicitly overcome the underlying issues of fragmentation that hinder CW in construction (Kent and Becerik-Gerber, 2010). For example, owners within this method often select their preferred trade contractors and make decisions in isolation from the construction manager, leading to waste and inefficiencies (Ancell, 2005). Similarly, Gould and Masterman (2002) added that the division of payments into percentage fees and lump sums for services provided could negatively influence the contractor's position as the client's consultant, leading to a conflict of loyalties. Accordingly, this practice led to the rise of more integrated forms of delivery such as partnering and alliancing.

2.3.4 Partnering Arrangements or Life Cycle-Oriented Delivery System

Most of the abovementioned delivery strategies are categorised based on working relationships and how design construction and other elements are managed in projects. However, in recent times a trend has evolved within the building and construction industry, whereby clients and stakeholders are now emphasising the need to maintain teamwork and collaborative relationships (Seppänen *et al.,* 2004). This new approach, called partnering, became popular in the UK during the late 1990s and early part of 2000s (Oyegoke *et al.,* 2010). It was one of the specific recommendations made by Egan (1998), which was profoundly influenced by the lean production system (Womack & Jones, 1996).

Partnering is a structured managerial approach that enables teams to work across cultural boundaries (construction best practice, 2003). It led to a major paradigm shift in construction that amplified the commitment to more open and transparent working in construction practices. Within this system, stakeholders are selected based on negotiation rather than competitive tendering, which means longer and repeated working relationships (Winch, 2000). The chief differences between these arrangements and the others are that CM@R comprehends roles that are more active for the client during delivery, and relevant stakeholders are brought in early under a multi-party contract, thus reducing transactional costs that previously required clients signing different bilateral contracts. In addition, partnering is delivered based on the concept of shared risks and rewards, which is reported to increase motivation, innovation and collaboration amongst project stakeholders (Sarhan, 2018). Indeed, the logic behind this approach is to align all stakeholders in the best interests of the project, as opposed to the activity thinking seen in the conventional arrangements. Arguably, this could be the transition required within the UK construction model - away from the transactional-based strategy to a more relational-based approach.

However, Greenwood (2001) reported some concerns regarding partnering uptake in the UK, querying whether there had been any change in attitudes and behaviours in practice. Interestingly, their results, and those of other studies, showed that the typical 'adversarialism' between contractors and subcontractors continued, highly influenced by cost-driven behaviours (Akintan *et al.,* 2013). Such concerns are believed to have made the UK government retracted from the partnering agenda and favour framework arrangements as the preferred route for public sector procurement; these are still being used by the NHS and Highway England. Accordingly, the UK construction industry continues to witness partnering losing ground and business reverting to the lowest price tendering (Wolstenholme *et al.,* 2009). These facts seems to support the findings of (Challender *et al.,* 2015), which emphasized that construction clients have now returned to their traditional competitive procurement preference, which is based on the lowest cost, seeking to reduce risk in their practices and maintaining control in uncertain times.

The analysis of the project delivery routes often adopted in the UK indicates that, despite the growing trend towards collaboration and integrated forms of procurements over the years in construction, performance in the industry it has not overtly improved. Evidence suggests that the prevailing system still struggles with the systemic fragmentation that promotes transactional characteristics and confrontational cultures, thus stifling innovation and radical improvement (Farmer, 2016; Yates and Battersby, 2003). In addition, some of the persistent commercial behaviours in practice, are still associated with clients decisions in the traditional procurement preference, which is defining some of the behaviours exhibits by consultants (Mesa *et al.,* 2016). Arguably, this could also be the reason why various parties continue to adhere to the cultural views that seemingly prevent CW within the construction industry (Akintan *et al.,* 2013; Gottlieb & Haugbølle, 2013). This pervasiveness has been a recurring theme within continued industry reports for over half a century, which attests to the fact that these issues are still not abating (Baiden, 2006). This segment has evaluated the dominant project delivery routes through the lens of commercial actors (e.g. QSs); subsequent paragraphs will discuss some of these implications in relation to CW within the UK construction industry.

2.4 Overview of Commercial Practices within the UK Construction Industry

The Institute of Commercial Management (ICM) defines commercial management as "the identification and development of business opportunities and the profitable management of projects and contracts, from inception to completion''. Generally, commercial management in construction exemplifies the management of a project and its finances, although commercial management practices (CMP) have different connotations. Zimina and Pasquire (2011) remarked that these practices are utilised to develop business models and strategize project operations (procurement, contracting, cost planning, money flow, and accounting). Lowe and Leiringer (2005) opined that they are widely regarded as 'the management of contracts and commercial issues in project delivery, from inception to completion'. Similarly, RICS (2010) added that CMP involves financial management of construction projects, including regular monitoring and reporting on cash flow and profitability, evaluation and advice on financial implications, as well as taking appropriate management actions. Therefore, this implies that the practice mainly serves as a bridge between traditional project management and organisational management, which focuses on business and financial control of on-site construction processes (Perera *et al.,* 2016). Thus, with these intricacies, i.e., valuing and costing construction projects, commercial management has evolved into a technical discipline, which is generally carried out by cost consultants in the UK.

Accordingly, CMP embodied the above descriptions, which means supporting construction processes like costing, design, procurement and other activities that underline the roles and functions of cost consultants (Perera *et al.,* 2016), popularly known as quantity surveyors QSs. These professionals provide service-based functions in the UK construction industry (Poon, 2003), which includes managing and administering construction projects. Kirkham (2007) asserted that the practice of QSs is represented in two distinct areas of working: planning/controlling of project costs and the management of contract terms and procurement routes agreed by the parties involved. These functions generally define the commercial activities of clients' cost consultants and QSs in a contracting capacity. QS is a revered practice in the UK because of its significance to the economy and the high level of management expertise involved (Wao, 2015). The QS Practice evolved from the middle of the seventeenth century (Seeley and Winfield, 1999; Ashworth *et al.,* 2013) and was officially established as a profession and part of the establishment of RICS in 1864. Conventionally, it entails offering cost advice on alternative design solutions, and managing cost implications in design morphology and procurement (Kirkham, 2007). In the same way, QSs also assists design teams on all cost implications of construction projects. This is carried out through project financial cost management where they utilise their expertise to establish costs for project developments and expands it through detailed cost planning, checking and monitoring at various stages during design development.

2.4.1 Development of QS Practices in Construction

Quantity Surveying Practice (QSP) is not a new discipline. It has been an integral part of the UK construction industry for about 170 years now. Its emergence in Great Britain was traced back to 1666 (after the great fire of London), where a few prominent architect-builders oversaw organising materials and hiring local artisans, as well as preparing final account statements for payment purposes (Pheng & Ming, 1997). It was officially established as a profession in 1864, and was subsumed by RICS. Traditionally, QSs offers cost advice on alternative design solutions for design and procurement purposes (Kirkham, 2007). In another capacity, they assist designers with cost information using the classical technique of cost planning, elemental costings and cost-checks for monitoring conceptual processes. Likewise, they offer some post-contract cost management activities such as valuation, change management and valuing variation to final account (Ashworth *et al.,* 2013).

However, as history revealed, they are often not appointed until after architects have designed the detailed drawings. QSs' tasks usually commence with the Bill of Quantity preparation and other formal tender documentations. However today, they are appointed, along with other professional consultants, to accept responsibility for the client's financial interests in project schemes (Kirkham, 2007). The QS Practice became integral to the industry, serving as a budgetary control mechanism that assists clients in achieving clear project end-values (Seeley, 1997). Today, QSs are known as professional cost consultants and industry's experts on cost build-up, assisting clients/owners to make a range of economic decisions. The role of the QSs has also changed dramatically and many have moved on from contractual and financial management of projects to embrace key roles as the client's construction project managers (Potts, 2008).

2.4.2 Main Functions of QSs in Construction Delivery and Management

With recent advances in the construction sector, more value adding activities are expected from QSs and other consultants. For example, whole life costing, value management, and risk analysis and management are now seen as the established roles of QSs that add best value in practice (Ashworth, 2010). With this trend, QSs are now seen as financial managers in construction, contributing added value that balances time and quality requirements in practice. Thus, this implies that, the traditional role of QS has changed immensely, as they are expected to contribute in the long-term project vision, assessing alternative options and providing clients with valuable information to facilitate informed investment decisions (Kirkham, 2007). RICS in 2002 reported that QSs are now working as consultants and within contracting company's in the following capacities as illustrated in table 2-1.

Table 2-1: QSs Main Construction Functions (RICS, 2002).

Preparing development appraisals for different sites, assessing the effects of capital and revenue expenditure, life-cycle costs, grants and taxation implications.	Advising client's brief, preferred procurement routes, costs and cash flow; contractual advice for either party in the case of dispute.
Planning the construction process; negotiating with the client or subcontractors; risk and value management.	Monitoring and control of cost during the pre-contract stages; controlling a project on behalf of their employer;
Preparing tendering and contractual documentation, leading to tender selection and appraisal; reporting on programme and financial matters.	Following the letting of the contract for the project, advising on payments to contractors and post-contract cost control, settlement of final account.

More recently, they have been geared towards developing better customer-focus to ensure that their clients' value is attained (Duncan, 2011). However, because of the increased demands in construction for modernisation, QSs have now been challenged to review their roles and create positive links within 'value-stream-channels' during project delivery (Mbachu & Frei, 2011). These demands have brought some new perspectives that compels QSs to explore other domains to strengthen their proficiencies and connections in the global construction landscape, and offer more valuable functions (Ashworth *et al.,* 2013; Cunningham, 2014; Thayaparan *et al.,* 2011).

2.4.3 Competency Requirements of QSs

Because of the industry's challenges and demands, QSs are now expected to adjust positively to meet these requirements. However, the transition within the construction market place has posed a threat on these professionals. This has left QSs seeking development and recognition in other domains (Ashworth *et al.,* 2013; Cunningham, 2014; Thayaparan *et al.,* 2011) in a move to stay productively flexible and available to support positive transformation within the construction industry. Accordingly, RICS developed QSs professional competencies, inspiring transformation in that direction to help QSs maintain their competency standards in the industry (Wao & Flood, 2016). These standards are grouped into basic, core and optional competencies as shown in Table 2-2 , which summarizes some of the QSs competency levels:

Table 2-2: QSs Competencies Source: Royal Institute of Chartered Surveyors (2015).

Basic Competencies	Core Competencies	Optional Competencies
• Business skills • Data management and information skills • Interpersonal skills • Law • Mapping and measurement • Professional practice & procedure	• Construction contracting and economics • Construction technology and environmental services • Procurement and financial management • Quantification and costing of works	• Building information modelling • Arbitraion and other dispute resolution procedures • Risk management • Insurance and insolvency • Project management & planning • Property investment funding • Research methods • Taxation allowance and grants • Value engineering & management

Indeed, the RICS standards provide a platform that can help QSs improve their behaviours and project performances using the core competencies, which are more organisationally driven, accordingly enabling QSs to venture into other niche areas (Said *et al.,* 2010). All professionals under the RICS requirements will be able to demonstrates the basic competencies; however, the 'core' and 'optional' competencies are more crucial for transformational development (Cunningham, 2014; Oke, Ogunsemi, & Adeyelu, 2018).

Despite these broad skill-sets, consultants in general (QSs, PM's, estimators, designers etc.) are under tremendous pressure from the UK sector to improve performance and efficiency. The project QSs were criticised for lack of value creation during project proceedings (Ashworth *et al.,* 2013; Farmer, 2016), although this could be linked to their current position within the delivery model, where they are predominantly placed outside the core production team. Consequently, in this position, they support their normal activity-to-activity functions, which in turn limits the capabilities they can offer upfront (Olanrewaju & Anahve, 2015). For instance, under the prevailing system, cost advisers are only involved when strategic decisions are taken, e.g. when designers and engineers have been appointed, briefings conducted, and technical drawings reaching completion if not completed (Olanrewaju & Anahve, 2015). In addition, Zimina and Pasquire (2011) added that some of these commercial practices do not comply with a different models like the 'lean system' in today's build environment. Seemingly, because of fragmentation and lack of integration, this has left commercial actors (QSs) with a short-term focus to seek benefits at the expense of CW. This makes it even more difficult to improve project performance, as we continue to see higher concentration on local efficiencies with decline in trust and mutual relationships among stakeholders (Matthews & Howell, 2005).

In view of that, Brien *et al.,* (2014) reported that QSs' challenges in these contemporary times are multifaceted. Predominantly, they are more service-based oriented, providing cost and value management expertise in construction (Abidin *et al.,* 2011; Olanipekun & Aje, 2013; Smith, 2010). Consequently, this does not allow commercial actors to be proactive in the face of innovation, which means information sharing amongst these professionals and their counterparts would be minimal (Olatunji *et al.,* 2017).

2.4.4 Commercial Management Practices and Implications for CW

For many years, the UK construction industry has attracted much criticism over poor relationships, a lack of collaborative culture, and the way projects are delivered (Chan, *et al.,* 2004; Egan, 1998; Eriksson *et al.,* 2008; Latham, 1994). This is because organisational, commercial terms and the institutional environments that supports project delivery are protected within the prevailing procurement arrangements, which cover every aspect of setting transactions, from business case identification and funding to the appointment of consultants, contractors and suppliers (Sarhan *et al.,* 2014). As seen in the preceding sections, the procurement routes mostly adopted in the UK are the ones that encourage fragmentation or separate roles with hierarchies and professional dominance (Zimina & Pasquire, 2011). Bennett (2000) described this mentality as where each profession occupies a well-defined position within the hierarchy of powers: architects at the top and their supporting artisans at the bottom. This perception dominates the working relationships throughout construction and the professionals involved rarely challenge this monotonous approach.

With this mind-set, clients and decision makers tends to allocate risks and deploy safeguarding mechanisms in their project-specific investments against exploitation and opportunism, thus placing formal governance control means contained within the contractual agreements (Pasquire *et al.,* 2015). In doing so, they seek advice from their lawyers, who are familiar with construction contracts and the laws related to them (QSs); and these consultants are mostly remunerated by professional fees for providing safeguarding means (Sarhan *et al.,* 2014). Eriksson *et al.,* (2008) argued that these consultants are not properly incentivised to adopt the unfamiliar delivery strategies that could potentially be more efficient than the conventional norm, because of 'institutional' pressure (DiMaggio and Powell, 1983;Sarhan *et al.,* 2014). In view of this, scholars have argued that increased in collaboration amongst project stakeholders could be the required remedy for many of the industry's drawbacks (Eriksson *et al.,* 2008; Sebastian, 2011; Walker *et al.,* 2017; Xue *et al.,* 2010). This suggests that having a system that shapes project organisation and commercial practices to support the overall production process remains crucial (Pekuri *et al.,* 2014). This also means that, procurement and contractual arrangements needs to be optimised and aligned with project operational systems (Sarhan *et al.,* 2018), in order to strengthen commercial relationships.

Despite these concerns, the business delivery model in the UK has been the main route to procure and construct facilities (RICS, 2007). Invariably, it seems dualized and continues to dominate practice (Pasquire *et al.,* 2015; Sarhan *et al.,* 2016), and is often preferred by one-off clients. This division, as illustrated in Figure 2-5, shows how one stream focuses on actual production (building the project to completion) and the other reveals a separate role that is mainly concerned with overcoming transactional governance, using risk as a criterion to influence construction procurement (Pasquire *et al.,* 2015; Thomsen *et al.,* 2009). This position has been observed to have profound influence on production, creating barriers that is affecting CW in construction (Cox & Thompson, 1997; Eriksson & Laan, 2007; Kent and Becerik-Gerber, 2010). The separate stream (cultural/ contractual system), typifies commercial practices, often associated with the roles of QSs', operating outside the production teams, and advising clients with safeguarding means, which forms a bigger part in the system widely known but unacknowledged (Love *et al.,* 2010).

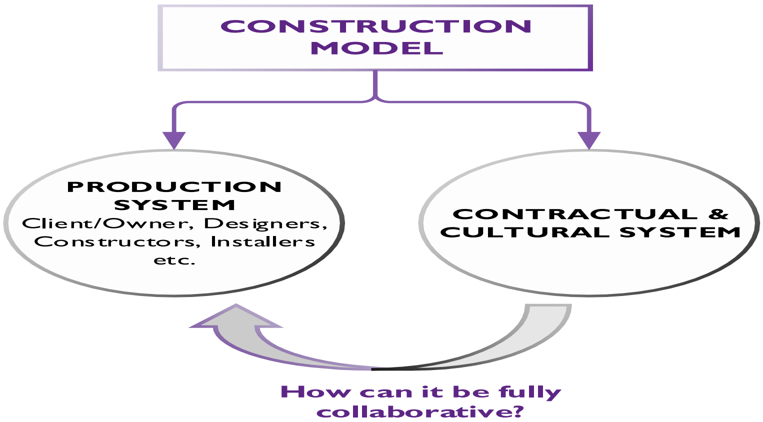


Figure 2-5: The Prevailing UK Construction Model (Adapted: Gottlieb and Haugbølle, 2013).

Gottlieb and Haugbølle (2013) observed that the cultural stream institutionalized contractual relationships and project-organizational goals, where rights and duties were defined and maintained. This also supports the rationale of bargaining power amongst cost consultants through commercial governance (Winch, 2010), encouraging so much emphasis on price and contract management. The author further cautioned that, for collaboration to become embedded in the daily actions and operations of project activity, it is a prerequisite for these institutionalized roles and arrangements in construction to be shaped and transformed by an integrated system. However, Zimina and Pasquire, (2011) added that there are external factors, such as the macroeconomic environment and regulations, market agents, informal institutions, and culture, that continue to exacerbate these commercial practices and behaviours. These misalignments, particularly from a commercial standpoint, add to the low productivity, litigations, cost overruns and adversarial relationships amongst participants within the construction industry (Egan, 1998; Latham, 1994; Thomsen *et al.,* 2009). Indeed, better alignment and incentives for commercial actors (QSs) in a system like IPD/TVD (Law *et al.,* 2016; Lichtig, 2006; Thomsen *et al.,* 2009) might improve the current status quo in the UK setting.

Furthermore, Sarhan *et al.,* (2014) analysed some of the safeguarding problems with commercial governance using the theory of transactional cost economics (TCE). The authors discovered that clients and decision makers in construction often conform to the "buy it" type of governance where contractual instruments are often adopted, whilst transactions and performances are evaluated through stringent conditions agreed in advance. These instruments include the use of standard forms of contracts, disclaimer and privileged clauses of contracts, conventional insurance arrangements, and collateral warranties. However, scholars have argued that these practices are based on transactional considerations, which offer little incentive for collaboration to emerge; instead, they embed wasteful activities in construction processes and encourage opportunistic behaviours (see e.g., Cushman, 2003; S. Laryea & Hughes, 2009; Osipova & Eriksson, 2011).

More so, Pasquire *et al.,* (2015) added that this stems from the 'institutional' pressure exerted on clients by the third parties (consultants, QSs and lawyers), who have vested interests in the wider spread of these inefficient strategies. Indeed, clients and decision makers in the conventional system do not seems to comprehend the implications and the misalignment of commercial interests in the production system, and consequently, these continue to diminish project value and the dynamism of collaboration (Doloi, 2011).

Furthermore, Fellows *et al.,* (2003) examined leadership practices and power sources within QSs in construction projects in Hong Kong, and concluded that, QSs power possession has been related to their position in client and contracting organizations, which they continued to exercise as leadership and power ratio. However, they cautioned that, these professionals often deploy this mechanism to dominate and control through surveillance (routinization of procedures, supervision etc.), activities that are designed to control the behaviours of members of an organization. The implication of this is that, they are formalized in practice through contract mechanisation or deployed for negotiations in pursuit of self-interest. However, this continued to show a lack of shared understanding of project value among these groups, which reiterates the issue of incentives and misalignment, that thus affects collaboration (Zimina *et al.,* 2012). Consequently, this deprives QSs of the ability to optimise end-to-end processes, which is why they often lean towards a ‘push’ approach. This means that having power that is used negatively in practice is counter-productive, as often QSs roles largely onerous, instead of linking with value identification e.g. optimising the whole piece (Bertelsen, 2002).

Indeed, this pursuit of power still dominates QSs’ activities, and stems from the deficient system (one that typifies transactional characteristics). Therefore, this means that reviewing commercial functions to accommodate innovation in construction practices remains critical. Interestingly, this highlights the view within the UK construction industry, which indicates that a replicable recipe for aligning stakeholders’ interests is still missing, hence the need to review commercial practices to support large-scale industry transformation in construction.

2.4.5 Further Implications for Process Integration

The importance of integrating frontend processes along with production activities for performance improvement has long been emphasised in literature (Cain, 2004; Fischer *et al.*, 2017; Mcdermott, 2009; Pasquire *et al.,* 2015; Zimina, Ballard, & Pasquire, 2014). It is not surprising that collaborating to share knowledge, expertise and information amongst stakeholders in practice has progressively yielded much success (Mcdermott, 2009). Some of the benefits achieved through such integration include: increasing value and predictability of work, improving the owner’s condition of requirements, eliminating process waste (rework, design iterations etc.), reducing contractual disputes, and creating an enabled environment where CW prevails (Bresnen & Marshall, 2000; Constructing Excellence, 2004). The chances of achieving these feats in projects through collaboration are high. Unfortunately, this does not look likely in commercial practices, particularly during costing and design activities within the UK construction model.

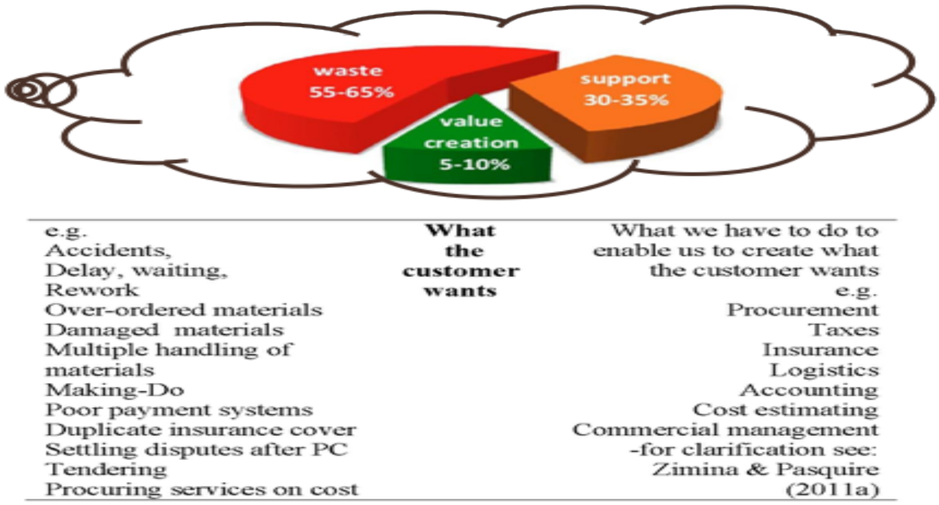


Figure 2-6: Institutionalised Waste in Construction (Mossman, 2009; Sarhan *et al.*, 2014).

Figure 2-6, illustrates that 55-65% of construction activities are categorised as process wastes, 30-35% are regarded as supporting functions, and only 5-10% of these activities delivers value to the customer. This shows that commercial functions like tendering, settling disputes, and service procurements are all supporting activities and does not add direct value to the final product, which reiterates the waste incurred during design and construction operations. Similarly, Winch (2000) emphasised that business delivery models are largely viewed as 'institutions', which dictates the rules of the game. Accordingly, cultural structures in this system heavily relied on these rules, which means influencing alignments and performances in practice.

Akintan *et al.,* (2013) observed that, these 'institutions' within the UK are yet to fully embrace the principles of 'lean', and have yet to improve on integration and collaborative relationships. The authors stressed that these poor performances, especially in commercial practices, remain. Arguably, this could still be due to the established cultural/contractual system that dominates in practice, yet, commercial interests are still misaligned. This has not only hindered actors like QSs, estimators etc., and the ability to create value, but also allowed inefficiencies (termed wastes in the lean system) across their managerial functions. For instance, consultants and lawyers are not the main users of a contract; however, the complexity with which they interpret the onerous documents has encouraged opportunistic behaviours between parties that leads to severe disputes (Rameezdeen & Rodrigo, 2013; Sarhan *et al.,* 2014). Conversely, how they apportion risk, using disclaimer clauses, attracts about 8-20% of the project cost as contingencies (Zaghloul & Hartman, 2003). This also creates more severities, which stifle collaboration, with determined focus on individual party functions that create more distance among stakeholders (Eriksson *et al.,* 2008). Consistently, these practices stems from the 'institutional' system, which continues to lead teams away from trust towards self-seeking interest i.e., opportunism (Pasquire *et al.,* 2015).

Sarhan *et al.,* (2014) conceptualized 'waste' in the construction process and gave an account of institutionalized sources, which are deeply linked with the imperfect construction systems, embedding entities operating wastefully and opportunistically. These practices dominate the activities of QSs, estimators etc., and support waste across the supply chain and throughout project delivery. Thus, this has become part of the norm and institutional fabric of the construction industry (see Figure 2-7 below). The authors further described five tentative hypotheses, which typify the roles associated with QSs in the institutionalised environment. These include the following:

> *'The higher the degree of social legitimacy or stability, conceived by social actors, to be attainable from acquiescence to imperfect institutional pressure, the greater the likelihood of waste to be institutionalized'.*

This draws comparisons with how commercial actors adhere to the industry norm, by caving to the short-term philosophy and low price-competitive tendering approach as the accepted norms, despite them being linked with many flawed risk assumptions that have plagued cost estimating practices (Laryea & Hughes, 2008; Samuel Laryea, 2011).

> *'The higher the degree of dependency of social actors on the institutional construction environment, the more the likelihood of waste to be institutionalized'.*

This relates to clients' cost advisor's roles and how they conformed to the 'rules of the game' (via procurement and tender processes) dictating how everyone else must work within these parameters, which is dysfunctional (Sarhan *et al.,* 2014).

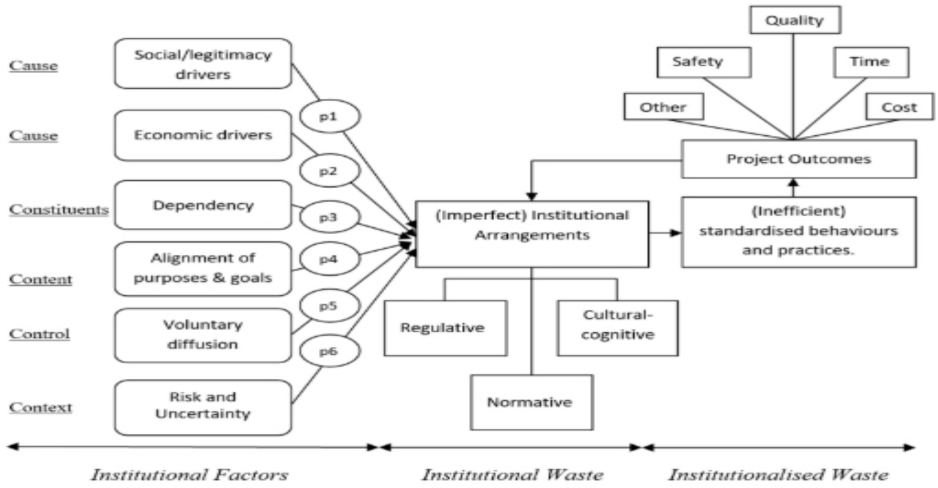


Figure 2-7: Concept of construction procurement as institutional arrangements (Source: Sarhan *et al.,* 2018).

> *'The higher the degree of consistency of organizational goals and purposes with imperfect institutional pressures and norms, the greater the likelihood of waste to be institutionalized'.*

This relates to construction actors and organizations: to how they are seen to make profit through commercial processes and manipulation of roles, away from striving to improve production efficiencies (Zimina & Pasquire, 2010).

> *'The higher the degree of voluntary diffusion of imperfect institutional practices, routines or norms, the greater the likelihood of waste to be institutionalized'.*

For instance, this revealed how QSs often interpret contracts, with a bounded culture on protecting clients or contracting organizations at all costs. This illustrates how they are mostly confined by custom and practice, rather than the interests of the project. Thus, during the tender process, their mentality is generally to read, understand and confirm the brief likewise during costing functions, which becomes affirming rather than contesting for best value options. This characterizes how they are employed (largely to inform intelligent clients), thus reluctant to challenge their prescriptive roles; consequently this limits their input on CW.

> *'The higher the degree of environmental uncertainty, the greater the likelihood of waste to be institutionalized'.*

This relates to environmental uncertainties, austerity, and economic pressures within the industry. Under such conditions, commercial actors (QSs, estimators, designers etc.), uphold these institutional norms, which are often dictated by regulatory bodies, for the sake of survival in the construction environment (Sarhan *et al.,* 2014).

Indeed, these behaviours have shown that the continued cultural resistance to change, as often seen within the UK industry, does have consequential influence on commercial practices and implications for CW. The Egan report (1998) has laid down some excerpts demonstrating parallel thinking that could fit with a collaborative project delivery system. This was also reported by Latham who suggested the use of relational contracts e.g., NEC3, and the development of collaborative agreement produced by construction excellence, were evidently heading towards an integrated project delivery approach. Equally, David Mosey in 2000 developed partnered contracts that in many ways resembles the IPD agreement (PPC2000). Yet, over the years, we continue to see the usage of traditional project delivery approaches and procurement protocols that have not comprehensively improved performance in the industry (Baiden, 2006) nor aligned commercial interests. Evidence points to fragmented teams and the hierarchical arrangements that are put in place, which form various sub-layers of parties, yet bounded by traditional cultures, preventing radical change in the construction industry (Payne et al, 2003; Akintan *et al.,* 2013).

These findings have offered some rationales compiled by this study, which means that understanding the wider dynamics of CW within commercial practices, especially in multidisciplinary settings, in a bid to increase production effectiveness of the industry, remains crucial. This section has explored project delivery arrangements and commercial practices in the UK construction. The next segment will look at the understanding behind ‘lean production’ thinking, to see how the production control and management approach accommodates commercial relationships to support collaboration.

2.5 Lean Thinking: Production Concept

The emergence of Lean Production or the Toyota Production System (TPS) can be traced back to the 1950s, when the Toyota Motor Company successfully implemented the principles of TPS. Two principles stood out from this development: (a) Just-in-time flow (JIT) and (b) problem solving. The term ‘lean’ was coined by researchers working on auto production to reduce waste during craft and mass forms of production (Womack and Roos, 1990). Moving on from the total quality management (TQM), an approach geared to reduce set-up times; other goals were established for design in the production system. These included: (a) identifying and delivering value to the customers – whilst eliminating anything that did not add value, (b) organizing production as a continuous flow, (c) perfecting the product whilst creating reliable flow through collective information sharing and decision making, and (d) seeking perfection to deliver value that meets customer requirements with less waste. Through these objectives, lean production went on to achieve perfection by optimising TPS against the standard requirements. Thus, at the beginning of the 1990s, the philosophy became the mainstream approach practiced, at least partially, by major manufacturing companies in America and Europe. It then further diffused into other fields, like customized production, services, administration, and product development.

Accordingly, in 1992, Koskela reported the adaptation of lean production concepts into the construction domain, and presented it as a production management paradigm where production was conceptualized in three complementary ways, namely: (1) Transformation, (2) Flow, and (3) Value generation; the TFV theory of production as mentioned earlier. This multilateral view of production has led to the birth of lean construction as a discipline that subsumed the transformation-dominated contemporary construction management (Bertelsen, 2004; Bertelsen & Koskela, 2002).

According to Bertelsen (2002), managing construction under lean methodology is different from typical existing practice because it: (a) has a clear set of objectives for the delivery process, (b) it's aimed at maximizing performance for the customer at the project level, (c) concurrently designs product and process, and (d) applies production control and management throughout the project lifecycle. In other words, to understand lean construction, one must fully grasp the physics of production, the effects of dependence and variation, and supply-chain assembly (Aziz & Hafez, 2013). Thus, lean construction preserves the production principles through: (a) planning - by defining criteria for success and producing strategies for achieving it, and (b) control - by ensuring events conform to plan, which triggers learning and re-planning throughout the project lifecycle (Ballard, 2000). Therefore, it is considered as a strategy which sets out to enhance construction management practices in various ways, bringing the best out of the stakeholders involved

– thus reducing dependencies and variations, as well as identifying and eliminating waste (Ballard, 2000).

2.5.1 Understanding Lean as a Production System

Lean is generally known as a philosophy that focuses on identifying waste and optimising value streams, from an organisational level down to the supply chain management (Scherrer-rathje *et al.,* 2009). Nonetheless, it has transcended beyond the ordinary waste removal in processes into a production philosophy, which brings more innovative advances into the construction domain (Koskela, 2000). Hence, Koskela in 2000 introduced the theory of production to the construction industry, which further contextualised the definition of lean construction to a production-based management approach that supports integrated project delivery systems and collaborative practices. This then brings in the perspectives of transformation, flow and value propositions TFV, revealing how resources are transformed from inception to completion. It also identifies how efficient flow is maintained within interrelated activities over a project's lifecycle.

In the same way, value streams are identified, which the customer pulls to satisfy their needs. Therefore, from this perspective, lean construction was conceptualised as a production system that minimizes the waste of materials, time, and effort, and generates the maximum possible amount of value (Koskela *et al.,* 2002). More so, the lean system uses the same principles as in production to reduce waste and increase the productivity and effectiveness in construction work (Aziz & Hafez, 2013). However, there are two slightly differing interpretations of lean construction: one view holds that it is about applying methods of production principles to construction; the other view holds that it is a theoretical inspiration for the formulation of new, theory-based methodology for construction (Koskela *et al.,* 2002). Despite these interpretations, the classical view of production from the traditional system remains unchanged (transforming resources towards a finished product): a view that has failed to consider production as a way to complement integrated practices to deliver project values. Therefore, it is vital in this study to clarify the emerging concept of 'lean production', as it is gaining more traction in the construction landscape, and equally as a philosophy, that provides a platform for cross-functional integration.

Yet, the concept of lean system in the UK is still misunderstood, and often regarded as a way to improve supply chain management (Ballard & Howell, 2004; Green & May, 2005; Taylor, Reifi, & Emmitt, 2013). Höök and Stehn (2008) cautioned that this move is problematic, because the mainstream approach is still on contract-based and does not focus on continuous improvement, nor the integration of project participants. Koskela and Vrijhoef (2001) remarked that this view within the UK construction is flawed, which continues to typify the level of fragmentation, especially the multiple task division amongst stakeholders. This is also because projects in construction take place under dynamic and unsteady site conditions, with considerable levels of uncertainty – thus carried out by temporary organizations and executed in provisional production facilities (Koskela, 2000; González and Alarcón, 2010). This conceptualisation revealed two aspects: (1) a production process (Koskela, 2000), and (2) a social process (Hill, 1995). Nonetheless, production, commercial, technical, organizational and social aspects need simultaneous integration for construction projects to be successfully delivered (Gonzalez, Sacks, Pavez, & Poshdar, 2015). However, this view is still not widely grasped within the UK context, given the way commercial activities are practiced, which is why it is imperative to understand the 'lean production' views in order to sustain the TFV concepts in construction (Zimina *et al.,* 2012).

2.5.2 Transformation, Flow and Value (TFV) Perspectives in Lean

Whilst developing TFV theory, construction project management fall into the realm of manufacturing, primarily lean production. As mentioned earlier, TFV theory was introduced by Koskela in the 1990s, and later developed as a single theory (Howell & Koskela, 2000). The authors claimed that the current project management theories are flawed, suggesting that project management today needs reforming, because of the assumptions and idealised theories. Howell and Koskela (2000 p.1) summarised these assumptions as:

- uncertainty of scope and methods are low,
- relationships between activities are sequential,
- activity boundaries are rigid,
- it is believed that control against standards for activities will ensure outcomes, and outcomes can be improved by improving individual activities and,

- production management are not considered as project management concerns.

Indeed, these are still the dominant views within construction, given that the conventional approach does not overtly support the TFV theoretical assumptions (Ballard *et al.,* 2001; Howell & Koskela, 2000; Johnston & Brennan, 1996). Moreover, these views also failed to comprehend the full philosophy behind lean transformation, as the norm in practice has often been to target principles without fully considering other aspects like planning & control, production management, and commercial relations (Alves & Tsao, 2007; Granja *et al.,* 2005; Pavez & Alarcón, 2008).

2.5.3 Transformational View in Lean

The transformation view was the first concept analysed by Koskela (1992). In 2000, Koskela confirmed that this view was not new, as it had been dominant in recent centuries in operation management and even implicit in the construction sector. He stated that the transformation view stems from economics, with a conceptual root in scientific management to improve economic efficiency through task management. The logic behind the task management is that the work to be executed requires investigating, and deconstructing it into tasks to define ideal methods and orders for its execution. However, Koskela (2000) argued that the transformational view has two main deficiencies: first, the failure to recognize production phenomena other than transformation, and second, the narrow view that transformation makes the valuable output, away from the fact that value is achieved when the output conforms to the customer's requirements (Koskela *et al.,* 2002).

Similarly, Bertelsen (2002) added that, from the field of construction management, the transformational view is still unchanged (Bertelsen, 2002). This affirmed that projects are still procured and delivered in the same way, with clients continuing to take the lowest price, in operation believing that it's the safest way to achieve value. Koskela (2000) further maintained that as much as transformation is useful, it only addresses adequate amounts of work to be carried out, stressing that it does not particularly revealed how to avoid wasting resources or how to ensure that customer requirements are met in the best possible manner. Therefore, this compels the need for the flow concept to complement the transformation view.

2.5.4 Flow View in Lean

Flow is the second concept proposed by Koskela in 2000, with the objective of eliminating waste (non-value activities) i.e. reducing variability. Koskela (1992, 2000) reported that it was first initiated by Gilbreths as a scientific management concept in 1922, which provided the basis for JIT and lean production. Nonetheless, Henry Ford originally interpreted it in 1913, and it was subsequently adopted by Toyota (lean production) in the 1940s. In 2000, Koskela presented three types of flows (material, location and assembly), comparing construction with the Toyota company. However, he later proposed the seven flows for construction tasks. Bertelsen (2002) added that the flow concept introduces several dimensions into construction, stating that principles such as lead-time reduction, variability reduction, and simplification are now promoted and understood. Mossman (2009) argued that the pursuit of waste elimination from a project or organisational view is potentially wasteful itself, if it is carried out in isolation from the value purpose of the project. This is because the dominant construction system hoards quite a lot of non-adding value activities, that shift the focus from optimising value generating tasks to the reduction of waste. Undoubtedly, waste creates no value for the customer and, at the same time, is a cost to the client and the overall project, thus its elimination is desirable. However, if the focus is on waste and not value (which the customer seeks), there is a risk of eliminating something that is potentially is of value to the customer even if it would generally appear as waste (Mossman, 2009).

2.5.5 Value Perspective in Lean

The collective view of value in production is the idea that value can only be determined by the customer, and the only goal of production is to satisfy the needs of the customer (Koskela, 2000). In other words, the emphasis is upon matching all the requirements in the best possible way to satisfy the customer. The practical representation of value can be seen in Table 2-3.

Table 2-3: Value Generation View of TFV (Koskela, 2000)

	Conceptualisation of production	Main Principles	Methods and Practices	Practical Contribution
Value Perspectives	As a process where value for the customer is created through fulfilment of requirement.	Elimination of value loss (achieved in relation to best possible value).	Methods for requirement capture, quality function deployment.	Ensuring that customers' requirements are met in the best possible manner.

Koskela *et al.,* (2002) argued that the current value standpoint puts much emphasis on scope, cost and schedule, which are often pulled by the client at inception. However, Ballard (2000) suggested that value is created through iterative dialogue based on ends and means. In other words, value is generated through the process of negotiating the customer's end-goals (Ballard & Howell, 1998), a process that requires designers to ensure that their clients are aware of their desires and consequences. In this fashion, value can arguably be divided into two perspectives (perceived-value and delivery-value). The former is to be considered as the client trying to establish value through the three triangles (time, cost and quality); while the latter is determined through the process of production. Emmitt *et al,* (2005) expanded on this and suggested that value can be categorised into external (perceived-customer) and internal (delivery-production) value.

However, construction today is often perceived as a service providing industry. The final products are usually assembled through a combination of trades. Still, the product scope and value are not well defined, and there are no traditions to strengthen what the 'true-value' of the final product is (Bertelsen, 2003). This is because the client's value perceptions are not clearly stated from the outset and their fulfilment is not monitored systematically. Consequently, the crucial contribution of the TFV theory of production largely depends on calling attention to modelling, structuring, controlling, and improving production from these three points of view combined (Koskela *et al.,* 2002). Indeed, production management requires the TFV perspectives to be integrated and balanced; in this way the wider understanding of value and waste in the construction process would become mainstream (Pasquire *et al.,* 2015). Hence, Koskela (2000) remarked that these views of production should not be considered as alternative competing theories, but rather partial and complementary to each other, which need to be incorporated and developed into a comprehensive theory of production.

2.5.6 Collaborative Production System in Lean

The project delivery system in the traditional construction model is often used to dictate contractual relationships, as seen in the DBB and DB systems. So, 'delivery' in these arrangements is understood to be a type of transaction. For instance, the DB as seen in the UK setting: is an arrangement that provides clients with the opportunity to interact with a single contracting entity, as opposed to holding contracts with multiple players which would transfer risks (Koskela *et al.,* 2002). Despite the range of options (DBB, DB, CM@R etc.), owners remain dissatisfied with the litany of overruns, project delays and lower quality (Lichtig, 2006), more precisely in the UK, commercial actors continued to struggle, when responsibilities for design are so far removed from the production process (Mossman *et al.,* 2010). With this growing trend, scholars have maintained that a move towards a system that has better coordination of participants for integrated delivery of the project is imminent (Egan, 1998 2002; Fairclough, 2002; Alarcón and Mesa, 2012). Recently, there has been a shift towards more integrated procurement in the UK construction, but it has been piecemeal, partial, and is still far from the norm, particularly in public sector design and construction (Mossman *et al.,* 2010). Whilst in the lean world, this approach continues to offer numerous improvements over the existing models of procurement, consolidating CW amongst stakeholders (Raisbeck *et al.,* 2010). In addition, 'delivery' in this domain is understood in terms of the actual work process used for moving the facility from concept to customer (Ballard, 2000), which are accomplished via the three principles in the lean construction triangle, as illustrated in Figure 2-8.

Figure 2-8: Three Basic Domains of Project Delivery

These principles typify the project organisation, operating system and the commercial terms, all binding stakeholders and their interests in projects (Thomsen *et al.,* 2009), hence, within these domains, the IPD system was developed, (also referred to as lean IPD, or IPD-ish (Engebø *et al.,* 2019)).

2.5.7 Integrated Project Delivery (IPD) System

IPD was earlier defined and interpreted by the American Institute of Architects (AIA) "as an approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimise project results, increase value to the owner, reduce waste, and maximise efficiency through all phases of design, fabrication, and construction''. However, Ballard (2000) later mentioned that it further integrates an essential feature – organizations. This was confirmed by Cohen (2010), who described the new interpretation of AIA's IPD "as 'a project delivery method distinguished by contractual agreement between a minimum of the owner, design professional, and builder where risk and reward are shared and stakeholder success is dependent on the project success''. Thus, IPD is one of the most common collaboration-based delivery models designed for construction projects, and part of a larger global movement towards more collaboration and relational contracting practices (Lahdenperä, 2012). In addition, it is parallel with Koskela's lean construction movement, which aimed to translate product manufacturing and production methods into construction (Raisbeck *et al.,* 2010). In other words, designed to pursue the three goals of transformation/flow/value (Koskela, 2000).

As such, the innovation behind IPD development revealed a contractual arrangement between principal actors (e.g., owners, architects, builders, consultants, and contractors) who are involved early on, making collaborative decisions; who jointly offer innovation and control as well as respect, trust, and transparency; and who share risks and rewards (Cohen 2010). In addition, the method integrates BIM technology into contracts, which increases value for money (VfM) for building owners (Raisbeck *et al,* 2010). Figure 2-9 illustrates an example of IPD and with the traditional DBB delivery models. As shown, the DBB is designed with organizational boundaries working in favour of firms (marked with a clear line), contributing to a hierarchical relational structure. In contrast, stakeholders working in IPD have joint organizational boundaries, where the traditional boundaries of the firms become less significant (stippled lines). Thus, according to Cohen (2010), relations in IPD are dynamic.

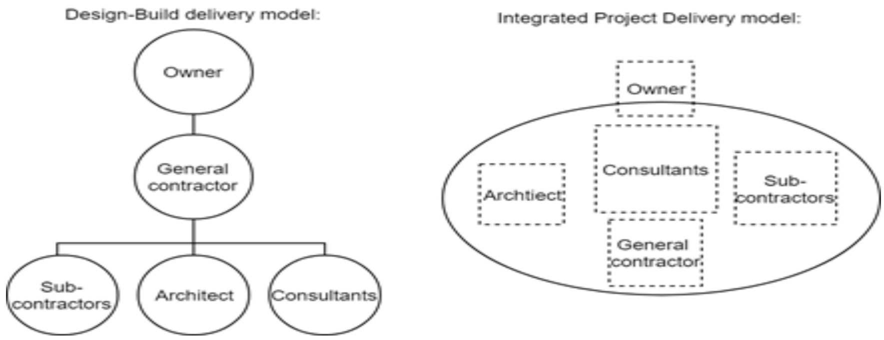


Figure 2-9 Differences in the structure of design-build and IPD models (free from (El Asmar *et al.*, 2013 p.2).

IPD has been described as an answer to the need for collaboration and the room for innovation in the construction industry (Lahdenperä 2012), because it deals with interdependence through alliances (Scott 2006). In addition, IPD is characterized by advanced communication technology. Thus, it requires actors to work outside the boundaries of their traditional roles as constructed in the DBB delivery model. However, when examined closely, IPD seems to relate to the alliancing model, which was developed in the UK. Nonetheless, Howell notes that IPD was not inspired by alliancing, although it has much in common with it, asserting that alliancing '*is a form of contract and organizational governance*' and lean construction is ' *the operating system*'. Accordingly, one can deduce and denote IPD as a combination of an alliance governing structure with lean construction as the operating system. Relatedly, Cohen (2010) added that the system has certain criteria's that link teams during project delivery, which is different from the traditional systems, namely: (a) multiparty contracts, (b) early involvement of key participants, (c) collaborative decision and control, (d) shared risks and rewards, (e) liability waivers among participants, and (f) jointly developed project goals.

All together, these features found in IPD are formed through concerted efforts and underpinned by the three domains (organisations, commercial and operating systems) in the lean system. They are particularly seen as appropriate in 'complex, lengthy, and evolving transactions in construction projects, where the underlying contractual scenario may change considerably over time' (Kumaraswamy *et al.,* 2005). Therefore, from a philosophical standpoint, the IPD approach is developed to engage all stakeholders in an intensified collaboration for better project delivery (Lahdenperä, 2012), as well as to continuously improve team relationships in construction (Alarcon *et al.,* 2013; Cohen, 2013). Yet, Kent and Becerik- Gerber (2010) argued that despite the growing interest in IPD, its current adoption status in the UK construction industry is still unknown. This is despite the fact that it updates the alliance model with advances in information technology, and provides a fair consideration of risk apportionment (Raisbeck *et al.,* 2010).

Several studies have consistently emphasized the need to maintain high levels of collaboration amongst stakeholders within complex processes, and attitudinal behaviours (Kadefors, 2004; Laan *et al.,* 2011). Therefore, in terms of formal and informal contracting, IPD has embodied various financial incentives, like those revealed in target cost contracts (e.g. pain-share/gain-share or risk/reward arrangements), and these formal contractual structures are formed to stimulate cooperation and team integration (Bygballe *et al.,* 2014). Other improvements include organizational innovation, such as communication and behavioural mechanisms (Mollaoglu-Korkmaz *et al.,* 2014), BIM and lean approaches (Matthews and Howell, 2005; Raisbeck *et al.,* 2010).

Similarly, Kim and Dossick (2011) found five key elements that support integration in the IPD approach: (1) contract type, which includes an integrated form of agreement, (2) culture, (3) organization, (4) lean principles, and (5) building information modelling (BIM). Dewulf and Kadefors (2012) showed that these formal (IPD) contractual terms and the informal relationships like trust do interact. This means that, after signing a contract, the engagement begins with partners jointly making sense of what the relationship implies in both contractual and behavioural terms (Bygballe *et al.,* 2014). This also confirms the argument of Cicmil & Marshall (2005) that structural intervention, like contractual arrangements alone, is not sufficient to deal with the inherent paradox of the relationship between project performance and control on the one hand, and the practice of cooperation, collaboration and learning on the other. Hence, Bresnen and Marshall (2002) added that collaborative project delivery approaches such as the IPD also depends on the complexity and interplay between formal and informal mechanisms. This means that the rigid structure and one-sided contractual relationships that are often seen in the traditional system might not necessarily change the status quo, unless they incorporates the social and informal factors for true collaboration to be sustained.

Similarly, Fischer *et al.*, (2014) remarked that IPD has been set out to overcome the dysfunctional flaws created by traditional systems in design and construction practices. Over the years, it has illustrated its prominence in the US, Canada and other parts of the construction marketplace, with positive results and improvements. With such differences in the IPD systems, construction consultants and lawyers (e.g. QSs in the case of UK) were urged to assess these systems without being coloured by prior experience, and to draw upon a wide range of concepts such as lean theory, BIM and organisational behavioural principles in their practices (Fischer *et al.,* 2014). This is important, given that these consultants often protect the interests of their clients and employers, but a more effective way to secure interests would be to understand the structure of a successful project for all parties involved (Ballard, 2008). Indeed, such a transition could further facilitate collaboration, creating an open learning environment, where teams work together to achieve transparent and cooperative exchanges of information (Lichtig, 2008).

In terms of contracts, the traditional systems typically only explain: conditions on site, responsibilities of the parties, warranties, who pays when things go wrong, and timing of the work, costs, etc. (Knapp *et al.*, 2014). IPD contracts usually explains what management systems or tools will be used (e.g. last planner® system, target value design, etc.) and more importantly how the project will be managed. The IPD approach also supports the “Five Big Ideas” of lean project delivery. This concept was developed by lean project consulting in 2006, which revealed five overriding principles that stimulate new ways to deliver projects and maintain collaboration, and has proven successful in the Sutter Health’s projects (Lichtig, 2010). According to the lean project consulting group, these principles, as illustrated in Figure 2-10, which include: (a) collaborate; really-collaborate, throughout design, planning and execution, (b) increase relatedness among all project participants, (c) treat projects are network of commitments, (d) optimize the project, not the pieces, and (e) tightly couple actions with learning. Fischer *et al.*, (2017) further analysed these ideas and elaborated them to mean:

- Involving downstream players in upstream decisions from the outset, to provide more avenues to resolve a series of problems, using the art of conversations to explore possible solutions. Thus, Howell (2014) added that this close collaboration between teams early in the project development process will significantly reduce the scope for changes later in the project.

- Establish relationships that are based on trust. This is suggested to increase relatedness between the project participants to innovate and learn, which will consequently affect the growth of relational contracting and largely dictate the culture of the project, whether it is adversarial or non-adversarial (Howell, 2014).
- Projects are always viewed as processes but not as an entire network of commitments – hence the need to work together and maintain these commitments.
- One of the fundamental ideas of collaboration is the emphasis on early involvement of key players, which would provide greater opportunities for savings, value creation and project optimization (Brodtkorb, 2017). Therefore, incorporating expertise specifically during early project stages to decrease design cost, increase efficiency, find better solutions and build trust (Hosseini, Windimu et al. 2017) is encouraged – as this would allow teams to act on what is best for the project rather than what is the least costly.
- Participants contributing throughout the project process should align with the client's demands, with an opportunity to learn while in action. Macomber (2010) states that continuous improvement of cost, schedule and overall project value is possible when project performers learn in action, while Biton and Howell (2013) place emphasis on regular inspection and control for identifying mistakes to reduce the risk of future re-work.

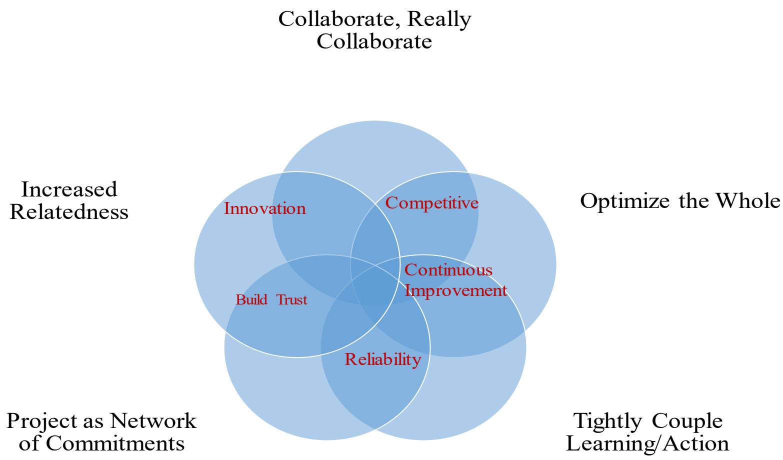


Figure 2-10: Five Big Ideas in Lean

These are part of the behavioural cultures expected in the IPD system, which require managers to incorporate such ideas in their daily actions. However, various studies within the UK and industry-wide have shown that there is poor understanding of these principles and seemingly the adoption of the IPD approach. This is despite the fact that, IPD owes much of its initial framework to the project alliancing approach developed initially in the UK for oil exploration in the North Sea (Fischer *et al.,* 2017). The study of Daniel *et al.,* (2014) examined the relationships between collaborative planning and the last planner system in the UK construction industry, and maintained that there is poor understanding of construction as a production system and of the significance of flow in project delivery for benefit realisation. This continues to show why the traditional project management view persists: a view that typifies fragmentation and adversarial relationships in practice. This also confirms the interpretations of Challender *et al.,* (2014), that perceptions of collaboration and partnering working have shifted within the UK context, as project performers are now responding with a quest for job security, which in turn has contributed to the risk-averse behaviours that continue to hinder efforts and establishment of long-term collaborative relationships in practice.

2.6 Summary

This chapter explored project delivery routes, the concept of lean production, and commercial practices within the UK construction industry. The review established that demands for performance improvement over the years for innovation are not limited to the UK construction industry, but are a global phenomenon. The study recognised that, over the years, the much-adhered to project delivery routes have not comprehensively improved performances in the industry because of the following: fragmentation, hierarchical arrangements, commercial behaviours, multiple transactional interfaces, and deep-seated cultural issues, thus resisting radical improvement. This also explains why the term ‘delivery’ appears to be understood as a type of transaction, rather than a process for moving facility from concept to customer. Therefore, this continues to illustrate poor understanding of construction as a ‘production’ system and amongst stakeholders in practice. More so, this shows why various parties in construction, particularly the commercial actors, continue to adhere to the cultural system, which is hindering CW. The review also recognised how the UK prevailing system separates commercial functions from production processes, which reveals implications that contributes to waste in construction. This was discovered among others from the concept of ‘institutional waste’ that explained the cultural antecedents surrounding project delivery and commercial practices in the UK industry. This review indicates that the radical change required in the industry seems to hinge on improving collaborative culture, and aligning commercial interests in production systems, especially as described by the concept of IPD in the lean system. Therefore, this indicates that CW remains crucial in the UK construction industry, and in need of strategies like IPD to improve production efficiency. Chapter 3 will further review the literature and explore the idea of ‘costing collaboratively’ in practice to broaden the understanding of collaboration in the UK construction industry.

CHAPTER 3 COLLABORATION IN CONSTRUCTION: COSTING PERSPECTIVES

3.1 Introduction

Chapter 2 concluded that the much-adhered-to model for project delivery within the UK construction does not encourage CW; consequently, the review established that commercial functions needs to be aligned with production activities to improve the culture of collaboration in construction. This chapter provides a wider perspective on collaboration, by exploring the idea of 'costing collaboratively' (CC) in practice. Specifically, the review looks at CW in construction and its relationship with the current costing practice. The first section examines innovation and process improvement, and the need for CW at conceptual stages (costing, design) within the UK construction industry. Then, the chapter examines platforms that promotes CW in costing activities, e.g., target costing in manufacturing, and the TVD from the lean system; these are then compared with the UK costing practices. The review shows some differences, implications and areas for improvement to strengthen CW in the current costing practices. Following this, the chapter lays a foundation for the study to explore the perceptions of CC in practice using TVD as a guiding lens within the UK construction industry.

3.1.1 Innovation & Process Improvement in Construction

Innovation has for long been the yardstick for improving and maintaining competitiveness in various sectors like manufacturing, business management, process engineering and more recently the construction industry. For instance, Panuwatwanich *et al.,* (2008) remarked that innovation has now diffused into the construction marketplace, as more organisations now spend fortunes to increase their competitiveness. Accordingly, there are several interpretations of innovation in the literature. For instance, Van de Ven (1986) posited that, from an organisational point of view, innovation is described as new practice and technology, while Dulaimi *et al.,* (2006) asserted that it is the profitable exploitation of ideas substantially to seek competitive advantage. Similarly, Gledson and Phoenix (2017) added that innovation means ingenuity, entrepreneurship, process improvement, development and growth. The Cambridge dictionary (2016) defines it as 'the process of translating ideas into goods or services that create value where customers will pay'. These descriptions indicate that innovation is the structural creation of new ideas to improve processes to achieve new results. Therefore, this can be summarised in construction to mean development of new ideas, processes or practices, in a bid to increase organisational efficiencies (Egbu *et al.,* 1998; DTI, 2003; Ling, 2003; Sexton and Barrett, 2005; Panuwatwanich *et al.,* 2008).

For a long time, processes have been the main area that draws innovation into projects and organisational operations, particularly in the field of manufacturing, engineering, and information technology. The term 'process' has several descriptions. Akintoye *et al.,* (2012) posited that a process is a series of steps, where value is added, which transforms into a final product - comprising of actions, methods and operations. On the other hand, Jeong *et al.,* (2004) opined that people's interpretations of process vary depending on their field of expertise and the role they play. For example, Harrington (1991) mentioned that process consists of activities that take in resources and transforms them into output for customers' needs. Whilst, Ould, (1995) mentioned that process comprises of activities, people, and equipment, synchronised for effective working. This means that process is not just a collection of activities, but also encompasses materials, people, and machines that need harmonising for better output.

Equally, Jeong *et al.,* (2004) argued that, since process also includes a wide range of people, it should hence, be clearly defined as incorporating all stakeholders involved within the process to achieve the required improvement. Thus, the emphasis here should be on all the various steps that make up the process. This implies that any incremental improvement within a process relies on many of the steps identified, rather than overhauling the complete system (Paulk *et al.,* 1995). Therefore, this suggests that process improvement should follow a defined procedure. In other words, a series of steps starting with the visible, that can later be made repeatable and measurable (Deming, 1986). Increasingly, in construction, projects are carried out within various steps known as processes. Consequently, this means that the final product in construction largely depends on how this series of steps is effectively planned, organised and managed.

Accordingly, this highlights the need to manage the steps effectively, as they can support productivity and the capacity for construction development (Stewart and Spencer, 2006). This further implies that productivity and efficiency within a process will remain impracticable if the series of steps is not well managed (Daniel, 2017). Hence, managing the steps should be done collaboratively, as each process involves information, people, and materials. Moreover, process in construction consists of multiple participants, and each step must be clearly defined to all parties involved at the earliest possible moment for collective improvement and development (Jeong, 2004; Ould, 1995).

3.1.2 Overview of Process Improvement in the UK Construction Industry

It has been acknowledged in the literature that organisations and project performers continue to struggle in terms of managing their construction processes. For instance, Jackson (2002) mentioned that costing processes in construction continue to change, which often begins with poor planning in design, thus creating cost overruns in production stages. These changes are often linked with the prevailing construction model (the business as usual system), which encourages the inherent variability and uncertainty in construction processes (Latham, 1994; Ballard and Howell, 1998; Sunil *et al.,* 2015). Furthermore, Smith (2010) reported that improvement in this regard seems not to have been continuous, as contractors are distant from direct value creation, increasingly relying upon others in the supply chain.

This indicates that the capacity for continuous process improvement appears largely transient and insufficiently embedded to persist where present. Stewart and Spencer (2006) added that there is evidently a lack of a framework and guidelines to support process improvement in construction activities. This means that benefits realised from processes are seen only in isolation and thus cannot be managed. Arguably, this has painted a picture, which illustrates that efficient frameworks, models, systems etc., are needed in the construction industry for process improvement. Consequently, as discussed in the previous chapter, numerous reports have been commissioned in the UK after Egan (1994, 2002), and most have called for the integration of processes and stakeholders for performance improvement in the construction industry, which means that such transition would equally require extensive CW, and shifting of mind-sets to achieved the necessary improvement.

3.1.3 Concept and Definition of Collaboration

Collaboration is a ‘term’ that is increasingly gaining prominence in areas like manufacturing, information technology, and service delivery because of the collective benefit and impact. Several studies have provided detailed accounts of the concept.

According to Mattessich and Monsey (1992), collaboration is about mutual and well-defined relationships entered into by two or more organisations to achieve common goals. This matches with Malone and Crowston's (1994), (p. 4), description of people "working together on an intellectual endeavour". Similarly, Schrage (1990 pp20) added that it is a process of shared creation between two or more individuals with complementary skills to interact, and create shared goals that none had previously shared or could have come to on their own. Shelbourn *et al.,* (2012) maintained that this exemplifies an activity where shared objectives are realized, when teams collectively combine their resources. Likewise, Grudinschi *et al.,* (2013) explained that it is a concept where autonomous actors from fragmented sectoral systems negotiate to share power and resources, leverage core capabilities and create rules and structures to govern their relationships, with the purpose of addressing multifaceted social concerns, thus create and capture social value. These descriptions indicate that the underlying principles for true collaboration to emerge, requires 'interaction', 'negotiation', and 'shared understanding', among stakeholders to develop and create social value.

Similarly, Fischer *et al.,* (2017) maintained that collaboration does not simply mean interaction between two or more individuals, but should also entrench key principles like 'trust and transparency', 'cultural consideration', and 'sense of ownership', for the relationship to flourish in practice. This was supported in Suprapto *et al.,* (2015) who opined that collaboration requires key attributes such as 'relational mind-sets', 'capabilities and joint working'. Thus, this further implies that the concept needs shared environment (physical or virtual), with teams properly integrated to achieve the mutual goals. This is why Poirier *et al.,* (2016) cautioned that the challenge is not a matter of if an organisation or individuals should collaborate, but rather how they should collaborate. It is worth nothing that not all these described relationships are well defined, well-structured and truly mutual, or indeed work towards the same goals. Mainly because, most often, the practice of collaboration varies in terms of how the term is used in today's construction industry (Xue *et al.,* 2010), which at times is interchanged with 'partnering' (Challender *et al.,* 2014). This means that collaboration must transcend beyond the traditional norm, where people turn up in joint venture arrangements, but invariably work independently or in parts to safeguard the interest of one company over another. As an alternative, teams need to support each other and build a product in an environment where many internal and external uncertainties exist (Pryke, 2004, p. 790).

In view of this, Fischer *et al.,* (2017) added that collaboration for construction should be a community of people working together to achieve common goals - through deep level trust, clear understanding of project values, and a sense of ownership. This description highlights the need for construction participants to work harmoniously within a community, i.e., designers, constructors, trade vendors and asset owners, to create social value and shared understanding. This matched with Keast and Mandell's explanations (2014), where they maintained that the formation of collaborative relationships, particularly in construction needs the following criteria to be satisfied; these include: (1) high levels of reciprocal interdependency, (2) open and frequent communication, (3) shared risk and power, (4) dense relationships, and (5) commonly recognized goals and the recognized need to collaborate for mutual success. Again, this suggests that collaboration goes beyond the current practices (alliancing/joint ventures), where individuals often work in silos; instead it should be that people within these communities engage with one another to achieve their individual goals as well as support the success of others (Fischer *et al,* 2017), as compiled in table 3-1.

Table 3-1: Cornerstone and Attributes of Collaboration

Sources	Underlining Principles
Mattessich & Monsey (1992)	Mutual relationship and common goal.
Malone & Crowston (1994)	Working together and intellectual endeavour.
Schrage (1990)	Shared creation, complementary skills, shared goals and interactions.
Shelbourn *et al.,* (2012)	Shared objectives and resources
Grudinschi *et al.,* (2013)	Negotiation, power and resource sharing, common goal and social value creation.

Keast and Mandell (2014)	Reciprocal interdependency, open and frequent communication, shared risk and power, dense relationships, common goals and needs to collaborate for mutual success.
Suprapto *et al.*, (2015)	'relational mind-sets', 'capabilities and joint working'.
Fischer *et al.,* (2017)	Trust/transparency, cultural consideration and sense of ownership
Pasquire & Ebbs (2017)	Shared understanding

In addition, the preceding discussions highlight the importance of shared understanding, which is a fundamental part of collaboration, particularly during early construction preparations (Valkenburg, 1998). Accordingly, Smart *et al.,* (2009) remarked that shared understanding among stakeholders is 'the ability for multiple agents to exploit common bodies of causal knowledge to accomplish common (shared) goals'. This indicates the ability for various participants to coordinate their behaviours with respect to each other and support the realisation of common objectives. Noticeably, this shows that shared understanding is an ability that, grows with interrelationships more than knowledge, because it involves reasoned actions and its dynamic (Bittner & Leimeister, 2013). Similarly, in the context of lean construction, Pasquire & Ebbs (2017) advised that shared understanding is now critical to social aspects of sociotechnical systems that needs to be precise and project specific to achieve desired outcomes. The authors proposed it as an addition to the seventh flow model of production, as a measure of collaboration. Thus, if understanding breaks down within the system, the whole system fails. Accordingly, from the above explanations, this study has compiled various descriptions of collaboration as presented in table 3-1, to scrutinise its application in construction practices.

3.1.4 Current State of Collaborative Working in the UK Construction Industry

Collaborative working is a term used in the construction industry to denote a mutual and beneficial working relationship amongst stakeholders, to deliver a project to the required standard (Mattessich *et al.,* 2001; Xue *et al.,* 2010). Although in construction, CW is often interchangeable with partnering, Bresnen & Marshall (2002) argued that partnering necessitates commitment by organisations to co-operate and achieve common business objectives. This means that partnering is perhaps best conceptualised as making progress towards CW, in other words an element of CW.

Interestingly, it is now fairly common to see construction organisations claiming to work in collaboration, but in hindsight they are not effectively transparent (Pasquire *et al,* 2015). CW is still gaining prominence in the modern construction landscape. It has been increasingly adopted over the last decade to underpin relationships between stakeholders, transparency and cooperation instead of operating based on contractual formulations (Dagenais, 2007). It has also been argued that it brings numerous benefits to projects, especially when stakeholders are integrated early (Alderman and Ivory, 2007). Despite that, organisations in construction continue to revert to their traditional norms, which is why Wilkinson (2005) cautioned that true collaboration cannot be easily accomplished in construction.

Consequently, Akintoye & Main (2007) argued that CW in construction is often overshadowed by cultural attitudes and behaviours, where contractors enter with the hope of financial gains. This practice is preventing the industry from reaping the benefits of CW, and shows that contractors only enter such relationships if they are viable propositions for them. Similarly, Baiden *et al.,* (2006) added that construction projects continue to witness overruns in time and cost, which are due to the lack of CW. Likewise, Barraket and Loosemore (2018) added that the existing process of social value co-creation through supply chain relationships reflects more cooperation rather than collaboration; they cited that this is driven by commercial concerns, and influenced by industry norms and institutional imperatives. Challender *et al.,* (2014) posited that perceptions have now shifted after austerity, and that individuals are now responding with a quest for job security, which in turn encourages the risk-averse practices that are affecting the idea of long-term relationships in construction.

It can be argued that CW seems to exist in principle rather than in practice. Most clients and stakeholders have acknowledged its benefits, but the propensity to inculcate it properly in practice is still missing. Part of the issue is that the prevailing construction model largely emphasizes on "cooperation", characterized by the traditional hierarchical power structures that defined the construction industry's supply chains, and by informal, temporary, unstable, low trust, voluntary and low commitment relationships that involves little sharing of resources, risk or reward (Keast and Mandell, 2014). According to Erikson and Laan (2007), construction clients now place more emphasis on price and authority and very little on trust, a position that is also taken by the contractors to keep their subcontractors at arm's length. This establishes a form of governance within the system that focuses on price and control, despite the suggestions that CW would allow teams to develop beyond the transactional perspective of 'buying behaviours'. It seems that, for genuine CW to exist, trust and cooperation must thrive amongst stakeholders (Latham, 1994) to enable organisations to restructure and manage their interrelated activities, thus improving communications and shared understanding (Challender *et al.,* 2015).

Therefore, CW, particularly during conceptual activities (costing/design), remains significant. However, this rarely exists in practice. For instance, the study of Zimina *et al.,* (2012) observed that cost advisers and members of the contracting parties do not collaborate in this regard, especially when developing project costs. In fact, the costing model adopted in the UK drives cost consultants to work in isolation from designers and vice versa. This not only results in developing unrealistic estimates, but compounds more waste in production processes and encourages opportunistic behaviours (Pasquire *et al,* 2015). Without a genuine culture of collaboration, consistency and accuracy in costing processes cannot be effectively achieved.

3.2 Collaboration and Costing Practices in Construction

3.2.1 Construction Cost Management

Costing is a term widely recognised as a major project management function. According to the Institute of Cost and Works Accountants England, costing is a technique and process of ascertaining project costs. The Cambridge Business Dictionary (2016) defined it as a 'system of computing cost of production or running a business, by allocating expenditure to various stages of production or to different operations of a firm'. This means that costing is an integral and necessary aspect for running businesses and various operational tasks. Carr (1989) remarked that costing activities are substantial, as they provide information for decision-making, cost scheduling and resource management. These descriptions suggest that costing alone cannot guarantee the achievement of quality for the intended tasks or manage organisational resources. However, the activity also needs cross-functional interactions to generate information that would support business decision-making (Hanid *et al.,* 2011).

However, more often, costing is described synonymously with cost management. Hence, according to Agrawal *et al.,* (1998), cost management entails cost accounting and management accounting techniques. Thus, Anthony (1989) asserted that cost accounting deals entirely with numbers while management accounting involves people interacting with numbers (accounting information), with the objective of assisting managers, that hence, influences their behaviour. According to the Cambridge English Dictionary (2015), cost management 'is the process of effective planning and controlling costs involved in businesses'. Maskell (2009) added that it is a technique used by companies internally to help with managerial tasks and control business improvement. This implies that the concept has no strict requirement on how to carry out costing activities, thus, this has in part altered the way in which cost management has been approached in practice, as well as its multidisciplinary origin and evolution (Hanid, 2014).

In the context of construction, cost management is regarded as a major project management function. Ashworth (2010, p. 434) described it as 'a process of planning, estimating, co-ordination, control and reporting of all cost related aspects from project initiation to the time of an asset's eventual disposal'. Similarly, Hanid *et al.,* (2011) added that cost management produces sets of techniques for controlling and improving companies' activities and processes, products and services, to achieve cost effectiveness (cost reduction, value improvement and substitution) by collecting, analysing, evaluating and reporting cost information for budgeting, estimating, and monitoring costs, to assist decision-making. These descriptions also interpreted cost management as service-based delivery function, where the primary objective is cost reduction or substitution (Kelly and Male, 1993). This often relates to a commercial function that characterises the role of QSs in the UK construction industry. Therefore, succinctly, cost management in construction is seen as a function that focuses on providing objective, reliable, accurate, and operating cost assessments, usable for investment and project control. Indeed, one can argue that developing or managing cost alone cannot guarantee the achievement of quality in the cost related tasks. This is why Hanid (2014) remarked that the primary objective of cost management should be to generate information that would also support the decision-making process. In this way, it can be tied into value engineering processes and financial management activities.

3.2.2 Overview of Costing in Construction

Cost management has been established as the primary process for managing construction projects. For example, Michalak (2001) reported that it contributes to business and project objectives, which ensures that accurate and efficient information is available to support decision-making. Hence, this implies that the management of project cost depends largely on the cost forecasting information and the recommendations put forward to facilitate or mitigate any action in the project. However, cost management in construction it spans across the end-to-end project lifecycle, which include pre-contract, cost management, contractor's estimation and post-contract. This shows that cost management is a 'hard-core' process and essential for achieving project success. Eldash (2012) added that, despite it being separated into stages, it is still imperative to maintain continuous dialogue during the costing exercise, as this will enhance value creation.

There are numerous concepts associated with costing practice, such as Full Absorption, Activity-Based Accounting, Constraint-Based Accounting, Throughput Accounting, Target Accounting, Lean Cost Accounting, Inter-Organisation Cost Management, Whole-Life Costing, Value Management, and Risk Management (Agndal & Nilsson, 2009; Burtonshaw-Gunn, 2009; Cartlidge, 2009; Dallas, 2006; Hanid et al., 2010; Kelly, Male, & Graham, 2004; Kishk *et al.,* 2003; Potts, 2008; Wübbenhorst, 1986). Most of these approaches aimed to reduce and control project costs, yet the traditional practice still ignores the notion of 'value' and 'process improvement', as discussed by Fine (1974) and Hanid *et al.,* (2010), which means that the current practice has failed to achieve these targets (Sunil *et al.,* 2011).

In addition, Marchesan & Formoso (2001) argued that the goal of cost management is to provide accurate estimates, which would provoke discussions and decision-making to influence the overall production output. However, previous studies confirmed that the current costing and estimating efforts have not truly achieved these purposes (Johnson & Kaplan, 1987; Howell & Ballard, 1996; Koskela & Ballard, 2000). For instance, Howell and Ballard (1996) and Koskela (2000) reported that traditional cost management placed much emphasis on managing contracts ahead of the overall production process. This means that various professionals entrusted with this function work in isolation, and thus separate the activities of costing and design from production (Marchesan and Formoso, 2001). Indeed, efforts in construction cost management should be tailored towards improving its transparency and timeliness in terms of information sharing, as this would help to identify and remedy early waste in production flow through strategies that would support collaboration (Hanid *et al.,* 2011).

3.2.3 Current State of Costing and Collaborative Working in Construction

Costing and estimating practices have often been criticized in the literature. Johnson & Kaplan (1987) identified that cost management information tends to be too late, aggregated and distorted to be relevant for production planning and control. Similarly, Marchesan and Formoso (2001) mentioned that the approach is failing to stimulate decisions that would influence production activities, citing that it has mostly developed to satisfy fiscal and financial needs. This continues to show the lack of sufficient details during early costing development, which permeates inconsistency and uncertainty throughout the process.

Inconsistency and uncertainty are two of the common themes associated with the traditional costing approach in construction. Elfving *et al.,* (2005) observed that uncertainty is still a major issue during early design development that often leads to changes in projects, thus causing considerable amounts of waste in terms of resources. Flyvbjerg & Holm, (2002) described the impact of uncertainty during cost estimation, which reveals the 'dark side of forecasting'. Elfving *et al.,* (2005) concurred with Flyvbjerg and maintained that uncertainty during early design increases variability that leads to suboptimal solutions in the process. Despite this empirical evidence, professionals in charge of these processes (designers and QSs/estimators) seem not to acknowledge this, and proceed even when imprecisions are detected at the outset. Moreover, most of the cost data used is taken from previous projects that inherit waste (Ballard, 2008) and, more commonly, clients often decide on less detailed issues early on during tender formulations. This means that these details are likely to change during delivery, and hence result in more consequential waste (Jaya *et al.,* 2010).

Similarly, authors such as (Ashworth, 2010; Hastak, 1998; Kern & Formoso, 2004; Dallas, 2006; Hanid *et al.,* 2011) lamented on these issues. They cited on design liability, lack of collaboration, isolated decision-making, and limited understanding of cost management techniques. Relatedly, Kirkham (2007) pointed out that the classical 'cost planning' technique, which is a key process in construction cost management, still follows the conventional process outlined by the RIBA plan of work. This guides the procedure that sets the final contract sum, yet, it supports competitive tendering and places more emphasis on costing detailed design rather than establishing a detailed estimate. Akintoye & Fitzgerald (2000) reported that this approach lacks proper communication and feedback channels, as it usually leads to ferocious competition, low levels of trust and data sharing, that ultimately escalate project costs (Eastman *et al.,* 2011). Cartlidge (2006) affirmed that this growing trend indicates low levels of collaboration amongst the stakeholders involved, which also means that the interest in developing communication and sharing information in the process is still missing.

Other authors (Nicolini *et al.,* 2000; Marchesan and Formoso 2001; Kern and Formoso, 2004; Ballard, 2006 and Ballard and Pennanen 2013), have also reviewed the current costing practice. For instance, Nicolini *et al.,* (2000) established that the main barrier to the adoption of a 'fully-fledged' version of target costing (a concept developed in manufacturing) in construction stems from the existing commercial practices in the UK construction industry. This confirms the criticism labelled against the industry, regarding fragmentation: particularly among contractors, who often operate without a full understanding of costs across their supply chain. The norm in the costing approaches has often been to develop designs first, and then invite prices from suppliers who are not involved in the design development. The result is usually a series of prices based on commercial judgments, instead of true costs. Ballard (2012) connoted that costs, as opposed to prices, are rarely investigated, thus margins are dependent upon expediency. Similarly, Laryea (2010) examined the reliability of estimated costs provided for projects in Ghana, and reported that projects estimated by consultants experienced an average cost overrun of 40% and time overrun of 62%, whereas projects priced by contractors experienced an average cost overrun of 6% and time overrun of 41%. This seems to show that the contractors have a reasonable understanding of actual costs, whereas, when consultants are involved, up to 40% of estimated cost is added as a margin for inaccuracy.

These statistics are alarming, and even though the study was reported from a developing country, they still highlight inconsistencies and the lack of shared understanding amongst stakeholders in the process.

Furthermore, cost overruns remain one of the serious problems that have plagued construction operations all over the world, irrespective of geographical location. The phenomenon has been described by several authors and varies depending on the stage during project delivery. Different synonyms have been used in relation to the term cost-overrun: 'budget increase', 'cost increase', 'cost development' and cost growth'. However, these differ from 'cost escalation', which is a term used to explain projected growth in a planned cost because of factors such as inflation (Love *et al.,* 2012)**.** Flyvbjerg *et al.,* (2003) described cost overrun as the variation between the final detailed cost estimate that was available at the time of decision and the total cost at the time the project was completed.

Accordingly, over the years, cost overruns have grown in projects and become the norm rather than the exception, particularly in infrastructure projects (Love *et al.,* 2017). Love *et al.,* (2012) posited that the prevalence of cost overruns is not prevalent because projects do not go according to cost plans (budgets), but rather because these plans do not represent the project. This is not surprising given that dialogic discussions in these processes are often non-existent at the feasibility stage, and because costing and design are not considered as integrated to 'production', as acknowledged in lean construction. Hence, the challenges inherent in predicting the future uncertainties are affecting early cost management and resulting in a considerable amount of 'guess-estimation' (Ballard, 2006). This often results into a significant disparity between initial budget forecasts and the actual construction costs of projects (Raisbeck and Ayodeji-Aybinu, 2010). Likewise, projected costs for many large construction and infrastructure projects often escalate at these early stages, and this is due to the disparity in procurement strategies employed, which presents risks and uncertainties (Love *et al.,* 2016). As usual, this results in too much firefighting during project delivery, dealing with cost uncertainty and managing the consequences of changes to brief and project scope (Laryea, 2010). Likewise, previous explanations such as optimism bias and strategic misinterpretation (Flyvbjerg, 2008) do not enable us to understand the wider underlying conditions that contribute to poor costing practice (Love *et al.,* 2011). Still, empirical evidence shows that most of the common problems of cost estimation and management are 'institutional' and due to organisational cultures, rather than inherent in project-work (Wearne, 2014).

Furthermore, studies have shown that cognitive and psychological factors tend to drive down the actual cost of projects during the formative stages and thus create a deceitful and unreliable cost forecast (Caffieri *et al.,* 2018; Smith, 2014; Winch, 2010). For example, the Scottish Parliament project was initially costed at £40 million (reported to be unrealistic at that time), but was completed at a cost of £431 million and 3 years behind schedule; the Channel fixed link project costs increased by 69% with a 14.2% schedule escalation. Flyvbjerg *et al.,* (2003) observed that, once a considerable amount of resource has been invested to start a project, it makes it makes termination seem unreasonable. This is because project promoters have manipulated the estimates to make them look good on paper and get approved to build it, thus they often try to redeem a suboptimal choice once it is observed that the project is going badly. Psychologists called this behaviour "sunk cost fallacy", which is a tendency to continue a course of action due to the amount of resources already invested in a failing project or decision, despite overwhelming evidence that the course of action is suboptimal (Braverman and Blumenthal-barby, 2012; cited in Love *et al.,* 2011).

3.2.4 The Need for Early Collaboration in Costing and Design Activities

Interdisciplinary teams often face several challenges, which is affecting their ability to collaborate in practice. Common problems are: poor communication between members, deficient or missing information for making timely decisions, and a lack of coordination between various disciplines (Tillmann *et al.,* 2013). These problems are also reflected in the quality of the design documents produced, which require additional design iterations that do not add value for clients or subsequent disciplines in the supply chain (Ballard 2000; Ballard & Koskela 1998). For instance, a recent study on the cost of quality failures (deviations, defects, nonconformance and reworks) found that design change in scope, errors and omissions in documentation contributed to 13.9% of the cost of nonconformance (Love, Teo & Morrison 2017).

Lean philosophy in construction emphasizes that time should be spent upfront during these early processes, because once construction has begun it is expensive to change the design (Ballard 2008). Lean management strategies rely on a comprehensive model that brings project process under control, improves information flow, recognises and copes with uncertainty, and delivers value to the client (Koskela 1992). These strategies advocate on integrating the design and construction phases to realise these values and ensure that design can be produced cost effectively (Koskela *et al.,* 2002). Incorporating construction details in the design process requires a systematic approach, as it comprises of two knowledge groups: product (design) and process (sequencing and plans) knowledge (Ballard & Koskela 1998).

Accordingly, attempts to address these concerns led to a growing body of research that stressed the need for early collaboration, especially during costing prior to design. For example, the study of Shalpegin *et al.,* (2018) examined collaborative prototyping scenario where manufacturers involved suppliers in the detailed design process; such collaboration was found to have a significant influence on the manufacturer's optimal decisions. The authors recommended that such an approach needs adjustment to capture suppliers at conceptual stages, as this would reduce commercial friction. Similarly, Ballard (2006) stated that industrial sectors are more disciplined in this regard than the general building sector; he stressed the importance of shifting the construction industry's focus during design from prices to costs. A subsequent study (Ballard & Pennanen, 2013), which was based on descriptive research, discovered that the use of the TVD approach to define and deliver scope within client constraints, increased the accuracy of conceptual estimating processes. Likewise, Jung *et al.,* (2012), who used the game theory concept to compare, DBB systems with IPD based on TVD, considered collaborative design alignment and illustrated how target-costing strategies shifted the traditional dominant behaviour to cooperative management practice. According to these authors, this economic approach is expected to provide further understanding on collaborative practices, which might reveal what level of target cost is appropriate and how risks and rewards need to be shared to induce collaboration. Other studies that suggested the use of collaborative approaches in costing and procurement methods include Laryea (2010), Love *et al.,* (2017), and Tillmann *et al.,* (2017). Indeed, these findings showed a growing trend, which indicates that collaboration is an integral component required to transform the customary costing approach in construction.

3.3 Concepts Reinforcing CW in Costing and Design Processes

3.3.1 Target Costing in Manufacturing

The emergence of target costing (TC) has been well documented in the literature. Feil *et al.,* (2004) reported that TC was first spotted in the manufacturing industry in the 1930s by Toyota, where it had been used with a value engineering (VE) concept to reduce the overall product cost of automobiles during early design stages (Ansari *et al.,* 2006). Due to the competitive nature and challenging financial conditions in the Japanese industry at that time, it led companies to explore TC as a viable way to improve product cost using lean manufacturing (Kato 1993). It was developed in the West, where costing and performance metrics are considered during planning processes as well as during early design stages. This means moving away from developing full designs, and later ascertaining the material price and resources needed to satisfy requirements (Alwisy *et al.,* 2018).

The rationale behind the new approach is to accomplish cost predictability during new product development, so that the product will meet the market-determined price and offer financial returns (Zimina *et al.,* 2012). As such, the TC concept was borne in manufacturing in search of better cost management practice, which turns out to be a powerful strategic instrument for management and profit planning (Cooper and Kaplan, 1999). Its Japanese name is '*Genka Kikaku',* which means a strategic concept to reduce the overall cost of new product to ensure that it meets the market-determined prices with financial return (Nicolini *et al.,* 2000). Authors such as (Nicolini *et al.,* 2000; Yook *et al.,* 2005; Okano and Suzuki, 2007) have all attested to its emergence from the Japanese car industry in the early 1960s. Although, before that, a similar effort was found to be in used at Ford and Volkswagen (Feil *et al.,* 2004), which then became a popular tool and technique for value engineering that gave rise to the cost management practices, widely adopted by the Japanese corporations (Savio *et al.,* 2014).

Simões *et al.,* (2008), added that the practical application of TC began in the 1960s with the aim of first establishing a target 'cost' and second being able to 'achieve it' during the production of new vehicles. This gave the entire team the desire to support the process and achieve profit (Cooper & Slagmulder, 1997 & Kato, 1993). It then became popular and mainstream, driving design activities, while cost and value were used as benchmarks, away from cost computation, after detailed designs were complete. Similarly, Cooper (2002) mentioned that the concept developed from a simple cost reduction process into a strategic system for managing profits in the Japanese automotive industry.

In addition, TC does not stop at 'setting the cost target': it also allows the process to be optimized to maximize project value under the predefined total cost (Alves *et al.,* 2017). This aligns it closely with inter-organisational cost management practice (Cooper & Slagmulder, 2004; Hakansson & Lind, 2006; Anderson, 2006), which is another effective strategy that enhances multidisciplinary integration, with mechanisms for cost-reduction and buyer-supplier interactions (Cooper and Slagmulder, 1999). The TC technique is most successful when management take into consideration all costs of a specific service and all service ingredients over its entire life cycle. This means that, the method requires the functional integration between all business activities such as design, engineering, research and development, marketing, and the accounting department. It also needs excellent plans through a comprehensive strategic framework to align price, cost and quality elements (Kato, 1993; Cooper and Slagmulder, 1997).

The functional collaboration of business sections requires from organizations to build several teams, whose joint goals is to achieve the desired target cost. The focus of these teams is to eliminate or discharge any costs that have no added value to the service, in addition to conducting analyses of the feasibility of cost reductions. This is why, Zimina *et al.,* (2012) revealed that multi-disciplinary teams find it helpful using this method to improve: design aesthetics, functionality of the future product, manufacturability, choosing procurement options, and lifecycle performance during new product development. Indeed, the emergence of TC has not only revealed a strategy that strengthens cost management practice, but also shifts the traditional view (Alwisy *et al.,* 2018) towards a systematic process.

3.3.2 Overview of TC in the Construction Industry

Several studies have reported on TC impacts within the project-based environment in construction. Among the early studies is Knott (1996), who described on the anecdotal citing of TC in construction on an oil and gas platform in the North Sea's Andrew field. Subsequently, Nicolini *et al.,* (2000) described the application of TC in the UK construction industry based on two case studies of Ministry of Defence projects.

Similarly, Ballard and Reiser (2004) reported on the first successful implementation of TC in the US. Jacomit and Granja (2011) commented on TC application in a social housing project in Brazil. These studies gave succinct accounts of TC applications; for instance, Knott (1996) reported that about 30% savings were realised. However, Nicolini posited that the main barrier to the fully-fledged adoption of TC in the UK construction stems from the commercial and cost management practices. The authors concluded that the existence of long-term relations with suppliers is one of the preconditions for applying a fully-fledged version of TC. Jacomit and Granja (2011) established that the standardization and replication of these in design were seen as opportunity. They lamented that the bidding process and the way designs are outsourced are still the main barriers preventing TC applicability in construction.

In a nutshell, TC is designed to prevent management from offering low profit margin products or services that rarely generate the desired revenues (Cooper and Chew, 1996); hence, initial evidence shows that the methodology of this system eliminates the non-value added costs at an early stage of the design and development of the product. Some researchers considered this costing method as an efficient managerial tool to manage the current product costs and for newly developed products (Ellram, 2006). Others argued that TC is not only a simple cost-reduction technique, but also a strategic system for profit management (Kato, 1993; Atieh, 2014). Construction projects continue to suffer with cost overruns, and unsatisfactory customer value is common (Forbes and Ahmed, 2011). Lean construction practitioners developed and envisioned a new concept called target value design (TVD), as a target costing adaptation for the construction industry (Macomber *et al.,* 2007).

3.3.3 The Rise of TVD in Construction

TVD is a collaborative approach and a step ahead of TC. Both have the collective purpose of involving stakeholders early during costing and design activities (Oliva *et al.,* 2016; Savio de Melo *et al.,* 2016). However, the TVD approach takes the best features of TC and adapts them into the peculiarities of construction. The rationale behind that is to allow 'cost' and 'value' to drive the design process, instead of calculating cost after a detailed design (Ballard, 2016). This means that TVD is a practice that steers design and construction to deliver customers value (cost, function, sustainability targets etc.) within project constraints (Miron *et al.,* 2015). Hal Macomber, Greg Howell & Jack Barberio were the first to use the model in 2007, after the adoption of TC in the construction industry (Macomber, *et al.,* 2007). TC was first spotted in the Construction of the Tostrud Fieldhouse at St. Olaf's College in Northfield, Minnesota, a project completed in 2006 (by Boldt Construction and Sutter Health) with reported savings in overall project costs of 19% below the market benchmark (Denerolle, 2013). Subsequently, in 2007, it was officially introduced as a framework for TC - to create the link between construction project cost and overall performance, and to develop a structured framework for its adoption (Ballard 2007; Macomber *et al.,* 2007). This means that TVD is a comprehensive management system, which has the potential to complement multidisciplinary collaboration (Jung *et al.,* 2012). This is why Ballard (2011) added that the model has better intent to deliver customers value.

The procedures of TVD were created, tested, and improved through project experiments by contractors and healthcare service providers in the US, through close collaboration with their supply chains (Zimina, Ballard, & Pasquire, 2012). In TVD, costs are input to the design process instead of output. It adopts the principles of TC, taking into account on factors like project organization, commercial terms, and the lean system approach, thus improving the delivery of projects, shared understanding and value (Zimina *et al.,* 2012). TVD's main goal is higher value-added delivery, using continuous improvement and waste reduction (Denerolle 2013). Since its inception, anecdotal evidence shows that, to date, over 100 TVD projects have been completed in the USA (Savio de Melo *et al.,* 2016), and its implementation has produced significant improvements in project performances, with final costs of projects finishing on average 15% lower than the market cost (Lee, Ballard, & Tommelein, 2012). Even though, the system seems mostly suited to IPD, where all the members involved with the project development work collaboratively as a single team, it can be applied to other procurement approaches such as DBB and CM@R (Pishdad-bozorgi & Karasulu, 2013). Accordingly, Zimina *et al.,* (2012) revealed that TVD is appropriate for most projects except:

- Those that have been pre-designed, whether completely or in need of only minor adaptation to local conditions, and designs are sufficiently optimized that further investment is not likely to pay off;

- Those where the customer cannot find service providers that are capable and trusted to execute the TVD techniques and;
- Those that are prohibited by statute from integrating organizations.

This means that TVD can steadily support cross-functional team integration, but needs (a) TC principles with alternative project organization (value-based selection as opposed to lowest bid procurement routes), (b) the use of relational contracts (such as IPD), and (c) a lean system of operation (Sampaio de Melo *et al.,* 2015). In this way, project members are incentivized to participate and align their processes (Lee, 2012). With such alignment, contingency funds are reduced, cost and project durations are also reduced to meet the customer's needs, whilst profits for project members increased.

3.3.4 Integrated Concepts within the TVD Model

Integrating cross-functional members (such as designers, consultants, and builders amongst others) in order to validate financial business plans steer design and construction targets, and maximise customer's value, are the fundamental differences between TVD and other costing approaches in construction (Ballard, 2011; Zimina *et al.,* 2012). Within the model, TVD incorporates several managerial concepts, such as: set-based design, concurrent engineering, last planner system; and tools such as BIM, choosing by advantage techniques (CBA) for selecting design options, and A3 formats for proposals (Ballard, 2011). These practices emerged from the lessons learned during TVD implementation in the healthcare and educational facilities (Denerolle, 2013). They are grouped in Table 3-2, as: (i) "***Organizing***" denoting commercial terms, which highlights on integration, and everything that allows TVD implementation, (ii) "***Defining***" referencing what the team does in order to define the target cost, and (iii) "***Steering***" which indicates how the team steer designs to the cost targets.

Table 3-2: TVD Elements (Adapted from Denerolle, 2013)

	TVD Elements
Organising	Some form of relational contract is used to align the interests of project team members with project objectives. The feasibility study involves all key members (designers, constructors, and customer stakeholders) of the team who will deliver the project if the study findings are positive. The customer is an active and permanent member of the project delivery team. Co-location is strongly advised, at least when teams are newly formed. Co-location need not be permanent; team meetings can be held weekly or more frequently. A cardinal rule is agreed upon by project team members – cost and schedule targets cannot be exceeded, and only the customer can change target scope, quality, cost, or schedule.
Defining	With the help of key service providers, the customer develops and evaluates the project business case and decides whether to fund a feasibility study; in part based on the gap between the project's allowable and market cost. The business case is based on a forecast of facility life cycle costs and benefits, preferably derived from an operations model, and includes specification of an allowable cost – what the customer is able and willing to pay to get life cycle benefits. Financing constraints are specified in the business case; limitations on the customer's ability to fund the investment required to obtain life cycle benefits. All team members understand the business case and stakeholder values. Feasibility is assessed through aligning ends (what's wanted), means (conceptual design), and constraints (cost, time, location, etc.). The project proceeds to funding only if alignment is achieved, or is judged achievable during the course of the project. Targets are set as stretch goals to spur innovation.
Steering	Target scope and cost are allocated to cross-functional TVD teams, typically by facility system; for example, structural, mechanical, electrical, exterior, and interiors. The Last Planner®4 system is used to coordinate the actions of team members. The feasibility study produces a detailed budget and schedule aligned with scope and quality requirements. Cost estimating and budgeting are done continuously through intimate collaboration between members of the project team – 'over the shoulder estimating'. TVD teams update their cost estimates and basis of estimate (scope) frequently. Example from a major hospital project during the period when TVD teams were heavily in design: estimate updates at most every three weeks. The project cost estimate is updated frequently to reflect TVD team updates. This could be a plus/minus report with consolidated reports at greater intervals. Often project cost estimates are updated and reviewed in weekly meetings of TVD team coordinators and discipline leads, open to all project team members. The cost, schedule, and quality implications of design alternatives are discussed by team members (and external stakeholders when appropriate) prior to major investments of design time.

Similarly, Macomber *et al.,* (2007) observed that these managerial concepts within the TVD system enable early cross-functional integration during costing and design development. In doing so, the authors added that the model embraced the following components:

Target Costing: Because of the extreme competition and increased internal and external pressures, various entities and organisations have been pushed to review their pricing strategies in order to become more competitive in the market place. However, traditionally, organisations still consider low prices as the most vital component for competitive advantage. In doing so, market prices are determined by accumulating all the costs of the product, and a specific profit margin is added to the cost. Consequently, this conventional approach is no longer helpful for management to identify opportunities for innovation and value enhancement. TC was developed to overcome these shortcomings, where products and services costs are decreased to establish more competitive prices in the market and ensure more control over costs to satisfy customers' needs, and achieve the desired level of competition and consequently organizational success. The logic behind the approach is to allow companies to set their quality, price, reliability, delivery terms and targets at the time of product planning and development, to meet customers' perceived needs and interests (Cooper & Slagmulder, 1997). The process has been described in a simple equation: target cost = target price - target profit. The process uses data and information in a logical series of steps to determine and achieve the TC (Aladwan *et al.,* 2018). As such, it has been implemented through the following steps (Feil, *et al.,* 2004):

(a) Conducting market research in order to see what products are available in the market place, and what new products any competitors are trying to launch, in order to ascertain the customer's requirements, and the price they can afford for the product.
(b) Establishing the desired price, margin and cost feasibility. Target price is determined based on market survey: the price at which the product can be sold. A standard margin is determined, which will be taken off the scale price to reveal the cost figure (Target Price − Target Profit = Target Cost).
(c) Make the necessary design improvement. If the product designed cannot be provided in the cost range decided, value engineering is used to drive down the cost to a level at which target price and margin can be attained.
(d) Continuous improvement on the TC plan by eliminating any unnecessary non-value added costs and processes.

Therefore, price and profit are treated as variables determined by various external competitive market forces in the industry (Ansari, Bell, & Okano, 2006). In this way, the TC approach is used in place of the traditional costing process that mainly focused on detailed design. The difference is that this involves rigorous market analysis, where companies set the sale price of the new product and subtract the target profit margin, which is done prior to designing the product (Lee, 2012). According to Banham (2000), this multidisciplinary collaboration would overcome barriers that often appears during cost development; however, TC needs total system integration to share the cost reduction purpose. In addition, the cross-functional teams that participate in the process should have the valuable knowledge, training and motives to understand the elements of cost reduction and how TC is achieved in the overall strategic framework (Choe *et al.,* 2012). In a nutshell, the process requires an extensive degree of time and commitment for teams to cost, which means the enterprise organizations need to be empowered and engaged during the process (Zsidisin *et al.,* 2003).

Collaboration: The lack of ability to integrate stakeholders early during design development has been a well-known issue in practice, which often leads to cost overruns, poor decision-making and other problems in the process (Adamu *et al.,* 2015; Pikas *et al.,* 2015). These often have a significant influence on cost, performance, and reliability, accounting for more than ¾ of the final product costs (Hsu & Liu, 2000). Therefore, the need for upfront collaboration at a conceptual stage intensifies, which means deconstructing tasks, assigning roles and responsibilities, synthesising information, discussion, and negotiating with regards to shared representation (Qu & Hansen, 2008). Noticeably, these tenets are also embedded within the TVD practice: instead of designing and then converging later for group review and decision, the concept emphasizes on working together to define issues and make decisions collaboratively, and then design based upon those decisions (Miron *et al.,* 2015).

Colocation: In a highly collaborative setting, the concept of colocation enables intense communication amongst team members. The introduction of this element raises the flag on the biggest drawback in the traditional construction process, where there is a high level of communication breakdown. As such, this organisational approach brings teams together to reinforce collaborative practices. This means that teams would have multiple representatives, operating either periodically or permanently, in a shared office, which would align all interested parties e.g. client, designers, contractors etc. Thus, instead of working in silos and separate rooms as prevailed traditionally, the method advocates working in pairs or in large groups and face to face. This solution also allows frequent communication and numerous ways to promote rapid problem solving, thus breaking away from the traditional flow of documents and meetings that often occurs in the traditional setup (Lostuvali, Alves, & Modrich, 2014).

Set Based Design (SBD): This is a concept that encourages team members to explore alternatives for design solutions, and gradually refine them it until the preferred solution is determined (Ward *et al.,* 1995; Ballard, 2008). This allows members of the project team to explore multiple alternatives over time and not discarding them at first glance (Alves *et al.,* 2017). The logic is that, instead of considering narrow choices to proceed with the design, the team is enabled to research the attributes of each alternative, prior to analysing the data and converging on what is perceived to be the best solution (Tommelein & Ballard, 2016).

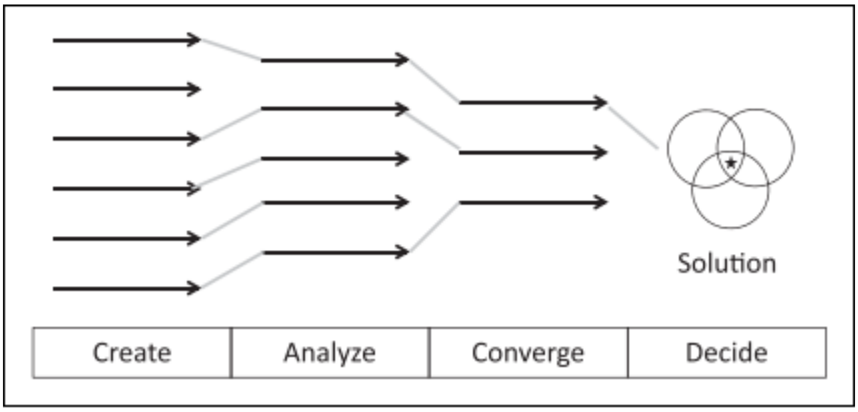


Figure 3-1: Set-Based Design. Source: Alves *et al.,* (2017).

As time progresses, the team starts to narrow down the range of options based on factors that might be related to cost, client preferences, feasibility within the project etc., as illustrated in figure 3-1. This means that the team would collectively consider sets of options and alternatives from the start, instead of developing a single solution in detail; in the conventional system a single design option is the common norm, which hinders collaboration and reduces value addition (CIRIA, 2011). Accordingly, the SBD compliments TVD, by allowing designers (along with other cross-functional team members) to deliberate over costing and design alternatives. These alternatives are then narrowed to a point where they are analysed; the team then converge on a solution and decisions are made based on that.

Choosing by Advantages (CBA): CBA was developed by Suhr (1999), and has been used in lean practices. It is a multi-criteria decision-making system where alternatives are evaluated based on the importance of the advantages they offer, relative to the set of factors that contribute value (Suhr, 1999). With this approach, designers are able to provide sound decisions used in alignment with TVD after exploring alternatives steps in the SBD to implement the solutions (Arroyo *et al.,* 2012). Equally, stakeholders can see which ideas offer the greatest advantages, and thus evaluate relative cost. CBA and SBD are usually employed together to document how teams converge to find solutions and the factors used to make decisions (Alves *et al.,* 2017). Hence, they support decision-making processes from simple to complex situations, thereby controlling actions to improve outcomes (Suhr, 1999).

Last Planner System (LPS): The principles of this approach can be used to manage the reoccurring challenges between upstream and downstream players within the traditional construction procurement strategy. The concept emerged from the commitment-based production control system, which allows the coordination of design activities and scheduled design decisions to align with pull planning (Ballard, 2000). It is designed to produce predictable and reliable workflow in construction projects. The underlying theory behind LPS revolves around planning, control, and execution – thus it is viewed as an integrated platform to promote systemic thinking (Daniel *et al.,* 2014).

Although LPS centres primarily on project programming and planning, it also brings about collaboration and relational commercial terms into one-off-project-based production (Mossman, 2012). LPS was developed to support the creation of a platform for stakeholders in projects to plan together in order to reduce uncertainty and improve the quality of the construction programmes. It's essential objective is building trust amongst stakeholders in five key ways which Mossman (2012) referred to as conversations. These include: (i) collective pull-based planning, (ii) 'make ready', (iii) collaborative production, evaluation and planning (PEP), (iv) production management, and (v) measurement, learning and continual improvement. Thus, operating within the framework of these conversations would ensure that processes in the planning, development and execution stages involved all stakeholders in jointly developing in the project (Akintan & Morledge, 2013).

Unlike the traditional system, where project management focuses mainly on activities in the programme, the LPS in addition to this manages relationships, conversations, and commitments, and ensures construction planning decisions are agreed collaboratively amongst the stakeholders at the lowest level of the project (Gonzelez *et al.,* 2015; Hamzeh *et al.,* 2015; Mossman, 2014; Ballard, 2000).

Indeed, these managerial practices and concepts support collaboration; prompt shared understanding among stakeholders, with the means to eliminate waste during costing and design activities (Rubrich, 2012). In addition, Savio Sampaio de Melo (2015) added that TVD implementation in the US further revealed other enablers for collaboration during costing and design development. These include: shared incentives, integrated governance, best value contractor selection and project personnel training. According to the author, these factors showed that more benefits could still be realized even when TVD is applied after the design process has started, while GMP and lump sum contracts could still motivate stakeholders to collaborate, thus move money across boundaries without the need for multiparty contracts.

Consequently, these managerial practices have shown that TVD has the potential to complement multidisciplinary integration, thus 'cost projects collaboratively'. In other words, TVD has mature components that underpins collaboration in commercial activities, which is different from the UK system. The above discussions have explored platforms that promote collaboration in costing and design stages, revealing key components worthy of emulation in multidisciplinary practices within the UK construction industry. The next subsection will examine conceptual estimating practices using TVD as an exemplar in contrast to the UK costing approach.

3.3.5 Conceptual Estimating: Target Cost Setting Under TVD

One of the main unique features of the TVD system is higher added-value delivery, using continuous improvement and waste reduction (Denerolle, 2013). The model incorporates a consensus planning approach that brings relevant stakeholders closer, with the objective of devising the best means of attaining value outcomes (Melo *et al.,* 2013; Tommelein & Ballard, 2016). Accordingly, the leading criterion in the process is providing an avenue for stakeholders to interact and develop the client's value vision (Zimina *et al,* 2012). With this arrangement in place, it has been considered to immensely contribute towards effective collaborative working between upstream and downstream players, which spurs on innovation in costing methods and value enhancement using pain/gain share relational arrangements (Oliva *et al.,* 2016).

The cconceptual estimating approach under TVD has been improved (prior to design), with the usage of programmatic data (Ballard and Pennanen 2013) to include: what is wanted (functionalities, capacities, and features of the desired asset), where the asset is to be located, and when it is to be produced. Based on this, it follows a series of five cost-lines to steer design and construction to the TC (i.e., worth of an asset, allowable cost, market cost, expected cost, target cost, and actual cost). These principles are set, but the method is flexible. Accordingly, it begins with a detailed discussion to understand the allowable cost (AC): what the client is able and willing to spend to get what they need (Savio de Melo *et al,* 2016).

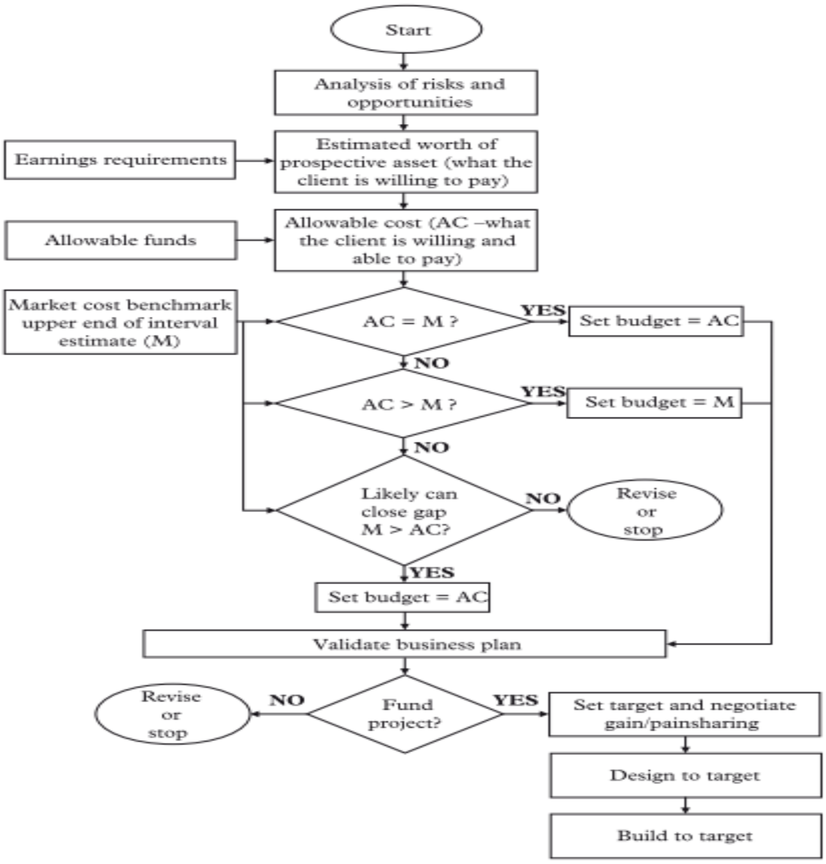


Figure 3-2: Determining the Project Budget. Source: Zimina *et al.,* 2012.

At this juncture, the market cost (MC) is determined, using output from the cost model, which then allows the team to work with a benchmark to establish an estimated maximum price for the project (Zimina *et al,* 2012). Through this, the client identifies his/her AC, based on the minimum acceptable return on investment or maximum available funds, preferably from an operation model, where he/she explicitly defines how the 'to-be-built' structure needs to perform, so that the business planning and validation are thoroughly engaged. The EC is the forecast or estimated cost of the project at current best practice, which is not allowed to exceed the AC. If the EC exceeds the AC, it is advised that the business case should be re-engaged or cancelled. The target cost (TC) is then set below the EC to spur on design innovation (Ballard, 2008).

In addition, Pennanen and Ballard (2008) developed the above-mentioned procedures and recommended on the following steps for setting the TC, as illustrated in figure 3-2:

1. Assess the business case
2. Determine stakeholder's values and defined specifications of the project
3. Determine the AC
4. Determine the EC
5. If EC is bigger than AC, then modify the specifications
6. Go to Step 3
7. If the EC is equal to or less than the AC, start project delivery by setting the TC equal to or below EC.
8. Launch design phase
9. Deconstruct product level TC to component level target cost.

Based on this, Figure 3-3 and 3-4 illustrates the team composition and the social conversation loop for stakeholders to 'cost projects collaboratively' using TVD as an exemplar. As indicated, integrated teams need to be assembled early to validate the TC based on what the client is willing to spend, using the set-based design tool to steer it below the AC. During this phase, understanding of value from the client is the main goal (Alves *et al.,* 2017) so that the client addresses the solutions found within the intersection of desirability, affordability and feasibility. These drivers define the target solution and constrain the team to develop the desired outcome. At this stage, cost and value parameters are extended from asset to system level and managed jointly by stakeholders (Zimina *et al.,* 2012). Accordingly, an 'over the shoulder' estimating technique is advised here for swift cost information sharing, to create value within the process. In this way, a trade contractor can look 'over the shoulder' of a specialist designer and provide concurrent cost and buildability advice as the work is designed; they can then collaborate with the designer regarding the details, thus these targets are set as stretch goals to spur on innovation (Oliva & Granja, 2013).

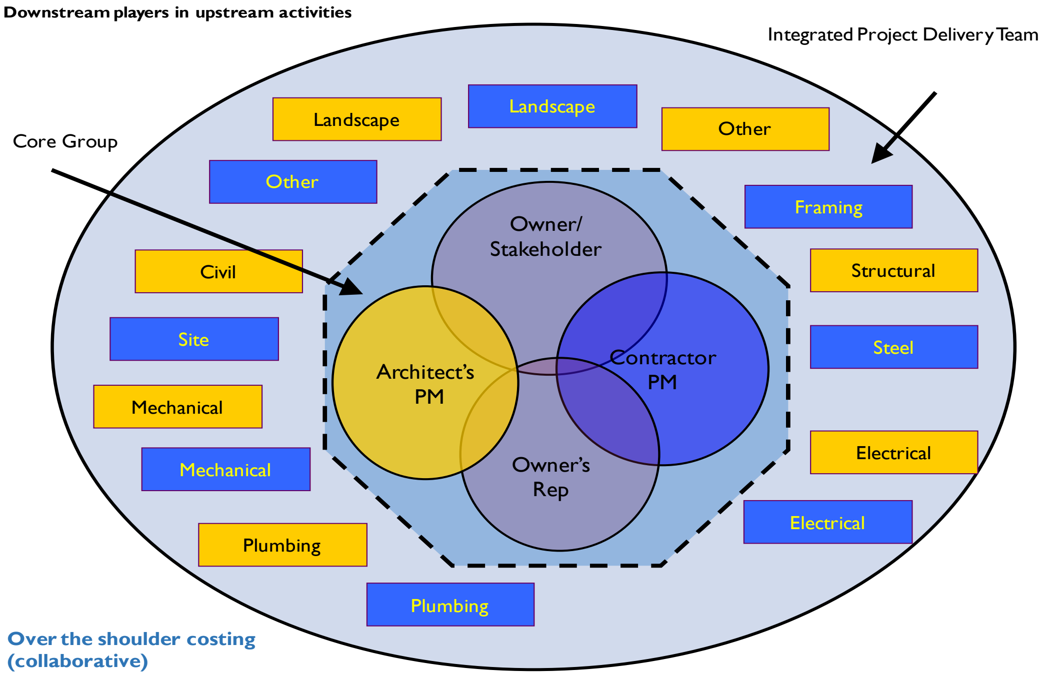


Figure 3-3: Team Composition for Collaborative Costing.

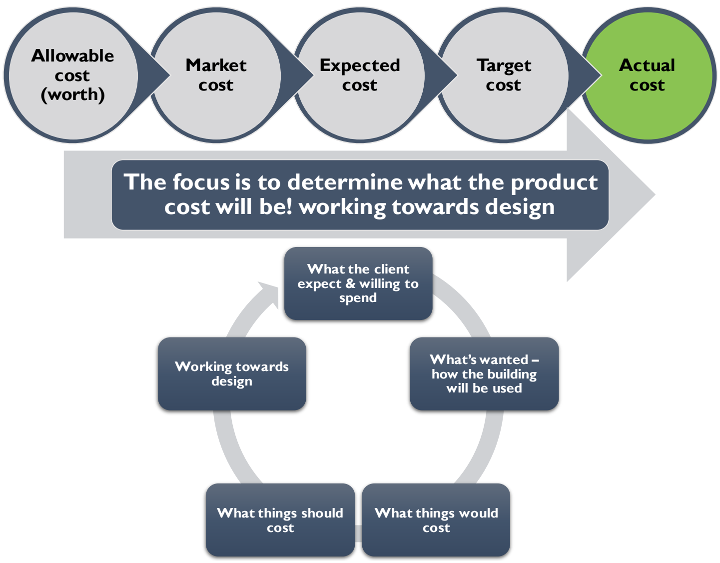


Figure 3-4: Social conversation during conceptual estimating

Therefore, the TC set is derived from the validation study, which becomes an influence on design and decision-making rather than the outcome of design as often seen in the traditional approach (Zimina *et al.,* 2012). Hence, this means calculating the AC, EC, and MC in their different possible quantitative relationships. The MC is only benchmarked to understand how realistic the target is and to assess project risks. As illustrated in figure 3-4, the team focus is to determine what the product cost would be, working towards the design, to allow the excess savings to be reinvested. The entire process goes through the social conversation loop illustrated in figure 3-4 i.e., AC, MC, EC, and TC respectively. After the TC is established, designs are then steered to meet the detailed estimates, rather than producing detailed estimates around the preliminary designs. Noticeably, the customer here is not the only client in the project, as all of the cost information is shared with the cross-functional teams. These exercises create clear channels for clients to communicate their project value visions from the outset (Zimina *et al.,* 2012), thus enabling stakeholders to cost the projects collaboratively, so that all parties involved will have a clear understanding of exactly what should be delivered and at what cost (Torp, 2019).

3.3.6 Conceptualizing Cost Estimating Practices in the UK Construction Industry

Cost planning is a process that ensures planned development of design and procurement of projects aligned with the price of construction, to provide value for money and delivery within clients' anticipated limits (Kirkham, 2015). It usually follows the traditional outline design-estimate-redesign process, which requires procedures and techniques that are used concurrently by estimators, building economist and QSs in the UK (Potts and Ankarah, 2013). The practice has been changing over time to cater for the needs of clients, largely driven by procurement reforms and contractual strategies within the UK construction industry (Murray and Langford, 2003). Consequently, cost planning is a critical process that ensures good value for money, with opportunities to fully assess the risk during project developmental stages. However, in the UK, QSs are still traditionally in charge of cost advice and assisting with alternative design solutions and cost implications of design and procurement using the key techniques of elemental cost planning and cost checking (Kirkham, 2015).

Nonetheless, cost planning is still the system that comes up with the cost limit at the end of business planning, feasibility studies and bill of quantities production after the detailed design. In other words, the costs established are business case driven rather than elaborate estimates (see figure 3-5). Traditionally, the process still follows the RIBA plan of work 2013, and conforms to the new rules of measurement (NRM) suite of documents (RICS, 2014). It starts with the development of 'ball park' (costs) at business case strategic level to allow clients to decide whether the project is feasible. These estimates are refined using cost planning techniques (elemental method) to break down the various building components into sub-elements using the building cost information services (BCIS) cost structure (Kirkham, 2015). Cost plans, cost checks and Bill of quantities are used here to monitor scheme costs during design development as illustrated in figure 3-5.

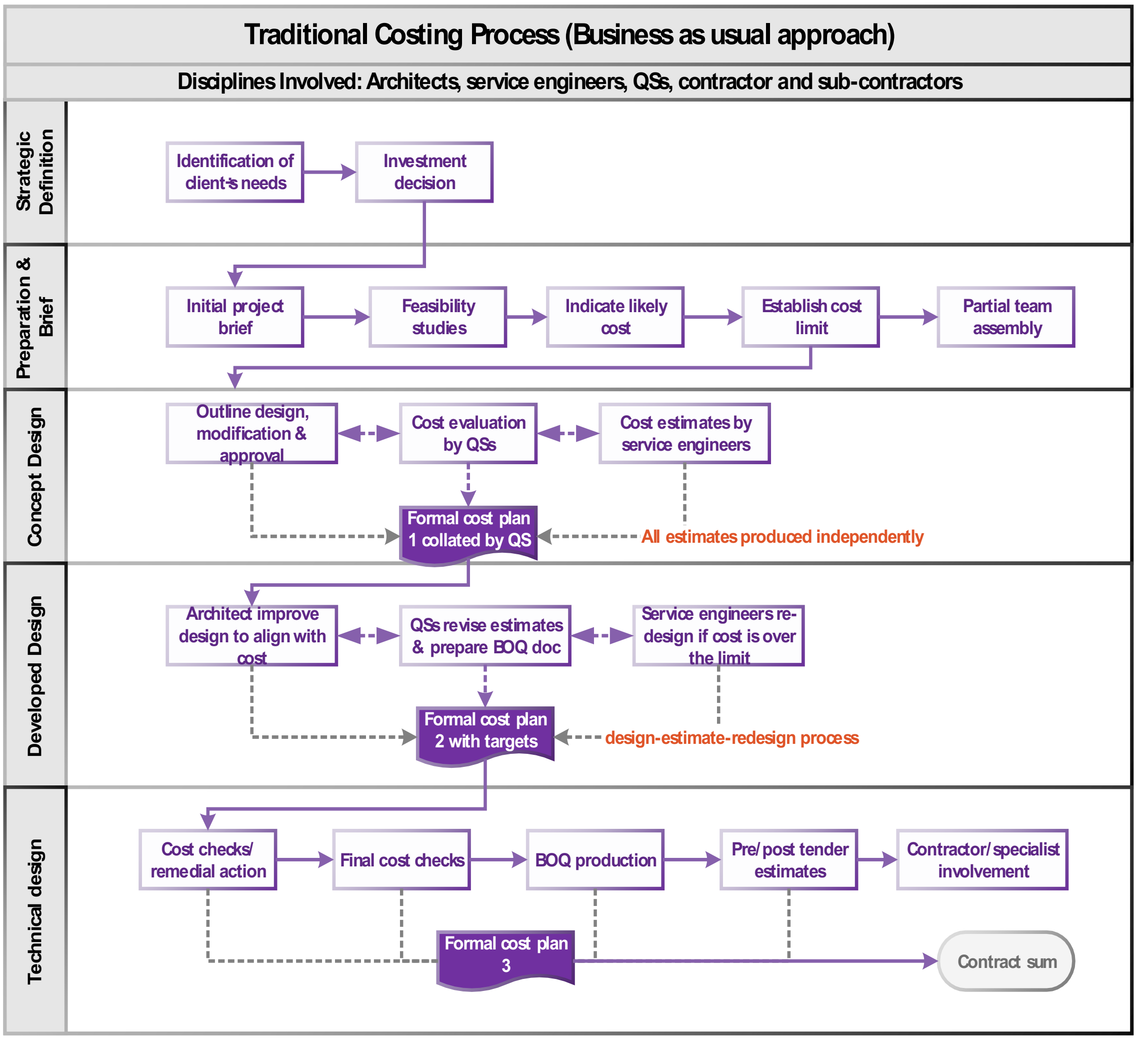


Figure 3-3: Traditional Costing Approach. (Adapted from the RIBA Plan of Work 2013).

After establishing the initial estimates, detailed designs are produced at concept and development stages, which are complemented by the three formal cost-planning milestones described by Kirkham (2015):

(a) Cost plan 1: defines the brief and sets the budget referred to as scoping or framing;

(b) Cost plan 2: prioritise the designs; and

(c) Cost plan 3: mainly utilised at procurement and construction stages.

Thus, cost planning, controlling and checking are carried out in isolation, without much interaction, as illustrated in figure 3-6. Therefore, the budgeting normally involves the use of average market costs of a facility or unit-based calculations, where sums that corresponds to the cost estimate are committed, and the estimated cost figure becomes the benchmark for the client's construction budget (target) for cost control during design stages (Zimina *et al.,* 2012). As shown in figures 3-5 and 3-6, the process, which leaves the budget setting to the eventual production stage, is based on competitive tendering, which characterises the expensive iterative cycle of design-estimate-redesign. The three-cost planning & checking mechanisms emphasizes on costing the detailed design drawings (Kirkham, 2007). Therefore, any challenge that arises from the design will automatically activate the process of redesigning to balance the projected costs. Although, the model indicates contractors' inclusion (at developed design stage), however, their actual engagement is often late and deep inside the technical design stages.

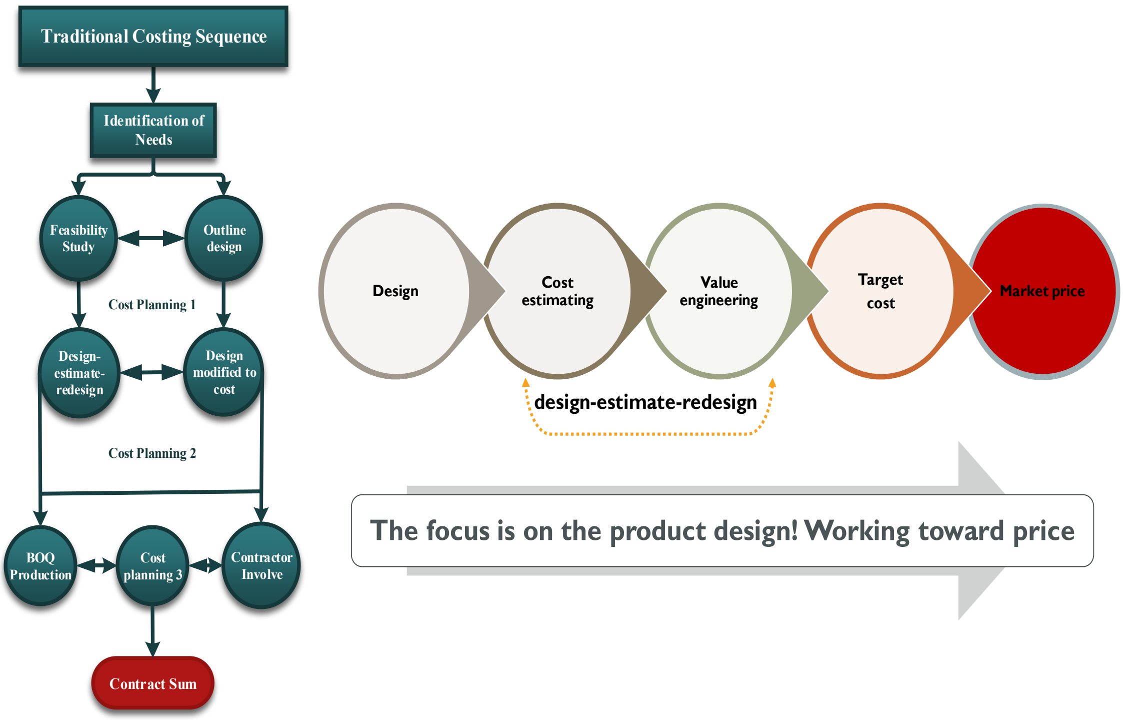


Figure 3-4 Cost Planning & Checking Phases

Apparently, this is a common practice for the client's QS (PQS): not only to use market prices that already have contractors' risks and contingency costs attached during early estimation, but also to add further percentages to cover price and design risks (Ferry *et* *al.,* 1999). Generally, these costing exercises are carried out in isolation by the client's consultants without much input from the design teams or contractors. More often, the costs established are modified between designers and contractors without interaction, providing limited opportunities to enhance customer value (Zimina *et al,* 2012). For instance, Sunil *et al.,* (2015) observed that traditionally cost advisers (QSs) are not open to cost re-evaluation or sharing information with their counterparts during conceptual estimating, mainly because this does not serve their interests or those of their employers. As illustrated in figure 3-5, when teams converge to value engineer, the emphasis is more on the detailed design and working towards the price, instead of focusing first on what the project cost should be as described in the TVD system.

Flyvbjerg (2003) mentioned that this mentality is highly systematic and routinely deceptive, so much so that it leads to costs misrepresentations and the miscalculation of scarce resources. This means that estimates produced by these professionals are mostly inaccurate with high levels of guess estimation, given that the procedures lack transparency and dialogue (Flyvbjerg, 2003). Likewise, Rush and Roy (2000) acknowledged that, clients often commit to the design solutions early, which restricts cost and design options, thus limiting the opportunity to enhance value. Thus, the cost target developed using this approach (or other means by the purchasing side in the supply chain) is often used to guess a tender price; or it can be used by contractors to make their bid look attractively cheap during the negotiating process, described by Nicolini *et al.,* (2000) as 'target pricing'. Invariably, this situation is still the case in costing and design practices within the UK construction industry.

3.3.7 Differences & Areas to Improve to Collaborative Costing

The development of collaborative approaches in costing and design under the TVD system should serve as a great learning point, particularly for cost consultants and other stakeholders in UK practice. For instance, it is a precondition in the lean system for project stakeholders to collaborate early, especially when embarking on TVD and IPD projects. The logic behind this is to manage the production and design process concurrently using the mechanics of pain/gain sharing (Tommelein & Ballard, 2016). The main difference compared to the UK practice is that the integrated/TVD approach ensures that there is minimal waste left in the design process, and promotes transparency and the early integration of cross-functional teams. Accordingly, this provides the right atmosphere for collaboration to emerge, so that the team can define the client's requirement. Zimina *et al.,* (2012) highlighted that:

1. The project definition process in TVD roots the target cost in the allowable cost and client's business goals, as well as engaging designers and builders to validate the business plan;
2. Cost and target management - design to cost and value, decentralized management; and,
3. The model uses a systemic approach to project management, which aligns project organization with operating systems, using lean principles and commercial terms.

These distinctions are lacking from the traditional costing practices, because the model is characterised by commercial behaviours. These behaviours are reinforced by the prevailing procurement protocols and the 'institutional' factors that surround the project delivery approach in UK construction (Namadi *et al.,* 2018; Sarhan *et al.,* 2018). Furthermore, these commercial behaviours create costing approaches marred by irregularities and uncertainties, with little shared understanding amongst stakeholders (Nicolini *et al.,* 2000). This is largely because the prevailing approach still follows the RIBA Plan of Work, which is discrete, sequential and favours competitive tendering. Accordingly, this guides stakeholders within a narrow view that considers costing and design activities as separate functions. This creates 'guess-work' and inconsistent decisions managed through a risk contingency that provides money to safeguard the parties by concealing waste rather than revealing or removing it. Therefore, this acts against CW, increasing commercial pressure and stifling innovation.

Furthermore, Strickland (2010) identified other striking differences in terms of perception between these forms of costing approaches (see table 3-3). The descriptions show that the fundamental difference is arguably mind-set: as often seen in the traditional practice, the goal is mostly to exert competitive pressure and drive contractors to their lowest costs. However, this approach has often forced competitors to bid using the default model to facilitate the competition (Strickland, 2010). Other notable characteristics were the lack of cross-functional interaction, which has been formal and primarily through documents;

confrontational attitudes (win-lose and zero-sum) continues to restrict interest alignment, and value engineering exercises are mainly deployed to slash scope.

On the other hand, the integrated approach mirrors the TVD system and proffers that downstream players are involved in upstream activities. This highlights improvements in communication (extensive interactions and conversations towards problem solving) and motivation (revealing transparency and interest alignment). Furthermore, Zimina *et al.,* (2012) mentioned two fundamental principles within this approach, which promote collaboration in the process. These include: (i) allowing money to flow across organizational and contractual boundaries in search of the best project-level investment – which in turn unites commercial interests, and (ii) promptly using all relevant design criteria in the generation, evaluation and selection from products and process design options. This reiterates the involvement of downstream players in upstream activities. Consequently, from the descriptions in Table 3-3, it can be seen that costing practices in the UK needs a cultural shift; as without that, construction practitioners will continue to struggle, which is affecting their ability to collaborate in practice (Bresnen & Marshall 2000). This also means that CW will only thrive, when there is change in mind-sets, and that requires trust (Strickland, 2010).

Table 3-3: Contrasting Traditional and Integrated/TVD Costing Perceptions: (Adapted from Strickland, 2010).

Factors	Perceptions (traditional costing)	Perceptions (integrated/TVDish costing)
Contractor Selection Criteria	Lowest cost on a pre-defined scope so long as bidders meets minimum criteria.	Qualifications & expertise. Pricing (mark-ups, Overheads, Labor rates).
Key Assumptions regarding selection	All bidders are equal, or nearly so, as long as they meet minimum requirements.	Contractors have expertise and pricing information that can shape the basic design decisions, and thus have a large impact on project cost. Contractors are not commodities – the selection of a specific group of contractors can have a large impact on project success.
Communication Protocols	Cross-functional interactions are restricted. Communication is formal, and primarily through documents.	Scope and requirements are developed through extensive interactive conversation, and then documented.
Presumed Contractor Motivation	Charge as much as the market will allow. Exploit changes after awards to maximize margin or recover pricing required to win the job.	Working to help client develop a solution to a problem. Earn a reasonable, and transparent margin, at a reduced rate.
Alignment of Interests	Low. 'Win-Lose' and 'Zero Sum'. Confrontational and adversarial.	High – contract arrangement and project culture align interests.
Contractors Responsibility to Identify Scope	Contractors have almost no responsibility for defining scope. Contractors must bid only the scope clearly shown on the contract documents.	High – contractors accepts responsibility for recognising and defining the scope in return for an exclusive position on the project team. Contractors generally not eligible for change orders unless the client has made in requirements. Must select contractors that can 'see what is not on the drawings'.
Degree of transparency	Very low – in many case, the client is entitled to see only the bottom line price. Unbalancing bid line items and other gamesmanship approaches are common strategies to disguise true costs.	Very high – contractors must agree to full 'open-book' review by client. Client can see the actual cost details, and work with contractor to find less expensive solutions on a line item basis, if necessary.
Role of Gamesmanship in Project Administration	Very high – the focus and talents of project teams is often devoted to advocating positions – not on developing creative solutions to problems. Contractors may knowingly allow client to proceed with faulty cost assumptions.	Low – transparency does not promote or allow for much gamesmanship.
Use of Constructability and Value Engineering	Constructability 'reviews' after key designs decisions have been made are largely ineffective. Input is too late to be incorporated without reworking the design. Reworking design represents waste and added risk. Value engineering is typically an exercise to slash scope, disappoint the client and add risk. Extensive time can be lost trying to recover from scoping more work than the clients budget would allow.	Constructability 'previews' are highly effective, as options are discussed and debated before effort is spent transforming them into a design. Constructability and value engineering are built in from the beginning – not 'repair jobs' at the end. Up-front constructability is key to design quality – you cant expect to get high quality by doing, then inspecting, then fixing.

In general, the TC/TVD model has shown some insights and opportunities, which can be brought to the UK costing practices. The existing commercial arrangements have made it challenging for any teams that want to collaborate during these stages. However, some inspirations could still be drawn from the UK perspective on the 'collaborative costing' approach. This is because there are models (such as: Cost-led Procurement (CLP), integrated project insurance (IPI), and Two-stage open book (2SOB)), which have similar features to TVD and could support cross-functional integration, accuracy in costing, integrated supply chain management, and a CW culture, in a bid to reform procurement strategies and cost management practices (Cabinet Office, 2014).These models (in particular the CLP) are currently not patronised within the industry, but certainly have the right ingredients to allow the industry to use and develop similar advances like the TVD for construction cost management. This would arguably drive out waste in all parts of the construction processes while maintaining key criteria targets of cost, time and quality parameters.

3.3.8 Developing the idea of 'Costing Collaboratively' in Construction

After the foregoing discussions on collaboration and costing practices in construction, it is deemed important to set out the context and describe theoretically, what 'costing projects collaboratively' should necessitate in construction. Thus, as established previously, collaboration is considered as a relationship that is based on trust, equity and fairness, which requires shared understanding amongst parties and aligned interests for the realisation of project success. Additionally, attributes such as: setting clear goals, communication, trust, risks and rewards sharing, having a sense of ownership, and cultural considerations have been identified as strong components of collaboration (Fischer *et al.,* 2017). It is also logical to include other facets like intellectual endeavour, dense relationships, and having the collective objective to achieve outcomes beyond those attainable by an individual participant. Cost management entails planning, estimation, co-ordination, control and reporting of cost related items, or a technique for controlling and improving activities to achieve its effectiveness. It is important in this process that any organisation or multidisciplinary teams considers these components, particularly at the feasibility stage, since most of the issues highlighted in costing processes often occur at pre-contractual stages, demonstrating the lack of planning, collaboration and relational approaches.

Thus, from a theoretical position, 'costing collaboratively' should encompass all the above-mentioned descriptors, with the sole purpose of driving positive behaviours to achieve value for the owner and all the teams involved. Figure 3-5 provides a summary of theoretical contributions, which has identified key themes: the prevailing costing model within the UK construction industry and its challenges; the much needed transition to a collaborative system; and the knowledge gap in the literature. Figure 3-5 also indicates how the key issues discussed have fed into the idea of 'Collaborative Costing', which this study intends to explore. Table 3-4 illustrates the list of key concepts and authors that emerged from the literature review process.

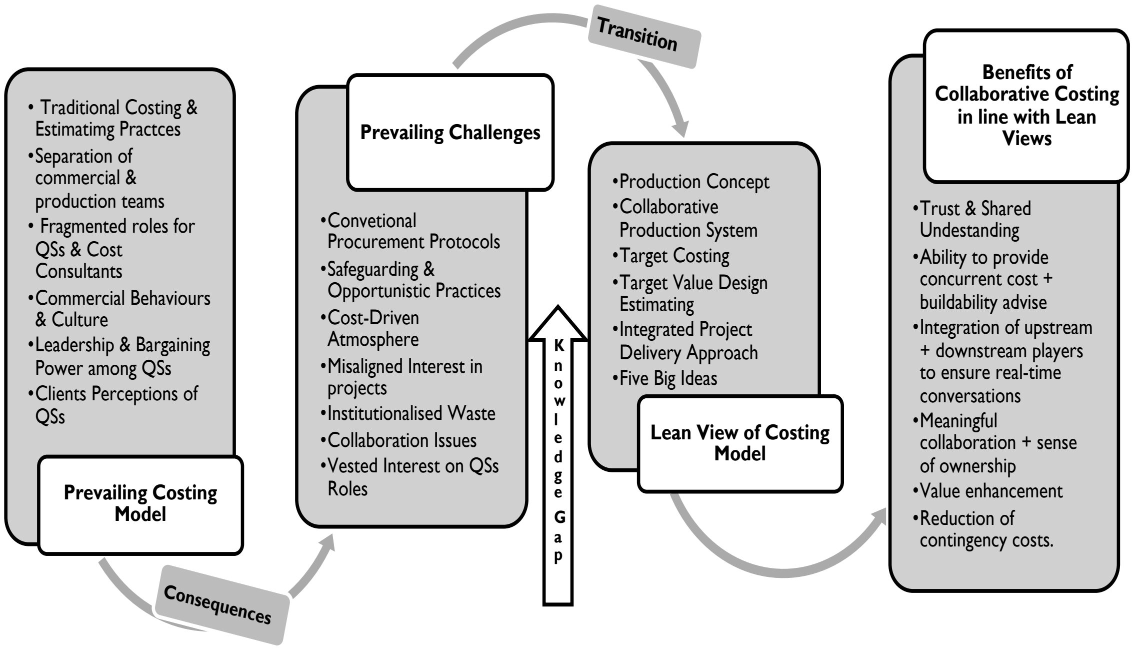


Figure 3-5: Summary of Key Theoretical Contributions

Table 3-4: List of Key Concepts and Authors

Key Concepts	***Key Authors***
Prevailing UK Construction Model	(HM Government, 2013; ONS, 2017); (Farmer, 2016); Savio *et al.*, (2014) and Cha *et al.*, (2015); Wolstenholme (2009); Construction 2025 strategy (2013); (Sarhan *et al.*, 2014); Common *et al.,* (2000); Latham (1994); Egan (2002); Industrial Strategy 2017; (Challender, *et al;* 2016); (Pasquire *et al*, 2015; Gottlieb and Haugbølle, 2013); (Cabinet Office, 2014).
Commercial practices/behaviours; QSs/Cost Consultants	(Namadi *et al.,* 2018; Sarhan *et al.,* 2018); (Nicolini, *et al.,* 2000); (Pasquire *et al,* 2015; Sarhan *et al,* 2014); (Challender *et al.*, 2014); (Akintan *et al.,* 2013); Bennett (2000). (Johansen *et al,* 2004); (Perera *et al.,* 2016); Kirkham (2007); Ashworth *et al.,* 2013); (Potts, 2008); (Kirkham, 2007); (Mbachu & Frei, 2011); Cunningham, 2014; Thayaparan *et al.,* 2011; (Wao & Flood, 2016); (Olanrewaju & Anahve, 2015); Brien *et al.,* (2014); (Olatunji *et al.,* 2017); Fellows *et al.,* (2003).
Cost Estimating Challenges	Marchesan and Formoso (2001); (Sunil *et al.*, 2011); Elfving *et al.,* (2005); Flyvbjerg *et al.;* (2003); (Pennanen & Ballard, 2008); (Kern and Formoso, 2004; Hanid *et al.*, 2011; Ashworth *et al.*, 2013); Kirkham (2007); Akintoye & Fitzgerald (2000); Nicolini *et al.*, (2000); Laryea (2010); (Love *et al.*, 2017). Owusu-Manu *et al.*, (2016); (Love *et al.,* 2011); (Potts and Ankarah, 2013); (Kirkham, 2015).
Project Delivery Performance Issues	(Chen *et al*., 2011); (El Asmar *et al.,* 2013); (Harris & McCaffer, 2003; Masterman, 2002); (Sarhan *et al.,* 2017); (Zimina *et al.,* 2012); (Potts and Ankrah, 2013); (Mesa *et al.*, 2016); Egan (1998); (Becerik-gerber & Kent, 2010).
Procurement Practices; Transactional/Contractual & Institutional Issues	(Sarhan, 2018); (Cox & Thompson, 1997; Eriksson & Laan, 2007; Ghassemi & Becerik-Gerber, 2011); Moore and Dainty, 2001); (Osipova & Eriksson, 2011); (Klein, 2004); (Masterman, 2002); (Chan *et al.,* 2010); (Oyegoke *et al.,* 2010); (Baiden, 2006). (Pasquire *et al.,* 2015); Sarhan *et al.,* 2014); (Sarhan *et al.,* 2018); (Love *et al.,* 2010); (Cushman, 2003; S. Laryea & Hughes, 2009; Osipova & Eriksson, 2011); Rameezdeen & Rodrigo, (2013). (Pasquire *et al.,* 2015); Eriksson *et al.,* (2008); (DiMaggio and Powell, 1983); Thomsen *et al.,* 2009); Gottlieb and Haugbølle (2013); Zimina and Pasquire, (2011).
Lean Production Philosophy	

Lean Production; Collaborative Production System View; TFV Theory; Integrated Project Delivery Approach	Bertelsen and Koskela (2002)**;** (Bertelsen, 2004; Bertelsen & Koskela, 2002); (Aziz & Hafez, 2013); (Ballard, 2000); (Koskela, 2000); Koskela and Vrijhoef (2001). (Koskela *et al.,* 2002; Koskela & Ballard, 2012; Mossman, 2009); (Bertelsen, 2002); (Mossman *et al.,* 2010; (Raisbeck *et al.,* 2010); (Engebø *et al.,* 2019). (Howell & Koskela, 2000); (Ballard *et al.,* 2001; Howell & Koskela, 2000; Johnston & Brennan, 1996); Koskela (1992, 2000); (Mossman, 2009); Ballard & Howell, 1998); Emmitt *et al,* (2005); (Bertelsen, 2003). (Matthews & Howell, 2005); (Law *et al.,* 2016; Lichtig, 2006; Thomsen *et al.,* 2009); Cohen (2010); (Lahdenperä, 2012); (Kumaraswamy *et al.,* 2005); (Alarcon *et al.,* 2013; Cohen, 2013); (Raisbeck *et al.,* 2010); Fischer *et al.*, (2014); (Lichtig, 2010); Fischer *et al.*, (2017).
Collaboration & Integrated Practices	
Process & Performance Improvement	(Cain, 2004; Fischer *et al.*, 2017; Mcdermott, 2009; Pasquire *et al.,* 2015; Zimina, Ballard, & Pasquire, 2014); (Bresnen & Marshall, 2000; Constructing Excellence, 2004); Gledson and Phoenix (2017); Jeong *et al.,* (2004); Latham, 1994; Ballard and Howell, 1998; Sunil *et al.,* 2015).
Collaboration and Costing Practices	(Lloyd-walker, Mills, & Walker, 2014); (Challender *et al.,* 2015); (Eriksson *et al.,* 2008; Sebastian, 2011; Walker *et al.,* 2017; Xue *et al.,* 2010); Zimina *et al.,* 2012; Shelbourn *et al.,* (2012); Fischer *et al.,* (2017); Poirier *et al.,* (2016); (Xue *et al.,* 2010); Pasquire & Ebbs (2017); Bresnen & Marshall (2002). (Laryea & Watermeyer, 2010; Jung *et al.,* 2012; Ballard & Pennanen, 2013; Love *et al.,* 2017; Shalpegin *et al.,* 2018); (Russell-Smith & Lepech, 2015); Tillmann, Do and Ballard (2017); (Ballard, 2008); (Ashworth, 2010; Hastak, 1998; Kern & Formoso, 2004; Dallas, 2006; Hanid *et al.,* 2011); (Eastman *et al.,* 2011); Ballard (2012); (Love *et al.,* 2012); (Tillmann *et al.,* 2013).
Lean & Integrated Costing Concepts: *Target Costing; Set Based Design; Choosing by Advantage; Last Planner System; TVD Estimating*	(Rubrich, 2012); (Do *et al.*, 2015); Jung *et al.*, (2012); (Ballard, 2016); (Macomber, *et al.,* 2007); (Denerolle, 2013); (Zimina, Ballard, & Pasquire, 2012); (Savio de Melo *et al.,* 2016); (Lee, 2012); (Miron *et al.,* 2015). (Jacomit & Granja, 2011); Feil *et al.,* (2004); (Ansari *et al.,* 2006); (Alwisy *et al.,* 2018); (Zimina *et al.,* 2012); (Cooper and Kaplan, 1999); (Nicolini *et al.,* 2000); (Cooper & Slagmulder, 1997 & Kato, 1993); Cooper (2002); Ballard and Reiser (2004). (Ward *et al.,* 1995; Ballard, 2008); (Alves *et al.,* 2017); (Tommelein & Ballard, 2016). Suhr (1999); (Arroyo *et al.,* 2012); (Alves *et al.,* 2017). (Daniel *et al.,* 2014; Akintan *et al.*, 2013; (Ballard, 2000); (Mossman, 2012); (Akintan & Morledge, 2013); (Gonzelez *et al.,* 2015; Hamzeh *et al.,* 2015; Mossman, 2014; Ballard, 2000). (Melo *et al.,* 2013; Tommelein & Ballard, 2016); (Ballard and Pennanen 2013); (Denerolle, 2013); (Oliva *et al.,* 2016); Zimina *et al.,* 2012; (Ballard, 2008); Pennanen and Ballard (2008); (Oliva & Granja, 2013); Strickland (2010).

3.4 Summary

This chapter explored the concepts of collaboration, construction process improvement, and early collaborative approaches in design and costing stages. The review started with the dissatisfaction with the non-collaborative culture and practices often seen in the construction environment. This examination revealed the development of target costing approaches in manufacturing that informed the eventual journey towards more integrated approaches in construction practices. The successful adoption of TC in manufacturing, led to the development of the TVD approach in the construction industry. Thus, the review looked at TVD and how it is developing in terms of costing and design practices. The study showed that the concept has been implemented in various countries with significant impacts, which indicates that TVD is not static, but has evolved greatly especially during early costing and design phases. More so, this revealed how TVD is compatible with various integrated concepts like IPD, BIM, SBD, CBA, and LPS among others, to promote collaborative working at conceptual stages.

This study also expands on the theoretical description of what ‘costing collaboratively’ should entail, which further illustrates the implications faced by cost advisers and consultants in the UK practice. The review showed that the RIBA Plan of Work has been the driver and basis for costing in the UK construction industry; however, it does not support early integration in the process. Thus, the study also found that, whilst realising the negative impact from the current practices, various efforts have been intensified, which advocates for more integrated approaches to strengthen CW in the UK construction industry. TVD development shows that UK practice can move from the conventional costing to a more social approach that encourages cross-functional integration. However, this would require focusing on systematic thinking against the current functional (activity-to-activity) view that dominates construction practices. This review confirms that the separation of costing and design activities often escalates the expensive cycle of ‘design-estimate-redesign’, which means costing and design activities need a collaborative approach to support ‘flow’ and ‘value’ perspectives for the smooth running of production processes as seen in the TVD system. Thus, this review has enabled the study to draw on TVD as a guiding lens to investigate the practical understanding and development of 'costing collaboratively' amongst stakeholders in the UK during the primary data collection. The next chapter (chapter 4) will discuss the research philosophy and methodology underpinning this study, including a detailed explanation of the research methods and procedures used for data collection and analysis.

CHAPTER 4 RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

Chapter 2 reviewed literature on project delivery approaches and commercial practices within the UK construction. The chapter concluded that the current QSs position within the construction model is hindering CW, however, that can be improved if commercial and production functions are integrated. Chapter 3 then explored the concept of 'costing collaboratively', as a strategy to integrate commercial functions in 'collaborative production' systems in construction. The chapter concluded that the current costing approach needs collaboration to support 'flow' and 'value' perspectives for efficient production management. These reviews were the basis of the key research questions in section 1.5. The research questions focused on exploring CC: and how CC would be improved by the integration of commercial actors. This chapter presents a detailed account of the research design and methodology used to address the key questions raised in chapter one. It also discusses the selection of and justification for the choices of exploratory interviews, multiple case studies and the framework development and evaluation. The methods and techniques used for data collection, analysis and interpretations are also presented. Section 4.2 centres on the research philosophy and paradigm, while sections 4.4 and 4.5 presents the research strategy and design. In addition, section 4.6 provides detailed accounts of the four main stages of the research, and lastly, section 4.8 discusses the research summary.

4.2 Philosophical Consideration

It is imperative in any research to consider the underlying philosophical assumptions and the perceptions of reality (ontology), so that the emerging knowledge (epistemology) can be grasped. Philosophy fashioned ways for researchers to interpret knowledge, how they see themselves in relation to that knowledge, and the various strategies they use to acquire the knowledge (Guba, 1990). Therefore, it is imperative for researchers to maintain consistency between their chosen methodologies and the theoretical perspectives (Crotty, 1998). Ponterotto (2005) argued that researchers need to first identify and discussed a research philosophy (paradigm) before becoming embroiled in the investigation. Therefore, it is important within this to understand a research paradigm, as this informs the belief system that frames our knowledge understanding.

4.3 Research Paradigms

The term paradigm was first reported by Kuhn (1970, p. 182), as " universally recognised scientific realisation, which provide model for problems and solutions to community of practitioners". Easterby-Smith *et al.* (1991) added that paradigms often influence methodological choices. Similarly, Fellow and Liu (2009) remarked that paradigms are theoretical frameworks or systems for researchers to view events, knowledge etc. This implies that they are not only used as a lens to see how certain views are adopted, but also as a means to interrogate and discover new knowledge. Therefore a paradigm, as described by Denzin and Lincoln (2012), is the philosophical stance taken by researchers, which provides the basic set of beliefs that frames one's actions.

These beliefs and practices drive research inquiry within a discipline, providing frames and processes for which investigations are to be carried out (Weaver and Olson, 2006). Equally, Killam (2013) asserted that paradigms are essentially ways of thinking about or viewing the world. This means that a paradigm is a belief system that frames our understanding of the world we live in. Figure 4-1 provides a summary of the four main components of a research paradigm, which stem from the philosophical beliefs classified as *ontology* and *epistemology* (Guba and Lincoln, 1994), which are hotly debated within the realm of social science.

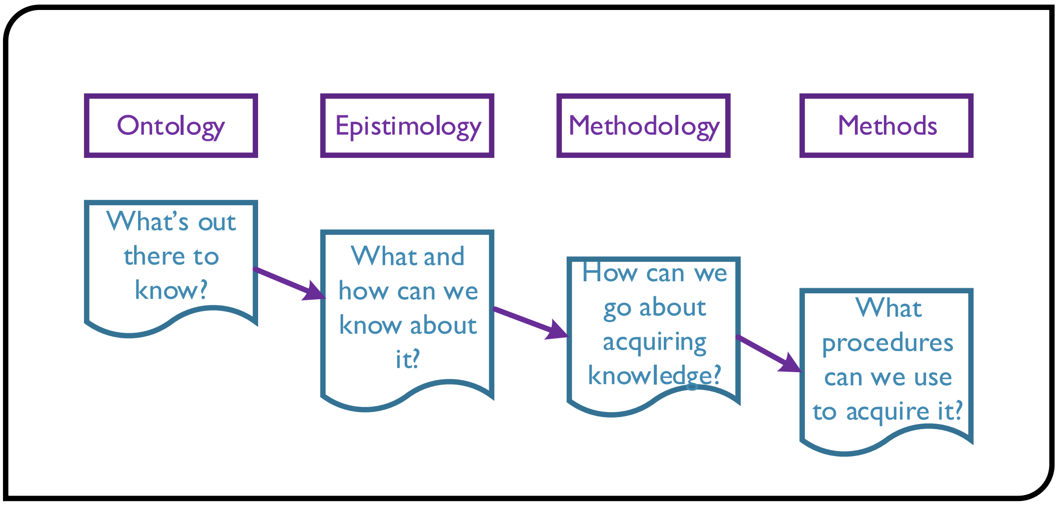


Figure 4-1: Components of a Research Paradigm (Adapted from Hay, 2002).

Saunders *et al.* (2012) and Bryman (2012) mentioned that ontology and epistemology are the two major schools of thought in research philosophy that govern the entire research process. Hence, finding a strong philosophical stance is daunting, as it requires clear understanding of ontology, epistemology and methodological directions. The challenge is that, without establishing the philosophy properly, the research framework would not be robustly achieved. Saunders *et al.* (2012) remarked that these philosophical positions governed the way knowledge is accepted and the process undertaken to answer research questions. Therefore, debates and positions on the meanings of these theoretical perspectives will continue within the research community. Hence, the emphasis is not only to reflect on a chosen position, but also to justify why an alternate philosophy is not chosen (Johnson and Clark, 2006).

4.3.1 Ontology

Ontology represents the context of the paradigm or the reality of a belief system. It refers to the nature and conception of reality, i.e., what exists, what is true, and how we can sort out existing things (Saunders *et al.,* 2012; Blaikie, 2007). It generally refers to the researcher's beliefs on the nature of reality, and in philosophical terms it is considered as the study of our existence and the fundamental nature of reality or being (Killam, 2013). This means understanding the social world and its characteristics (Creswell, 2013). The goal of ontology is to assist researchers in identifying existing knowledge and sorting out how it can be presented. Thus, different ontological positions have been identified in the literature.

The first view on ontology shows the perception of a researcher towards reality: whether social phenomena are objective realities or the constructions of social actors (Dainty, 2008). This means ontological positions range from *realist* to *relativism*. Under realist, the social phenomena are external facts beyond the observer's influence (Bryman & Bell, 2003). The principles of realistic ontology emphasise the following:

- There is a single reality and a single answer
- The observer is external to reality
- Reality can be studied through reductionism (a complex phenomenon is no more than its parts)
- Facts are the main concerns; and
- Reality should be defined and manipulated.

In contrast, relativism assumes that truth should not be validated based on the process used in ascertaining it, and that there are many truths, while the nominalism position argues that there is nothing called reality: and that all realities are created by human actions (Easterby-Smith et al., 2012). Bryman & Bell (2003) argued that it is guided by the following principles:

- There are multiple realities and multiple interpretations
- The observer is not external to reality
- Reality can be studied through holism (a complex phenomenon is more than its parts and should be seen as whole)
- Meaning is the main concern
- Reality should be understood and appreciated. Thus, the actors construct social phenomena from interactions and constant states of change.

The ontological position of this study leaned towards social constructivist i.e. relativism, which deemed that reality is a co-construction between the researcher and participants. It is a view that also centres on subjectivity with social interaction and textual phenomena. The discussion in this section has shown that ontological consideration is vital in any research, as it guides researchers to understand the nature of reality that exists in the world before investigating how to know that reality i.e. epistemology.

4.3.2 Epistemology

Epistemology is mainly concerned with the nature of knowledge and the relationships between the knower and the would-be known. It emphasizes questioning knowledge acceptability in each field of study, i.e. 'how we know', and the methods by which knowledge is acquired (Bryman, 2012). Thus, this requires examining the relationship between knowledge and the researcher during discovery (Killam, 2013). This was also seen by Blaikie (2007), who posited that epistemology examined the knowledge produced, how it was developed, and the conditions used to differentiate valid knowledge from invalid knowledge. Hence, every research study must indicate a specific epistemological direction. Consequently, there are two main perceptions in relation to epistemological stance: *positivism* and *interpretivist*. Crotty (1998) described epistemological positions as objectivism and constructivism, while Grix (2002) viewed them as positivism and interpretivism.

Table 4-1: Summary of philosophical considerations Sources: Bryman (2004), and Fitzgerald and Howcroft (1998).

Ontological Consideration	
Realist External world comprises pre-existing hard and tangible structures. Structures exist independent of individuals ability to acquire knowledge	**Relativist** Existence of multiple realities as subjective construction of the mind Perception of reality is directed by varying socially transmitted terms
Epistemological Consideration	
Positivist Application of natural science methods to the study of social reality and beyond World conforms to the laws of causation and complex issues can be resolved by reductionism	**Interpretivism** Absence of universal truth and emphasis on realism of context Understanding and interpretation come from researcher's own frame of reference

Positivists hold the view that natural science research needs to be objective in order to understand the social world. This view also advocates quantitative research designs that uses existing theories to develop hypotheses, which are tested with sample populations to confirm statistical generalisation of a theory or knowledge (Bryman, 2008; Saunders *et al*., 2007). From this assumption, researchers' roles are to stick to what he/she can observe and measure. This also follows the pattern of realist ontology, which focuses on fundamental laws, causal relationships and reductionism. An interpretivist perspective, on the other hand, is the opposite of positivism, as it is rooted in the constructivist or relativist ontology (see table 4-1). It generally lies within the difference between the subject of study in natural science and social sciences (Fellows & Liu, 2003). It has been argued that matters of social science (people and organisations) are complex and fundamentally different from those in natural sciences. As such, this view raises some doubts on using natural science approaches to understand the social world. Bryman (2012) argued that to grasp the subjective meaning of a social context, social scientists must use a different research procedure from their natural science colleagues. Some views attached to this position believed that knowledge is a social construct, which is subjective, and empirical works context dependent, thus the knowledge and research are primarily concerned with meaning rather than causality.

Most interpretivist studies are generalized into qualitative research. This is where researchers closely study a social phenomenon in order to increase their general understanding of a social context. It is worth saying that researchers here assume the role of interpreting social actions of others in line with their own values and prior knowledge in their field of study (Saunders *et al*., 2007; Lee, 1999). Therefore, truth and reality in this position are social constructs, rather than existing independently, hence researchers determine truth and reality from the participants' shared viewpoints (Fellow and Liu, 2008). This also means seeing things through a participant's lens, which would require an extensive discussion in order to acquire the truth and reality. From the above discussions, it is obvious that choosing an epistemological position would influence the methodology that one would use for research inquiry. Therefore, the epistemological position of this study leans towards interpretivist or constructivism and the justification is presented in the subsequent section.

4.3.3 Philosophical Position of this Research

After critically evaluating the various research paradigms in the preceding paragraphs, it is imperative for this study to position its own philosophical stance to achieve the intended aim and objectives. The importance of taking a philosophical stance is to frame the research process as emphasized by several authors (Saunders *et al.*, 2012; Lipscomb, 2011; Dainty, 2008; Fellow and Liu, 2008; Henn, 2006; Grix, 2002). Within the social science realm positivism and interpretivism are the mostly utilised paradigms. Therefore, from the ontological position, this study adopts the relativist position, which is also referred to as 'constructivism', because it aligns more with the methodologies that would enable this study to understand the research subject under inquiry. More so, because the researcher believed that multiple realities are subjective and a construction of the mind. Besides, by taking this position, participants' views, opinions, concerns and the meaning they ascribed to their problems would be known (Fellow and Liu, 2008; Cole, 2006).

In addition, this study seeks to objectively explore and understand how stakeholders would 'cost projects collaboratively', as a strategy to align commercial actors in collaborative practices within the UK construction industry. This could be achieved by examining the core commercial function in practice (costing) using the TVD approach as a conceptual guiding lens, which aligns with the philosophical stance associated with interpretivism. Similarly, from the epistemological position, this study believes that exploring the complex interactions amongst construction practitioners, to objectively understand the subjective notions of CC and identify the associated challenges in supporting industry-wide collaboration, is essential. Therefore, the research needs to be conducted in a non-biased fashion, and the impact of social structure should be considered from the perspectives of structuralisms (Fellow and Liu, 2008). Thus, this requires interactive cycling to determine the social structures that affect values etc. Accordingly, based on this understanding, the adopted epistemology in this study is interpretivism (Fellow and Liu, 2008), as this will enable the researcher to achieve the set intended aim and objectives. Moreover, the role of humans in managing construction projects is significant; because humans have the capacity for reflection, they might exhibit a novel behaviour, and the researcher could reveal patterns and norms that interpret their actions.

4.4 Research Methodology

After identifying the philosophical positions that underpin this study, it is equally important to clarify how the research study intends to acquire the knowledge (Bryman 2004). Accordingly, Denzin and Lincoln (2011) mentioned that research strategies provide specific direction and procedures. In other words, they outline ways to answer the research objectives. Generally, research designs tend to be either, *quantitative* or *qualitative*; they differ in many ways but can complement each other (Neuman 2003). The decision to adopt any strategy would largely depend on the purpose of the study, and the type and availability of information for the research (Naoum 2003). This research follows a qualitative strategy for the research design and method, which will be further discussed in section 4.5. The two main research strategies are examined in section 4.4 and this will clarify the adopted choice in this study.

4.4.1 Quantitative Research Approach

Quantitative research strategies lean towards the positivist paradigm, as outlined in table 4.2. According to Creswell (2007), the strategy organises the use of mathematical and statistical techniques to identify facts and causal relationships. This follows a deductive approach, based on testing a hypothesis or a theory comprising of variables, measured with numbers, and analysed with statistical procedures, to determine whether the hypothesis or the theory holds true. Bryman (2012) added that post-positivist claims are primarily used to developed knowledge when a quantitative approach is adopted (e.g. cause and effect thinking; reduction to specific variables, hypotheses and questions, use of measurement and observation; and tests of the theories), employing strategies of inquiry such as experiments and surveys, and collecting data on predetermined instruments that yield statistical data.

However, Denzin and Lincoln (1994) cautioned that quantitative methods ignore social and cultural influences, and assume a value-free and objective report. Glaser and Strauss (1967) opined that using purely statistical logic can make the development of hypotheses a small matter and can fail to help in generating theories from data. This implies that quantitative methods follows a deductive approach and are concerned with design measurement and sampling. They are objective in focus, whilst also trying to establish a trend in a study, and are concerned with answering questions such as, what? how much? and how many? (Naoum, 2013). Although the strategy provides the means for large data collection and generalisation of findings, the highly structured research design poses a great limitation on such findings, as there are various ways to explain why an event occurs. Besides, sample surveys and experiments are the two basic methods used in a quantitative research. However, the aim of this study is not to a test theory, hypothesis or make any form of generalisation, but to understand a phenomenon under a social context. Thus an alternative strategy, that can explore the underlying 'real world' environment, which also includes the hard-to-define factors that influence actual human behaviour (qualitative method), is generally preferred (Creswell, 2013).

Table 4-2: Quantitative versus Qualitative Research Strategy Sources: Bryman (2004), Fellow and Liu (2003), Naoum (2002), Neuman (2003), and Sherif (2002).

	Quantitative Research	Qualitative Research
Objectives/purpose	Gather factual data and study relationships between facts and relationships in accordance with theory.	Study issues in depth and detail, and seek to gain insight and understand people's perceptions.
Orientation to the role of theory to research	Deductive and thus associated with verification of theory and hypothesis testing.	Inductive and geared towards the generation of theory from specific instances.
Common data collection methods	Objective collection of data is a requirement. Questionnaires, tests, closed ended questions and existing databases.	Objective collective of data is not a requirement. Semi-structured interviews focus group, observations and documents.
Data characteristics	Hard data, structured, large sample size, analysed using statistical methods.	Soft data, descriptive, less structured analysed using non-statistical methods.
Outcomes	Conclusive findings used to recommend a final course of action.	Exploratory and/or investigate and findings are contextual.
Research design	Research design is specified before the start of the investigation.	Research design is flexible and develops throughout the investigation.
Data analysis	Data are represented and summarised in numerical form.	Data are represented or summarised narrative o verbal forms.
Sample frame	Samples are selected to represent the population.	Samples are purposefully selected or single cases are studied.

4.4.2 Qualitative Research Approach

Qualitative research follows an inductive approach, which is suitable for studies seeking an in-depth understanding of subjects mainly concerned with exploring the meanings embedded in people's experiences rather than testing predictions (Bryman, 2008). This means it relies on interpretive or critical social science and follows a non-linear research path. Creswell (2007) added that qualitative method 'starts with assumptions, worldviews, possible theoretical lens, and explores the meaning individuals or groups ascribed to social or human problems'. Similarly, Miles and Huberman (1994) added that qualitative research seems most appropriate when a study seeks to develop new theoretical propositions or to identify specific managerial actions, but the details of the phenomenon under study are unknown. This means that, the approach follows the interpretivist paradigm, which emphasizes the use of words in the collection and analysis of data, rather than measurement and quantification. This enables research studies to closely explore problems and develop solutions. Fellow and Liu (2008) also concurred that it seeks to know the why, what, how or where of an event, and the likely meaning ascribed to such an event by the participants in a particular setting, all of which aligns with the aim and objectives of this study.

Qualitative research is subjective in nature and is exploratory and attitudinal (Frechtling and Sharp 1997), as such it follows an inductive approach in relation to theory building. According to Denzin and Lincoln (2000), qualitative research involves the studied use and collection of a variety of empirical materials (e.g. case studies, personal experiences, introspection, life stories, interviews, artefacts, cultural texts & productions, observations), that describe routine and problematic moments and meanings in individuals' lives. Therefore, it is characterized as a form of systematic empirical inquiry (grounded in the world of experience) into meaning. However, its validity of generalisation does not depend on statistical inferences, but on the credibility and cogency of the logical reasoning used in describing results from cases and in drawing conclusions from them (Walsham, 1993). Yet, the approach still faces some criticism due to a lack of objectivity and the fact that the data are not large enough to generalise findings. Accordingly, in this study, an effort was made to improve this, as the study used multiple approaches for data collection and triangulation.

Figure 4-22 shows the two main methodological categories in research (quantitative and qualitative). In the quantitative inquiry, the researcher's task is to gather and systematise the data. The methods used are experiments, surveys and statistical techniques (Alvesson and Skoldberg, 2009), which are rooted within the realist ontology and positivist epistemology. Accordingly, quantifying meanings of variables, and hypothesis testing, are some of its features (Orlikowski and Baroudi, 1991). On the other hand, qualitative inquiry is a reformist movement of social scientists against the use of the realistic approach in social sciences (Denzin & Lincoln, 2005). It is an approach that allows data to be collected with a focus on how people interpret their social setting and the phenomenon, which accommodates the investigation and exploration of different views (Bryman, 2012). These are embedded within the constructionist ontology and interpretivist epistemology and use inductive reasoning to analyse data. The main thrust in qualitative research is that it permits the use of different methods for data collection and empirical analysis, such as grounded theory, interviewing, case study, ethnography, and phenomenology (Denzin & Lincoln, 2005). Therefore, a qualitative strategy was considered more suitable for this reserach this research, to focus and understand the subjective views on CC and its development within a social setting (the UK construction industry), by interacting with stakeholders (QSs, lean practitioners, and construction professionals) in practice.

4.4.3 Adopted Methodology for this Study

The importance of conducting research is not just to assemble data, but also to adopt a logical and systematic process that will answer the research questions (Berg, 2007). Hence, qualitative research seems to answer questions by investigating social phenomena and participants' actions within a particular setting (Berg, 2007; Henn, 2006). In this study, the social setting is the UK construction industry, and the participants are the construction industry professionals and organisations. Therefore, a qualitative strategy is deemed appropriate for this study, based on the attributes identified by Naoum (2013), Bryman (2012), Fellow and Liu (2008), and Henn *et al.* (2006) in table 4, which align with the outlined aim and objectives of this thesis. Firstly, it allows the study to be conducted in a real-life social setting in order to understand the phenomenon under investigation. Secondly, it permits the use of different methods like interviews, case studies, action research, ethnography (participant observations), and participative enquiry (Henn et al., 2006; Bryman, 2012).

4.5 Research Designs

Research designs are structural outlines which guide the process used for collecting and subsequently analysing data. They are therefore regarded as a frameworks that guide the research method. This enables researchers to connect empirical data to their conclusions in a logical sequence (Bryman 2004; Yin 2003). Therefore, to establish a logical design, it is crucial to examine various design methods relevant for this research study. There is also a need to rationalise the process of data collection and analysis for each of the design methods considered. Accordingly, the method chosen should be able to achieve the overall research aim and objectives. Hence, a number of research designs were critically examined in relation to this study, including: grounded theory, case study, action research, ethnography, research surveys and interviews.

Action Research

Design science research (DSR), also known as action research (AR), is a method that involves solving real-life problems. It provides innovative solutions to the identified research problems (Hevner *et al*., 2004). Both qualitative and quantitative forms of data are collected using this method. The method consists of collaborative analysis and evaluation of a problem, where the researcher becomes part of the study. It is carried out under a complex process, which consists of problem formation, action hypothesis, implementation and analytic cycle (Bryman, 2004; fellows and Liu, 2003). Generally, it is used to propose and validate solutions to a problem that lies within a basic research group.

The method embraces exploratory and AR approaches and has been identified as a proactive research methods that directly influences real world problems and provides practical solutions (Cole *et al*., 2005; Berg, 2007). However, in the past, the method was hardly used in the construction management field, because of the requirement for intense involvement of multiple researchers in such studies. Nonetheless, it is now being adopted more often in this field, especially for innovative research (Cole *et al*., 2005; Hevner *et al*., 2004; Ahiakwo *et al*., 2013; Formoso *et al*., 2012). However, this study mainly seeks to explore the concept of 'costing collaboratively' in the UK construction settings. This implies that there is no expectation that the research process will need to be repeated; hence, this method is less feasible and was therefore discounted.

Surveys

Surveys are widely accepted research design methods, which necessitate acquiring information from participants through questionnaires and interview strategies. The method provides a means to obtain responses from a large sample of respondents in a structured format, using statistical analysis and a deductive approach (Saunders *et al*., 2012; Henn *et al*., 2006). In so doing, respondents are expected to be true representatives of the study population before the conclusion becomes valid. However, the main shortcoming with this approach is that it does not allow new perspective to emerge from the respondents under the subject of investigation. This is because the factors to be investigated are already predetermined by the researcher, especially in questionnaire surveys, thus limiting the views of the respondents (Henn *et al*., 2006). It is worth noting that the survey method is not limited to questionnaire surveys as commonly believed.

Other structured methods, such as observations, structured and semi- structured interviews among others are used as well (Henn *et al*., 2006).

Considering the exploratory nature of this study, proceeding with predetermined questions in the form of a survey would not support its aim, as the respondents would be limited to sharing their experiences on the research questions asked. Although, some of the interview questions in this study were developed from the literature review, they were open-ended questions and flexible. Thus, a survey method was not considered for this study. Besides, the focus of this study is not to generalise findings, but to seek to understand CC concepts in the construction industry, thus obtaining a representative sample for statistical analysis would be unrealistic.

Ethnography Research

This is a qualitative method of inquiry that studies groups of people or cultures, and the interactions and practices that occur among them within a social environment or setting (Saunders *et al*., 2012; Fellow and Liu, 2008). The method involves the researcher closely observing the participants in their natural setting. Empirical data for such a method is obtained through questioning (formally or informally) to gain insights into the problems (Fellow and Liu, 2008). Henn *et al.,* (2006) suggested that the use of an informal approach to conduct the investigation would enable the researcher to observe and gain an understanding of the problem without being seen by the participant as surveillance. In this approach, the goal of the researcher is to study the participants in their setting to understand the problem without causing any form of obstruction to the work carried out by the participants.

From the foregoing descriptions, an ethnographic approach could have been a potential design for this study, as it would enable the researcher to explore how commercial practices are conducted in a multidisciplinary setting – thus shedding further light on CW. More so, because of the ability to interact and observe specific practices in each context (Saunders *et al*., 2012; Fellow and Liu, 2008). However, the ethnographic approach is often dominated by participant observations over a long period, which makes it less suitable for a study that has a limited timeframe. Besides, the focus of this study is not mainly to observe participants, but to understand the meaning they ascribed to the phenomenon under investigation.

Grounded Theory

Glaser and Strauss (1967) reported that grounded theory method is a 'set of flexible analytic guidelines that allow researchers to focus their data collection into building inductive middle-range theories through successive levels of data analysis and conceptual development' (Charmaz, 2005, p. 507). It is a qualitative research design approach where the researcher creates a general explanation (theory) of a process, action or interaction, which is then shaped by the views of many participants (Creswell, 2007; Strauss & Corbin, 1998). They hold the view that theories should be grounded in data from the field, especially in the actions, interactions and social events of people. Thus, this method enhances theory generation (complete with a diagram and hypothesis) from actions/interactions by interrelating the categories of information based on the data collected from the participants.

Mostly often, there is no actual theory to be tested at the beginning of this method: but rather, the theory is the result of the research. Therefore, the distinction between grounded theory and other methods is that it involves theory development. However, there are two different views associated with this approach. Firstly as a more systematic analytic procedure (Strauss & Corbin, 1990, 1998), which allows researchers to focus on process, actions or orientations. The second variant of the method is found in Charmaz's (2005, 2006) constructivist approach, which relies on interpreting qualitative research with flexible guidelines, focusing on theory that stems from the researcher's views; learning about experience within a social setting, events, relationships; and making visible communication. From this view, this approach aligns with the constructivist paradigm, as it takes 'a reflective stance on modes of knowing and representing studied life' (Charmaz, 2005, p. 509). Thus, it is also compatible with the ontological and epistemological positions of this research.

However, generating theory remains the focal point of this method. This study seeks to understand a new phenomenon, where the focus is to use the theory and conceptualise a new holistic approach. It is therefore, untimely to solely use grounded theory, however its analytical procedure includes a set of rigorous techniques that supports the creation of conceptual categories (thematic analysis), which would be important and feasible to adopt in this study.

Interviews

Interview designs vary from author to author. For instance, Yin (2014) grouped them into structured, focus groups and in-depth interviews. This is paralleled by Bryman and Bell's (2011) classification of interviews as structured, semi-structured and unstructured. The latter authors further asserted that interviews are grouped into two formats (structured and qualitative interviews). The authors argued that structured interviews lean more towards quantitative and positivism, where the researcher solely quantifies the views of the interviewees; however, this does not fall under this study's research strategy (qualitative). Bryman and Bell (2011) argued that qualitative interviews fall under two categories: semi-structured and unstructured. Based on their argument, an unstructured interview has similarities with character conversation, which is where the interviewer asks a single question but allows the respondents to respond freely with vital points and seek clarification accordingly.

However, several authors believed that interviews are conversations in which the interviewer follows a line of inquiry, and they can be conducted in a variety of ways (e.g. face-to-face, telephone, Skype, and e-mail correspondence Bryman, 2012; Sanders *et al*., 2012; Creswell, 2007). Yin (2014) added that these interviews serve two main purposes: (a) to satisfy the needs of the inquiry, and (b) to project friendly questions simultaneously.

On the other hand, semi-structured interviews follow a clear line of inquiry; the interviewer has a list of specific questions with a carefully prepared interview guide. However, some questions that have not been drafted could also be asked as follow-up questions. Thus, qualitative interviews (semi-structured) are deemed suitable for this research, because this study is investigating collaborative concepts in costing practices, which requires in-depth exploration and focused interviews (Yin, 2009). This line of inquiry will strengthen the validity and reliability of the study findings. More so, it is commonly used in this field to promote standardisation in the process of asking interviewees question and recording their responses.

In addition, Creswell (2013) added that exploratory interviews are more suitable when a study seeks to know the meaning people ascribe to their social experiences and not the meaning from literature alone, which aligns with the aim of this study. Therefore, a semi-structured interview approach has been considered appropriate, as it identifies effective means to learn about a phenomenon in a particular setting.

Case Study

Creswell (2007) defined case study research 'as a qualitative approach where the investigator explores a bounded system (a case) or multiple bounded systems (cases) over time through detailed, in-depth data collection involving multiple sources of information (e.g., observation, interviews, audio-visual material, and documents and reports) and reports a case description and case-based themes'. This means that case study methods can be used to explore research problems or phenomena of real-life situations or contexts. However, many case studies focus on issues within a case (individual, multiple individuals, or activities) selected to provide insights. This may exclude any interest in theoretical influence or empirical generalisation (Hammersley and Gomm, 2004).

The case study method has unique advantages, for instance, where the boundaries between the concept being studied and the context are not clear, and where questions of 'how' and 'why' are being asked about contemporary sets of events that the researcher has little or no control over (Yin, 2014). There is also the advantage of incorporating different sources of evidence – triangulation (Proverbs and Gameson, 2008; Yin, 2013). However, it has been argued that these sources (interviews, document analysis and observations) must be interwoven to arrive at a coherent narrative (Proverbs and Gameson, 2008). According to Yin (2014), three conditions inform the choice of case study method: when the study seeks to answer research questions such as "how" or "why"; when the goal of the study is not to have full control over the phenomenon under investigation; and when the goal of the study seeks to focus on real-life situations within a context. All of these align with the research questions of this study, which seeks to answer the following questions:

What does 'costing collaboratively' mean? What are the factors affecting CW and commercial practices? How would the integration of commercial actors improve collaborative costing in the UK construction industry?

Therefore, mapping the aim and objectives together with the research questions, a case study and interview approach seems most suitable for this research study.

4.5.1 Research Design Adopted for this Study

A qualitative research design was adopted for this study, having considered the differences, strengths and weaknesses, as well as the philosophical and realistic reasons with the research objectives alongside the wide range of information to be acquired. This is considered suitable based on the attributes identified by Naoum (2013), Bryman (2012), Fellow and Liu (2008), and Henn *et al.,* (2006), which aligns with the aim and objectives of this study. Primarily, it allows the study to be conducted in a real-life social setting to understand the current phenomenon investigated. More so, it can also be carried out under different methods such as interviews, case study, grounded theory, and ethnography (Henn *et al.*, 2006; Bryman, 2012).

The study research design was chosen based on the reasons outlined below:

- The study is exploratory in nature, as it seeks to understand how stakeholders 'cost projects collaboratively' in order to widen the understanding of collaboration within the UK construction industry. The findings and subsequent conclusions drawn in the study were applicable within the context where the research was carried out.
- The research explored the development of CC, which shed light on commercial practices and challenges. The study covered these issues in-depth and involved detailed rather than numerous descriptions. The approach was necessary to gain the insights needed to appreciate and understand the views of participants in both traditional and multidisciplinary settings.
- The data available in the research quotations were gathered from the semi-structured interviews as well as the case exploration. These were soft, descriptive and less structured and had to be collected using techniques such as interviews and documentary analysis. The data were analysed using Nvivo qualitative techniques and involved the creation of interpretations as suggested by Fellow and Liu (2003).

4.6 The Research Process

The previous sections in this chapter examined the research philosophical positions, research strategies, designs, and rationale justifying why they were adopted. This section fully describes the research process and how it was carried out in the study. This is because research process is not just a plan of work to be carried out by researchers, but procedures that will allow the research study to address the initial inquiry (Yin, 2014). Figure 4-2 presents the overall process involved, which consists of four key stages. The first stage highlights the research design; the second stage shows the data collection phase; and the third stage presents the data analysis process; whilst the fourth stage highlights on the framework development and evaluation. These processes were further divided into four sub-stages:

1. Literature review
2. Exploratory interviews
3. Multiple case studies
4. Framework development and evaluation

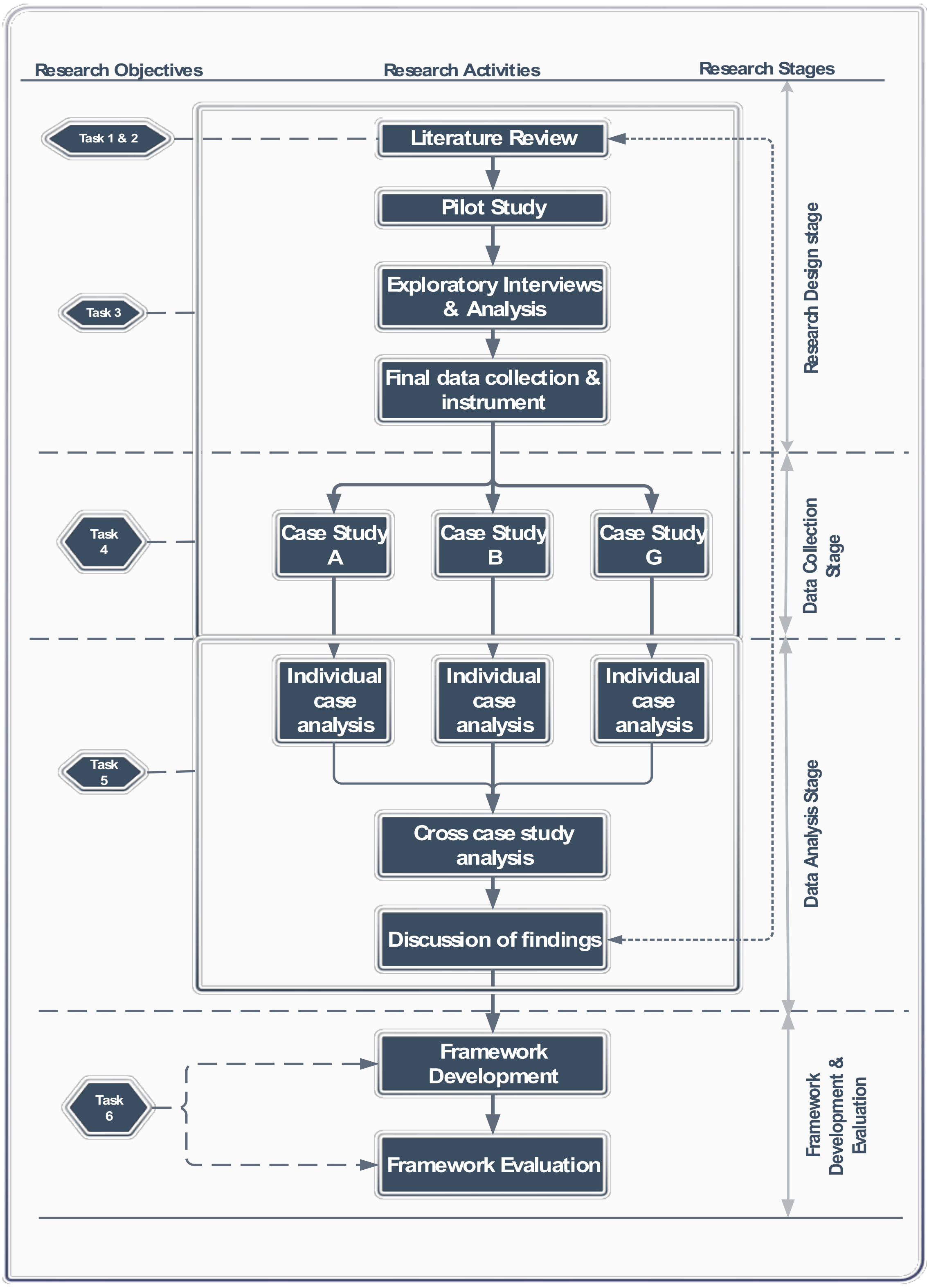


Figure 4-2: Research Design Process

4.6.1 Stage 1: Literature Review

Literature review (LR) is a critical process in any research activity. According to Bryman (2012), it allows researchers to understand existing knowledge, theories and methods used, as well as the unanswered questions in their respective fields. Similarly, Hart (1998 p.13) added that 'it is a way of selecting available documents, which contain information, ideas, evidence, written from numerous perspectives to achieve an aim or express a view within a particular subject area'. Therefore, this means that the process entails assessment of literature, which would guide researchers to actively investigate and identify gaps in research work (Collins and Hussey 2009). This also means that the process of literature review would assist researchers to identify the importance of current knowledge, thus frame their positions and arguments accordingly, in order to avoid repeating what others have already done in the research area.

In addition, several authors have remarked that literature review enables researchers to build on existing knowledge and expand their scope of understanding (Fisher, 2007; Naoum, 2013). Accordingly, this also played a vital role in this study. For example, understanding of the research problem, identifying gaps and the research questions were carefully discovered through the literature as presented in chapter one. More so, objectives one and two were achieved through the literature review process, whilst the rest of the objectives were partly supported by the literature. Figure 4-3 depicts the flowchart and the sequence of the literature chapters.

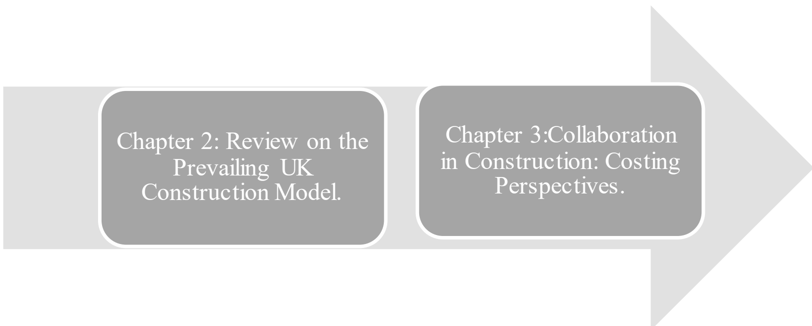


Figure 4-3: Literature Review of the Chapter Flowchart

The LR process in this study started by reviewing the UK construction industry sector, its characteristics and significance for the national economy. This was followed by evaluating the prevailing construction business model, where project delivery routes and commercial practices were examined. This was subsequently contrasted with the lean project delivery system, which revealed implications for CW practices in the UK construction sector. The study reviewed the lean construction system as a basis for comparism, because it is gaining much traction in the construction industry, and its approaches are now reshaping project delivery in construction. Furthermore, the study considered the concept of collaboration in relation to costing practices in construction. Through this, the study was able to elaborate a theoretical description of CC, which was further investigated in practice. The CC described was narrowed and used TVD as a theoretical lens to examine the maturity of the collaborative approach in costing practices, and was thus used to probed the perceptions of 'costing collaboratively' in practice.

The procedure was carried out through a systematic literature review process as described by Kitchenham (2007). This is usually applicable where there is very little evidence or when the topic area is too broad during initial investigation. Hence, this allows the identification of evidence clusters to direct the focus of the review, thereby identifying areas for more primary studies to be conducted (Kitchenham, 2007). Accordingly, the review started with the identification of search terms and definitions. This was done through database selection from: scholarly journals, technical reports, conference proceedings, textbooks, Google Scholar, and the Nottingham Trent University (NTU) database. This provided the research with a protocol to select publications based on sources, period and their relationship with the study i.e. search string formulation of keywords. Paper selection criteria were used. The goal here is to identify primary studies that provide direct evidence on the research questions (Kitchenham, 2007). This process is in twofold. The '*inclusion*' criteria considered theoretical or empirical paper types, and scoping to look at terms like collaboration, integrated concepts, partnering, costing and commercial practices etc. The '*exclusion*' criteria looked at non-English written papers, which were discarded.

In addition, the technique of snowball sampling was used to explore other hidden populations. Thus, through the references of the relevant papers, other sources were found (Konda and Mandava, 2010), leading to more relevant samples. This was followed by data extraction, where papers were categorised and identified for later reviews, without wasting too much time (Kitchenham, 2007). For example, considering authors, title, source, publication year and purpose. In terms of data coding, the research used a bottom-up (inductive) approach within Nvivo software, where large numbers of textual data were coded into smaller categories (Bemelmans *et al.,* 2012). Lastly, through the data synthesis, the review focused on summarising the data to answer the research question and graphical representation.

4.6.2 Stage 2: Semi-Structured Interviews

The importance of interview techniques in a qualitative study cannot be overemphasized. Interviews are also associated with exploratory studies, where the objective is to understand in-depth inferences and meaning ascribed to findings (Fellows & Lui, 2008; Sanders et al, 2012). This is in keeping with the aim and objectives of this study. Following the literature review stage, an exploratory semi-structured interview was designed (see appendix), with the purpose of understanding perceptions on CC and how it is developing in UK construction. This practical exploration became important given the varied views on collaboration in the industry; as such, this study seeks to add more understanding to the phenomenon across the UK construction industry.

More importantly, since the study was aiming to develop a framework, which has the potential to guide stakeholders within the UK construction industry on CC, in-depth interviews with these practitioners were considered necessary to understand the current situation. The interview process as shown in Figure 4-4 consisted of six stages, which are discussed accordingly.

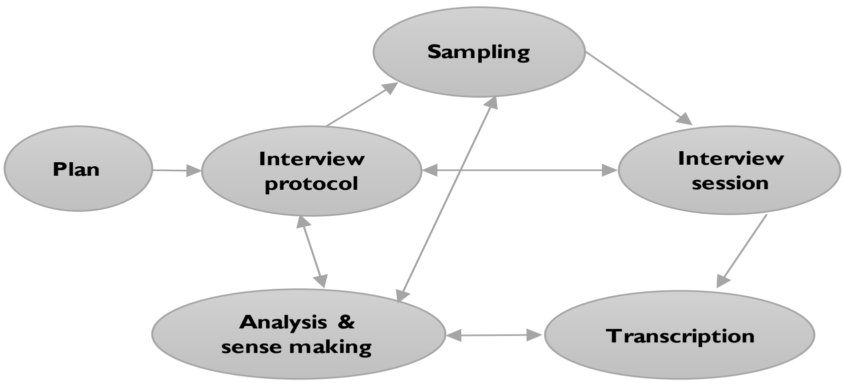


Figure 4-4: Interview Process

Interview Plan

As illustrated in Figure 4-4, the plan set the interview process in motion, which covered the entire data collection and analytical process, to ensure that the research study questions were answered sufficiently by the end of the process. In addition, the researcher further reviewed the aim and objectives and mapped them against the developed process to ensure that the overall goal could be achieved. Where possible, the researcher acquired the necessary skills and competences to conduct each process successfully. More importantly, the researcher sorted the necessary ethical approvals required to conduct the research from within and outside the institution (see appendix 5).

Interview Protocol

The protocol provided a guidelines for the researcher on how to conduct the interviews. The process cannot be overemphasized as it reflects on the questions, techniques and the ethics required to conduct interviews. Knox and Burkard (2009) observed that interviews are about understanding the experience of others and the meaning they ascribe to their experiences. Therefore, developing a robust protocol to achieve the research goals is vital, and this increases the confidence of the respondents in the process that further supports quality responses from them (Naoum, 2013).

After the university's ethical approval was obtained, an invitation/consent letter for participation was designed (see appendix), which was sent to the respondents. Upon receiving their responses, which indicated their interest in participating in the research study, arrangements were made to conduct the interviews. This is important, as it assured the participants total confidentiality in their responses. The interview instrument consisted of six sections. The first section focused on the participant's backgrounds; section two focused on industrial perceptions of CC in construction; and section three examined the conceptualised CC. Sections 4 and 5 investigated the constraints, barriers, and enablers of collaboration and costing practices, while section six focused on CW in relation to commercial practices within the UK construction industry (see appendix for interview guide). The interview questions were semi-structured and open-ended, thus allowing the participants to express their views on the phenomenon under investigation, in order to reduce bias and improve robustness of the findings.

Sampling

Sampling is a technique for selecting a population for a research study. Sanders *et al.,* (2012) remarked that sampling methods are mainly grouped in twofold (*probability or non-probability*), emphasizing that selecting the right sample would sufficiently answer a research question. Accordingly, probability sampling is mostly associated with quantitative methods (surveys, experiments etc.). The non-probability sampling approach aligns more with qualitative methods, and is appropriate when statistical inference and sample representation of the population are not musts in a study (Sanders *et al.,* 2012). Therefore, a non-probability sampling approach was adopted for this study. The non-probability sampling approach has been further categorised into the following: *quota*, *purposive*, *snowball*, *self-selection* and *convenience sampling* (Sanders *et al.,* 2012).

Quota sampling techniques are mainly associated with large populations such as in the case of surveys. Although Bryman (2012) argued that quota sampling is more of a probability sample than non-probability. In purposive sampling, sample cases/participants are often selected by researchers so that the population sampled is relevant to answerer the research questions (Bryman, 2012). This sampling technique is often utilised in exploratory qualitative research such as case studies focusing on key themes, or in-depth investigations to obtain balanced information. Snowballing on the other hand is used when it is difficult to identify the members of the proposed population for the study from the onset (Sanders et al, 2012). Thus, this would require identifying a population who can then suggest other members who could also participate in the study. Lastly, the convenience sampling approach centres on cases that are easier to find and could be achieved through random selection. This implies that quota, convenience and self-selection sampling might not align with the aim of this study, and hence, purposive and snowballing sampling were considered more applicable to this study.

These approaches allow the researcher to consider those who qualify to participate in the study. For instance, to present a holistic view on the current understanding of CC in the UK construction industry, purposive sampling was used to select the key stakeholders interviewed. This included project managers, lean practitioners, designers, commercial directors, QSs, and main- contractors in the UK construction industry. The minimum criteria used in selecting these participants were:

1. Having 5+ years' experience in the UK construction industry
2. Having 5+ years' experience of collaborative practices in the UK and
3. Having an awareness of the current practical issues, particularly during early costing and design development in projects.

This process was carried out to ensure that only those with the above requirements in the UK construction industry were included in the interviews. This was also achieved through the extensive network and contacts of the researcher's Director of Studies, who is a professor in Lean Management and a director and trustee of the Lean Construction Institute UK. However, the initial purposive sample and access were small. This is because respondents with both lean and similar expertise in the UK are very limited, thus the snowballing technique was subsequently utilized. This was achieved through the initial participants, who further recommended other contacts that were relevant to this study. The sampling size was not predetermined, as it would have been in a quantitative study. The interviews were carried out to a point of saturation, i.e. when there was no new information emerging (Sanders *et al.,* 2012).

Overall, 25 in-depth interviews were conducted over a period of 12 months, involving: six commercial directors, six project managers, six senior QSs, four lean practitioners, three designers and two main contractors. All of the participants interviewed had 5+ years' experience in collaborative practice and were drawn from construction, infrastructure and manufacturing backgrounds. All of the respondents were contacted via telephone and email before the interview sessions.

Interview Session

Kvale (1996) maintained that there are ten criteria that support the quality of an interview. These include:

- Researcher's knowledge of the subject area
- Communicating the purpose and intent of the interview to the respondents
- Being open and flexible to the interviewees
- Relating your questions to what has been previously been said by the interviewees
- Being patient with the interviewees
- Being ready to challenge what the interviewees are saying
- Using questions and prompt questions to steer the process
- Responding to what is important to the interviewee and;
- Providing a summary of what was said in the interview.

The above criteria were followed when conducting the research interviews. The researcher began by sending emails to the participants describing the research aim, along with the consent form (see appendix). Prior to the interview session, a sample guide was sent to the respondents: this was to allow the participants to familiarise themselves with the subject prior to the session. The interview sessions were carried out in a neutral location, and known to the respondents i.e. in their offices, work places, and were mostly done face-to-face. There were cost implications from this, as the researcher had to travel to these places, but this improved the data richness of the data, and the researcher was able to probe further in response to interesting points made by the respondents.

However, some respondents preferred to be interviewed via Skype and telephone because of time and distance proximity. Out of the 25 interviews carried out in this study, 4 were carried out via Skype and 2 were conducted using the telephone. The interview durations varied from one respondent to another, but were generally between 50 – 80 minutes, and the average time spent in each interview was 60 minutes. Each of the interview sessions was recorded using a digital application, and some hand-written notes were taken during the sessions. Towards the end of each interviews session, the researcher allowed the participants to further share their thoughts on what they felt was relevant to the study; this generated other useful topics and links. Afterwards, most of the interviewees asked if they could have a copy of the research when completed. This was a good and encouraging signs, which indicated that research into this issue was long overdue.

Interview Transcription

All of the interviews were carefully transcribed. Although, this was a challenging procedure, but it was an beneficial learning process. It logically allows researchers to minimise the likelihood of omitting some of the participants' responses during the interview (Bryman, 2012), thus evaluating the data to capture the salient meaning. In this study, each interview was immediately transcribed after the session, which helped ease the work prior to the analytic stage. All of the interviews (at both the case study and the exploratory stage) were transcribed verbatim. In addition, each direct quote was placed in an open and close manner ('' ''), ensuring that no part of the participants' responses was paraphrased.

Interview Analysis

Scholars have generally concluded that there is no rigid method for analysing qualitative data (as seen commonly in quantitative studies), simply because the data type and the researcher's creativity often prevails (Henn *et al.,* 2006; Berg and Lune, 2014). Thematic and coding processes are commonly used to analyse qualitative data (Bryman, 2012; Sanders et al, 2012). This study focused on collating and synthesising the data through the interviews and comparing it with the existing knowledge.

The transcribed interview were categorised into data sets and analysed using a thematic analytic process. Braun and Clarke (2008) characterised the thematic analytic process into six main steps: (1) familiarising oneself with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing a report. This study adopted the preceding thematic analytic process, as seen in Braun & Clarke (2008), during data analysis and transcriptions. As illustrated in Figure 4-5, the process shows various iterations ensuring flexibility, accuracy and social interpretations.

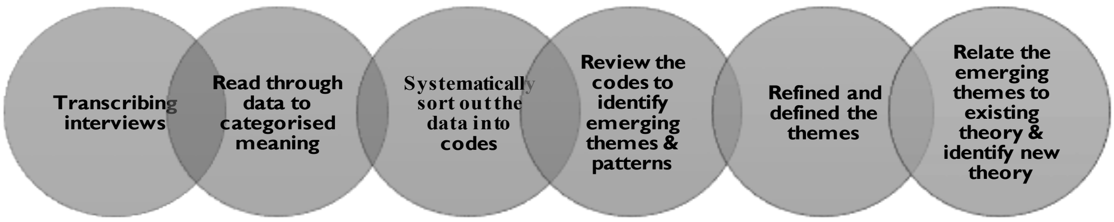


Figure 4-5: Interview Data Analysis Process

The analytic process commenced with coding of the participants' interview transcripts. Various codes and themes had been developed based on the interview questions. Inductive and abductive approaches were used in this process, depicting a continuous cross evaluation of what CC is from the participants. Whilst the inductive approach focused on making meaning from the analysed data to generate theory, the deductive approach considered predetermined theory to explain the data analysed (Sporrong and Kadefors, 2014; Dubois and Gadde, 2002). Therefore, an inductive-deductive approach was adopted, as both approaches allowed the study to gain new theoretical insights from the data, as well as from the established theoretical lens (TVD).

The participants' transcriptions were categorised into respective groups, for instance codes like CD, LP, MC, D, PM, SQ were used, where CD = commercial director, LP = lean practitioners, MC = main contractor, D = designer, PM = project manager and SQ = senior quantity surveyor. This was applied to all the interviews, and there was systematic adherence to the qualitative data analysis protocol revealed in Figure 4-5. In doing so, the emergent themes were examined further to identify any association with the existing knowledge, hence the detection of new themes. The analysed findings and the emerging themes are presented and discussed in chapter five of this thesis; each finding is critically discussed alongside the existing literature and in relation to the research objectives. This leads to the conceptualisation of CC and other factors established in the process.

4.6.3 Stage 3: Multiple Case Study

The rationale for case study adoption has been discussed in section 4.5 of this chapter. Stage three focused on achieving the study's third and fourth objectives, as mentioned in chapter one. This is a crucial stage, which informs the development of a framework. In view of this, a multiple-case study strategy was adopted to achieve these objectives, primarily because such an approach provides an in-depth view of the phenomenon, resulting in deep and raw findings (Fellows and Lui, 2008). The major aims targeted using the case study approach were:

- To understand the current views on 'costing projects collaboratively' in practice.
- To examine commercial practices and identify associated challenges in collaborative working.
- To identify factors that would engender collaboration amongst commercial actors within the UK construction industry.

To achieve the above objectives, the study required a detailed interaction with the participants in their work settings, which could be fully addressed using the processes identified in stages 1 and 2. A multiple case study approach was incorporated, because it is generally more robust than a single case study, and it improves result findings for generalisability (Yin, 2014). Besides, all of this offers an opportunity to interact with various stakeholders and fully understand the subject under investigation. The next section describes the process in detailed.

Case Study Planning

Like any other research study approach, planning is a necessary step when conducting a case study (Yin, 2014). Thus, from the outset, the researcher was concerned with how the case study is designed and conducted. This was to avoid the usual criticism directed to case study researchers of being sloppy and illogical in the process. Therefore, after reviewing the likely issues (weaknesses and strengths of the approach) as well as any difficulties (such as access to sites, research participants, and documents), the researcher conducted an extensive literature review as described in section 4.5 to counter these likely constraints.

All the three case studies were conducted independently, but simultaneously, between October 2017 and June 2018. The planning stage ensured that all the case study processes were carefully planned according to the research programme. However, there was a time issue challenge in this research. This took longer than expected and lengthened the researcher's time for data collection. This was also due to the unavailability of respondents and difficulty accessing some research documents. Nonetheless, the researcher ensured that all the cases were completed and managed properly according to the programme.

Unit of Analysis

Authors such as Darke *et al.,* 1998 and Yin, 2014 maintained that the unit of analysis in a case study research consists of an individual, a group, an organisation, a phenomenon or an event. These are what constitute a 'case', which is why Fellows and Lui (2008) remarked that the unit should be made explicit from the outset in any case-study research approach. The unit of analysis in this study is the multidisciplinary organisation, as it is an environment known for collaborative practices. Thus, this research aims to explore these settings. It is also; in this type of setting that commercial interests are presumed to be aligned with the overall production activities. Hence, this could further reveal the complexities and behaviours surrounding collaborative project teams. Therefore, this environment was considered as the 'focal-lens' to investigate costing processes and commercial relations, as well as behaviours and the implications for collaborative practices.

Case Study Selection

This research study carefully designed and selected cases based on the relevant factors associated with a case-study approach. These were carefully selected as described by (Creswell, 2012; Bryman, 2012; Yin, 2014) to reflect different perspectives on the research inquiry or the process under study. More importantly, to avoid situations where the evidence collected becomes insufficient to address the problem under investigation (Yin, 2014). With that in mind, the author and his supervisory team selected three cases to study, which are regarded as 'cutting-edge' practicing companies in the UK construction industry. These cases were chosen to enable comparisons between their costing approaches and the known TVD practices. Two of the cases were from the water industry and one from the highway sector. The focus was to develop a framework for CC in the UK construction industry, thus selecting various cases that cut across infrastructure was considered appropriate. This was to ensure that the findings are sufficient and reflect the current reality of CC in the UK construction environment. Therefore, the purposive sampling method was used. Bryman (2012) maintained that this allows researchers to choose the case(s) that can answer the question(s). This is advantageous to research like this: that focuses on finding key themes, on an in-depth analysis, and the importance of specifics. For example, the criteria for case study selection in this research were that the companies must:

- Have adopted TC or other integrated approaches during early costing and design development;
- Have an intensive collaborative culture that cut across project teams and supply-chain management;
- Be domiciled in the UK and accessible to the researcher in terms of affordable costs of visiting the site.

Maintaining a balance when selecting cases for investigation is vital; as suggested by (Stake, 1995), this helps to strengthen research study results. This was observed during the case study selection. For example, two of the selected cases were chosen to maintain a balance in delivery approach (joint venture), whilst the other case used an alliancing approach. This is because this study is interested in both joint venture and alliancing, using them as vehicles to understand CW and the project delivery approach. All of the cases studied had similar population samples and attributes. These were classified into four groups: directors, commercial managers, contractors and QSs/estimators/designers.

The author believed that considering these groups was necessary, as their inputs can be significant in developing the proposed framework to promote CW. Two of the cases studied were in the East Midlands, whilst the other case was in the East of England. Most of the cases were located close to the researcher's location and university, which offered reasonable travel and time costs. All the three case study findings are discussed in chapter six.

Data Collection Protocol

A data collection protocol was designed for the case studies. This is essential in formulating all efforts to answer the research questions and objectives. As such, contact was made with commercial managers in each of the organisations, and the author discussed the key evidence the study needed from the selected cases. A formal consent form was signed by each case representative following the discussion. The study mainly utilised documents and semi-structured interviews as the primary source of evidence to achieve the research objectives. The semi-structured interviews supplemented the research, as they allowed for generalisation of results and conclusions, while the documents helped to corroborate other sources and in obtaining information about the cases (Knight and Ruddock, 2008).

The researcher informed each of the organisations regarding his involvement in other similar case studies; this was to avoid any conflict of interest between the companies. Lastly, a formal letter of invitation was sent to the proposed research participants (see appendix 3). This was done to satisfy ethical requirements and, more importantly, to reassure them with regards to confidentiality. Creswell (2007) maintained that assuring research participants about confidentiality to improves the quality of information provided. Through this, the author maintained a strong relationship with the research respondents.

Data Collection

Data were collected on each of the three cases via two major sources. These sources include documentary evidence and semi-structured interviews. Details of these have been illustrated in Table 4-3.

Table 4-3: Sources of data across the three case studies. X: was not possible as the process has elapsed, but was captured & reflected in the interviews.

	Case Study A	Case Study B	Case Study G
Semi-Structured Interviews	(4) directors, (2) commercial managers, (4) QSs/estimators/designers	(3) QSs/estimators/designers, (1) director, (1) commercial manager and a contractor	(4) QSs/estimators/designers, (1) director, (1) commercial manager and a contractor
Documentary Analysis	Documents on financial business case (cost-based information), design & costing delivery processes, procurement & commercial model, cost and risk management guidelines.	Company profile document, supply chain policy documents, project description documents	Costing & estimating manual cost estimating & project framework (PCF).
Participants Observations	X	X	X

Documents

Sanders et al. (2012) remarked that documents provide useful information for collecting primary and secondary data to address research questions; however, they are often overlooked by researchers. This is because of the dominance and the usage of other methods such as surveys and interviews (Robson, 2002). In this research, documentary evidence was used together with the interviews to achieve the main aim and objectives of the study.

After receiving consent from the case study organisations, the documentary review commenced. The documents reviewed were predominately associated with costing and design activities in projects. These included materials such as cost base information for financial business plans, costing & estimating manuals, company profiles, and supply chain policy documents. The documents gathered from across the case studies are summarised in Table 4-3. Reviewing the provided documents assisted the researcher to understand and describe the current costing approach adopted by each organisation. Subsequently, after receiving approval from these organisations, a snapshot of the documents was taken; others were photocopied and some were electronically sent to the researcher.

Interviews

The rationale for adopting semi-structured interviews has been discussed in the earlier section of this chapter. An interview guide was developed using evidence from the literature review and documentary sources from each of the cases studied. The interview questions were designed to sufficiently answer and aligned with all the case study objectives earlier identified in section 4.6. The interview guide included four major sections (see appendix). Some of the interview questions were designed to follow up on the earlier exploratory study. However, the case study interviews were more holistic than the exploratory phase, as key project performers (cost consultants) were engaged. As such, participants were drawn from top, middle and bottom line cadres for each case study.

The process described in stage two of this study was used to conduct the interviews. The interview session began with the author introducing himself as a PhD student from NTU. The author also assured the participants of non-association with any third party, and that the details of any materials discussed would be confidential. The session was planned not to last for no more than an hour, and during the sessions, questions were asked and participants provided responses. When necessary the author interrupted in order to gain further clarity, but in many cases the researcher simply listened and took notes.

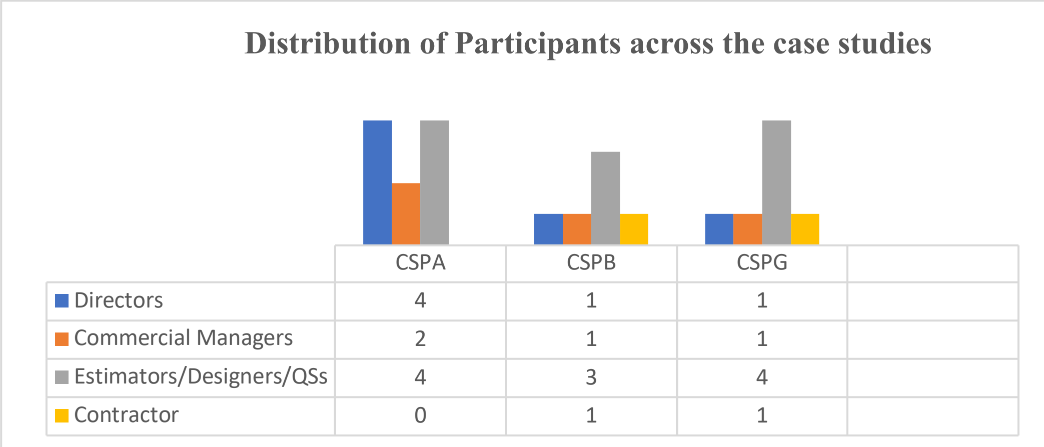
The interview sessions extensively covered the subject of the costing and design process extensively, particularly with regards to multidisciplinary setting. In addition, they thoroughly explored the extent of collaboration in those activities and the relationships with commercial practices. Overall, 23 interviews were conducted across the three case studies. The interviews were carried out until the point of saturation was reached. This is when the author notices that responses are being repeated and new findings are not emerging. All of the interview sessions were audio-recorded as requested by the participants.

Data Analysis

Evidence for the case study analysis was obtained via two sources: semi-structured interviews and relevant documentation. All of the collected data were carefully stored in electronic folders depending on the data type. Interviews were audio recorded and carefully transcribed and crosschecked with the documentary findings. Through this process, the researcher immerses and becomes conversant with the results, which strengthens the knowledge of data analysis. The main purpose of analysing research evidence is to make sense out of the data collected. Therefore, each source collected from a case was analysed individually and crossed examined to arrive at the converging point of inquiry. Figure 4-6 presents the individual case study analytical process.

Individual Case Analysis

Data triangulation from multiple evidence reinforces the validity and reliability of research findings (Yin, 2014). In addition to the interview transcriptions, the author also ensured that other documents were word processed to enable sense making out of the data. The process is very cumbersome, but it allows the researcher to maintain an interaction and consistency with the data. The case studies were coded thus: case study project alpha (CSPA), case study project beta (CSPB), and case study project gamma (CSPG), which are referred to as case studies alpha, beta and gamma respectively. The case studies were coded mainly for the purpose of confidentiality. Figure 4-6 shows the distribution of participants interviewed across the cases. In all, 23 interviews were conducted across the three cases. This was to give the study to have a holistic perspective on CC and the nature of support required for commercial actors' involvement in CW.



	CSPA	CSPB	CSPG
Directors	4	1	1
Commercial Managers	2	1	1
Estimators/Designers/QSs	4	3	4
Contractor	0	1	1

Figure 4-6: Distribution of participants across the case studies

The detailed descriptions of the case-studies are presented in chapter six of this thesis. The process described in stage 2 (above) on interview analysis was also used to analyse the case studies. Due to the large volume of data collected, the researcher deployed a computer aided qualitative data analysis software (CAQDAS), also known as *Nvivo,* to facilitate the process and for the storage of the data. The software does not only assist in managing large volumes of data: it also assists with transparency, reliability, and validation of data (Silver and Lewin, 2014). The software platform provided a systematic way to organise and interrogate qualitative data from different sources. This allowed the current study to create different folders and analysed the transcribed interviews and documents using the latest version of *Nvivo 12,* thereby managing the process effectively.

The main purpose of this strategy was to reduce the data set and gain in-depth understanding from each case. This is paralleled by Miles and Huberman's (1994) suggestions on large qualitative data reduction. As such, the case study transcribed interviews were word processed, and grouped into data sets, and analysed through coding and thematic analysis. These were then exported for coding and refining of the emerging themes. The codes and themes were developed based on: (a) interview questions, (b) identified themes from literature, and (c) emergent themes developed from the interview transcripts. The concept used is presented in Figure 4-7, which captures the emergent themes and their sub-themes prior to the definition of the candidate themes, and hence, the linking of codes.

The emergent themes and their sub-themes were coded and linked with the relevant nodes. This allowed the author to capture the salient meaning and cross-examined the findings. The *'explore'* tool in Nvivo 12 was used to analysed and graphically explore the emergent themes and the sub-themes. Figure 4-8 depicts a sample of the emergent themes and sub-themes on CC from CSPA, as exported from Nvivo 12 using the 'visual tool'. The subsequent findings are presented and discussed in chapter six.

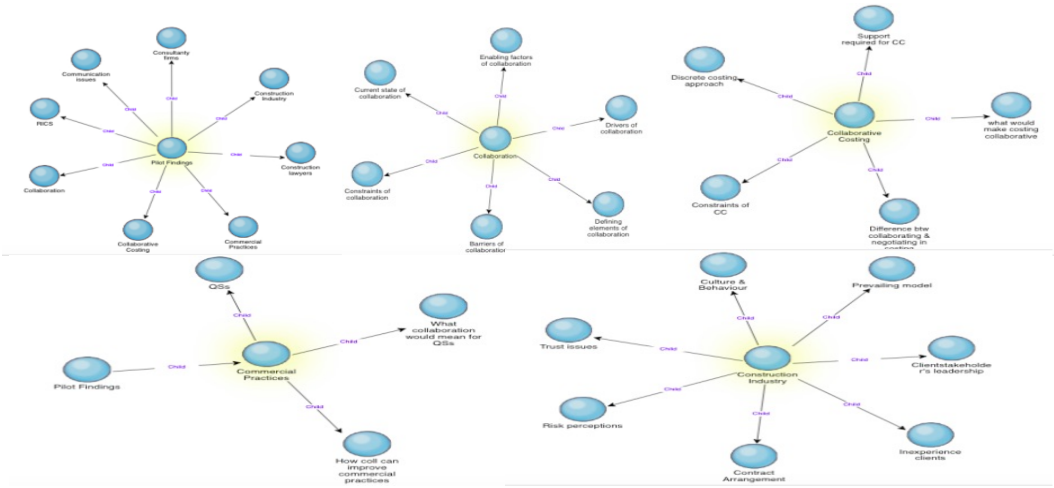


Figure 4-7: Initial thematic map on collaborative costing

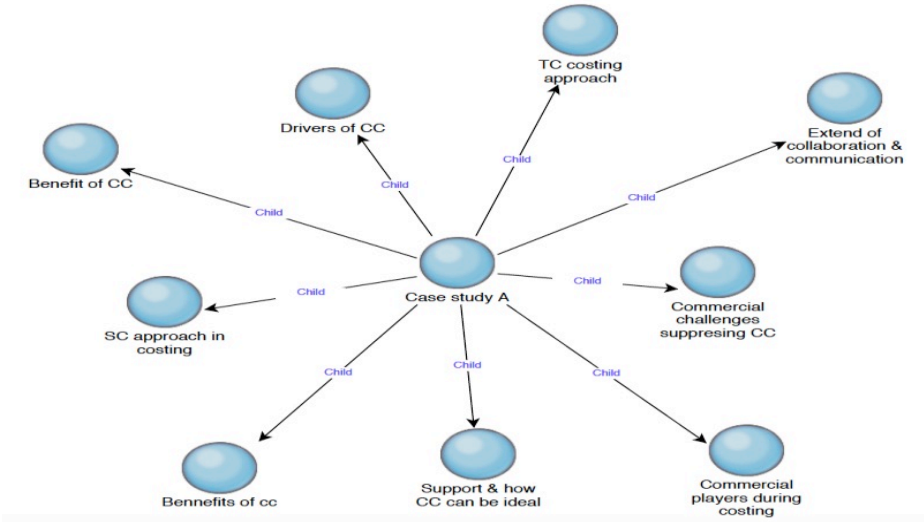


Figure 4-8: Developed thematic map on collaborative costing on CSPA graphically represented from Nvivo 11

Cross-case Analysis

The final stage of the analytical process involves a 'cross-case' analysis, which reveals how the three individual cases were evaluated. This was essential as it improves generalisability of contents within the cases and offers better understanding of the phenomenon studied (Miles and Huberman, 1994). The cross-case analysis followed the individual case (within-case) analysis, identifying any similarities and differences across the three cases, thereby identifying the current CC adopted and the support required for commercial integration in collaborative practices. The cross-case analysis is presented in chapter six. This is then discussed in relation to the previous literature.

4.6.4 Stage 4: Framework Development and Evaluation

After the activities in stages 1, 2 and 3, the study developed a framework to guide stakeholders on the necessary steps required to achieve CC in practice. The purpose of this was to strengthen CW in the UK construction. Stages 1 – 3 formed the building blocks for developing CC. In doing so, drivers and enabling factors for CW approaches were identified in stages 1 to 3 of this study. In addition, constraints, barriers and ethical influences on commercial practices were also identified. To understand the usefulness of the developed CC framework, a semi-structured qualitative questionnaire was developed for validation and evaluation (see appendix 7). Six participants were purposively sampled to participate in the evaluation. A full description of the evaluation process and analysis is provided in chapter seven of this thesis. The results of the evaluation of CC are presented and discussed in chapter seven.

4.6.5 Quality of the Research

Qualitative studies are often criticised with regards to research validity and reliability, even though validity and reliability are more associated with quantitative studies (Bryman and Bell, 2011). Thus, Bryman (2012) argued that validity and reliability are now increasingly important in qualitative research. Even so, authors have suggested that qualitative research has improved with alternative terms, which run parallel to quantitative research, and these are used as criteria to authenticate research quality (Guba and Lincoln, 1994; Yin, 2009; Bell, 2011). These terms are comprised of four tests, such as: credibility (*internal validity)*; transferability (*external validity)*; dependability, and conformability, (*objectivity*). These criteria were adopted in this study prior to the research design and data collection/analysis, in a bid to increase the quality of the findings, which are described in Table 4-4.

Table 4-4: Researcher's actions to strengthen the quality of the study

Qualitative test	Description	Researcher's action
Credibility	How believable are the research findings?	▪ Through multiple source of evidence, (triangulation) construct validity was achieved. ▪ Methodological triangulation was achieved by acquiring the data via interviews, field notes and documents. ▪ The data source triangulation was attained by interviewing different participants on similar issues thus avoiding individual bias. ▪ A chain of evidence was maintained for the study using Nvivo software, which housed the interview transcripts, field-notes and relevant documentation for each case study.
Transferability	Do the findings apply to other context for generalization?	▪ Findings were organised to allow replication logic for conducting similar case studies in different settings. ▪ Findings were also obtained from external participants who were not part of the case- study i.e., interview of participants in stage 2 ▪ Detailed description of the cases was given offering sufficient information for readers to access its application in other setting ▪ The study sample cut across major high profile companies that also involves key stakeholders in the UK.
Dependability	Are the findings likely to be apply at other times?	▪ This was achieved through full documentation of the research process. ▪ Standard protocols were designed for data collection on the exploratory interviews and case study ▪ Detailed description of the methodology and methods used for the study were fully documented ▪ The author's supervisory team further audited research instruments and data collected.
Conformability	Has the researcher's personal attributes influenced the findings?	▪ Multiple source of evidence was used to collect the data and were analysed independently ▪ Individual cases were analysed separately before the cross-case analysis ▪ The researcher took a neutral position in the data collection ▪ The researcher's supervisory team constantly audited all the stages of the study.

4.7 Summary

This chapter started by demonstrating the philosophical assumptions considered in this study. This was followed by the description of various research paradigms, such as positivism and interpretivism, and the chapter showed why a qualitative research paradigm was the suitable choice for this study investigation. This was due to the appropriate qualities seen in the approach, which have the potential to answer the outlined aim and objectives of this research.

This chapter also showed how research paradigms and philosophies that influenced the choice of methods and methodology used in this study. After that, a detailed description of the unfolding stages (1 to 4) of the study was provided, as well as the justification for the methods used. This means that the study was built on rigorous methodology, which implies that the evidence provided and discussed in the study will be reliable. The chapter also provided a detailed account of each method and approach used, and how the study results were captured. Finally, the chapter showed measures undertaken to enhance the quality of the research data regarding validity and reliability of the study. The next chapter will present and discuss findings from the exploratory study.

CHAPTER 5 EXPLORATORY FINDINGS AND DISCUSSIONS

5.1 Introduction

The previous chapter provide a detailed account of the research method and methodology used in this study. This chapter presents and discusses the findings gathered from the exploratory interview investigation. Section 5.3 starts with findings from semi-structured interviews; it examined the attributes of collaboration, which shed light on the current costing practice from the participant's point of view. Section 5.4 and 5.5, discussed some of the constraints, barriers, drivers and enablers of collaborative practices within the UK construction industry. Section 5.6, looked at commercial actors and their challenges in collaborative working relationships. It precisely looked at the pitfalls facing QSs in the UK construction industry. The chapter finally presents general discussion in section 5.7, and the summary in section 5.8.

5.2 Stage 2: Semi Structured Interviews

5.2.1 Analysis, Presentation, and Discussion of Semi-Structured Interviews

The protocols for data collection has been discussed extensively in the methodology chapter. This chapter presents and discusses the findings analysed in stage 2. Accordingly, it examined the attributes of collaboration, perceptions on CC and cost negotiation, barriers and constraints to collaboration in cost management practice. In addition, challenges facing QSs/estimators during costing & design phases and the related implications were also discussed.

Overall, 27 semi-structured interviews were conducted. The interview analysis started with note taking sessions to transcription, and it ended with a detailed examination as presented in this chapter. The analysis generates simple and candidate themes, which were derived from the interview constructs during coding process. These themes were discussed alongside the literature findings, describing any similarities and differences. The findings are presented in three sections; section one presents the cornerstones of collaboration, attributes of CC, and the subtle difference between CC and cost negotiation. Section 2 focuses on describing CC and the associate barriers in practice. The final section presents an overview of commercial practices and the challenges facing cost consultants in collaborative working practices – which shed light on other factors affecting industry-wide collaboration. Finally, conclusion and summary were drawn from these discussions.

5.2.2 Demographic Information of the Respondents

Table 5-1 provide an overview of the respondents interviewed. The participants were drawn from construction, infrastructure and manufacturing fields. The purpose of exploring these groups was to seek for broader reflection and insight on 'collaborative costing' practices in the UK construction industry. More so, to understand how commercial actors align with collaborative programmes. Some of the participants interviewed included project managers, lean practitioners, designers, commercial directors, senior QSs, and main- contractors.

Table 5-1: Descriptions of Interviewees across the UK Construction Industry

Respondents Code	Background	Exp in Construction	Exp in Collaborative Practice
SQs 01	Construction	20 years	5 years
PM 01	Construction	16 years	5 years
SQs 02	Infrastructure	19 years	4 years
CD 01	Infrastructure	25 years	7 years
PM 02	Construction	17 years	5 years
SQs 03	Construction	19 years	5 years
LP 01	Manufacturing	26 years	10 years
PM 03	Construction	20 years	6 years
CD 02	Infrastructure	33 years	13 years
CD 03	Infrastructure	31 years	15 years
SQs 04	Construction	17 years	3 years
CD 04	Construction	25 years	8 years
PM 04	Construction	20 years	7 years
D 01	Infrastructure	20 years	8 years
D 02	Construction	21 years	6 years
LP 02	Manufacturing	32 years	12 years
MC 01	Construction	19 years	7 years
CD 05	Construction	28 years	9 years
PM 05	Construction	22 years	9 years
CD 06	Construction	23 years	7 years
D 03	Construction	21 years	6 years
SQs 05	Construction	15 years	3 years
PM 06	Infrastructure	20 years	5 years
LP 03	Manufacturing	33 years	16 years
SQs 06	Construction	14 years	2 years
MC 02	Infrastructure	20 years	9 years
LP 04	Infrastructure	28 years	10 years

CD= Commercial Director, LP= Lean Practitioner, MC= Main contractor, D= Designer, PM= Project Manager, SQ= Senior QS

Table 5-1 illustrates the respondent's and their individual experiences in collaborative practices in construction, which indicate that traditional approach in construction has been the dominant view in the UK construction industry. This also means that the idea of 'costing collaboratively' within these setting could face tremendous challenge, given that the wider prevailing approach has since been known to prioritize on stringent contractual relationships against CW (Ballard and Howell, 2004).

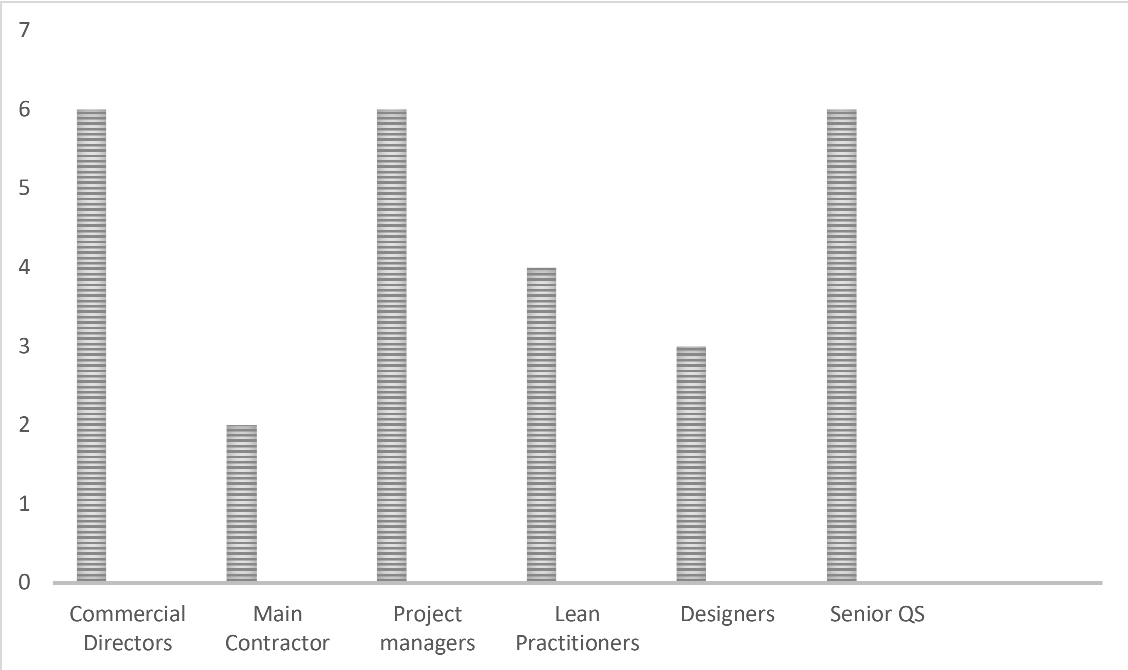


Figure 5-1: Positions Occupied by Interviewees

Figure 5-1 showed how the respondents occupied various positions within the research context. From the figure, above it shows that majority of the participants are key players during project delivery, which means they all partake in conceptual processes (e.g., costing and design, procurement). This is important; as the author tried to understand and capture the salient meaning these participants have on 'costing collaboratively', and their independent views on commercial relationships in collaborative programmes within the UK construction industry.

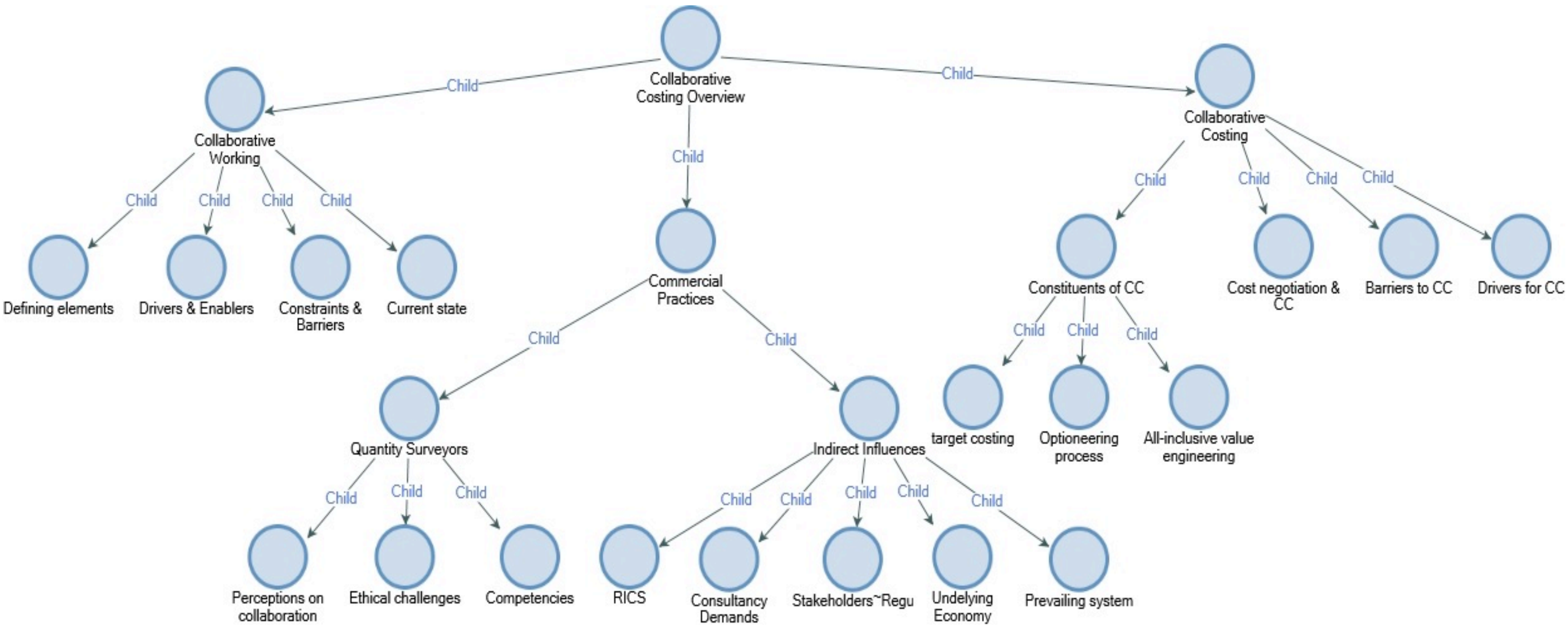
5.3 Perceptions on 'Costing Collaboratively' (CC)

The interviews analysed in this study's investigation revealed three major themes. These include attributes on CW, perceptions on CC, and commercial practices within the UK construction industry. These themes are presented and discussed in

Table 5-2.

The rationale behind this exploration was to identify key attributes in CW, in order to describe the idea of CC, and secondly to understand how the concept is progressing in practice as earlier discussed in chapter three. The investigation in this section further considered the difference between CC and cost negotiation. This is because professionals often normalise the two terms in practice. Hence, describing CC would shed light and better understanding of CW in practice. Of interest, this could potentially provide platform for adopting integrated concepts like TVD, BIM and other sustainable procurement options within the UK construction industry (Mossman, 2009; Zimina *et al.,* 2012). Therefore, the investigation explored what CC mean from the views, insights and experience of practitioners within the UK construction industry.

Table 5-2: Emergent themes: thematic analysis



5.3.1 Industrial Perceptions of Collaboration

The interview findings showed some correlation and clear understanding amongst the participants on what the term collaboration means, i.e., relational approach to project delivery, which is based on trust and transparency, where common goal and interest are aligned (see Table 5-3). Further analysis showed other elements that also contribute in defining collaboration and its application in practice. Some of these elements are consistent with those found in the literature (see chapter three). Respondents in this study described key attributes of collaboration as *'working based on mutual goals'* **[SQs01],** others cited '*working repeatedly with common base'* **[SQs02].** Participants with manufacturing backgrounds view this as '*effective team working through strategic alliance*', while those with contracting background described it as *'teams working together, driven by clients* **[LP01]** *and driven by clients'*, **[CD02]**. Similarly, other respondents suggested it as '*an idea of working together based on common goals where project outcomes are dependent on collective performances'* **[MC01].** This indicates that majority of the respondents have a clear understanding on collaborative working in construction. Accordingly, these views are also consistent with those found in literature, which implies that its actual conceptual meaning is not far apart from the practical understanding. Table 5-3 illustrates various industrial perceptions on collaboration from the respondents and the attributes associated to it in practice.

Table 5-3: Varied Description of Collaboration from Construction Practitioners

Definition of Collaboration	Elements & Attributes
…an idea of working together within organisations with common goal rather than on contractual sense…SQs01	Team working, common goal
…having a common base with teams to operate with same goal and work repeatedly…SQ02	Working repeatedly, common goal/base
…effective working relationship between people & companies to achieve a strategic alignment based on trust…LP01	Effective team relation, trust, strategic alliance
…a coming together of stakeholders with same goal, KPI to have a shared outcome…PM01	Common goal, shared outcome
…working towards a common goal with mutual benefits and being dependent on each other…MC01	Mutual benefits, common goal, team dependability
…Working together where problems are solve collaboratively with common goal…PM02	Collective problem solving, common goal
…working together with project teams led by clients with defined responsibilities…CD02	Team working, clients driven
…working together with stakeholders through solutions and problems towards the right outcome for a project…MC01	Project first thinking, outcome delivery

Although, these definitions might not change the conceptual meaning of collaboration entirely from the respondent's views. Nonetheless, Fischer *et al.,* (2017) maintained that collaboration does not only mean interaction between two or more individuals - but should also encompass core attributes that would enable cross-functional relationship to thrive. Interestingly, this raise an important point, as often collaboration in construction environments seems to only exist in principle (Udom, 2013). Some of the key attributes mentioned by Fischer *et al.,* (2017) in the literature include *trust and transparency*, *clear goals and values*, *open conversation*, *cultural consideration* and *feeling sense of ownership*. However, we often see the partial application of these elements in construction, largely because individuals, teams and professionals are influenced by cultures, assumptions, and lack of clear understanding of the abovementioned elements, which seemingly continue to divide the expectations of upstream and downstream players in practice (Gomez *et al.,* 2019). From the analysis and interpretation of the respondents' views, this study further identified attributes of collaboration as *'working repeatedly'*, *'strategic alliance'*, *'team dependability'*, '*collective problem solving'* and *'having sense of ownership'*. Certainly, these elements need to be practiced as the core constituents of collaboration in construction (David & Alves, 2019).

5.3.1 Descriptions of 'Costing Collaboratively'

The analysis on collaboration has also set the context for CC. From this point, it is only prudent to understand the concept as discussed in the earlier chapters. There is no consensus definition of CC in the literature. Therefore, this study explored some of the constituents of collaboration in a bid to describe what CC mean and to understand how it is progressing in practice. The interviews explored to determine the respondent's perceptions on CC. As such, several assertions associated with the idea emerged. Some of the participants viewed it as '*collective value engineering efforts aimed at developing project costs* **[MC01].** Others mentioned *'open dialogue and transparency during costing activities*', **[SQs01]** '*Open discussions during costing development'* [**D01**] '*the process of attaining economic cost solutions'* **[PM03]** *and 'cost negotiating strategy*' [**LP01].**

An intriguing discovery from this is that, cost negotiation is also referred to as CC, even though the former stems from individual party position whilst the latter is linked to a comprehensive effort that benefits the overall project team. It is very clear from the interviewees that there is a general concern in cost management practice, which continued to reveal varied understanding. In the same way, even within the literature, there is no clear distinction between teams collectively working to develop project cost and those negotiating from individual party positions.

Indeed, the description of CC should start from the perceived understanding of collaboration since most of the participants alluded that there is strong correlation between collaboration and cost management. On the contrary, there are some commonalities between collaboration and costing, for instance, when the researcher asked about attributes that would stimulate collaboration amongst stakeholders during costing activities? The participant's responses were '*trust, and open interactions during costing and design activities*' **[PM05]** '*collective value engineering exercise'*, **[D02]** '*reliable costing & estimating process'* **[SQs06]**. Likewise, other respondents cited attributes like; '*sharing pain/gain with cost visibility*' **[LP03]** which is reference to open book estimating, while others cited '*alternative cost solutions'*, **[MC01],** '*optioneering*' in search of efficiency & reliable cost outcomes **[CD03].**

This clearly described an effective cost development strategy with potentials to arrive at a 'win-win' scenario. This also highlights the commonality between collaboration and cost management activities, which require mutual understanding, interactions and sense of ownership from all stakeholders involved. Some of these attributes are elements derived from CW for project teams to benefit. Therefore, they are socially driven. This is in keeping with Fischer *et al.,* (2017) definition of collaboration as a *'community of people working together to achieve a common goal - through a deep level trust, clear understanding of project values and feeling the sense of ownership'.* This definition acknowledged the social interaction of community to mean project performers i.e., designers, constructors, trade vendors and the client team working together towards a common goal.

Table 5-4: Description of attributes for 'costing collaboratively'

Themes	Attributes 1	Attributes 2
Target Costing	Open dialogue Cost certainty Open book estimating	Transparency in costing & design process Cost negotiations
Integrated Value Engineering	Well-informed discussions during costing; Shared understanding	Value creation Cost visibility
Optioneering Process	All-inclusive validation study Risk/reward sharing	Open conversations Reliable cost planning & estimation

In addition, the participants stressed that CC would certainly require building new competencies, which need to be supported by factors like *cross-functional integration*, *relational agreement* and *trustful relationships*. Indeed, this will not only encourage teams to cost projects collaboratively, but would enable individuals to support the success of others (Lloyd-walker, et al., 2014b). Thus, this view has described an ideal concept of CC. The various themes that described 'costing collaboratively' are categorised in Table 5-4. These categories showed terms that are largely understood in construction, while the attributes use conceptual terminology to delineate the concept. This could further support theory generalisation and development. The themes are characterised into three as presented in table 5-4. This consist of optioneering process, integrated value engineering, and target costing.

Target Costing Approach

Respondents described CC as a form of open dialogue during conceptual costing process. Participants such as **SQs01, MC02, and LP01** referred the concept as '*target costing'* which means clear substantiation of information to develop a target cost. Others suggests that 'costing collaboratively' is a niche approach in construction. For example, **LP02** clearly described it as *'a process that drive design to achieve a collective solution within the boundary of what has been contracted'*. This view indicates that the approach need shared understanding, open communication with dense interaction around a wider scheme budget or any assumptions that support the development of cost solutions.

Respondent **SQs05** mentioned *'collective pain and gain sharing'*. This means transparent relationship between clients, contracting parties and supply chain groups. Interviewee **CD04** described it as 'a bottom-up pricing', implying a situation where project teams are incentivised to work jointly to come up with feasible cost target. Thus, from this analogy, CC can also be seen as open book estimating or target-costing approach based on these attributes. This is also in line with the explicit assertions of Macomber *et al.,* (2007), who described five overriding principles that reinforces early collaboration during budget development (i.e.; target costing, collaboration, colocation, set-based design and work structuring). In view of these, the attributes mentioned further strengthen the point made earlier on CC approach.

Integrated Value Engineering

Value engineering is a process that thrive well with early stakeholders' integration, where teams can effectively influence design and its iterations. This attribute is also derived from the respondents' descriptions of CC, which indicates the importance of integrated team as well as aligning commercial actors in the process. It is worth noting that this exercise strengthens cost management processes, value creation in design, and improve performances, especially during early project planning and development (Grau, 2019). Some of the respondents also shared this view. Respondent **D02** described it as *'a regular dialogue and understanding of what's required, knowing where cost, time and quality fit, thus developing trust and relationships with the team'*. From the respondent's viewpoint, collaboration during value engineering is meant to benefit all the parties involved. Equally, this highlights how teams should collectively cost project and track other variables associated with the costs, thus, drive optimum and eloquent solution in the process.

Similarly, respondent **LP04** believed that the idea to achieve collaboration during costing development should also embrace *'integrated value engineering, and the alignment of commercial actors in the process.* Accordingly, combining these elements would enable teams to understand waste inserted in cost models, resources, thus recognized all the associated costs elements. Arguably, commercial actors (QSs) in this instance could be instrumental, as they could ensure everyone understands how target costs are set and developed. Thus, this implies that integrated value engineering is a key component to CC in construction. Even though, this is contrary to the conventional norm where the process is stuck at sketch design or the elemental level (as was the original focus of value engineering) with implications that leads to 'fire-fighting approach' i.e. cost-cutting, rather than proper value-enhancing exercise (Ellis et al., 2005).

Optioneering Process

CC was also considered to have commonalities with optioneering process. This means that the concept need integrated value engineering and target-costing elements to achieve owner's condition of requirements (Ballard and Tommelein, 2016) as earlier discussed. Respondent **LP03** described optioneering as '*a process that encompass extensive discussions, which involve exploring multiple design and costing options, distilling it into a single solution to enhance value creation'*. This means that, arriving at a single solution is a crucial process that sees costing and design intertwined and established by the team collectively. The process is significant especially in a collaborative environment, where stakeholders are presumed to be integrated early for value identification and decision-making.

Similarly, participant **CD05;** concurred and described it as *'validation study'*. This further reiterates the significance of integrated teams, having open dialogue to validate client's condition of requirements. In this way, everyone involved would see the consequence of cost components within a programme or adding to a programme thereby tracking the cost pieces (Grau, 2019). Indeed, this could also bring more benefit to the team, focusing precisely on factors that would generate the best outcome for the client and stakeholders from value perspective. Arguably, establishing this would further enhance commercial input in the process to provide opportunity and avenue for innovation and value enhancement upfront. Although, literature finding shows that such arrangement is lacking, especially during early budget assessment and feasibility studies (Pishdad-Bozorgi & Karasulu, 2013; Salam *et al.,* 2019). Ballard (2012), added that these are largely because owners established their target costs without involving key stakeholders required in the process, and in turn it often lead to consequential waste in construction practices (Sarhan *et al.,* 2018).

5.3.2 Cost Negotiation and CC

This question can equally be addressed by the first two sections discussed above (collaboration and CC), but the researcher further cross-examined the respondents with this inquest to strengthen the rigour of the data collected. As such, the difference between CC and cost negotiation was asked.

The purpose of this was to verify the participants understanding on CC. The researcher believed that cross-examining the respondents would help to validate the main research questions. There were no further themes identified, although some of the respondents shared some similarities while others differ. Only 5 out of 27 respondents in this investigation share their views that CC is same as cost negotiation in practice [**SQs05, PM06, MC02, SQs04, and SQs01].** Respondents **PM01, D01,** and **CD05** asserted that '*In practical terms, they are the same thing - clients awaits the main contractor to make or supply the cost and then red-pen it through negotiation'* **[D02]** stated that *'teams usually collaborate together to negotiate a price'* **[CD02]** *'sees it as 'a collaborative conversation between teams'.* This is not consistent with the number of respondents whose views were similar but asserted that *'Cost negotiation comes from individual party positions that people usually chose because of commercial advantage which is contrary to the collaborative approach'* **[LP03, PM03, CD06, MC01]**. Respondent **LP04** maintained this stance, stating that they are not necessarily the same because *collaboration is working together to agree the best cost option for the project, while negotiation seem to encourage the act of gaming tender process which is creating* *adversarial relationship.* These views indicate that CC is working together and not trying to agree on the lowest cost. **CD03** mentioned that '*often, they are similar in practice'*. However, this means that teams can also collaborate and negotiate terms, prices together to arrive at a win-win scenario – hence through trust and transparent ways. **PM05** confirmed that they are generally interchangeable terms in practice, where clients normally provide cost information for pricing, *'but the subtle difference between the two is trust and shared understanding'*. Even though, some respondents suggested that collaboration and negotiation are similar, they did admit that 'costing collaboratively' is a progressive approach in the construction industry. Majority of the respondents seems to agree when asked on a single description of CC. For instance, respondent **LP02** replied saying it is about *'open dialogue'* **MC02** said '*it's about trust'* and **LP01** stated '*optimizing cost to enhance design*. These views were also extracted to delineate a single description of CC as discussed above.

In conclusion, most of the participants generally agreed that cost negotiation is not necessarily same as stakeholders collaborate to cost project. Thus, this means that attempts to normalise the two concept is arguably part of the issue that is dominant in construction practices. For instance, **CD02** connoted on this saying *'after we've done our internal costing, we then approach couple of supply chain to get quotes – where we make comparism and verification, but of course price is the biggest driver'*. Equally, this is what participant **MC02** stated:

> *''We once bid and negotiate on a new scheme worth £75m and we've already won the job, only for the client to come in later and said we're now doing it at $60m. So, after lots of negotiations for about 3 months, in the end we settle on £65m. Therefore, the first day, we went in with a claim team pushing our ways to get more profit and recover the £10m back''.*

This shows that from the contractor's perspectives, it is down to how much profit they are willing to compromise to even consider collaborating in this approach. So, when the researcher asked the client side on the same project? The response was that: *'we don't openly share or build the cost together, because we don't know whether they'll come for less than our target cost, and the minute we do that – you can guarantee they would come close to that'* **[SQs02].**

This indicates the challenge faced in practice between upstream and downstream players during costing and design development, which means practitioners need to step away from negotiating position to collaborate. More so, it shows that cost negotiation is not the same as collaboration in practice despite agreeing terms with strategic partners, as often when tier-2 suppliers are engaged in the process; the sense of uncertainty instinctively reappears to hinder any effort for collaboration. Arguably, this point has distinguished the difference between people negotiating and those working collectively to build the price openly. More so, this point indicates why contracting parties continued to struggle in this approach – as they are not encouraged to feel any sense of ownership around the wider scheme budget nor are they entrusted in these collaborative arrangements (Engebø & Skatvedt, 2019).

5.3.3 Describing 'Costing Collaboratively' (CC)

The study explored collaboration in relation to the current costing approach from stakeholders in traditional and multidisciplinary settings in the UK construction industry. The analysis revealed attributes that shed lights on factors that described CC. These include *target costing approach*, *integrated value engineering* and *optioneering process*.

The target-costing attribute indicate that the process is centred on building cost together (prior to design) to achieve viable solution from the client's condition of requirements. This means that the approach relies on trust, open dialogue and sense of ownership around the wider budget. This aligned with Macomber *et al.,* (2007) assertions that the process of determining early project costs should encompass principles like collaboration, colocation, set-based design and work structuring. Equally, the integrated value-engineering factor is another important element found, which enable regular dialogue among stakeholders to understand how cost and design details are link with the project end-values. Thus, in this way teams would be able to forecast and track costs variables collectively, thereby achieve eloquent cost solutions. More importantly, the process could thrive with cross-functional teams (client, designers, contractors, commercial groups etc.); as this would bring the project teams closer to understand how waste are inserted into a cost model and manage resources efficiently, hence, achieve value for all stakeholders involved.

In addition, optioneering process is another attribute discovered, which would enable teams to discuss multiple cost & design alternatives, and distils it into a single solution. This means that the process of establishing single solution is a vital step that need dense interactions within the team. More importantly, aligning commercial actors in the process. Similarly, the study discovered other attributes associated with CC, which could also strengthen the integration of commercial actors in this arrangement. These include ***value***

creation, ***waste minimization****, and* ***certainty of cost***. Others are ***open communication*** *and* ***shared understanding***. However, this means moving away from the accustomed practice where cost consultants simply turn up to count or keep records - towards finding ways to add value at conceptual stages. Consequently, for QSs, this would mean the ability to establish price certainty, which has the potential to change their traditional costing approach to value-driven if they're involved more in the process. Equally, this could offer commercial actors different perception to risk and cost management practices. This is because, with their technical ability to assemble the information that goes into establishing TC, it would allow them to understand the details in costing, design, construction techniques and other social skills required for collaboration and value creation.

This comment aligns with what Kuo and Wium (2013) described, that in construction there are always misunderstanding of what constitutes a constructible design. Mainly because we rarely have cross-functional teams that are fully embedded, thus, early approach such as CC would require flexible team to accept opinions from other parties as well as understand how to build and construct it together. Consequently, this requires sufficient collaboration and knowledge sharing among parties at conceptual stages. Accordingly, CC as gathered from this exploration can simply be described as a process that incentivise all participants (upstream and downstream) around the wider scheme budget to have a sense of ownership, and influence behaviours to achieve desired cost outcomes. This definition acknowledged the social interactions of community to mean project performers i.e., designers, constructors, QSs, supply chain and the client all working together towards a mutual goal and shared understanding.

5.4 Constraints to 'Costing Collaboratively' (CC)

There are several factors preventing stakeholders to collaborate over costing in practice, as identified in the literature. These include poor planning and communication, inconsistency in costing approach, client's erratic decisions in design, and lack of integration among others (Hastak, 1998; Kern & Formoso, 2004; Elfving *et al.,* 2005; Dallas, 2006; Flyvbjerg, 2008; Ashworth, 2010; Hanid *et al.,* 2011). Nonetheless, this study discovered other constraints that also affects CW and costing practices. Figure 5-2 indicates some of the barriers found within the UK construction industry as discovered from the interview analysis. These barriers are discussed in relation to previous studies in the section below:

Poor Erroneous Assumptions & Orientation

The study finding revealed that activities that led to the budget setting & development i.e., cost planning, and cost estimation in construction are based on probable cost of past projects that often inherit wasteful elements. A Senior QS explained this saying, although they sometimes received input from contractors during cost planning, but further confirmed that these activities are inconsistent implying that:

> *''This is where I think we failed to progress in this process, as we get our work information basically drawings and the scope next to that and then we simply price it..., As such, there is simply no room for working together to understand the cost complexities or deliberate over it''* **[SQs01].**

Another similar response from one of the respondent observed saying:

> *''It's worth noting that this process is totally driven by client's interest i.e., much focus on price and not necessarily concerned with formulating teams to determine the accuracy of cost or any optimum solution in the process''.* **[MC02].**

This confirms what Flyvbjerg (2008) and Elfving *et al.,* (2005) described that costing is subsumed with erroneous assumptions and normally carried out under pressure, cost consultants protect their role through 'secrecy' with budgets fixed even when too little information is available at the outset. This creates 'guess-work' and inconsistent decisions in the process, which is often carried out through risk contingency pot. This continued to conceal waste rather than reveal it in the process.

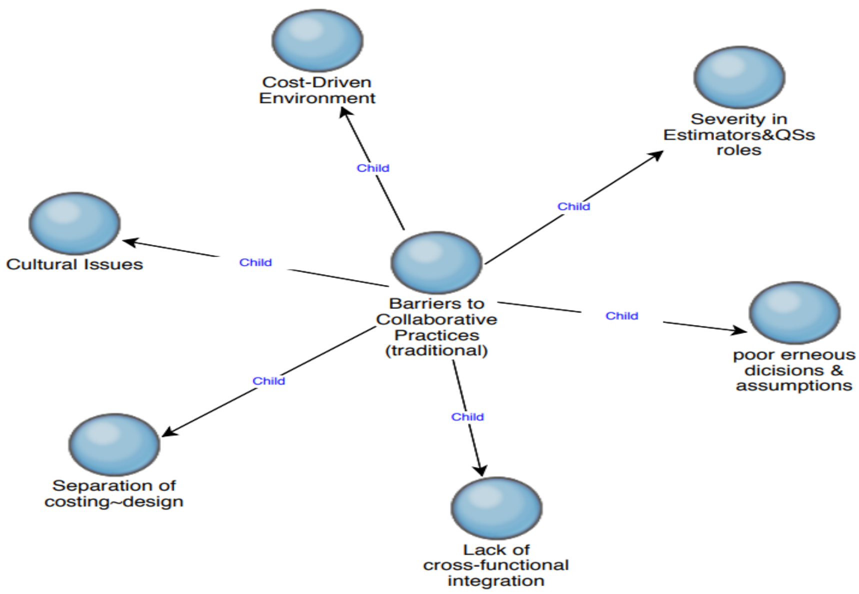


Figure 5-2 : Constraints & Barriers to Collaboration & Costing Approach

Separation of Costing & Design Activities

Majority of the respondents agreed that cost estimates are usually developed in project either by cost consultants (QSs) alone or by designers in isolation without much information sharing and feedback. One of the interview respondents captured this:

> *"Designs are usually developed before detailed estimates are available; this results into large cost expansions i.e., design-estimate-redesign cycle. In addition, the overall strategy of establishing the scheme budget, its buildability and other project constraints are carried out un-collaboratively".* **[CD02].**

This means that stakeholders responsible for costing and design functions are not assembled early enough i.e., (QSs, designers, estimators) and when they are involved - they work in isolation. This confirmed with what (Zimina *et al.,* 2012) explained, that the current costing practice needs collaborative understanding, given that the prevailing approach is based on the RIBA plan of work, which is discrete, sequential and favours competitive tendering. These drive stakeholders within a narrow view that consider costing and design activities as separate functions. The implication of this is that it restrains value flow within the process, and prevent stakeholders providing constructive feedbacks during costing and design exercise, inevitably; this transfers waste into production processes (Kern & Formoso, 2004).

Lack of Cross-functional Integration

The interview findings revealed that traditionally, commercial actors and contractors are not involved early (pre-contractual stages) during costing and design development. Senior QS observed that:

> *''A lot of the times QSs and contractors are brought into the process late and at different times, where everyone wants to defend their turfs with high tension going on, consequently impairing their inputs in the process''* **[SQs02].**

This statement indicates the lack of upfront investment and early team integration, which is needed for stakeholders to collaborate over costing. This means that the accustomed partial integration is not effective, especially when one considers the significance of commercial and supply chain groups during these interactions. Laryea & Watermeyer, 2016) reported that this early integration is essential, because it stimulates innovation and provide the opportunity to understand risk items through open interactions and alternative problem solving techniques. Arguably, with this arrangement in place, the expensive iterative cycle of ‘design-estimate-redesign’ could even be minimize, steering designs to the expected cost with fewer changes later.

However, because the norm still viewed costing and design activities separately (Kern & Formoso, 2004), this often led to a divorce between client organization and the contracting parties with both focusing on profit ahead of the overall project benefit, while architects continue to ignore production conditions in their designs (Seymour and Rooke, 2000).

Again, this shows that, the lack of collaboration and interaction among stakeholders is a general issue that consequently would create commercial friction in practice, where the attitude of mining for profit from contracting parties persevere (Pasquire *et al.,* 2015). One of the respondent interviewed observed saying that:

> *’’This lack of upfront investment has a customary gap with lots of waste starting with incomplete estimate, inaccurate designs, and disruptions caused by design changes with massive variations transferred into production process’’* **[LP03].**

This further illustrates the need for the industry to adopt integrated models to combat issues during early costing and design development to enhance value creation. Forgues and Koskela (2009) added that CW in this manner would help mitigate the socio-cognitive barriers and improve integrated design team performances. Equally, this could create opportunities for commercial actors to be more deeply included in collaborative working approaches thus removing a major barrier to the performance improvements demanded in successive UK Government reports.

Cultural Resistance

Although, this has been identified in previous studies with regards to radical change and industry modernization (Common *et al.,* 2000; Alarcon *et al.,* 2002; Johansen and Porter, 2003; Farmer, 2016). Unsurprisingly, many of the respondents in this study also acknowledged that ‘resistance to change’ and ‘cultural attitudes’ are part of the main issues to collaborative practices in the UK construction industry. These constraints are prevalent in both project and organizational environments. Some of the respondents observed saying that:

> *’’I think people are busy and so entrench in what they’ve always been doing, so no one has time to think about doing something else’’.* **[SQs03].**

> *''Changing the way people work is difficult, in this environment everyone is trying to squeeze each other for profit/gain. Theoretically, we can agree on a profit margins but practically it's in our nature thinking on how to gain a little advantage''.* **[MC02,].**
> *''It is just a historical thing I think; people are just comfortable and would like to stick to what has been working before''* **[SQs04].**

The above statements paint a picture on how deep-seated cultural resistance issues are within the UK construction industry and the implication to industry reforms, hence the need to improve relational and collaborative cultures in practice. This might not be a new finding but still shows how deep-seated the cultural issues are which continued to impede CW in practice. More so, Sarhan and Fox (2013) opined that these attitudinal behaviours are the bottleneck to radical transformation in the UK construction industry.

Cost-Driven Environment

As discussed early in this study, target costing and risk management approach are not transparent, which continues to reveal varying perspectives from both client and the contracting parties. One of the main contractor lamented on this saying:

> *"In every 5% increase we lose 20% of our cost. In a TC of £120m, the client gets 80% of the cost spend, which means if we spend over we get punish heavily and if we spend under, we get little compensation. The contractor further adds that we share the pain but the gain isn't equal, I would say somewhat 80-20 in favour of the client. On the current scheme, we've bid and negotiate on the TC, but the client later decides to cut 10% from the TC, after 3 months of negotiation we later agreed to proceed - but we know deep down that were going to find ways to claim the 10% back".* **[MC02].**

Evidently, this typifies why negative behaviour persist, which stems from the prevailing risk-averse environment and external influences (regulators, stakeholders etc.) in practice. As revealed from the participants, these influences exert pressure on project teams, which eventually spread across boundaries inciting all sort of opportunistic behaviours right from the start. This also confirms the old clichés in construction (risks are transferred to those who can best manage it), yet without proper incentives to spur innovation or support collaborative working relationships. Hence, the chances of projects finishing under target remain slender. In the same way, this indicates how narrow collaborative culture is, as the environment is incessantly driven by price. Moreover, collaborative relationships is still overwhelm by certain contractual clauses, which further advance legality concerns among contractors and supply chain groups. Hence, the relentless opportunistic behaviours in practice.

Inflexible Roles of Consultants (QSs) & Estimators

Another issue discovered from the interviewees associated with costing, which has undue influence on collaboration is the role played by estimators/QSs during pre-contract cost planning and management. The roles of these professionals are perceived to be prescriptive and rigid, often confine to what they're told to do. Some of the respondents lamented on this saying:

> *"During tender process, QSs point of view are generally to read, understand and confirm to the brief, this is also similar in their costing approach, as affirming on what they're being told to do rather than challenging it or advising on what's the best valuable option."* **[CD03]. "***The issue is that they are not seating closely in the project team to influence design, and they are not involved as they should be during conceptual stages thus, they wouldn't have any details to comment on"* **[PM03].**

This epitomise how QSs are employed, largely to inform intelligent clients, thus, reluctant to challenge their prescriptive roles, and this limits their input in collaborative relationships. More so, because consultants generally are assessed based on how they are utilised in projects instead of being valued according to their performance. Hence, their disinterested view in collaboration. This also feeds into how clients perceived the role of QSs, where they traditionally engage them to settle commercial disputes. Regardless of the environment, they still conform to the conventional protocols, custom and practice, maximising their positions and fees. Arguably, the upfront investment (platform for collaborative dialogue with clients and other stakeholders) could equip them with the necessary skill to be able to have that conversation prior to contract formulation. Perhaps, even enable these groups to become more constructive in collaborative practices.

5.5 Drivers & Enablers for Collaboration in Construction

5.5.1 Clients Leadership

The interview findings showed that client's leadership pushes some key factors that could support collaborative working relationships and project team performance. This influence could also stimulate other construction practitioners to support innovation in the construction industry. For instance, some of the respondents interviewed stated that:

> *''Why collaboration and its adoption keep stalling in the industry, is because nobody wants to trust or blink first, it certainly need momentous effort from clients putting heads together to get high-level support''* **[SQs01].** *''This will require identifying who can change, and this need strong leadership from clients, stakeholders and eventually it will get to the ones that are resisting the change, it also need transparency, right ethical behaviours, understanding each other's ambition to align interests – and certainly client's needs to lead this ambition.''* **[LP01].**

This means that clients can intervene and support collaborative practices, specifically when it comes down to commercial relationships, which seems to be lacking within the construction landscape. This has the potential to allow cross-functional interactions and better understanding of project value and optimization across boundaries. Although, it can be argued that clients themselves are hesitant when it comes to collaborative practices because of the sector dynamics (short-term focus). Thus, owners are reluctant to commit, they often opt to stick with what has worked before. However, their intervention could transform commercial thinking; potentially decrease the transactional characteristics that surrounds project delivery approach (Farmer, 2016).

5.5.2 Early Contractor Involvement (ECI)

The interview analyzed revealed that engaging contractors early not only would improve collaboration, but also could enhance early costing interactions.

> *''Involving contractor early helps us to sit closely to influence design and its changes''* **[CD02].** *''With teams integrated early, man-marking jobs could be reduced, eliminating massive amount of wastes in our processes''* **[LP02].**

This indicates that early collaboration has the capacity to strengthen not only conceptual processes, but also the roles played by commercial actors. However, this need integrated team-involving client, contractor, designers, and supply chain group away from the customary approach, where it involves several teams each having their own estimators/QSs validating and replicating similar tasks. Establishing this arrangement could provide the platform for QSs to relate with contractors and other stakeholders thus, developed cost plans and estimates jointly (Rahman and Alhassan, 2012). Whilst this exploit is not new in collaborative setting, it simply showed that when the right people are assembled early, the integrated team would be able to improve efficiency, accordingly, eliminate unnecessary waste during pre-contract stages. However, this approach rarely happens in practice, as evidently QSs are still contracted traditionally within the prevailing model. In fact, most stakeholders are brought in at different times, and this continued to affect how parties adapt in collaborative practices.

5.5.3 Shared Risk/Reward & Relational Contracting

Most of the respondents interviewed observed that the use of what is best described, as 'relational contract' to inspire early collaboration in practice remain substantial. This arrangement focus on developing long-term relationships among the project parties. More importantly here, consultants such as QSs needs to be involved with opportunity to work closely with the client and contractors over time. Some of the respondents lamented that:

> *''The arrangement here is not created through traditional or D&B, its relational and it facilitate early collaboration and involvement of contractor & consultants''* **[LP03].** '*An example of it would be the procure 21, which is very much collaborative, QSs work as cost managers, the contractor is very much involve early, as well as the architects developing an indicative high level design, they work together to develop the cost plans for the project. Once concept designs and elemental cost estimates are prepared, contractor is brought into the design for cost development process to assist in value engineering of design and production drawings''* **[CD01].**

Again, this reiterates why early collaboration of project stakeholders is important. This also characterizes the essence of 'costing collaboratively' where trade contractor looks 'over the shoulder' of the specialist designer to provide concurrent cost and buildability advice as the work is designed, detailed and finalised. In fact, this is where the idea of CC needs to be reinforced, allowing cross-functional integration (including QSs) to link with the value stream. Potentially, this arrangement would also support to maintain long-term relationship, ensuring repeated workload and efficiency, but consequently, this would mean less work for QSs and construction lawyers who continue to influence contractual arrangements (Pasquire *et al.,* 2015).

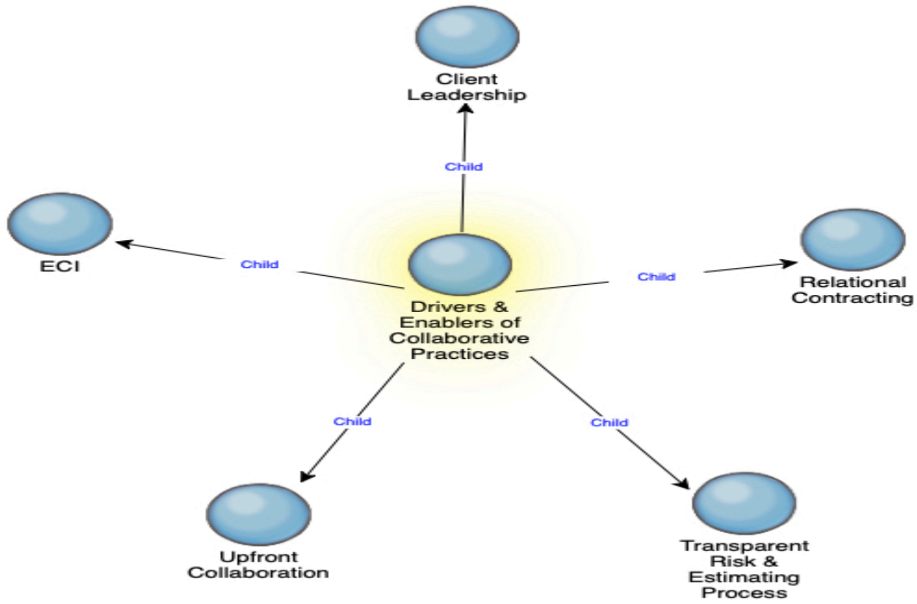


Figure 5-3: Drivers & Enablers for Collaboration in Practices

Furthermore, some of the participants interviewed are of the view that adopting pain-share/gain-share mechanism could also be one of the better ways to break down the siloed boundaries during early costing activities, to achieve true collaboration in the process. Although, the approach focuses more on building long-term relationships, open-book estimating and shared objectives. The respondents connoted on this saying:

> ‘*’We use the pain/gain strategy right from the start with the key teams involved, it is an open practice and it reinforces target costing approach’’* **[CD01].** *‘’ What happen traditionally is that bill of quantities is used to measure things and transfer risk to other parties, in this system, we measure and have discussion on how we’re going to do the work and how to build it’’* **[LP01].**

The importance of transparency and shared accountability cannot be overemphasized here. This also marched with Sunil *et al.,* (2011) that emphasized on trust and shared accountability as the key components required to reinforce CW. This would also enhance the developmental process of costing and design, where the business case is largely validated by the team to achieve the client end-goal (Ballard, 2011).

5.5.4 Upfront Investment/Collaboration

Collaborating over costing has been described in this study as not only the approach to develop project costs timely, but also the opportunity to understand flow efficiency and value creation during costing interactions, which is highly lacking in the prevailing model. One of the respondent interviewed agreed that industry wide collaboration in this manner would be beneficial to clients and the practitioners in involved. The participant further connoted that:

> *'' We sometimes collaborate with stakeholders during costing to validate our design and costs targets, in doing that we build optimal relationships and we understand each other's ambitions and purposes''* **[PM02].**

Again, this showed that to be able to participate or engage in cross-functional integration, all stakeholders including those that are not signatory to the contracts (QSs, consultants, lawyers etc.) must interact and respect each other's ambition – thus, work toward a common goal. Nonetheless, owners need to lead this ambition.

5.6 Collaboration & Commercial Practices in the UK Construction

This section of the analysis focused on understanding how commercial practices affect collaborative working. This brought a close examination of practices carried out by traditional cost consultants (QSs), their norms and assumptions in construction as well as its implications in practice. Accordingly, the analysis revealed factors that is supporting the status quo.

5.6.1 Commercial Practices & Collaborative Working

Safeguarding/Custom and Practice

The study revealed that cost consultants (QSs) are used traditionally in the construction industry, especially within the prevailing system to meet either client or contractors demands. For instance, some of the respondents stated that:

> *"We have 2QS's in the system, one looks after the contractor's pocket and the other look after the client's wallet"* **[MC01]** *"Unsurprisingly their roles and functions are also split and they don't work harmoniously"* **[SQs05].**

This is an example that demonstrates how highly under-utilized QSs are and their perceptions in practice. Although, this could be contrary in a collaborative system, where the onus is to encourage these professionals to work as a team, supporting end-to-end process, and synchronize their activities. The ethical implication with this fragmented arrangement is that, both parties are trying to gain advantage over one another to make money. It is worth nothing that this whole scenario does not rest squarely on QSs practitioners, but also on clients and the influence of transactional cost economy (TCE), which has undue influence on CW increasing commercial pressure and stifling innovation (Sarhan, 2018).

Another respondent stated that:

> ''*Yes we know clients & contractors are slow to engage in collaboration, but QSs themselves see their primary role to be down the line when the bulk of the design comes up, i.e.,' after- the-fact-estimating' so even if they're engage in collaborative practice, they might struggle to make impact''* **[CD06].**

This indicates two implications where firstly clients presumed QSs are inferior to be part of the collaborative team hence – they continued to engage them traditionally (outside the core production team). Secondly, QSs and equally the profession by nature stick with this arrangement in other words preferred the 'survivalist' mentality. For instance, during tender process, the QSs point of view are generally to read, understand and confirm the brief driving, thus, they affirm rather than contest for best value options. Evidently, these are inspired by 'institutional' factors and the corporate environment in construction, which continues to encourage transactional characteristics and safeguarding practices (Sarhan, 2018).

5.6.2 Vested Interest on Professional Roles (QSs, lawyers, consultants etc.)

The interview analysis discovered that 'vested interest' is a prevalent norm in practice and common amongst PQS and CQS, especially on activities that relates to costing and risk management in construction. This is standing well as a barrier to commercial actors, discouraging efforts to collaborate in projects. One of the respondents lamented on this saying that:

> "*There is massive issue of trust & transparency among the two streams because of QSs presumptions and self-interest, it's a huge barrier, as everyone is trying to protect their own parent companies even at the expense of the team and the project''* **[CD06].**

Previous studies have identified that this mentality emerged in construction because of strong absence of relational norms and fragmentation (Pasquire *et al.,* 2015). Accordingly, this offers little incentive for QSs to collaborate in practice, instead it harbors and entrench wastefulness in various processes across boundaries through opportunism, unnecessary premiums, claims and disputes. The manifestation of this indicates a strain in commercial practices and hence, the need to discard these and support industry-wide collaboration.

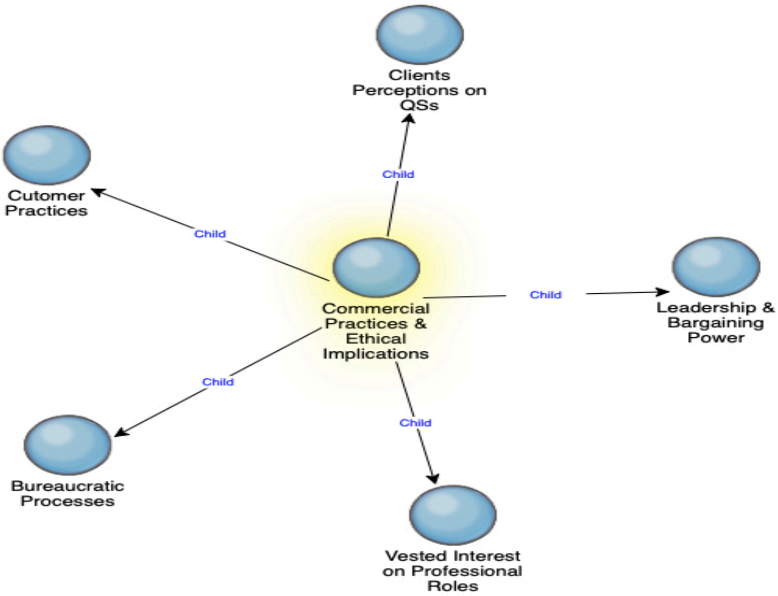


Figure 5-4 Commercial Practices & Implications on CW

5.6.3 Clients Perceptions of QSs

As the study revealed earlier, cost adviser (QSs) roles/competencies are generally underutilized and used traditionally where its suites clients and employers. Thus, the more this situation continues, the more it hinders commercial actors from participating in collaborative practices. More so, because, clients perceives that the roles of QSs are to settle commercial friction with the contracting parties, which seems to be the challenge in construction. Some of the respondents observed saying:

> *"Traditionally, where clients decide to buy designs, multiple number of QSs are engage to fight battles with contractors, and these QSs comes in with different objectives and agenda into the project"* **[MC02].**

Evidently, this means that client advisers would have different interest and agenda going into a project, and when clients decides to buy the design, they pay exorbitant amount to these professionals who cannot guarantee the project outcomes, and part of their roles and expectation is to get more people (QSs) for safeguarding purposes. Another respondent observed saying:

> *"After we're employed by the client, within the early days we get more pressure usually within 6 months to get in more people, and from there our objectives and agenda becomes different with the overall project goal"* **[SQs04].**

This indicates how clients view QSs in construction, which arguably typifies their behaviours when it comes to CW in construction. Indeed, this mentality detaches QSs from collaboration in practice (Mbachu, 2009). Possibly, it could also be because they're not part of the core production team and link with the value stream in project, but instead confined to service-based roles or subduing commercial adversaries between clients and contracting parties. Additionally, it could also be the reason why QSs are reluctant to take risks in projects, where they need to be assessed based on their collective performance, but rather prefers to be paid on the cost-plus-fee basis (Frei, 2010). As customarily, these consultants are generally assessed based on how they are utilised in projects rather than valued based on their performance. Hence, their disinterested views in collaboration.

5.6.4 Leadership and Bargaining Power amongst QSs

The study findings revealed that leadership and bargaining power is still an issue associated with QSs and is still lingering within the commercial world, which is also serving as a barrier to CW. For instance, one of the respondents stated that:

> *"QSs often sit on the cost and would not share information because for them knowledge is power"* **[SQs05].**

This corresponds with the finding of Fellow *et al.,* (2003) which reported that QSs possess power by the nature of their position in client/contractor organizations and exercise it as leadership. The authors cautioned that, QSs deploys this as mechanisms to dominate and control via surveillance (routinization of procedures, supervision etc.), activities that are designed to control the behaviour of members of an organization. The implication is that; these are formalise in practice via contract mechanisms or employed through negotiations in pursuit of self-interest. Obviously, this means that there is apparent lack of trust and the mentality to collaborative between QSs and other stakeholders. As most often, QSs do not necessarily optimise the end-to-end project process, for instance during costing development they still encourage clients to include blanket costs as contingencies in their budgets, which they are often reluctant to share the cost information with their counterparts.

5.6.5 Bureaucratic Processes & Protocols

The study earlier mentioned 'institutional' factors; and how it affects CW with undue influence on commercial practices (see chapter two). Some of the respondents also shared this view. When the researcher asked why this is happening? They lamented saying:

> *'Everything we do is determine to be success or failure by the people outside the business 'indirect influence' (stakeholders, regulators etc.). So, these regulators who work in the head office persist on these bureaucratic reports and protocols',*

> **[SQs06]** *'We manage risk register to the client and it takes more than a week to populate it with lots of details and box ticking that are not being look at in the end or add value to production activities'* **[MC02].**

This example revealed how some of these commercial activities affects CW, through bureaucratic protocols and 'indirect influence'. This is hindering collaboration because of the protocols and procedures put in place for validation, man-marking. These are usually carried out by QSs to satisfy clients' needs through bureaucratic procedures at the expense of production value.

Table 5-5: Payment Disparity among Practitioners within the Prevailing System

Case Study Example of £100m Infrastructure Capital Project in the UK: QSs and Project teams with their Costs Fees			
Professional on Production	Average fees Annually	Non-Production Professionals	Average fees Annually
1x Main Contractor	£50,000.00	Client QSs x5	£58,500.00
1x Architect/Designer	£40,000.00	Contractor's QSs x10	£50,000.00
Main Subcontractor	£55,000.00	Sub-contactor's QSs (1x35 =35)	£50,000.00
2 x Project Managers (1 x client; 1x contractor)	£114,000.00	Total = 50 QSs	
2x Engineers	£110,000.00		
	£369,000.00 p/a		£2.6m p/a

Another point related to this, is the excessive number of QSs/consultants deployed on either commercial assurance purpose or managing supply chain contracts. The main contractor attested to this saying: *'on our current project we've got 10 QSs apportioned to the contractor, 8 from the client and we have 35 sub-contractors who each have a QS all working differently but on the same thing, either commercial assurance or governance'* **[MC02].**

This is prevalent in practice, because traditionally clients deploy their QSs to protect their interests, same goes to the contractors who make money through claims, valuations, etc., coupled with the fact that there is lack of trust & shared understanding among the two streams. Sadly, this situation still prevails in practice; however, efforts to support collaborative working will continue to diminish as revealed in table 5-5.

5.7 Perception of CC from QSs

After observing some of the challenges in commercial practices and the implications to CW. This question was asked to investigate the interviewee's (QSs) perceptions of what CC means. Some of the respondents contributed saying 'it's about adding value not simply turning up to count, keep or record score', 'In an efficient system these redundant roles would be gone because they would be simplified massively' **[SQs01, SQs03]**. Respondent **CD05**, added saying 'I think collaboration particularly for QSs would mean the ability to establish price certainty because of the repeated working relationships'. Similarly, **PM04** asserted that 'collaboration in this regard would change commercial behaviors towards value-driven that can be link with a larger team, agreeing targets and margins against their discrete functions'.

Other respondents lamented on this saying: 'collaboration generally would offer more scope and different perceptions to risk allocation and management to QSs in particular the consultants', **[LP03]** 'the technical ability of assemble all the information that goes into establishing what target cost is', **[MC01]** 'understanding the intricacies in design, construction techniques, methods of team-working'**, [CD06].**

These assertions suggest that 'QSs have commercial skill sets that is quite relevant even in collaborative arrangements. However, as earlier mentioned they need to optimize their functions and support project teams. For instance, in manufacturing industry planners are not needed as much because everything is pull through the system i.e. last planner system, target value delivery (Ballard, 2008). Therefore, drawing from these responses, this point to the fact that CC for QSs could mean *value creation*, *waste minimization*, and *providing cost certainty*. However, this will further require knowledge sharing and better understanding of perceptions to risk management approach from QSs in their traditional functions to excel in collaborative programmes.

Furthermore, the respondents interviewed lamented that commercial actors could transform in collaborative arrangements if professionals obligated with these roles could exhibit the right competencies and behaviours that would contribute to the overall success of project and minimize the tension in construction environment. Some of their responses are below:

> *''I think establishing social skills to enable conversations at the front-end could improve commercial team's ability to collaborate and be more constructive i.e.,*

> *looking at the end-to-end process not the fragmented parts''* **[LP05].** *'Another competency would be to rotate their roles engaging them in production related activities, to have a close feel of how things are put together'* **[CD04].**

This implies that exhibiting right behaviours would be a valuable competency that could revitalize QSs and their commercial practices in collaborative environment. Although, their commercial drive should not be on cost only, but also to improve the social behaviours, interactions and shared understanding among stakeholders

5.8 Discussions on Costing Collaboratively & Commercial Practices in the UK Construction Industry

Majority of the respondents felt that CW offers significant benefits in construction. However, not fully applying the core attributes especially in the current costing approach means maximum benefit would not be realised in practice. Exploring the concept of collaboration and 'costing collaboratively' as shown in Figure 5-3 revealed how partially the process is understood in practice. This is even though previous studies (Sunil *et al.,* 2011; Hanid *et al.,* 2014; Kuo and Wium, 2013; Marchesan and Formoso, 2001) have stressed on the significance of collaboration for cost management practice. Whilst achieving CW seems essential in practice, the study also discovered that the current costing approach does not overtly considers commercial and supply chain groups during conceptual planning either in traditional or in multidisciplinary settings.

For instance, a main contractor interviewed on **MC02** stated that *'we don't involve our strategic suppliers (tier-2) when we're building these costs; we design and give them to quote'.* This can equally be interpreted as cost negotiation that dominates the current practice and a challenge to CC. Besides, this arrangement (cost negotiation), which is supposedly referred to as 'collaborative costing' completely lacks trust, open dialogue, shared understanding and the wider sense of togetherness, instead it encourage the habit of 'mining for profit' from the contracting parties (Pasquire *et al.,* 2015).

Invariably, the current practice continued to provide one-way streak for clients who negotiate or request for input when it suits them but thoroughly lack openness and interactions in the process. Unsurprisingly, these views are inspired by 'institutional' factors (Sarhan, 2018), which seems to be compounded by the issues of fragmentation, cultural resistance and the poor approach in costing practices.

In addition, the core attributes that were found to support CW are missing in the current costing practice. The most apparent is the absence of dialogic conversation when

establishing client's costs and the lack of cross-functional integration to explore cost and design alternatives. For instance, an interviewee stated that *''we build our projects cost mostly reliant on the market prices and sometimes that becomes the amount to spend on the overall scheme''* **[CD05].**
According to (Simonson, 2016), the essence of these dialogic conversations when establishing the target cost is to determine the degree of certainty on the overall costs for owners to ensure sufficient funds are available to finish the project, and to equally assist in making informed cost-benefit analysis before construction commence. It can be argued that if these dialogic conversations were not shared and widely understood, the chances of attaining cost certainty by QSs or contractors cost estimation would be slim, as the overall process still rely on excessive contingencies. Indeed, the current approach needs a strategy that best aligns the interest of all stakeholders involved, including commercial & SC groups to inspire productivity, innovation, and encourage value addition beyond the least cost approach. (Zimina *et al.,* 2012).

Factors that inhibit 'costing collaboratively' and encourage commercial behaviours were found to be the prevailing construction model, 'institutional' system, rigidity in estimators/QSs roles, client's presumptions of cost adviser's roles, deep-seated cultural resistance and bureaucratic roles among others. The lack of cross-functional integration is evident in costing practice as revealed from the study. For instance, during the interview, one of the respondents was asked; *''how do you think the prevailing system affect collaborative practice and cost management practice?''* the response is *''now more than ever, there is a huge divorce between costing and design activities and away from production''* **[SQs, 03].** This indicates poor understanding of 'collaborative production' (as discussed in chapter two), which is dominated by the functional approach (activity-to-activity) thinking, as seen in costing and design process. Thus, this shows that when the focus of project delivery is derail from managing efficiency, process flow and value in pursuit of cost reduction - the entire collaborative practice would collapse (Conte *at al.,* 1998).
Arguably, the prevailing construction system is encouraging the much focus on sharp cost reduction than achieving flow and value in practice. As seen from the study findings, inexperience clients often do not understand QSs value in practice; hence, this view does not encourage commercial actors to support collaborative efforts in construction. It is also clear that most of these professionals (designers, estimators, cost consultants QSs etc.) on

commercial functions are often assessed based on their organisational interests and profits instead of performances or their inputs in projects. Arguably, this arrangement will continue to encourage professional consultants to not take on risks or contribute in optimising value, but adamant to be paid on their accustomed cost-plus-fee basis (Eriksson and Laan, 2007). Consequently, this view is serving as a direct barrier to collaborative practices and the illustration where commercial imperative lie, hence, the custom and safeguarding practices.

Nonetheless, the study has found some drivers and enablers that would support CC, which perhaps could also be instrumental in aligning commercial interests in the industry. Some of these factors include early stakeholder's integration/upfront investment, which would enable certainty and transparency in costing process, thus, a platform for collaboration (Rahman and Alhassan, 2012). Others are client leadership, transparent risk and estimating strategies and relational contracting. Consequently, these might support information and knowledge sharing, linking costing and design development activities with the business objectives where clients get what they need within their affordability and service providers earn more when they assist in enhancing value in projects (Ballard, 2011; Kuo and Wium 2013). Indeed, these continued to show why commercial practices require significant change for it to allow the much-desired collaborative working to flourish in the UK construction industry.

5.9 Summary

The main purpose of the data collection in this chapter was to address objective (3) of this research, which is to understand and defined the idea of 'costing collaboratively' CC. The analysis further established a clear distinction between collaboration and cost negotiation. Similarly, the study found several attributes that shed light on the current practice and the idea of CC. These include *target costing*, *integrated value engineering* and *optioneering process*. Therefore, from this investigation CC is seen as an approach that engaged stakeholders (upstream and downstream) around wider scheme budgets creating a sense of ownership, driving positive behaviours to achieve desired cost outcomes. Accordingly, the chapter presents findings on the constituents of collaboration and its meaning in practice, the perceptions of CC from QSs, and the divergent views on collaboration and cost negotiation amongst the respondents interviewed in the UK construction industry. Furthermore, the chapter identified factors affecting CW practices, which also revealed the challenges in the current costing approach, commercial practices and implications facing professionals, culture, organisations, and the wider industry. In addition, these explorations also revealed factors affecting CW within the UK construction industry. These include the prevailing model, institutional arrangements, underlying economy, corporate environment, professionalism and drivers among others. More so, the chapter revealed some drivers and enablers for commercial alignment in supporting the culture of collaboration in the UK construction sector. Among others, these include client & stakeholder's interventions; cross-functional integration, relational contracting; social competencies and costing collaboratively. The absence of these factors continued to show poor understanding of efficient 'flow' and 'value' amongst stakeholders in practice. The next chapter will present and discuss the findings from the multiple case studies.

CHAPTER 6 MULTIPLE CASE STUDY DATA ANALYSIS, CROSS-CASE COMPARISON AND DISCUSSIONS

6.1 Introduction

The previous chapter (chapter five) presented and discussed the findings from the exploratory study conducted in stage 2. This chapter focuses on analysing the three multiple case studies carried out across rail and water infrastructure companies. The cases explored how costing activities are carried out, the extent of collaboration during early costing and design activities, factors affecting commercial relationships in collaborative programmes, and factors enabling collaboration within the UK construction industry.

6.2 Overview of the Multiple Case Studies

The rationale for selecting multiple case studies has been discussed in the methodology chapter. This study conducted three case study investigations; two of the cases were from water infrastructural companies and one from a highway project. Accordingly, information such as demographics and case descriptions was gathered. The purpose of this was to enable the researcher to understand their CC approach and facilitate discussion about it from a real-life context. Consequently, data evidence was collected from the following sources: semi-structured interviews, and documents relating to costing and design activities. These investigations were carried out in order to have a clear picture of how stakeholders conduct costing activities across the UK infrastructure sectors, using the TVD model as a guiding lens.

6.3 Case Study Project Alpha (CSPA): Anglian Water

6.3.1 Description of Case Study Project Alpha

Anglian Water (AW) is based in the East of England, in the city of Peterborough. The company deals with infrastructure and non-infrastructure projects, and specialises in the design and construction of water treatment centres, which serves more than six million people in the East of England region. Currently, they are involved in an alliance project called AMP6, worth circa £1.2billion, which started in April 2015 and is expected to finish in March 2020. The AMP6 project consists of an integrated team of organisations, consultants, and contractors, working to deliver more than half of the Anglian Water (AW) capital investment programme. The project alliance group includes seven delivery partners: Balfour Beatty, Barhale, Skanska, Sweco, Mott McDonalds Bentley, AW and MHW. The full description of the project and its attributes is presented in the Table 6-1.

Table 6-1: CSPA Project Description & Attributes

Project Description	**Attributes of CSPA**
Nature of project	Infrastructure & non-infrastructure
Location of project	East England, Peterborough UK
Nature of work	Design and construction of water recycling (wastewater) treatment plants.
Type of client	Public client
Mode of delivery/ supply chain selection	Alliance, framework
Proposed project duration	60 months
Procurement arrangement	Centralized procurement system
Contract sum	£1.2 billion
Process explored	Costing/Design
Contract form	NEC- Contract

The majority of the participants interviewed had strong backgrounds of working in collaborative practice to deliver infrastructural projects. The Alliance-One (project team) was formed to benefit from this experience and help the AW client deliver the infrastructural projects using sustainable and integrated approaches. The researcher conducted this investigation on CSPA over a period of 5 months, exploring the company's approach to early costing and design activities. This also enabled the researcher to also understand their procurement strategy and how supply chain groups (SCG) fits into the enterprise model. Thus, the researcher conducted face-to-face interviews with participants from AW, the project alliance team, and from the SCG members.

6.3.2 Demographic Details of Respondents in CSPA

Table 6-3 illustrates the number of participants interviewed in CSPA. Their work roles were: Alliance director (AD); Commercial Director (CD); Design Manager (DM); Procurement Director (PD); Technical Manager (TM); 2x Estimating Managers (EM); 2x Commercial Managers (CM); and Associate Director (AD). From Table 6-3, it can be seen that the personnel interviewed are members that are directly involved in costing and design activities within the project. This means that the information gathered from these participants is rich. The demographic data shows that most of the respondents interviewed had an average of 9 years' working experience in collaborative projects. At the same time, it shows that they also had over 15 years' experience working within the conventional system.

Table 6-2: Demographic Details of the respondents on CSPA

S/N	Respondent code	Specific role within the alliance	Years of exp. in CP	Years of exp. in construction
1	CSPA AD	Alliance Director	12	25
2	CSPA CD	Commercial Director	7	20
3	CSPA DM	Design Manager	11	15
4	CSPA PD	Procurement Director	10	30
5	CSPA TM	Technical Manager	6	17
6	CSPA EM01	Estimating Manager	3	15
7	CSPA EM02	Estimator	4	16
8	CSPA CM01	Commercial Manager	6	14
9	CSPA CM02	Commercial Manager	8	15
10	CSPA AD	Associate Director	9	20

6.4 Current Costing Practice in CSPA

Data were collected on costing approaches in CSPA, through reviewing related documents (costing and design activities) and conducting semi-structured interviews. All the case study data were then analysed using the thematic coding process in *Nvivo*, which revealed the parent theme called 'current costing approach' (CCA). The CCA theme was discussed under the following sub-themes: (a) target costing and supply chain approach, (b) extent of cross-functional collaboration, (c) drivers, enabling factors for collaboration, (d) commercial practices and challenges affecting collaborative programmes, and (e) support required for commercial actors in multidisciplinary practices. Figure 6-1 illustrates the parent theme and sub-theme elements.

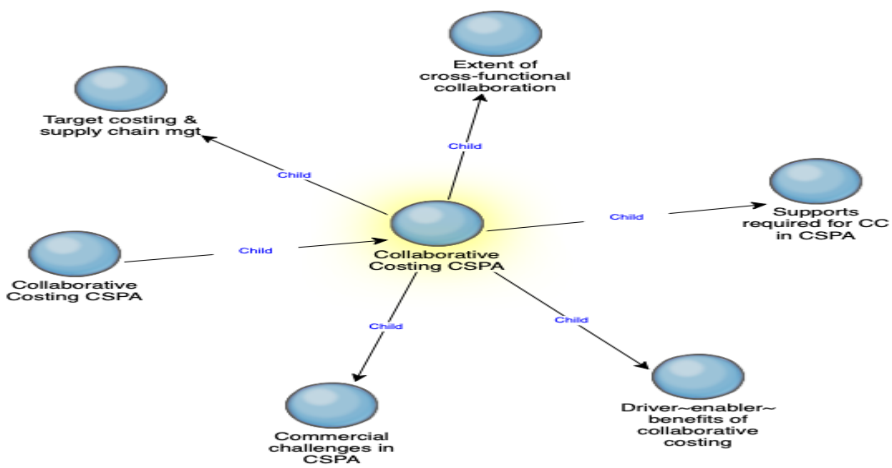


Figure 6-1: Parent Theme Describing Costing Approach & Collaboration in CSPA

6.4.1 Target Costing Approach in CSPA

Developing a TC for a new scheme in AW usually begins with the client team setting initial budgets, based on the outturn cost of previous projects (usually at DM5-6 stages) as illustrated in the figure 6-2. The process usually begins with collation of historical costs data from the previous schemes, where the final cost figures are extrapolated into the client's cost database. This reveals a highline TC, which informs the new financial business plan and other project requirements. The financial business plan is continuously refreshed with historical cost data of 3AMPs (Asset management programmes – 4 years' periods) as the project closes out. Subsequently, the client team assesses all the work at the end of DM5. The scheme costs compiled are then compared with the client cost figure; where the average cost is selected and the alliance team is tasked to value-engineer the cost. Accordingly, the process is centrally coordinated by the client's team called *Asset plus*, with little interaction or input from the alliance team.

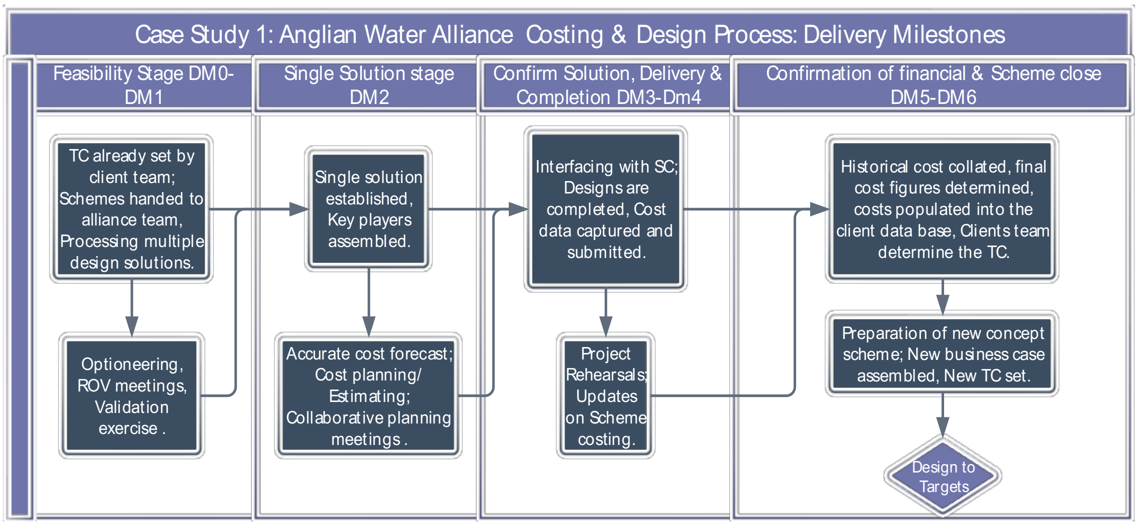


Figure 6-2: Target Costing Approach (A sample of documents analysed).

As illustrated in Figure 6-2, target costing in CSPA is mostly a top-down approach, which does not overtly involved members of the supply chain or commercial groups early enough during these activities; the alliance team is engaged, but only indirectly. This was emphasised by one of the respondents who asserted that:

"TC are set by the client organisation independent of the alliance team. They use the data from the 'cost capture system' (CCS) once the previous scheme costs are established; the final costs are then transferred to the CCS which drives the client database. Our input is indirect here, we've only started involving the tier-2 in the last few months a lot of people are sceptical about it then, but now they're more open.'' **[CSPA, CD].**

Based on the top-down costing approach deployed, the alliance team seems to be struggling, as they complained about some underlying issues associated with commercial and SCG, which infuse tension into the project. Some of the respondents cited the following:

"Insufficient provision of information/details to the alliance team when developing the TC" **[CD],**

"continued struggle with the SCG on pain/gain share structure", **[DM]** *and*

"the waste embedded within the costs taken from previous schemes, which the new TC is based upon." **[TM].**

This top-down approach does demonstrate some features similar to those seen in the TVD model, and some glimpses of collaboration, such as: having an integrated team, a standardised process for TC development, working in a collocated site, and the client appearing to be heavily involved with the alliance team. However, the current approach is still missing some key collaborative attributes and the principles described in the TVD system (Tommelein & Ballard, 2016).

For instance, the TC is often set in isolation from the alliance team and without cross-functional integration or in-depth dialogue with the client to discuss asset worth or market prices. It has also been discovered that, at times, the TC sent to the alliance team is on non-negotiable terms, which can sometimes become the final amount to spend. This means that the alliance team, including the SC and commercial group, often miss the chance and the avenue to discuss *desirability*, *viability* and *feasibility* in the process, or likewise to identify opportunities for innovation – which often require early cross-functional input. Other notable TVD principles that are missing include '*over-the-shoulder' costing* techniques, *set-based design* approach and a *relational contract* that would spur innovation and efficiency in the process. This indicates that the current approach might be customer focused, design centred and somewhat involved cross-functional teams, but it is still driven by price. Arguably, the absence of these principles might be the reason why they are still struggling commercially with some degree of inconsistencies in their costing approach, as lamented by some of the participants. More importantly, the lack of involvement of Tier-3s as well, who mostly play a key role in the delivery of projects, suggests that whatever form of collaboration they are achieving at present does not permeate further down, and is clearly missing some of the core attributes identified in table 3-1. Early collaboration at this stage might be productive, as this could promote dialogue in terms of understanding the complexities surrounding costing, design complexities and the risk management approach (Simonson, 2016).

6.4.2 Supply Chain Approach in CSPA

This study also discovered that there were some collaborative principles that resembled those seen in the TVD system, which were adopted by CSPA during conceptual stages and supported their supply chain groups (SCG). This involved early engagement during the detailed design process, which meant that the alliance team was established as a single entity. This further indicates that all members of the project team mostly ignored their parent company culture and assumed responsibility on the project to create and share the same norm. Additionally, SCG and other tier-2 members in this case were classified as a collaborative working group (CWG), and managed under the framework agreement. This approach improved the team's cohesion, working relationships, and the degree of collaboration. The procurement director stated that: *"Over the last nine years, we decided to switch from backend office procurement system to a central procurement approach with the alliance team, which means we can now aggregate our spending, work more collaboratively with the SCG and optimise their work process.''* **[CSPA, PD].**

This shows a significant progress in their procurement approach, where the alliance team interact with the SCG early during costing and design activities. It can be argued that the approach adopted here could have been favoured by the procurement system in place. The procurement director further explained that: *"we did this so that everyone would understand exactly what they're expected to do, by making sure everyone's interests and goals are aligned using our commercial model''* **[CSPA, PD].** However, this does not sum it all up, as there were some issues with the SCG which, as mentioned earlier, are not overtly integrated in the enterprise model, and they're sceptical about the risk/reward sharing strategy, with the management highlighting some commercial concerns during project delivery.

The study discovered that a centralised procurement system is used in CSPA, which is significant and in line with the company's commercial model. This approach has contributed to some underlying benefits, such as: creating close-team interactions for buildability and constructability reviews, encouraging a collaborative approach during costing and design process, improving trust and shared understanding, and social skills development among all the groups. This has further articulated a more collaborative culture, which is pulling the SCG closer to the team for better relationships and shared understanding. It also instils approaches that improve individual and personal relationships when working together on a project. More importantly, the concept of developing project costs was reported to be understood better by the team, which has improved transparency and visibility in terms of managing risk relative to costing and design activities.

The alliance director commented on the centralised procurement system and stated that: *"The centralised procurement system allows us to have a standardised alliance process, rather than 4-5 different partner processes in terms of dealing with SCG, different payment arrangements/terms and condition. This has now allowed us to put in a long-term framework for the SCG, and our QSs help us to manage these relationships.''* **[CSPA, AD].**

This statement further explains why an integrated system and centralised procurement strategy would be vital in any collaborative arrangement in terms of building cross-functional relationships. It also means that trust and shared understanding can improve greatly, to support collaborative working practices. This is because, the alliance contract alone cannot make the team to collaborate on the project; rather, it is the enterprise model behind this transformation. This suggests that trust, open conversations, dialogues and social developmental skills are instrumental to any form of CW practice. Moreover, the central procurement system is now more of a platform for collaborative practice. Arguably, the issue of short-term focus among commercial and the SCG, where activity-to-activity thinking perseveres could be minimised with this long-term perspective and strategy.

6.4.3 Extent of Cross-functional Collaboration

The research study discovered certain activities that also characterise cross-functional integration in CSPA. This indicates how early key players are involved in collaborative programmes. This transition goes through stages, such as early contractor involvement (ECI), and assembling of project delivery partners and SCG during the costing and design process. Key costing activities in these stages include business case validation, optioneering, risk and value sessions, cost planning and accurate cost forecasting, design rehearsal, contract administration, collaborative planning, and scheme costing. These activities are spread across the gated process called delivery milestones (DM0 – DM6) which runs from the feasibility stage to the scheme close stage, as illustrated in Figure 6-3.

a. Feasibility stage DM0 – DM1

Feasibility is the first stage, which illustrates when the client engages the alliance team for business promotion and cost validation. The main activities here are optioneering and risk & value assessments. The alliance team members here include: the project team leader (PTL), planners (P), designer manager (DM), estimators (E), technical manager (TM), commercial manager (CM), and procurement head (PH). The framework partners consist of a civil and mechanical CWG and other tier-2 members, whilst the client team consists of feasibility engineers and cost consultants. The feasibility stage usually starts with the alliance team confirming the scheme costs for the client, to determine the project delivery route. Optioneering is a key process in this, which involves in-depth discussion and investigation of multiple cost and designs alternatives, which are distilled into a single solution, and linked with the risk and value sessions, to establish the project costs. As mentioned earlier in the study, TC setting is based on a top-down approach; this means that the SCG are involved (but very late) and provide some inputs during the optioneering and preliminary design stages.

However, this still shows that some commercial members are not fully in tune with the delivery model, as their engagement is often late during these activities. When the researcher asked why, the EM (part of the alliance team) stated that: *"Well, our roles are different with members like the QSs in this arrangement, most of them are not involved early, because they're not part of the process – but are involved during forecasting and administering SC contracts at the end of DM2.''* **[CSPA, EM]**

This statement exemplifies some of the constraints discovered in this study's stage 2 exploration regarding commercial actors, which is evident even in the multidisciplinary setting. Members like cost consultants (QSs) are mostly based on the periphery when it comes to CW. Arguably, this might be because of how their roles are designed, which are prescriptive, and at times lacks collaborative nuance, and this is perhaps why the perceptions of these professionals remains traditional.

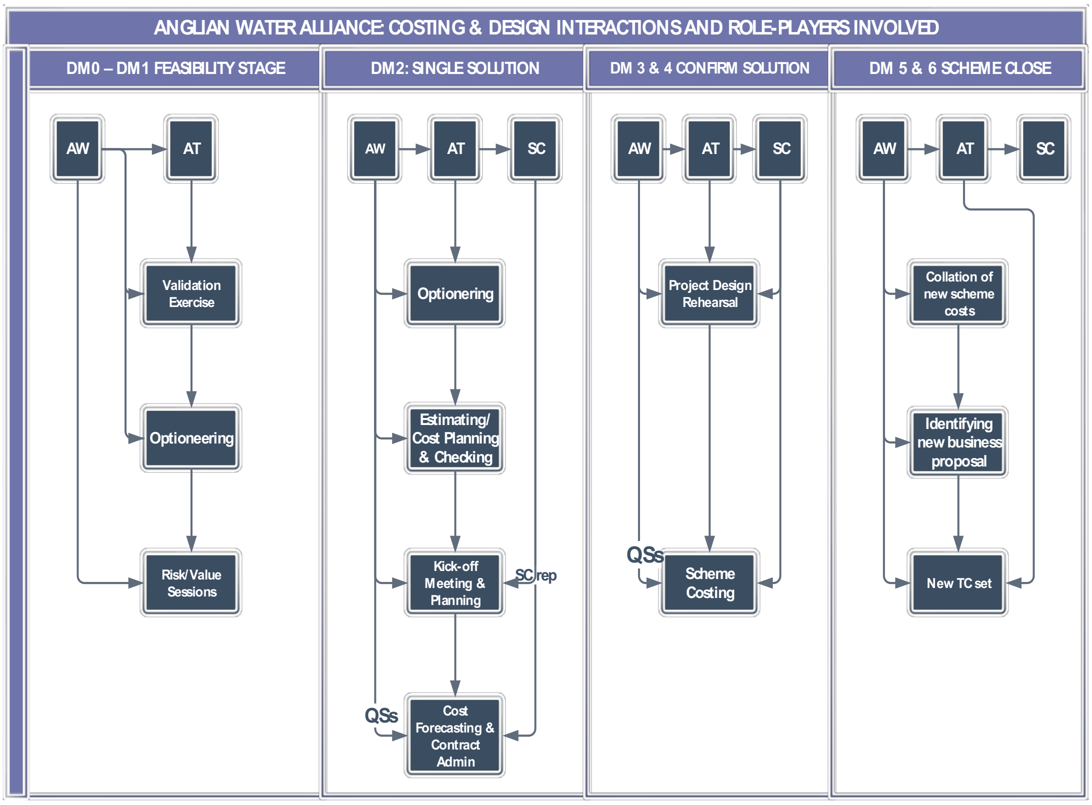


Figure 6-3: Extent of Collaboration/Costing Interaction & Players Involved in CSPA.

b. Single solution stage - DM2

Single solution is the next stage after feasibility, that sees a single solution established by the team. This begins with early engagement of stakeholders and some members of the SCG to determine the ideal solution. However, not all the stakeholders are directly involved in this stage, especially the SCG, as it is a top-down approach. The main cost functions here include estimation, cost planning and checking. The alliance team usually undertakes this, which consists of the client's representative, estimators and at times the SC. Other activities include planning for the stage 2 meeting, which is carried out by the client team and the project alliance team, exploring alternative options. The last activity at this stage is accurate cost forecasting, which is carried out by the CM, estimators and the SCG, putting together the solution costs. It is worth nothing that members of the commercial teams like QSs are not involved in optioneering, but are heavily involved at the end of this stage, assisting with the accurate cost forecast and administering contracts.

c. Confirm solution, Delivery & Completion Stage DM3- DM4

In this stage, designs are completed and ready for construction. This then reveals more SC interfacing and the confirmation of all contracts. This is when the commercial actors effectively take over with the cost reporting, project forecasting, change orders, and contract administration. The key costing activities here include project design rehearsal, which involves designers, PM's, CM's, TM, environmental consultants, SC and estimators. All the relevant stakeholders converge and deliberate over the design in the rehearsal meeting, exploring project constraints. Scheme costing is another key function at this stage that involved estimators, QSs/client rep, and SC working together to confirm with the solution and delivery plan, providing estimates on the scheme costing, reviewing risks strategies and other project constraints, as well as capturing all the costs data ready for the next phase.

d. Confirmation of financial & Scheme-close DM5 - DM6

In this stage, the scheme is confirmed closed and the client team put together a new financial business plan, using the final cost figures that were obtained from the project batches. Similarly, the client team independently uses the historical cost information that is extrapolated into the cost database to develop the new TC. At this stage, a new scheme TC will normally be set and sent to the alliance team, which sets the basis for the next project scheme. Thus, the costing activities here include: formulating new scheme costs (usually carried out internally by the client's team (auditors, cost consultants etc.))and the development of the TC, which is still internal and independent of the alliance team. However, the commercial director clarified this, saying:

"Historically there is not much integration at this stage, as we often involve the SCG indirectly and engage them in DM2 to do the pricing. Now we involve them earlier, so they are party to our solution cost, and we do that collectively. The process in which we set the target and the data are visible and transparent and we are to outperform that.'' **[CSPA, CD].**

The stages above illustrate the extent of cross-functional collaboration during early stages of costing and design activities in CSPA. This further shows some activities and the role-players involved in the process. From the analysis, two levels of collaboration were revealed. First at project level, which goes through the process initiated by the client i.e., on what is allowed in for the FBP to drive the target price. Secondly, the alliance team sets up a target base on a high-level outcome of which they are to achieve the highest performance and specification. The commercial model through the solution cost continuously incentivises the team, to focus on the optimum solution. So principally, the teams are highly integrated, with clear visibility of the ongoing cost solutions, and they jointly reviewed each cost forecast to work-on best before task.

However, this means that collaboration in terms of costing and design activities still needs some improvement, given that the degree of collaboration amongst commercial groups, cost consultants from the client camp, and SCG arrangement are still patchy, and the involvement of these stakeholders is late despite the enterprise model put in place. It can be argued, that the earlier these teams converge to build the scheme cost together, the better their understanding in terms of constraints, scope, solutions, and innovation, with better sense of ownership on the wider budget to influence behaviours hence, to achieve the level of collaboration required. Again, this still explains why certain challenges persists, even within the multidisciplinary environment. Invariably, the level of collaborative relationship between SCG and members of the commercial group is still on the fringes.

6.4.4 Drivers & Enabling Factors for Collaboration in CSPA

The analysis of the interview results revealed some key factors categorised as drivers and enabling factors for CW found in CSPA. Some of these factors are discussed below.

a. Cross-functional Integration

Some of the respondents were of the view that early team integration is a significant factor in any collaborative initiative. They added:

> *"It's massively fundamental and the reason why we're able to deliver most of our projects far more than before."* **[PD]**
>
> *"We get far more optimum solution earlier in our processes having those people engaged earlier to bring in innovation."* **CM, CSPA].**

This shows that on-boarding key players (including commercial and SCGs) early would support collaborative etiquette and the innovation required during conceptual processes, thus stakeholders would buy into the enterprise objectives. This could also allow high performing groups, where collaboration and social interactions are established before any defined solution can be achieved.

b. Trust & Shared Understanding

Some of the respondents further suggested that dialogue and shared understanding are essential for collaborative practices. The participants observed on this saying:

> *"The main thing is communication around everything, as it is important for people to understand exactly what they're expected to do, whereabout within the commercial model."* **[PD]**

> *'This allows us to understand what our KPI's are, and clear on our performances.''* [**DM, CSPA]**

This shows that trust, open communication and shared understanding improved CW with cost visibility and understanding of project scope, where members involved would keep track of the cost spending all the way to delivery. This is important as without proper cost visibility and shared understanding, collaboration in this sense would be hard to achieve.

c. 'Project-first' Mentality

The majority of the respondents attested to the significance of project first mentality and how it drives CW within their commercial model. They observed on this saying:

> *"All the partners are selected based on the core capabilities they can offer to the team.''* **[CM]**

> *"Our collaborative approach to costing is driven by how the teams are aligned which is also in line with the commercial model.''* **[EM, CSPA]**

This implies that there is no room for duplication, overlap or competition amongst the partners. It also means that the teams' aggregate performance is measured and assessed within the programme pool. Accordingly, their performances and rewards are not related to the work they do individually, but tied into the work the team does collaboratively. This suggests that if one partner is not doing well, then that goes into the programme pool (their returns). Therefore, everybody's return is reflective of the team's collective performance. If that is not the case, then their outcomes would be drawn effectively from the programme pool and that is what drives collaboration, which invariably contrary to the usual norm in construction. Remarkably, this further underpins the need for CC, where the project costs are set and the teams are assessed based on how they collectively achieve the desired project cost. Thus, the incentives for the partners as well as the commercial groups would be their own performances against the target: a significant driver for collaboration.

6.4.5 Benefits Using the Current Practice

The analysis of the current costing approach has set the context in this section; to not only understand the drivers of collaboration in the process, but also to identify some of its benefits. During the interview, the respondents were quick to point out some of the benefits of collaboration in costing. There were various assertions, some of the participant's connoted saying:

> *"I think having this expertise available early on is invaluable, because it provides insights into the site specifics, SCG can provide us with construction input that often the designer does not."* **[CD]**

> *"It helps us to understand total costs, the ability to use cost intelligently, familiarity with capital and operating costs and understanding the process of smart solutions."* **[EM, CSPA]**

This shows that there are significant benefits when teams are established early (upfront). For instance, when the design is evolving, all the stakeholders will know the design intentions and the risks. This is much better than receiving inquiries and having to make best guesses or assumptions on which the team might not know. In addition, in terms of building a scheme cost, the assumptions would be ironed out and the full picture would be clearer, thus the understanding of each other's perspectives would improve costs and save time. Similarly, this integration would have a positive impact on designers, thereby extending collaboration amongst the project performers. For example, they would understand the cost base of the final product, with visibility on true cost, and hence they could design in terms of how much it would cost etc.

Other respondents commented on these benefits, saying:

"*It provide opportunity where different partners converge to showcase and share their experience for the betterment of the project"* **[CD].** This solidifies their relationships and reduces the actual size of transactional characteristics. Thus, the team would completely understand each other's expectations, providing a strategic base goal for the team. The DM commented on this, saying: *"Right first time and visual management' are significant in this approach"* **[DM].**

This illustrates the essence of cross-functional integration, which highlights the importance of getting decisions right first time for the team. This is contrary to the conventional system where, after buildability and constructability meetings, everyone goes away clear on what is required, but when something happens, the first time everyone sees it is when the drawings get to site and many questions need to be answered, but the team does not have a clue on what to do. Interestingly, this also means that the more time the team spend together working in collaboration, the quicker they get to a decision, which often at this stage is reinforced by value stream mapping and visual management techniques (Ballard and Reiser, 2004).

6.5 Commercial Practices & factors Affecting CW in CSPA

6.5.1 Commercial backgrounds & training

Some of the respondents were of the view that commercial practices within the company were hindering CW and arrangements. When asked on how, the procurement director stated that:

> *"Commercial team often behave around the contract with the need to protect an organisation/client at all costs, which stems from traditional QSs trainings, where they perceive that the only way to maintain profitability is through constant aggressive stance, which is dictated by the market they came from conflicting with the business model."* **[CSPA, PD]**

Another respondent lamented on this saying: *"I think some of our QSs comes with such backgrounds, I mean you can see it on their CV's projecting how they save claims, monies in previous jobs which in turn affect their behaviours even in this environment, which also transfers into how they manage our SCG.*" **[CSPA, AD]**

This demonstrates commercial behaviours, which are inspired by the 'institutionalised' factors and political climate that promotes safeguarding practices in the construction industry (Pasquire *et al.,* 2015). Accordingly, these practices incite all sorts of opportunistic behaviours, even within a multidisciplinary setting. Arguably, this also influences the prescriptive roles of commercial actors (i.e., interpreting contracts) with a bounded culture to protect client/organisation at all costs. Perhaps, a lack of knowledge or shared understanding, as well as some of the perceptions of traditional clients on commercial actors, are contributing to these behaviours in practice (Sarhan, *et al,* 2019). Consequently, this view has brought in a short-term mentality and rigid mind-set (win-lose mentality) within commercial practices that continues to affect their behaviours in collaborative programmes (Eriksson and Laan, 2007).

6.5.2 Custom and Practice

Custom and practice are fundamental barriers and factors associated with members of the commercial groups in construction. Some of the respondents commented on this, saying: *"Members of the commercial teams are transforming well here under our model, but how they persist with due diligence, protocols are driving behaviours that continue to show inconsistency especially their working relationships with our SCG"* **[CSPA, CD].** Another respondent also observed: *"Reflecting on their activity-to-activity thinking, commercial teams are still lagging in terms of fully understanding what alliance is, how they should work within a team and being consistent here is a challenge"* **[CSPA, TM].** Similarly, another interviewee commented that: *"Custom and practice are still major factors in terms of how commercial teams operate which is served by a win-lose mentality (zero-sum game theory) behaviour, and we still witness this here. For them, its simply doing what their roles described, proving their worth to the client"* **[CSPA, CM02].**

These statements indicate that custom and practice are so prevalent not only in traditional environments, but also in multidisciplinary settings. Accordingly, this view creates an adversarial position in practice, which continues to entrench waste in the construction process and delays in the mainstream work. Perhaps, this could also be the reason why clients traditionally use members of these groups through transactional interfaces, instead of aligning their interests with those of the project team (production). Other practical implications associated with this are: misalignment of interest that reveals sub-optimisation (individual activity thinking), and lack of professionalism that still exists amongst commercial actors representing clients and those on the contracting parties (Fellow *et al.,* 2003).

6.5.3 Excessive Bureaucratic Processes

Another barrier and challenge associated with commercial actors is the way clients persists with strong governance, excessive monthly reporting and commercial assurance in projects within a multidisciplinary setting. This of course, typifies how commercial teams are used to mount pressure on project delivery groups through bureaucratic processes that often fail to add value to the project nor in their respective roles. The PD and the DM observed this, saying: *"Clients even here have strong governance with the belief that the team needs to be more efficient. But certainly, this puts more pressure on the team, and I think this process should be optimised – allowing commercial teams to contribute more value"* **[CSPA, PD].** *"One of our challenges here is focussing on what* *we need to do to deliver the project, but there is a lot of bureaucratic process, programme reporting and our commercial teams are so entrenched in these activities that sometimes can't give any degree of detail back to the delivery team for them to understand financial implications"* **[CSPA, DM].** Another similar view from one of the respondents was that: *"We sometimes witness these onerous requirements on process and justification from the commercial team. But it is more at the tier-2 level, which is seen that they must protect the client, and they've got to be seen finding things in that sense – but at the tier-1 you don't often see that because of the maturity in terms of collaboration"* **[CSPA, CM01].**

These quotes further illustrate how commercial activities can come into conflicts with business delivery models and CW. This indicates the need for commercial actors to be in a position beyond interpreting contracts, but engrossed in value creating channels to align with the overall project goal. The heavy reliance on data to measure performance leaves a huge hole through redundant monthly reporting processes that arguably could be better balanced by the project teams themselves. These persisting roles, especially from commercial perspectives, prevents the understanding of efficient 'flow' and 'value' channels in construction processes, as their competencies are continuously under-utilized – hence, the continued escalation of costs and time overruns in projects (Doloi, 2011).

6.5 Supports Required for Commercial Integration in CW (CSPA)

From the interview results and analysis, two key sub-themes emerged that revealed various supports required for aligning commercial interests, as well as the requisite elements to engender CW in construction. Some of these factors are discussed below. The emergent themes are twofold: supports required at project and organisational level, and the external support.

6.5.4 Project & Organisational Support for Commercial Integration in CW

Cross-functional Integration

Some of the respondents suggested that organisations must be committed in terms of assembling effective teams' very early, and commercial groups also need to be embarking on such arrangements. Some of the respondents in CSPA stated that:

> *"It's quite challenging because commercial groups need to be part of the team and the process outlined for setting the target cost before define solution is achieved."* **[CSPA, AD]**

> *"The only way we can achieve this, is involving everyone when building the solution costs to set the target cost together not pulling scope and asking other teams to get quotes from the SC and using commercial teams to manage the situation."* **[CSPA, DM]**

This indicates that the commercial groups are crucial for early cross-functional integration, which is an important principle that would allow collaboration to thrive as well as revive some of the redundant roles that contradicts the integrated delivery ethos. This could also be a platform to support stakeholders to 'cost collaboratively' in practice, as it could encourage high-level integration (a precondition necessary for interaction), high performing teams and shared understanding amongst stakeholders; thus commercial and SC members need to be at the heart of it.

Enterprise Model

Furthermore, some of the respondents were of the view that the commercial model could serve as a platform to underpin cross-functional integration and aligning of processes. Some respondents stated that: "*Through the commercial model, our interests are aligned which then spur innovation in our activities and we get clear representation of value as the teams are always trying to outperform the set target"* **[CSPA, AD].** This is because the model supports a back-to-back process, which means they are driven to perform collaboratively as everyone's return is reflective of the team's collective performance.

> "*The enterprise model is also supporting our commercial teams to understand total cost (capital & operating) and its intelligent usage, likewise, the process of smart solutions, risk management, identifying what true costs is from outset, and how that adds value with less transactional issues."* **[CSPA, CM01].**

However, the respondents acknowledged that prior to this, the commercial team's interpretation of value simply involved getting quotes from the market. But with the model in place now, he confirmed that they are now obligated to demonstrate how that process adds value into the project through continuous improvement; they're now focusing on how to add value to the solution costs. This implies that members of the team are measured based on their value input and performance, which is contrary to what cost consultants are measured on in the traditional systems (Ofori and Toor, 2009).

Centralised Procurement Approach

As mentioned earlier, a centralised procurement system is a known strategy in CSPA that aligns the project delivery teams, commercial teams and the SCG, thereby harnessing collaborative behaviours and working relationships; the respondents view this as a necessary approach. Interestingly, this revealed a different approach to SC management in terms of set-up and breaking down barriers: the project team, commercial and SC groups often work in tandem addressing the project constraints. The PD lamented that:

> *"With the CPS in place, we operate through discussion group including, the SC, our collaborative working group, the delivery partners & the commercial team, using behavioural development sessions to discuss and understand our project drivers and constraints."* **[CSPA, PD]**

Again, this exemplifies how integrated the system can be, which would allow teams to optimise their processes in line with the overall project end-goals, through interaction, and closer working relationships amongst stakeholders. More importantly, the behavioural workshops promote innovation, discussion of newer techniques, strategies and ways of working, description of business ideas, and assessment to appraise relationships and expectations.

6.5.5 External Support

These external supports stem from within the industry for CW and commercial management in practice. The respondents from CSPA identified two of these supports. These include: (a) clients/stakeholder's interventions subscribing to CW practices, and (b) professional body's (RICS) interventions on commercial roles.

Client's/stakeholder's Interventions

The respondents asserted that client's interventions subscribing to CW remains important in practice. Even more important is the motivation of other professionals and consultants (i.e. QSs) embarking on any industry innovative approaches. For instance, some of the respondents stated that:

> *"Collaborative practices keeps stalling in the industry, because a lot of people don't want to try something different, and this certainly need significant efforts from clients and stakeholders putting heads together to get high level support."* **[CSPA, AD]** **"***This will require identifying who can change, and these changes needs strong leadership from clients, and invariably it will get to the ones that are resisting, for instance here, the commercial model certainly incorporates the*

> *QSs providing them with the right culture to support our approaches and innovation."* **[CSPA, CM02]**

Whilst these factors are not new, they show that, from a commercial perspective, client intervention is still instrumental to their collaborative journey; it is also necessary for QSs and construction lawyers in practice to understand how they can contribute value within their functions. However, in this instance, clients are often hesitant to buy into collaborative practices or pay the upfront investments for cost reasons, thus reluctant to commit, and therefore opt for what has worked before. Conversely, this uncertainty and lack of intervention from clients creates doubts amongst the commercial actors, which disconnects them from collaborative practices (Wao, 2015).

RICS/CPD Training

The majority of the respondent in CSPA were of the view that the commercial team's competencies needs updating and support from the professional body (RICS) to recognise those inter-personal skills required for CW would underpin their ability to work in a multidisciplinary environment. The PD added that, "*Traditionally, QSs never build anything but assess personal interface in the transactional environment – either implementing, negotiating or delivering those transactional relationships. So, unless those inter-personal skills can support collaborative relationships to achieve a positive outcome, they would continue to struggle in any infrastructure setting."* **[CSPA, PD]**. Another view from the DM was: *"Without collaborative capabilities and support, they generate massive amounts of waste in the process that we applied, and I think any project requires participants who can work to eliminate wastes, and that's what collaboration is all about"* **[CSPA, DM].**

These statements demonstrate the weakness in skills and talents of cost consultants (QSs) and how they are perceived in a multidisciplinary setting, as traditionally they set out to represent the interests of one party. Based on these comments, it can be argued that members of the commercial team (QSs, estimators etc.) need to reinvigorate into a different skill-sets to become relevant in a collaborative environment, and support multi-party enterprise, which is a condition precedent required to participate in collaborative practices. However, this requires RICS intervention to redefine some of the commercial competencies that would accommodate collaborative values for sustainable project delivery.

6.6 Case Study Project Beta (CSPB): Severn Trent Water

6.6.1 Description of case study project beta

The STW project is in Derby, in the East Midlands. The company deals with infrastructure and non-infrastructure projects, specialising in collaborative projects, mostly on complex and engineering process development for long-term periods. Currently, STW is involved in a joint venture (JV) project worth £200 million for 30-sewage works over a 5 year period (2015 – 2020). The JV was built and based on a collaborative organisation that consisted of consultants and contractors who would deliver the capital investment programme. The JV comprised of four delivery partners: Costain, North Midland Construction, Mott McDonalds Bentley, and STW. The full description of the project is presented in the Table 6-3.

Table 6-3 CSPB Project Description & Attributes

Project Description	Attributes on CSPB
Nature of project	Infrastructure
Location of project	Derby, East Midlands UK
Nature of work	Sewage work and the construction of water recycling treatment plants.
Type of client	Public client
Mode of delivery team/SC selection	Joint Venture, framework
Proposed project duration	60 months
Procurement arrangement	Design & Build
Contract sum	£200 million
Process explored	Costing/Design
Contract form	NEC-Contract

The researcher investigated STW over a period of five months, exploring costing approaches within the company. At the beginning of this investigation, most of the project early stages had already elapsed. However, the researcher conducted interviews to reflect how these activities went on during pre-contract stages, as well as collect other relevant documents relating to costing, procurement and commercial practices in the project.

6.6.2 Demographic Information of Respondents in CSPB

Table 6-4 illustrates the respondents interviewed in CSPB; Associate Director (AD), Commercial Manager (CM), Programme Manager (PM), Process Designer (PD), Estimator (EM) and ASEC team auditor (QS).

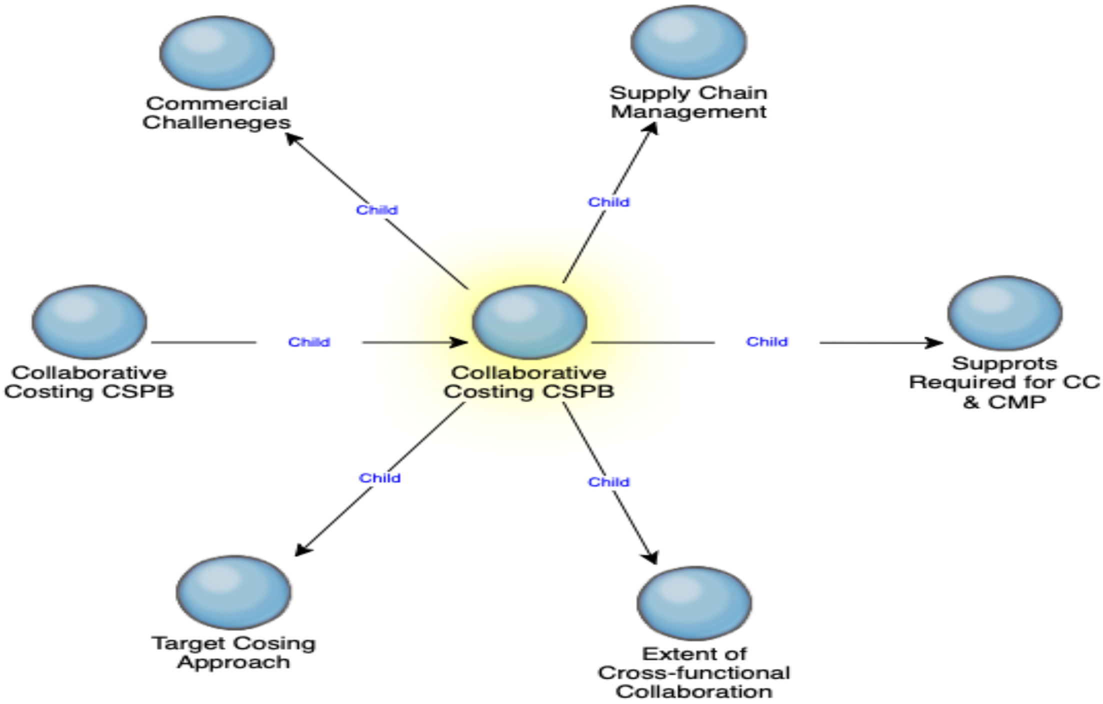
The respondents included members of the JV team, which was directly involved in costing and design activities in the project. This means that the respondents were able to explain the current processes adopted during the costing and design activities. The participants were fairly distributed across the project to minimise biased responses. Accordingly, they all had an average of 10 years' working experience in either JV or alliancing projects. This suggests that their responses could be relied upon in this study. Moreover, these findings would be used to develop a framework that aimed to guide stakeholder's costs project collaboratively in the UK construction industry.

Table 6-4: Demographic information of the respondents in CSPB

S/N	Respondent code	Specific role within the JV	Years of exp. in CP	Years of exp. in construction
1	CSPB AD	Associate Director	10	30
2	CSPB CM	Commercial Manager	7	18
3	CSPB PM	Programme Manager	9	21
4	CSPB PD	Process Designer	6	19
5	CSPB AT	Auditor/ QS	5	17

6.7 Current Costing Practice in CSPB

Data analysed on costing approaches in CSPB was similar to those gathered from CSPA. The analysis revealed sub-themes, which are discussed accordingly: (1) target costing approach, (2) supply chain management, (3) extent of collaboration, (4) commercial practices and factors affecting collaborative programmes, and (5) supports required for commercial actors and collaborative practices.



6.7.1 Target Costing Approach in CSPB

Developing a TC for a new scheme at STW goes through the gateway process (G1-G6), which begins with feasibility, design, and construction phases. The actual costing process starts with collation of historical costs data from previous AMPS and correlation with the final scheme costs, which are then extrapolated into the costs curve chat. This usually reveals a highline cost figure, and a platform for the client's team to establish the TC for the new scheme. Accordingly, the client's team puts together a new business plan using these cost figures. However, these activities are usually conducted internally by the client's cost advisers (QSs), feasibility experts, and in some cases, external consultants. Therefore, the client's team (called ASEC Programme) centrally coordinates these operations with little input from the delivery partners.

This shows that the company adopts a top-down target costing approach, which does not fully integrate delivery partners or the SCG at the point of early costing and design development. However, the respondents mentioned that the client sometimes engages delivery partners & SC, if they decide to go with a bottom-up costing approach. Therefore, this means that the TC approach in CSPB can either be top-down or bottom-up approach.

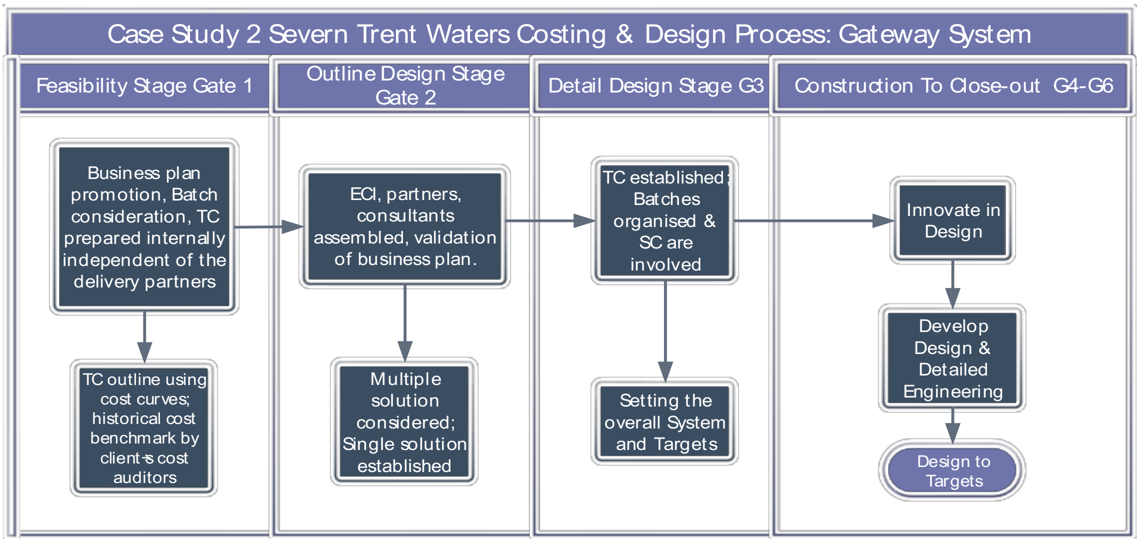


Figure 6-4: Target Costing Approach (Sample of documents analysed).

As illustrated in Figure 6-4, the idea of early cross-functional integration and collaboration for costing and design activities is still fragmented. Consequently, this revealed other challenges and shortcomings. Primarily these are: lack of transparency during the costing process, lack of adequate understanding of risk strategies amongst the team, persistent struggle with SCG on pain/gain share measures, and lack of process integration to eradicate waste within the scheme costs, upon which the TC is based.

Similarly, just like in CSPA, CSPB also revealed some glimpses of collaboration with some principles that are in line with those found in the TVD system. These include: a feasibility process for setting the TC, the use of the LPS approach for collaborative planning, and the client is often involved with project team activities. However, there were other principles missing. This points to the fact that the process of setting the TC is normally carried out unharmoniously, as the downstream players from contributing to the team, and there is little scope for collaborative dialogue with the client to assess project worth, viability etc. Accordingly, the process lacks the continuous estimating approach (over-the-shoulder-estimating), to provide real-time cost information, and relational contracting arrangements do not exist amongst the teams. Thus, the absence of these principles continues to show why certain commercial issues persist within the JV arrangements in CSPB.

6.7.2 Supply Chain Approach in CSPB

CSPB used a JV arrangement, where the project is procured through the traditional DB system. This means that designs are almost completed before the delivery partners and subcontractors are brought in. As such, this has further influenced their procurement approach, SC management, and collaborative arrangements.

Accordingly, the study found that the procurement approach adopted in CSPB has an influence on collaborative practices and the SC management approach. Some of these influences include issues relative to costing activities, as well as the incompatibility of the system they used for the JV arrangement. One of the programme managers lamented that:

> *"On this arrangement (TC), the D&B partners do some due diligence on cost to find out its viability after it's been sent from the client using, bottom-up pricing. It also involves external consultants, but the tier-2 are not incorporated into the process and we end up choosing the lowest cost."* **[CSPB, PM**]

This shows a lack of integration of downstream players in upstream activities; commercial teams in these arrangements are strategically positioned to manage the SCG during costing activities, which they often do using cost negotiating tactics that further compound the issues raised during costing activities. The implication of this is that the SCG will continue to have strain behaviours with this approach, as evidently (from their perspective) cost certainty and approaches to risk management are not assured, whilst their commitments is required to support the collaborative relationships.

In addition, the current approach adopted is conflicting with the JV arrangement. Figure 6-4 illustrates the schemes in CSPB projects which are procured through the JV procedure. This arrangement resembles partnering approach and is seen as a cutting-edge practice where CW is sustained. However, the respondents had differing views on how the JV approach was used in CSPB, as observed by the interviewees:

> *"STW has a contract with the delivery partners, but among the partners they've an addendum between them severely jointed"* **[CSPB, CM]**

> *"STW has its own process and procedures; all the delivery partners have their own process and procedures and that's how we're working."* **[CSPB, Auditor/QS]**

The above statements indicate how this uncertainty affects CW and the procurement approach in CSPB. This also indicates that there is no single entity or system in place, as one partner cannot bypass another company's procedure, because all the partners are adhering to their own company policies. Perhaps, one could argue whether this is how a JV arrangement should operate, as this shows different priorities, which stem from the partner companies and other external influences. This implies that the JV in CSPB is not working as a collaborative hub, because for that to happen, all the project participants must ignore the indirect influences to perform their collective responsibilities (Daniel *et al.,* 2014).

6.8 Extent of Cross-functional Collaboration in CSPB

The study analysed the CSPB commercial activities associated with costing, which revealed the degree of collaboration across the teams. This shed light on some costing activities within the delivery partners and their relationship with the SCG. The key costing functions include: business case promotion, establishing a single solution, risk and value sessions, estimating and cost planning, contract administration, and collaborative planning. These activities are illustrated in Figure 6-5, which spreads across the gated process (G1 – G6), running from feasibility, through to design, and to the project closeout stage.

a. Feasibility Stage (Gateway 1)

This stage revealed how internally the client's team proceed with the TC development. The key cost functions at this stage are identification of needs, validation process, and establishing cost solutions (usually 6-10 options). This stage involves the STW team (feasibility experts & QSs) and external costs consultants. It begins with the feasibility process and setting of a TC outline, which are carried out in-house, based on the previous amp's outturn costs value plotted to reveal a high-level TC. The delivery partners are sometimes involved in this process assisting with the bottom-up pricing (but very late), providing buildability and constructability input.

As discovered, QSs form part of the client's internal team in charge of the traditional costing exercise; the JV team also has their internal estimators set-up within the team. However, when the researcher asked the PM why the client's QSs are not involved further with the delivery team, but mainly to manage the SC and their contracts, the response was, *"Well, that is how it works here, they are predominantly engaged in this fashion because they are not part of the collaborative process – but to help the client put together the TC and validate the cost figures"* **[CSPB, PM].**

This means that QSs, especially the ones advising clients (PQSs), are often marginalised when it comes to actual CW. It can be argued that this sometimes comes down to how their functions or roles are set, even in the collaborative environment, as they are very prescriptive. Consequently, this further exemplifies why they are traditionally expected to manage contracts, claims and supply chain relationships (Mbachu & Frei, 2011).

b. Outline Design Stage – (Gateway 2)

This is a vital stage in the gateway process, where a single cost solution is to be established by the project teams. It normally starts with the integration of delivery partners, consultants, framework contractors and the STW team. However, not all the stakeholders are directly involved at this stage, especially the SC, as it is a top-down approach. The key cost functions at this stage are: joint validation of the business case, assessment of the earlier established options, and the process of attaining a single solution. The team usually consists of the client's representative, the commercial and design team embedded within the delivery partners, and it sometimes involves external cost consultants. At the end of this process, a single cost solution is established, which forms a baseline cost that determines the TC.

c. Detailed Design Stage (Gateway 3)

At this stage, the designs are completed and ready for construction. The stage also requires full involvement of the SC, and the TC is established and confirmed. The delivery partners here liaised with the SC to maintained buildability and constructability inputs. The scheme is divided into several batches, each managed by programme managers from STW, project delivery leads and design teams from the partners. The key costing activities are 'project detail design' that includes designers, client representative, project manager, construction manager, supply chain, and estimators. All the relevant stakeholders would then converge at a collocated site to discuss design constraints and project scope.

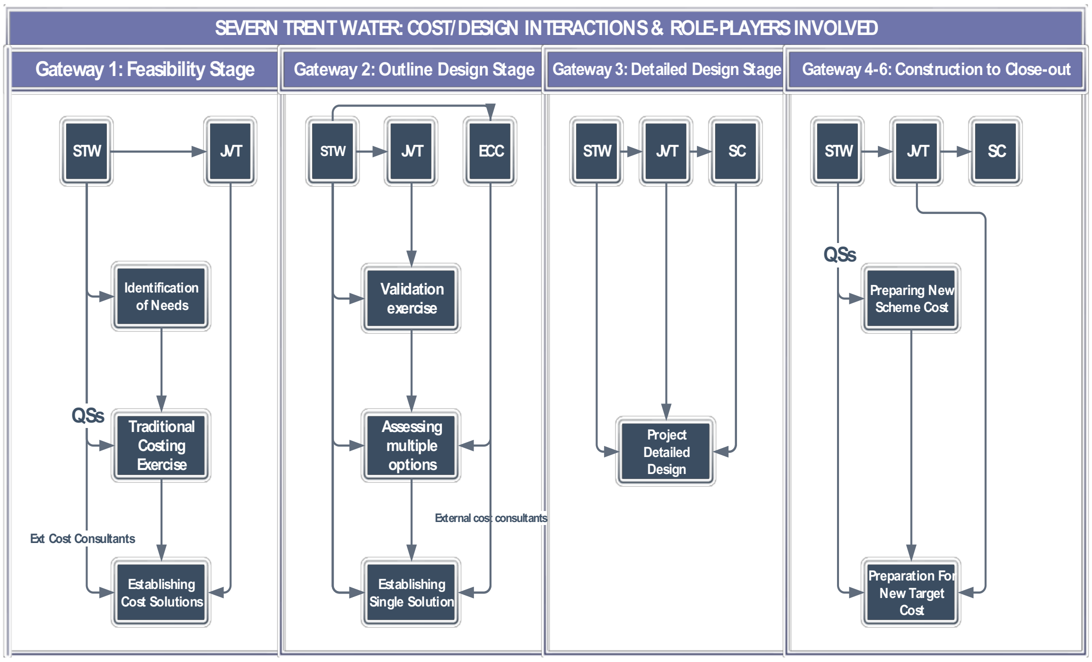


Figure 6-5: Degree of Collaboration/Costing Interactions & Players Involved in CSPB

d. Construction to Close-out (G4 – G6)

This stage confirms the scheme is closed, and usually goes through a 12-month review, appraising what was promoted in the business case and how it has been delivered, identifying major constraints and lessons learned. It also, provides a maintenance review report for remedial works. Accordingly, the costing activities here are: preparation of new scheme costs (usually carried out internally by the client's team (auditors, QSs, consultants)), and the preparation of a TC for the new scheme. Yet, this is still an independent process separated from the JV team. G3 demonstrates the bottom-up pricing process, where the SCG are interfaced.

The activities that underpins costing and design, as illustrated in the above stages, have shown some glimpses of collaboration between the client, project team, SC and the commercial teams. However, the method is still discrete, as the SC approach during costing and estimating is still traditional and fixed. This is because frameworks are managed by the QSs, and the client only deals with the delivery team (not with the SC) and vice-versa. However, deep inside gate 2, other key stakeholders are brought into the fore to support with the collaborative activities. Yet, these efforts are still fragmented, which undermines the essence of collaboration (especially during risk management and apportionment). Besides, commercial members are not integrated in this process, but they become more active when the contract is in play – managing tier-2. Consequently, this approach revealed two forms of collaboration: firstly, the client engaged the delivery partners at different levels; secondly, commercial groups (cost consultants, QSs etc.) who are independent of the JV arrangements managed the SC traditionally. Arguably, without properly incentivizing the SCG around the wider scheme budget, risk-averse behaviours that are prevalent in practice, will continue to increase, despite these collaborative arrangements. Moreover, all the stakeholders need to feel a sense of ownership, and to positively influence behaviours, for the desired collaborative outcomes to be achieved (Fischer *et al,* 2017).

6.9 Commercial Practices & Factors Affecting CW in CSPB

6.9.1 Balancing Standards with Innovation

Some of the respondents described how there are commercial practices that continued to prevent other innovative ideas in the programme, which in turn affects the JV arrangements. The CD stated that:

> *"Within the STW team, there are people looking after the process design, but they have no role to play in the JV and are quite risk-averse in wanting to protect the process trying to hold on to the usual standard. In addition, this spreads tension between those who want to be efficient and innovate against those who simply want to hold onto that standards."* **[CD, CSPB]**

This statement indicates how commercial activities prevent CW between the two streams (project and commercial teams); besides, they are working in an area where the water industry standards are below average, hence in need of innovation. This also paints a picture of the industry norm, where conventional practices and redundant procedures continue to prevail (Bresnen and Marshall, 2000). Hence the slogan *"because we're used to doing it this way".* More so, the people in charge of the standards are mostly engineers responsible for costing and product rates. Thus, this lack of CW amongst project teams and within the programme characterises the traditional protocols that are stifling innovation. Accordingly, this further reveals why members of the commercial team are struggling in the multidisciplinary setting, because of this practice of holding onto some prescribed standards, protocols, and procedures even to the detriment of the project (Pasquire *et al.,* 2015).

6.9.2 Excessive Bureaucratic Processes

As previously mentioned in CSPA, strong commercial governance is also discovered in CSPB. This is described as a commercial challenge, which is persisting through the company's internal governance and excessive monthly reporting. The PM lamented on this, saying:

> *"Each organisation has their own internal commercial stakeholder's requirement they must report to monthly, and thus some of the partners are paying lip service to the collaborative initiatives."* **[CSPB, PM]**

Yet again, this shows that CW is stifled from a commercial position. It also reiterates the need to revive these functions to support industry-wide collaboration. The bureaucratic monthly reporting system is a barrier that is commonly used as a norm by commercial team to seek promotion, it does not add value in the process nor the project itself. Indeed, its existence in practice will continue to prevent the understanding of 'flow' and 'value' adding channels in project delivery processes.

6.10 Supports Required for Commercial Integration in CW (CSPB)

6.10.1 Project and Organisational Support

Project and organisational support for commercial integration were identified in CSPB. These include: (1) Collaborative workshops and (2) Relational contracting agreements.

Collaborative Workshops

Respondents in CSPB were of the view that some of their commercial actors were involved in the joint risk and cost management workshops, which were important sessions to sustain CWP at both project and organisational level. For instance, one of the DMs stated that:

> "*Commercial managers, estimators, planners, supply chain among others need to be involved in this workshop, especially when we're looking at costing and design options and project constraints with the team."* **[CSPB, PM]**

This is significant, because everyone involved needs to see the consequences of moving an item from a programme or adding to a programme tracking the cost pieces. This would also bring more benefit to the team, focusing on exactly what might be the best outcome for the project in terms of costing, project timelines etc. Another respondent further added: "*Traditionally, after the constructability meetings everyone goes away clear on what's required, but when something happens, the first time everyone would see it, is* *when the drawings get to site and then you have lots of questions and your commercial team haven't got a clue on what to do."* **[CSPB, CD]**

This shows that collaborative workshops for costing and risk management practices would not only support members of the commercial groups, but would also improve their abilities to develop other beneficial relationships for cross-functional integration, thus improving project costs build-up, speeding lead-times, and getting decisions made in a more timely fashion (Osipova & Eriksson, 2011).

Some of the interviewees in CSPB believed that aligning the interests of these groups (QSs, commercial managers, cost controllers, and cost engineers) early in this process would further support the concept of 'collaborative costing', especially in complex project schemes. One of the respondents stated that:

> *"I think the built environment team and the planning team are involved in this process, the commercial side of the business needs to be in the loop in terms of accelerating and validating cost data by demonstrating value in this process."* **[CSPB, QS]**

Indeed, this affirms the reason why commercial teams and cost advisers need to be integrated in collaborative practices to optimise the redundant functions around contracting, safeguarding practices, and tendering for better relationships in practice (Wao & Flood, 2016).

Relational Contracting Agreements

Establishing a collaborative model for project teams should incorporate commercial teams, and the use of relational forms of contracting was identified in CSPB as part of the support required at organisational and project level. For instance, one of the respondents observed that. "*a single enterprise model could align the interests of everyone in the project."* **[CSP0B, PM]**

As such, this would provide a smooth transition for the traditional consultants, lawyers and QSs that seems to operate outside the multi-party contract, to fully embrace and support CW relationships.

6.10.2 External Support for Collaborative Practices

Alliance between Industry and Academia

Some of the respondent's in CSPB observed that a close collaboration between construction industry companies and the academic institutions would further support commercial alignment in collaborative practices within the UK construction industry. The AD suggested that:

> *"There is more need now than ever for close collaboration between industry practitioners and the academia. More articulation and reactiveness in communicating innovations and cutting-edge discoveries to support collaborative practice is required. In addition, more emphasis on collaborative practice should be placed in the university curricular for the young graduates coming up."* **[CSPA, AD]**

6.11 Case Study Project Gamma (CSPG): Highways England

6.11.1 Description of case study project gamma

The Highways England (HE) project is in Northamptonshire, in the East Midlands. It is an infrastructure project, upgrading a 12km stretch of the M1 (that runs between junctions 23a and 25) to smart motorway (SM). The upgrade is an improvement from the present scheme to SM, to lessen traffic congestion on the road network. HE (the client) awarded the £120m JV contract to Costain and GallifordTry in 2015. The JV arrangement also include Atkins as designers, with further inclusion of strategic partners, consultants and sub-contractors. The aim of the project was to convert the hard shoulder into a fourth running lane. This involved civil and technological work, which was meant to provide better communication and traffic flow for the road users in case of accidents and emergencies. The full description of the project and attributes is presented in the Table 6-5.

Table 6-5: CSPG Project Description & Attributes

Project Description	Attributes on CSPG
Nature of project	Highways and infrastructure
Location of project	East Midland Northampton England
Nature of work	Upgrade of motorway to smart motorway Junctions 19 and 16
Type of client	Public client
Mode of delivery team/SC selection	Joint Venture/Framework agreement
Proposed project duration	24 months
Procurement arrangement	Design & Build
Contract sum	£120 million
Process explored	Costing/Design
Contract form	NEC-Contract

Based on the data collected, CSPG was procured using a DB approach. It is worth nothing that the project initially started with £65m as the scheme budget. However, at the time of this case investigation, the project cost had risen to £110m: almost 100% growth. At that point, costing and design activities had elapsed, but the researcher was able to reflect through interviews and captured relevant information associated with the pre-contractual activities as well as other early construction processes, which informed this research study inquiry. Table 6-6 shows the roles of the respondents, as well as their working experiences in collaborative practice and construction respectively.

Table 6-6: Demographic information of the respondents in CSPG

S/N	Respondent code	Specific role in the JV	Years of exp. in CP	Years of exp. in construction
1	CSPG CM	Commercial Manager	13	20
2	CSPG SQ	Senior QS	8	15
3	CSPG CD	Commercial Director	10	22
4	CSPG CIL	Cost Intelligent Team Leader	5	14
5	CSPG EM	Estimating Manager	9	18
6	CSPG EM01	Senior Cost Negotiator	6	15
7	CSPG MC	Main Contractor	10	20

6.12 Current Costing Practices in CSPG

Data on the nature of the costing approach in CSPG were obtained from the company's estimating manual/documents and semi-structured interviews. Following a single case analysis approach, the findings also revealed similar sub-themes to those in the previous cases, which were discussed accordingly: (1) target costing approach (2) supply chain approach, (3) extent of cross-functional collaboration, (4) commercial practices and factors affecting collaborative programmes and (5) support required for collaboration and commercial integration.

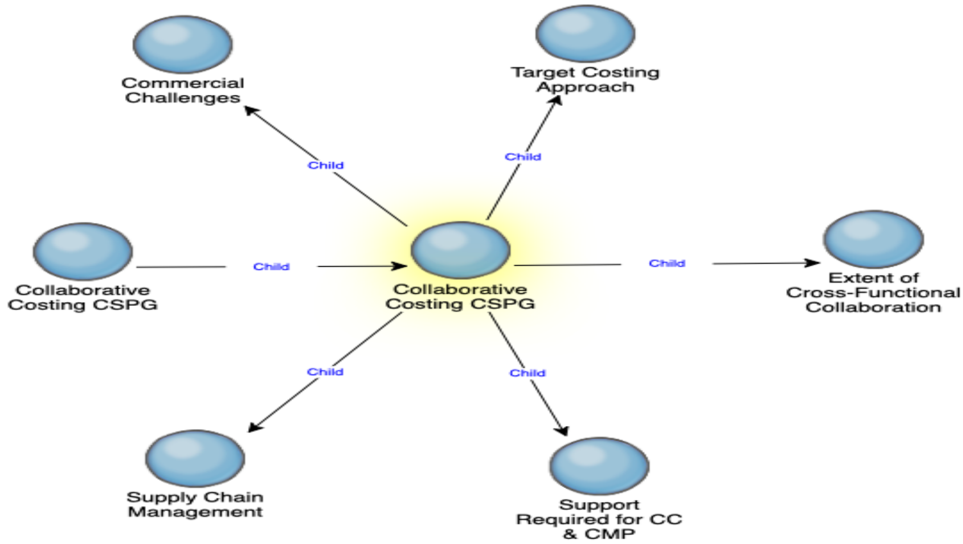


Figure 6-6 Current Costing Practices in CSPG

Target Costing Approach in CSPG

Target cost development for a new scheme in CSPG normally goes through the project control framework (PCF). The PCF is a process that sets out standard project life cycles for various products required at each stage. The PCF gateway process encompasses the following stages: (a) pre-options (strategy shaping & prioritisation), (b) options, (c) development, and (d) construction. Each stage requires several defined products (estimates, risk register and value management programme) to be in place and approved for the scheme to progress to the next stage. These estimates are usually carried out by the internal commercial service division teams (project, operations, negotiating and cost intelligence teams) using five estimating classification stages.

The first strategic estimate starts with an assessment of the proposals, putting forward a programme of schemes and the project lifecycle. This is followed by the options estimating stage, which identifies viable options, selection of an optimum alternative and the decisions to select a preferred delivery route that updates the estimating process aligning with design development. Subsequently, in the design stage, estimates are developed to cover the inception scheme costs, and the overall estimates is updated as design progresses, with tender validation for sustainable delivery. Other activities include issuing invitations for tender and appointing contractors. The final estimate is when the scheme budget is set to reveal the outturn costs and the formalisation of budget approval into construction process.

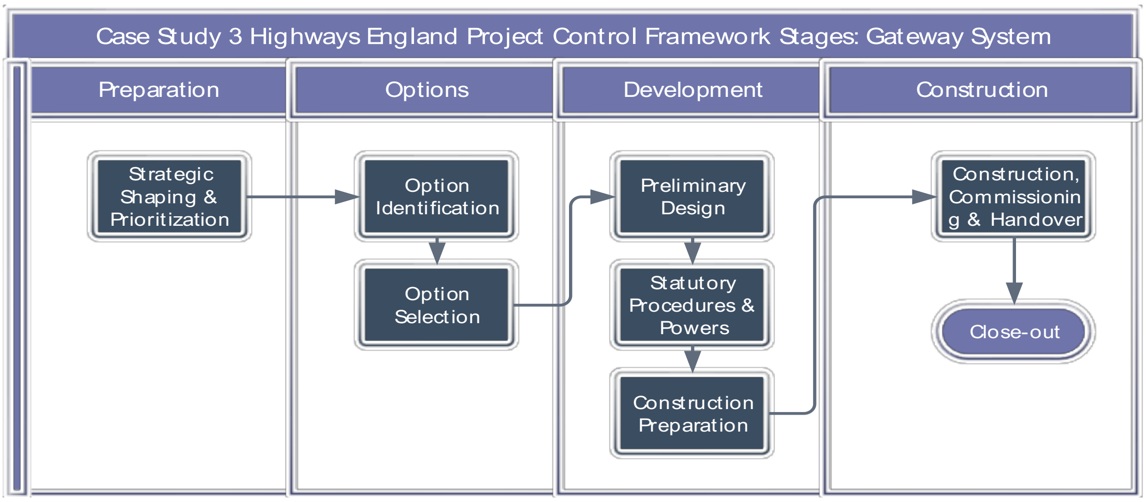


Figure 6-7: Project Control Framework Stages in CSPG

Figure 6-7; illustrates the framework, showing the estimating process and stages that are aligned with the PCF model, when major projects in CSPG are procured. This also supports the process of selecting constructors and sub-contractors to determine scheme budget (outturn cost) based on the PCF structure.

Figure 6-8 further illustrates how the cost estimating process supplements the PCF model. The output of these proposed scheme estimates is driven by the PCF framework and controlled by the investment decision committee process. The commercial teams administer the production of internal estimates to ensure efficiency and quality requirements. These early estimates are also vetted by each scheme's project manager, who acts on behalf of the client and liaise with the commercial service division hub, called the 'central inbox'. Commercial managers oversee the project cost on behalf of the project team, but all the estimates produced for the major project scheme are reviewed and approved by the commercial division's estimating manager and head of cost planning or commercial director, before they are formally released to the project teams.

Supply Chain Approach in CSPG

The SC approach during costing in CSPG is somewhat dualised. This is because the process alternates: at times the SCG are engaged on the framework, and at other times on a competitive basis. The CD lamented on this, saying:

> *"For some time now, our SC are engaged in a traditional competitive basis of which we realised the enormous transactional relationship and lots of adversaries that is costing both parties where the client ends up paying."*

He further affirmed that they are deploying a new strategy now and suggested that:

> *"We adopt the ECI running our optioneering and design with the SCG at a lower rate, so we engage contractors to help with the scheme design and negotiate with the SC at that stage."* **[CD, CSPG]**

This indicates a different type of costing approach, where the ECI process allows the team to challenge buildability and constructability during design development. However, they do adopt the cost negotiating strategy with the SCGs, which indicates a step forward, but obviously this is impaired by commercial behaviours, as they continued to witness strained relationships with tier-2 partners in the process. This is because, the tier-2 groups want to have the highest price possible, due to lack of trust and transparency in the arrangement and the unbalanced risk management strategy.

Another respondent also commented on this, saying:

> *"So what we're doing differently is getting the SC early and setting the price with them, and we ultimately end up agreeing the right price in a collaborative way over 12 weeks' periods of negotiation."***[CSPG, EM01]**

Again, this reiterates the fact that a 'collaborative costing' approach would indeed stimulate reasonable price determination that is fair to both parties and represent value to the customer. Thus, this means that the process needs to start from a position of transparency and sustainability to eliminate any transactional element, so that downstream players would not need to chase any claims or unnecessary disputes in practice.

The above statements distinguish between collaboration and negotiation during costing. The difference is very subtle, but the implication is enormous. The CD bemoaned that:

> "*For 5 years now we negotiate with the SC in costing, after 3 years, they didn't like it, and are always trying to do another negotiation saying this is too difficult, bemoaning why we wouldn't agree on a number. So, recently we let a new framework on competitive tendering, the same SC turned back and said, why don't we do it in a more collaborative way?. What we found out is that when they bid a*

> *price with us, which has gone through their own commercial governance, it is difficult for them to go back to their superiors and say, they have now agreed on 20% less because they will lose confidence from their organisations."* **[CSPG, CD]**

This indicates that cost negotiation still encourages opportunistic behaviours, as teams try to find ways that works for them, not for the betterment of the entire project. The implications are that SC members are not ready to look at the cost in much detail, because they haven't challenged themselves and they don't know the right prices or look at the detail more closely. This means that most of the team members would want it to be to their commercial advantage; competitive tendering is not beneficial because they must offer the lowest price. Consequently, this hinders collaborative practices.

6.12.1 Extent of Cross-function Collaboration in CSPG

The estimating process brings about certain cost build-ups and structures for all the project scheme estimations in CSPG. It begins with the base cost estimate that includes both direct and indirect factors like pre-options, development, land, and construction auxiliary costs among others, as illustrated in Figure 6-8. These are then converted to form the range estimate, where allowances are made to incorporate unscheduled items reflecting fixed scope items that are yet to be scheduled at the early stages. Subsequently there is the assessment of the project risk, which statistically is based on a risk register provided by the PM. This also encompass specific adjustments, dealing with the project uncertainties (defined as project-level risk). These adjustments are made during estimates to reflect the top down view of the overall risk profile, as against dealing with single component in the project risk register. A portfolio risk register is then allocated across the scheme with allowance included in the project cost estimate. Furthermore, issues like optimism bias are subsumed within the project risk, uncertainty and portfolio risk.

Accordingly, work breakdown structure (WBS) is used in CSPG to set out the cost estimates of each project component carried out by the commercial service division. This provides a framework and data for the commercial teams to analyse. The commercial group then captures the tender and actual rates from suppliers using the WBS format, and their contractors make submissions compatible with that format. The WBS covers all costs including direct and indirect construction costs, and those incurred during options and development stages. The commercial team also uses several estimating methods throughout the project lifecycle. However, these are largely dependent on the extent of detailed design information in the programme. The estimating methods often used entails: first-principle or bottom-up estimating, parametric estimating, analogic estimating, and expert opinion.

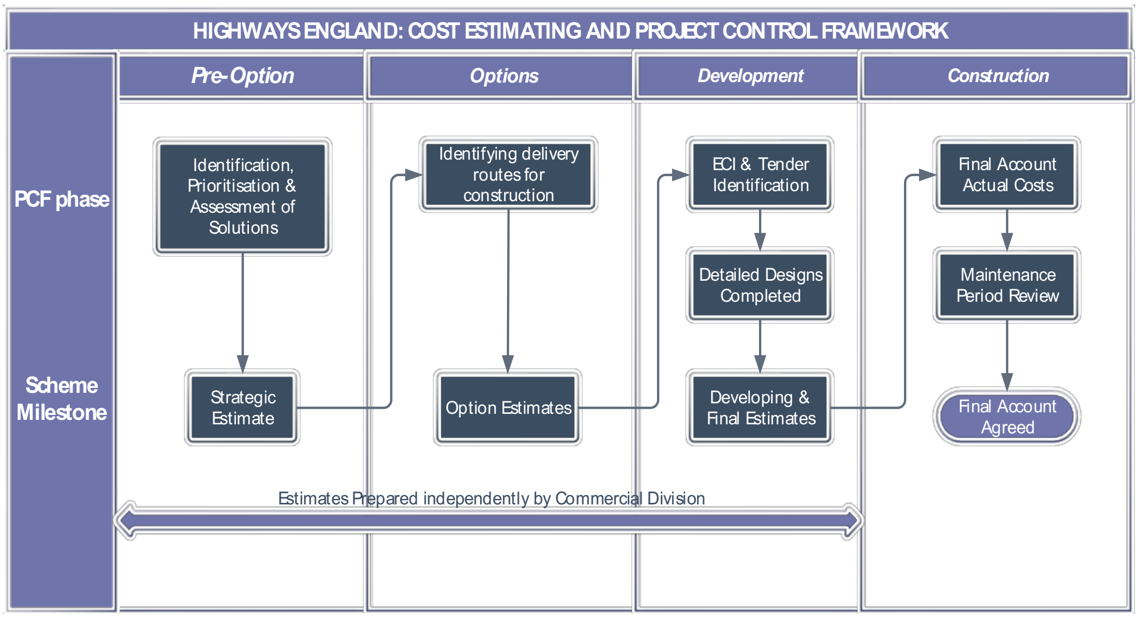


Figure 6-8: Cost Estimating in PCF (Sample of estimating document analysed).

The study earlier revealed that the estimating process, which leads up to the wider scheme costs, is largely carried out by the commercial service division, which comprises of cost intelligence experts (accountants & data analysts), a negotiating team (QSs), and an estimating team. Although, these teams are under the commercial banner, but they each work independently and are separated from the project delivery team during estimating and costing exercises. When the researcher asked why, the response from the CD responded: *"If the commercial team sits within the project team, sometimes there are undue influences on costing – so we recognise there is the needs for some degree of independent association to inform our decision."* **[CSPG, CD]**

This shows that the investment decision committee relies heavily on these independent forecasting conducted by the commercial teams, which determines how much needs to be invested before moving to the next stage. However, as revealed, the commercial teams work independently, and away from the project team during cost development. Partners/contractors are not considered at this point, nor the SCG. Evidently, this approach is weakening CC, which requires teams (partners, strategic suppliers etc.) to collectively discuss and determine what is allowable for the client and gauge it with the market prices. When asked about collaboration in this manner, the CD further added that:

"We've got an independent team that specialise in cost negotiation and agreeing the right price with the SC with an incentive mechanism to set the scheme budget." **[CSPG, CD].** This statement shows that collaboration has been interchanged with negotiation in terms of costing approach. However, looking at this from a conceptual formulation, there is a clear distinction between people working together to build project costs and people negotiating prices in the same context (Kaushik *et al.,* 2015).

There are some notable principles akin to those seen in the TVD system which were adopted in the estimating process in CSPG. These comprise of: a collocated site, the use of LPS for planning, as well as some form of CC discussion amongst the project teams. Nonetheless, there are quite a few key principles which appear to be missing. For example, the lack of cross-functional integration and collaborative discussions with the client on the investment worth and market prices. This shows the lack of standardised process to encourage cross-functional integration and to innovate on the established target cost. Other key principles missing are: *continuous estimating techniques* and a *relational contracting* arrangement that could spur innovation and productivity. Once again, the current process shows fragility in terms of customer focus and lack of full team integration prior to design. More so, it is still price-led. Arguably, these shortcomings might be the missing piece necessary to curb out the unproductive waste in the costing process, as discovered in CSPG.

6.12.2 Commercial Practices & Factors Affecting CW Programmes in CSPG

Fragmented Arrangement (JV or Competitive Approach)

The study earlier mentioned that CSPG is on a JV arrangement involving HE as the client, Costain and GallifordTry as partners, and Atkins as designers. Costain has 70% and Galliford Try has 30% of the turnover to carry out the project, even though there is no contractual relationships between the companies. This arrangement came about because the client insisted on Costain choosing Galliford Try as their partner (GFT are among the HE's tier-1 suppliers) and this warranted a negotiation on splitting the turnover. Some of the respondents were quick to point out how this improper collaborative arrangement affects production activities right from the outset. Interviewees observed: *"A lot of the time the client gives us information to price on TC basis, but the biggest issue is that we've very limited time to check if these figures are correct and we're expected to work on a live and active motorway."* **[CSPG, CM]**. *"The same cost information is also given* *to our competitors, and we've to price it in that sense – eventually the client ends up choosing the lowest option"* **[CSPG, SQ].**

These statements indicate that, despite the project team's JV set-up, the teams still operate on a traditional level, forcing contractors to make other adjustments to regain their losses through e.g. claims and change management. It is worth mentioning that this behaviour stems from how the teams are established, and the adoption of a conventional costing approach, which amplifies the lack of collaboration or interaction amongst these partners. It is also a reminder of why collaborative practice keeps stalling: as mentioned by one of the partners, that they simply get information (*basically drawings and scope next to it*) and they're asked to price, but without any room for collaboration.

Poor Perception on Cost Management Practices

As mentioned earlier, target costing and risk management approaches are not transparent between the partners and the client. One of the main contractors lamented on this saying: *"In every 5% increase we lose 20% of our cost. The TC was set at £120m, and we have spent £90m- the split is not the same. Therefore, gain wise the client gets 80% of the cost spend. 'This means that if we spend over we'll be heavily punished and if we spend under we get little compensation"* The contractor further added: "*On the current scheme we've bid and negotiated on the TC, but the client later decides to cut 10% from the TC, after 3 months of negotiation we later agreed to proceed – but we know deep down that we're going to find ways and claim the 10% back"* **[CSPG, MC].**

This illustrates why the negative behaviours persists: they stem from indirect influences (regulators, stakeholders etc.) exerting pressure on HE. This eventually transfers to the partners and the suppliers encouraging opportunistic practices right from the outset. This also confirms the old clichés in construction: *risks are transferred to those who can best manage them* without proper incentives to spur innovation or support collaboration from the top. Hence, the struggles to keep costs down under these arrangements will continue. It also indicates how narrowly 'collaborating over costing' is understood, as it is currently being substituted by cost negotiation. Moreover, there are certain clause changes in negotiating strategies which further stirs legal concerns from contractors' and suppliers' points of view, and hence encourage transactional characteristics.

Excessive Bureaucratic Processes

The study earlier mentioned commercial governance in CSPA and how it is affecting collaborative arrangements; this challenge also re-occurs in CSPG. When the researcher asked why this is happening, one interviewee said:

> *"Everything we do is determined to be success or failure by the people outside the business (regulators or stakeholders). So, these regulators who have nothing to do with the project, work in the head office persisting with bureaucratic processes. We manage risk register to the client and it takes more than a week to populate it with lots of details and box ticking that are not being looked at in the end or add value to production activities."* **[CSPG, MC]**

Indeed, this has implications, as clients often buy designs and sends their advisers for commercial assurance (in multiple numbers), who also have 'vested interests' separate from the project goals. When they are deployed on site, clients are anticipating commercial conflict from the contracting parties; thus, they exert more pressure on these advisers, usually within 6 months, to bring in more QSs to fight battles (claims, change orders etc.). This imposition is preventing collaborative practice because of the protocols and procedures put in place for validation, and man-marking usually carried out by the cost advisers, whose drivers are to satisfy clients using these redundant processes even at the expense of production value.

Another point related to this is the excessive number of QSs/consultants deployed on either commercial assurance or managing SC. A contractor attested to this, saying: *"On this current project we've got 10 QSs apportioned to the contractor, 8 from the client and we have 35 sub-contractors who each have a QS all working differently but on the same thing, either commercial assurance or customer practice."*

This is prevalent in practice, because traditionally clients deploys his/her QSs to protect their interests, and the contracting side deploys theirs differently: to make money through claims, valuations, etc.; coupled with the fact that there is a lack of trust and transparency amongst the teams. Arguably, this scenario will continue to prevail in practice and efforts to support CW will reduce still further.

Perseverance on Cost Negotiation

From the above discussions, it is evident that the idea of 'collaborating over costing' in practice has been substituted to mean negotiation with suppliers for the right prices, that often compounds more challenges and inefficiencies in the process. A senior QS in CSPG was asked on how they collaborate with the SC over costing. The response was that: *"After we've done our internal costing, we then approach a couple of SC's to get quotes – which we make comparison and verification, but of course price is the biggest driver"* **[CSPG, SQ].**

This shows that, from the SC perspectives, it is down to how much profit they are willing to go for and what they would compromise to even consider collaborating in this manner. In addition, when asked why they aren't collaborating properly in costing, the response was that: *"We don't share because we don't know whether they'll come for less than our TC, and the minute we share with them – you can guarantee they would come close to that"* **[CSPG, SQ].**

The above statements indicate that, despite a strategy of negotiation with the so-called 'strategic partners' and with whom the team work on a regular basis, when it comes to transparency about costings, the feelings of insecurity, lack of trust and opportunistic attitudes often reappear to deters collaboration. Arguably, this point has shed some light on the difference between people negotiating over costing and those working together to develop cost. It is even more obvious why the SCG are struggling in this manner, because they are not meant to feel any sense of ownership, nor are they entrusted in this arrangement. Which still begs the question whether an ideal 'collaborative costing' approach does exist in practice?

More so, on the wider breath of collaboration, this shows that QSs/commercial teams are completely on the side-lines, either talking to estimators and project managers or managing tier-2. Even so, the process of bringing information into fruition is very slow, which leaves them affirming cost data instead of improving their collaborative relationships.

Accordingly, the study also discovered that the data coverage leading to the target price development is being poorly captured. One of the respondents lamented on this, saying: *"Generally we've been historical on this, but we've started engaging individual schemes to investigate the process wastes used in building these costs. This is because some areas don't give us enough data or put in minimalistic cost information, and in those instances, we make serious assumptions which is the issue now"* **[CSPG, EM].** This issue continues to occur even though SCs are still placed under a long-term contract in the scheme.

Balancing Standards with Innovation

This challenge continues to linger, where the commercial teams struggles to embed innovative ideas. However, because they are not entrenched upfront with the project team, their innovative thoughts goes unacknowledged. A cost intelligent team leader lamented on this and said:

> *"This might be information asymmetry and because we don't speak directly to designers, a lot of the time people don't critique the delivery of most solutions and often these are left unchallenged"* **[CSPG, CIL].**

This indicates that, because of the interface and fragmentation, the commercial team leader can only talk to the PM to pass on new ideas to the designer. However, the designer might argue and stick to what he/she knows and the PM would not know otherwise or would not be able to test the true legitimacy of that claim, because the designer is looking at maximising an eloquent solution, whereas the commercial team comes from an efficiency perspectives. The implication here is that, because they are disconnected and sit outside the production team, the ability for that scheme to take such efficiency ideas on-board remains a challenge. This shows how far wide commercial teams are compared with designers in the production team, despite the efficiency knowledge they possess. Thus, this defeats the idea of knowledge sharing and collaboration (Challender *et al.,* 2014). The researcher asked why new coming from the commercial team aren't considered. The response was that: *"Part of it is because we are hitting our targets, and because the commercial team comes from the side-lines"* **[CSPG, CIL].**

This further explains the reason why clients and regulators are hesitant to subscribe or take on drastic changes if they're meeting their targets. This only becomes relevant when things aren't working as planned, thus the issue of knowledge sharing and collaboration will suddenly spring to mind.

6.12.3 Supports Required for Commercial Integration in CSPG

Analysis on this theme further revealed some factors required for supporting CW and commercial integration. These factors include: role-rotation for cost consultants, aligning commercial activities with production processes, and relational contracting.

Aligning Commercial Actors and Rotating their Roles in the Production System

Some of the respondents were of the view that an upfront investment, which involves aligning commercial functions in production activities, might improve collaborative practices from an efficiency perspective. As the number people (QSs), their inclusion would allow room for contesting data comparability; their involvement at the optioneering stage, examining the mechanics of the project or the historic nature of the data, could help affirms whether a rate is viable and how much a scheme would cost. One of the respondents in CSPG added to this, saying:

> *"This is one of the areas we could provide analytical support making sure that cost estimating teams are armed with everything they need at their disposal to drive efficient solutions – because a lot of the time the team make decisions without all these inputs."* **[CSPG, CIL].**

This shows a significant input from the commercial team as the data warehouse, informing the project team to support better decision-making processes throughout the business. Whether that justifies their inclusion, it is debatable and remains a resource and affordability issue, but surely their presence under the banner of efficiency would improve knowledge sharing and better collaboration upfront. The cost intelligent leader added: *"This move would also provide more cohesive understanding of data and efficiency initiatives allowing the SC to become more proactive."* Thus, if efficiency from a commercial perspective was on the collaborative agenda, the intermediary challenge (where they only communicate to the PM leads or the SC representatives, but are not particularly involved in the team meetings and discussions) would reduce, spreading commercial reach wider and improving effectiveness in collaborative practices.

Rotating the Roles of Cost Consultants

Some of the respondents shared an enthusiasm for the idea that the commercial team and their roles should be rotated, exposing them to the collaborative production views. The CD commented on this, saying:

> *"I think generally, QSs are technically savvy with high levels of technical capability theoretically but not practically."* **[CSPG, CD].**

A similar comment came from one of the CMs:

> *"This could bear more fruit if it can be empowered within their process, because most of their competencies do not necessarily demand them to go and see it for themselves, which could be one of the things that needs to change."* **[CSPG, CM]**

These examples show that having an experience of delivery is one of the things that requires going and seeing things happen on site. It could be argued that this can still fall under continuous improvement for QSs relative to their competencies, where they can engage with a fresh pair of eyes (theoretical insights), watching a process happening and thereby deconstructing it easily and understanding where to prevent productivity wastage. Indeed, this could also improve interdisciplinary working and improve the thin-line between client activities and those of consultants, which can only enhance the ability of the professionals to improve their services. More so, because QSs do not have enough interaction with the production team, hence engaging them in the process would be key to CW.

Relational Contracting

Another support to collaborative practices and commercial management was the idea of establishing a relational contract to support proper collaboration amongst project teams, as advocated by some of the respondents. The current project arrangement on CSPG indicates some disarray, with lots of external influences on the project structure. The main contractor lamented on this, saying: *"The contract formulation should encompass a single entity with HE, delivery partners, Atkins and SC running both costing and design activities together"* **[CSPG, MC].**

The contract structure in CSPG was not ideal, as earlier the study revealed some challenges. For example, the partners send design queries on design to the client, who forwards them to the designers for clarity; after two weeks the responses come back to the client, then it takes even longer for them to reach the partners. Ideally, under a single entity, both teams would be empowered to make decisions for the betterment of the project. Thus, it is a structure that can remove the barriers (due diligence, protocols and routinisation) put in place by the regulators to allow proper collaboration to flourish. This would also allow a collaborative approach to emerge in the costing and design process, with the optimisation of some commercial functions that are trapped in this arrangement. Although, this might be achievable, but it also requires external support from regulators, as this is a deep-seated industry challenge that spans organisations and project boundaries. Thus, a change would require a massive shift for everyone involved, especially the commercial teams regardless of any arrangement.

6.13 Cross Case Study Analysis and Discussions

The preceding sections (6.3 to 6.7) presented the three case study findings and discussions. This section will however focus on comparing these findings across the cases to delineate the results, as a strategy to develop a framework that could guide stakeholders to ‘costs projects collaboratively’ and improve commercial alignment in construction. The comparisons focused on the case study setting, the strategy adopted for TC development, the extent of cross-functional collaboration, commercial practices and factors affecting collaborative working, and the support required for commercial alignment. The interview transcripts are not included here, because they have been presented within the individual cases.

Case Study Background and Description of the Projects

The purpose of comparing the studied cases is to ensure that findings within the individual cases aligns with the discussion. Table 6-7 presents the case study comparisons and the project attributes. As discussed earlier, the process of TC development, SC approach, and commercial practices were investigated, which cut across some of the major sectors in the UK infrastructural sector. This indicates that the outcome of this study could offer a wider lesson to the UK construction industry in terms of CW, and a guidance note to RICS in response to UK policy on collaborative procurement and commercial management practices.

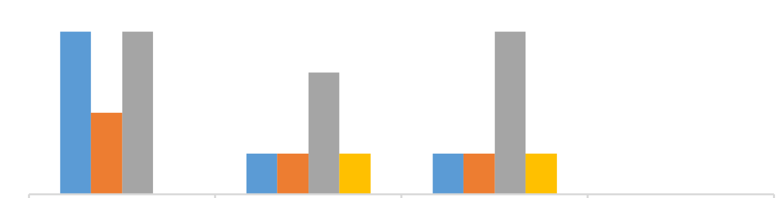
Table 6-7: Cross-Case Comparison of Project Attributes

Project Attributes	CSPA	CSPB	CSPG
Nature of project	Infrastructure & non-infrastructure	Infrastructure	Infrastructure
Location of project	East England, Peterborough UK	Derby, East midlands, UK	Northampton, east midlands England
Nature of works	Design & construction of water recycling treatment plants	Construction of water recycling treatment plants and sewage works	Upgrade of highway to smart motorway btw J19 &16
Type of client	Public client	Public client	Public client
Mode of partners/SC selection	Alliance, framework	JV, framework	JV/framework
Proposed project duration	60 months	60 months	24 months
Procurement arrangement	Centralized procurement system	D&B	D&B
Contract sum	£1.2 billion	£200 million	£120 million
Process explored	Costing	Costing	Costing

Demographic Information on Case Study Respondents

Overall, 23 semi-structured interviews were conducted across the three case-studies as illustrated in Table 6-8. The participants comprised of 6 project team directors, 10 commercial directors/managers, 3 senior QSs, 2 estimators, 1 main contractor and a designer. This shows that key construction practitioners were interviewed across the projects. CSPA had the highest number of directors/commercial managers interviewed, whilst CSPB and CSPG had fewer number of directors, commercial managers, QSs and other members from the contracting side. However, this variation has complemented the researcher's selection of these participants in the cross-case comparison and analysis. Moreover, their combined personal experiences in collaborative practices was vital, which makes their responses more credible.

Table 6-8: Categories of Participants



	CSPA	CSPB	CSPG	
Directors	4	1	1	
Commercial Managers	2	1	1	
Estimators/Designers/QSs	4	3	4	
Contractor	0	1	1	

6.13.1 Cross-Case Comparison and Discussion on Target Costing Approach

Table 6-9: Summary of TC/TVD Principles Examined Across the three Case Studies.

TC/TVD principles examined	CS1	CS2	CS3
Setting TC based on design, value, with cross-functional team.	Occurs partially	Occurs partially	Occurs partially
Continuous estimating (over-the-shoulder estimating technique).	Partially utilised	Not Utilised	Not Utilised
Colocation.	Utilised	Utilised	Utilised
Relational contracting.	Sporadic	Sporadic	Sporadic
Application f last planner system	Occurs partially	Occurs partially	Occurs partially
Application of BIM, Set-based design & Choosing by advantage methods.	Partially Utilised	Not utilised	Not utilised

The study analysis showed that both CSPA and CSPB mostly adopted a top-down costing approach. This means that the TC is set by the client organisation independent of the project teams, but data from previous schemes was frequently used to inform the client cost database. It was discovered that both companies faced similar challenges with their tier-2 through pain/gain share strategies, and because the process of TC setting lacked cross-functional integration and elaborate dialogue, waste embedded within the scheme cost became difficult to eradicate. Furthermore, Table 6-9 shows that the only TVD principles which was utilised in all three cases was co-location. However, some TVD principles were partially applied; these include: the last planner system principle, some form of relational contract, and a standard process for TC setting (which occasionally involved the SCGs). Similarly, the technique of 'over-the-shoulder' estimating appeared in CSPA. Other approaches e.g. the client liaising with cross-functional teams, the use of tools like choosing by advantage, and set-based design methods, appear not to have been utilised in the three cases studied.

These findings correlate with previous studies that described the lack of collaboration with the client's team during target cost development (Pishdad-Bozorgi & Karasulu, 2013). Similarly, Ballard, (2006 & 2012) emphasised that most often owners are not aware of their alternatives at project definition stage, nor are they offered new concepts in design that would allow efficient planning and discussion on their conditions of requirement. Thus, target costs are prematurely set without cross-functional integration nor an avenue for the team to establish an eloquent cost solution. This of course is slightly similar to the above case studies, which revealed comparable limitations in their costing approaches. This further confirmed the point made by Ballard (2012), who mentioned that sharing the cost-base model would maintain trust between client and project team. This would provide the opportunity for teams to assess the clients conditions of satisfaction (time, cost, scope, etc.), and achieved the value required.

The TVD approach is known to foster innovation and collaboration, particularly prior to design, where the team are financially incentivised to meet the stretch target, i.e. lower than the expected cost. This form of collaboration allows teams to understand the client's programme requirements, project scope and constraints. However, as discovered from the above cases, the owners often set their project criteria without in-depth interactions or much input from the delivery teams or the SCGs. Therefore, this indicates that the cross-functional team (including SCGs) is not fully integrated, thus missing the chance to cost the project collaboratively. Hence, their persistent struggles in terms of behavioural influences around the wider scheme continue (Cohen, 2012; Ballard, 2012). This also means that often, the comprehensive validation study is not fully considered by the teams, as identified from the cases. This is partly because most of the time the core teams are established after the business case, which signifies that some groups are fragmented, and that reduces team rapport, which is crucial for the team to establish early costs collaboratively (Afonso, 2012).

Other key principles lacking from the cases were the use of BIM, set-based design, and choosing by advantage strategies. The absence of these tools continues to prevent potential cost-savings ideas that could be used during design reviews. More importantly, without the set-bed design options, the teams will struggle to narrow down the set of possibilities that would aid the final cost solution. Besides, as seen from the cases, these teams are established at different times, and the chances of eliminating design iterations (design-estimate-redesign) jointly, to optimise costs and the advantage trade-offs, become minimal (Ballard, 2006).

The study has also discovered that some form of collaborative contracting (NEC option C) was utilised in all the three cases. However, the consistency of encouraging SC and tier-2 groups, within the pain/gain share mechanism, to support CW was inadequate. For instance, in all the three cases, relational contracts such as IPD or similar were found to be missing. This is because the current contractual relationships within tier-1 are quite dissimilar from those in the tier-2; moreover, they are kept at arm's length and managed differently. Often, these behaviours in practice stifles collaboration, as clients repeatedly specify solutions to their problems without sharing their objectives, and this concealed information is needed by service providers (QSs), and the tier-2's to provide the optimum value when required (Tommelein & Ballard, 2016).

6.13.2 Cross-Case Comparison and Discussions on Collaboration and SC Approach

Table 6-10 presents the cross-case comparison of the three case study projects on: costing activities, extent of cross-functional collaboration, and SC management. These are discussed under four sub-themes: costing activities, key role-players, extent of collaboration and SC approach, and how they respond to the 'collaborative costing' process. As revealed in the table, these activities are essential during early costing and design development. However, the way they are carried out determines how close the teams are and the level of collaboration amongst the participants. For instance, one of the respondents from CSPA argued that, these activities occurred in almost every project, but because most of the times participants are engaged at different periods, and this affects how others buy into the collaborative initiatives. This means that, assembling teams early is not just a platform to 'cost collaboratively', but a precondition that can create a collaborative working environment (Ballard and Reiser, 2004).

Table 6-10: Cross-case Comparison of Degree of Collaboration & Supply Chain Approach

	CSPA	CSPB	CSPG
Costing Exercise	Optioneering, risk/value session, validation exercise, collaborative planning meetings, cost forecasting, project rehearsals, and scheme costing.	Validation exercise, cost forecasting, optioneering, risk & value meetings and overall system TC setting.	Prioritisation, optioneering, detail design dev, risk & value sessions, cost forecasting/negotiations and system TC setting.
Key Players Involved	Clients rep (feasibility engineers); project manager, planner, estimators, technical manager, designer, contractor, cost engineers, and suppliers.	Clients rep, PM, designers, estimators, contractors, external cost consultants, cost engineers, and SC.	Client rep (accountants, data analyst); PM, designers, estimators, contractors, cost engineers, and SC.
Extent of Collaboration	Moderate – the alliance team managed these activities with downstream actors but sporadically.	Weak – the JV team & SC only converged to collaborate after the client team has established extensive detail.	Weak – there is no close collaboration btw the teams until after detail design is established.
Supply Chain Approach	ECI & SC engagement through a centralised system fostering collaboration and team relationships.	Procured through D&B, which revealed system incompatibility with the JV and other costing issues.	Although JV and ECI are used, but competitive tendering is still applied on SC pricing strategy.

Accordingly, as revealed in Table 6-11, members of the commercial teams, such as the QSs/estimators, are only involved with the team when the contract is in play, managing tier-2 and administering contracts. This of course has revealed some practical implications from each of the cases studied, where it has been reported to affect cross-functional integration and CW. In addition, the procurement approach and SC management cannot be overlooked, as all the three case study projects varied on this. For instance, in CSPA, which was procured under alliancing, they adopted a centralised procurement system to manage their SCGs. This has allowed the team to aggregate their spending and the commercial teams worked more closely with the SC, thereby optimising their work processes. This means that, adopting a flexible approach in procurement can embed other collaborative advantages, as opposed to the rigid approach shown in CSPB & CSPG (Sarhan *et al.,* 2017).

The approach in CSPB did reveal glimpses of collaboration between the client, project team, SC and commercial groups. Nonetheless, the method was still discrete, as the SC approach during costing and estimating was still traditional and fixed. This was because, frameworks were managed by the QSs, and the client only considered the delivery team and not the SC and vice-versa. Besides, the commercial groups were not fully integrated into the process, but were active when the contract was in play – managing tier-2 members. Furthermore, the partial usage of BIM and other TVD principles, as spotted in CSPA, has lessened other technical issues that could have occurred on the project, considering the traditional nature of costing and design development. This is evident, as CSPA adopted a strategy that utilised BIM capabilities in their project rehearsals exercises, which guided the team to reflect on the project budget, scope and constraints. Thus, this transition further promoted collaboration, and minimised the usual process waste during costing and design activities (Pennanen *et al.,* 2008).

6.13.3 Cross-Case Comparison and Discussions on Commercial Practices & Factors Affecting CW

Table 6-11 presents the results of the interview findings on commercial practices and the factors affecting CW from the three-case studied. These are also classified as factors inhibiting stakeholders from 'costing collaboratively'. These findings showed similarities between the factors identified, like excessive bureaucratic functions in each of the cases, and balancing standards with innovation on CSPB and CSPG respectively. Other factors closely associated with commercial practices include: custom and practice, commercial training and background, and the perseverance of cost negotiation.

Table 6-11: Factors Affecting Collaborative Working

Factors	CSPA	CSPB	CSPG
Commercial Practices Affecting CW.	▪ Commercial background/training conflicting delivery model. ▪ Custom & practice Safeguarding practice. ▪ Excessive bureaucratic functions.	▪ Balancing innovation & standards. ▪ Excessive bureaucratic functions.	▪ Fragmented arrangements. ▪ Poor strategy in cost & risk mgt. ▪ Perseverance on cost negotiation. ▪ Balancing innovation & standards. ▪ Excessive bureaucratic functions.

These results also complement what was described in previous studies about custom and practice, which originates from a cultural system associated with commercial actors (Gottlieb & Kim Haugbølle, 2013; Pasquire *et al.,* 2015). These activities continued to stifle collaboration in practice through behaviours around contracts, and persistence with due diligence to maintain company or client profitability at all costs (Sarhan *et al.,* 2017). The recurrence of this in a collaborative setting shows that CW is still patchy and these behaviours continue to hinder industry reforms.

Similarly, another factor which is consistent in all the cases is the onerous requirement for excessive bureaucratic functions, which is also mentioned in the studies of (Sarhan *et al.,* 2014; Rameezdeen and Rodrigo, 2013). This is found in practice where commercial actors mount pressure on the project teams via company protocols, validation etc., which add more waste and conflict to the business model. Although, these processes are designed to control the behaviours of project team members, but they are formalised in practice, which leaves a huge gap through redundant monthly routinisation processes (Fellow *et al.,* 2003) that arguably could be better balanced by the project teams themselves.

6.13.4 Cross-Case Comparison and Discussions on Support for CW & Commercial Integration.

Table 6-12 presents the nature of support required for collaboration and commercial integration, gathered from the three case studies. As revealed, the support requirements from the cases observed are categorised into: organisational, project and external supports. These factors showed commonality in the collaborative practice required within the cases, despite the different nature and specifications of each project. Furthermore, this revealed the importance of aligning commercial interests in a production system to promote industry-wide collaborative practices.

Table 6-12: Cross-case Comparison of Support Required for Collaborative Practices

Category of support	CSPA	CSPB	CSPG
Support required at project and organisational level	▪ Cross-functional integration. ▪ Enterprise model. ▪ Centralised procurement approach	▪ Collaborative workshops for costing & design process. ▪ Relational contracting.	▪ Aligning commercial practices in production process. ▪ Rotating cost-consultants/QSs roles. ▪ Establishing relational contract.
External Support	▪ Clients/stakeholder intervention	▪ Industry and academic alliance	▪ RICS intervention

6.13.5 Project and Organisational Level Supports

Several factors were identified from the three cases studied that would continue to support collaborative practices, and would also help to align commercial activities in multidisciplinary settings. Some of the identified factors have reoccurred across the cases, indicating how significant CW is to the construction industry. For example, the emphasis on cost consultants and SCGs being placed on relational contracts and their roles in the 'collaborative costing' process were mentioned across the cases. Thus, establishing an enterprise model would enhance CC, particularly when teams are looking at design options and project constraints.

This is significant, because everyone involved would see the consequences of cost components from the programme, or adding to the programme, thereby tracking the cost pieces. This would bring more benefit to the team, by enabling them to focus on exactly what might represent the best outcome from a value perspective (Mesa *et al.,* 2016). Therefore, establishing this would further improve CW and commercial practices, especially in terms of understanding risk and cost management strategies, thus improving the relationships between project teams and the SCG. Accordingly, establishing relational contracting would provide a smooth transition between project team, commercial and SCGs in a collaborative environment, particularly if QSs were effectively incentivised, as they could motivate everyone in the project to achieve high-level commitment in practice (Perera *et al.,* 2011).

Similarly, rotating commercial roles in production related roles, in a bid to offer efficiency in CW was considered essential at both process and organisational level. PQSs are generally well informed, with a high level of theoretical technical capability, but with less practical experience, and few of their functions are production related, which could be one of the things that needs to change for collaborative practices (Brien *et al.,* 2014). Arguably, this would improve their understanding of collaboration and bridge the gap between the client's activity and those of the consultants – thus enhancing the ability of professional service providers. Hence, rotating their roles in the production system would allow room for contesting data comparability, and examining mechanics of projects or the historic nature of data that normally affirms whether a rate is viable. Indeed, this might be where they could provide analytical support, making sure that the estimating teams are armed with all that they need to drive an efficient solution, project teams often make decisions without most of these inputs (Mbachu & Frei, 2011).

6.13.6 External Industry Support

As shown in Table 6-12, there are a number of external supports mentioned across the cases that are significant to industry reforms, and largely associated with commercial practices to sustain collaborative practices. Factors chiefly mentioned were: the client's intervention, industry and academic partnership, and RICS involvement. This indicates that the client's intervention remains fundamental to CW; in particular they have a role to play in motivating professionals like cost consultants, lawyers etc., to embark on any industry reforms. This is evident, as collaborative practice keeps stalling because the majority of clients are paying lip service to it (Challender *et al,* 2016).

Similarly, from a commercial perspective, this would require re-evaluation and support from the professional governing body (RICS), to recognise the inter-personal skills-sets required for CW. As traditionally structured, these professionals (QSs, consultants, lawyers etc.) never build anything, but utilise their interpersonal attributes in the transactional environment, to either implement, negotiate or deliver commercial functions. This means that they need to learn a different skill-sets to become relevant in the infrastructure environment, and support a multi-party enterprise, which is a prerequisite to participate in CW practices. Arguably, this could be supported by the RICS intervention in redefining commercial competencies that would support CW. More so, as mentioned in the cases studied, academic institutions and the construction industry need to forge an alliance with a specific focus on promoting collaborative practices. This change would be significant, as it would provide a clear channel for sharing new insights and developments on recent breakthroughs in construction between the two streams. More importantly, this would offer a new perspective for the younger graduates going into construction practices. (Perera, *et al.,* 2011).

6.14 Summary

The study revealed the results captured from the individual case studies and their comparisons. Thus, it identified the process of TC setting, SC approach, degree of cross-functional collaboration, commercial practices, factors affecting CW, and the supports required for collaboration and commercial actors in practice. These results illustrated why CW is significant in achieving industry reforms. They also show that, commercial practices need a substantial overhaul to allow such transition within the industry. Therefore, the results analysed indicate that the current costing practice is progressing within the cases examined, although for it to be more collaborative, commercial teams and the tier-2 members need to be fully integrated; this requires a shift in mind-set to subscribe fully to the collaborative culture. This is because the study showed that, within a multidisciplinary setting, the enterprise model provides a platform and qualities for CW to prevail.

The study touched on aspects that aimed to improve commercial practices and collaborative costing processes at organisational level. For instance, it showed that all commercial SCGs needs to be on relational contracts, and their roles need to support CW. Creating this within the enterprise model would encourage effective collaboration, particularly when teams are looking at early design options and project constraints. This is significant, because everyone involved would see the consequences of cost components from a programme or adding to it, thereby tracking the cost components. This would bring benefit to the team, by enabling them to focus on an optimum solution from a value perspective. Thus, this would further enhance CC, especially on risks and cost management strategies, accordingly improving cross-functional integration. Therefore, creating an 'all-inclusive' relational arrangement would provide the smooth transition required to align commercial interests in a multidisciplinary environment, as when effectively incentivised commercial actors would motivate everyone in the project to achieve high-level commitment.

Whilst comparing the TVD principles explored in the three case studies, the findings showed that an ideal CC is required in practice to improve on the current existing approach. This is because the depth for all-inclusive collaboration and dialogue with relevant parties is still weak/lacking, and risk & reward sharing mechanisms are not properly understood, especially among the tier-2 groups. For example, the STW/HE case showed that TCs are set in isolation from the project teams, using data from the 'cost capture system', and this drives the client database. It was also found that the current costing approach in HE alternates between negotiation and competition. Although AW seems to be steps ahead in terms of collaborative practices, they could also benefit from improving their take-up of further TVD principles e.g. set-based design, choosing by advantage methods, and the last planner system.

More importantly, these findings showed that all the cases seem to have integrated governance and cross-functional teams, however they would still benefit from using the project modification and innovation (PMI) process along with these principles, in order to improve their target costing approach. This is because the PMI allows stakeholders that have potential cost-saving ideas to bring them up for review, thereby allowing cost to steer design in the process. However, it would be better if the wider teams were involved from the outset (including the tier-2) to compensate for the lack of trade-specific and constructability input, to inform the limited options that aren't available during costing and design. Indeed, adopting this would further strengthen CC as a testament to its definition, upstream and downstream players need to have a sense of ownership and starts from a position of transparency and sustainability, in order to eliminate any transactional characteristics in practice. Based on the findings in this and previous chapters, a framework for 'collaborative costing' is suggested. Therefore, the next chapter will look at developing a framework to guide stakeholders to 'cost projects collaboratively' in construction.

CHAPTER 7 FRAMEWORK DEVELOPMENT AND EVALUATION

7.1 Introduction

Chapter 5 concluded that commercial behaviours still affect CW approaches in the UK construction industry. Three case study investigations were conducted to examine collaborative practices in multidisciplinary organisations. The findings were presented in chapter 6, which involved cross-case analysis to identify factors that affect CW during early costing stages. This chapter builds on these findings, including the literature review conducted to recommend a framework for CC. Section 7.2 presents the rationale and the need for the proposed framework. The overview of the framework components is discussed accordingly. The chapter concludes with an evaluation process to validate the framework.

7.2 Rationale for 'Costing Collaboratively' (CC)

According to Challender *et al.,* 2016, CW is fading within the UK construction industry largely because of commercial behaviours. These behaviours are reinforced by the prevailing procurement protocols and the 'institutional' factors that surround the prevailing project delivery system (Sarhan *et al.,* 2017). This has led to construction practitioners adopting a 'survivalist' mentality to resist change. Consequently, clients and SC organisations are struggling to realise the full benefits of CW. Similarly, these behaviours create costing approaches marred with irregularities and uncertainties, with little shared understanding amongst stakeholders; largely because the prevailing approach still follows the RIBA Plan of Work, which is discrete, sequential, and favours competitive tendering. This guides stakeholders with a narrow view that considers costing and design activities as separate functions. Conversely, the integration of design and construction creates an opportunity for commercial actors to be more deeply incorporated in CW approaches, thus removing a major barrier to the performance improvements demanded by successive UK Government reports.

However, this view remains despite the suggestions that collaboration, especially during the early costing phase, would shift the customary approach (Laryea & Watermeyer, 2010; Jung *et al.,* 2012; Ballard & Pennanen, 2013; Love *et al.,* 2017; Shalpegin *et al.,* 2018) towards cooperative management. More so, conclusions from chapter six indicate that collaboration is progressing in the current practice, especially within the multidisciplinary setting. Nonetheless, they showed that costing is still driven by price, and the limited understanding continues to affect the wider practice of collaboration in the UK construction industry. Therefore, the absence of a holistic approach to support stakeholders (including commercial actors) in CC practices informed the development of this framework. The objectives of the proposed framework are as follows:

- To identify the main factors that influence commercial behaviours and deter CW in the UK construction industry.
- To provide insights into how these factors influence commercial behaviours and CW practices.

7.2.1 Background and Development of CC Framework

The proposed framework is built on practices that have been used to explain CW in construction. It also reflects on the transition from traditional costing approaches to an integrated approach. The framework is supported by the extensive literature review conducted in stage 1 and the findings gathered from stages 2 and 3, and presented in chapters 5 and 6. Based on the literature review, the TVD system was studied as a guiding lens and some of its principles were embraced. This provided attributes that would collectively strengthen ‘flow’ and ‘value’ propositions in the proposed framework.

Data on CC are sourced from within the UK construction industry practice via interviews, documentary analysis and multiple case study investigations. Based on this, data on the current costing practice, SC approach, factors driving collaboration, barriers and constraints in costing, commercial practices affecting CW, and support required for industry-wide collaborative practice were identified. In total, 50 interviews were conducted in the study.

7.2.2 What is ‘Costing Collaboratively’?

In the exemplar of TVD, it is called ‘over the shoulder costing’, meaning that the trade contractor looks ‘over the shoulder’ of the specialist designer to provide concurrent cost and buildability advice as the work is designed, detailed and finalised. It relies on co-location of upstream and downstream actors either virtually (through BIM) or physically, to ensure real time conversations placing costing as part of design. This means project design is steered by cost, removing wasteful redesign because of budget checking as a secondary estimating/cost checking process. It requires a changed mind set and the development of new skills.

7.2.3 Overview of CC Framework

Figure 7-1 illustrates the schematic diagram of the proposed framework to guide stakeholders (clients, designers, cost consultants, contractors and SCGs) to cost projects collaboratively. It shows the journey from the prevailing approach (traditional) through an interim stage (multidisciplinary) to a mature stage (collaborative). **Maturity level 1** shows the transition of costing interactions from traditional to multidisciplinary, which is still affected by 'institutionalised' factors in construction. **Maturity level 2** illustrates organisational level commitment factors and the interfaces that need to be in place for collaborating over costing supported by sets of tools and techniques needed for effective functioning. The maturity level 2 factors enable the stakeholders (client, designers, cost consultants, contractors and SCGs) to develop an understanding of what is required to successfully costs projects in collaboration.

7.2.4 Description of the Framework Components

The framework, as illustrated in figure 7-1, contains various elements, which are discussed accordingly. The discussions explain what the proposed framework (CC) offers in terms of early collaboration during costing activities.

7.2.5 Maturity Level 1: Costing Interactions: Traditional and Multidisciplinary

Several factors were discovered to be drawbacks that affect collaboration and commercial behaviours in practice. These are broadly categorised under the 'institutional' factors arrangements, which revealed other elements like transactional cost economic (TCE) influence, the prevailing construction system, and professionalism.

7.2.6 Institutional Factors (the way we do business): This still affects CW with undue influence on commercial practices. These factors under these include transaction cost economic (TCE) influence, the prevailing construction model and professionalism.

Transaction Cost Economic Influence: There are several elements that deters CW:

- Safeguarding/ custom and practice
- Isolated (silo) practice and short-term focus
- Bargaining power among consultants

For example, bargaining power among consultants sees architects dictating the use of overly prescribed design specifications, and QSs convincing clients to include blanket contingencies in their budgets and consequently being reluctant to share information with their counterparts. Similarly, in the traditional practice, costing is subsumed with erroneous assumptions and normally carried out under pressure; consultants protect their roles through 'secrecy', with budgets fixed even when too little information is available at the outset. This creates 'guess-work' and inconsistent decisions managed through risk contingency that provide money to safeguard the parties by concealing waste rather than revealing it and removing it. This all stems from the TCE influence, which acts against CW, increasing commercial pressure and in turn stifling innovation.

The Prevailing Construction Model: This stems from the 'institutional' system establishment that reinforces traditional procurement protocols, thus encouraging commercial behaviours in practice. Factors under this include:

- Fragmented roles and professional hierarchies
- 'Survivalist' mentality
- Cost-driven environment

The prevailing model has been fragmented, and is typified by the 'survivalist' mentality where each professional occupies a well-defined position within the hierarchy of powers: architects at the top and their supporting artisans at the bottom. This mentality allows commercial actors in both traditional and multidisciplinary settings to persist with due diligence and they remain bounded by the rationality of protecting themselves and their clients at all costs. The implication is that these actors continue to exhibit 'win-lose' mentality at the expense of CW. Invariably, this encourages gaming of tender processes driving opportunistic behaviours in practice. Consequently, these practices leave cost consultants disconnected from collaboration in projects.

Professionalism and drivers: This centres on what drives consultants, in particular (QSs), and how their trainings and backgrounds affect collaborative initiatives. This includes factors such as:

- Vested interest in professional roles
- Excessive bureaucratic roles in projects
- Clients' perceptions of cost consultants (QSs)

These factors exert negative pressure on CW; for example, the role of cost consultants is too prescriptive and rigid, mostly confined by custom and practice rather than the interests of the project. Thus, during the tender process, the QSs' point of view is generally to read, understand and confirm the brief, likewise their costing activities become affirming rather than contesting for best value options. This epitomises how they are employed, largely to inform an intelligent client, thus reluctant to challenge their prescriptive roles, and limiting their input into CW. In addition, the fact that cost consultants are generally assessed based on how they are utilised in projects, instead of being valued according to their performance, perpetuates their disinterested view of collaboration. This also feeds into how clients perceive the role of QSs, where they traditionally engage them to settle commercial disputes. Regardless of the environment, they still conform to conventional protocols, customs and practice, maximising their positions and fees.

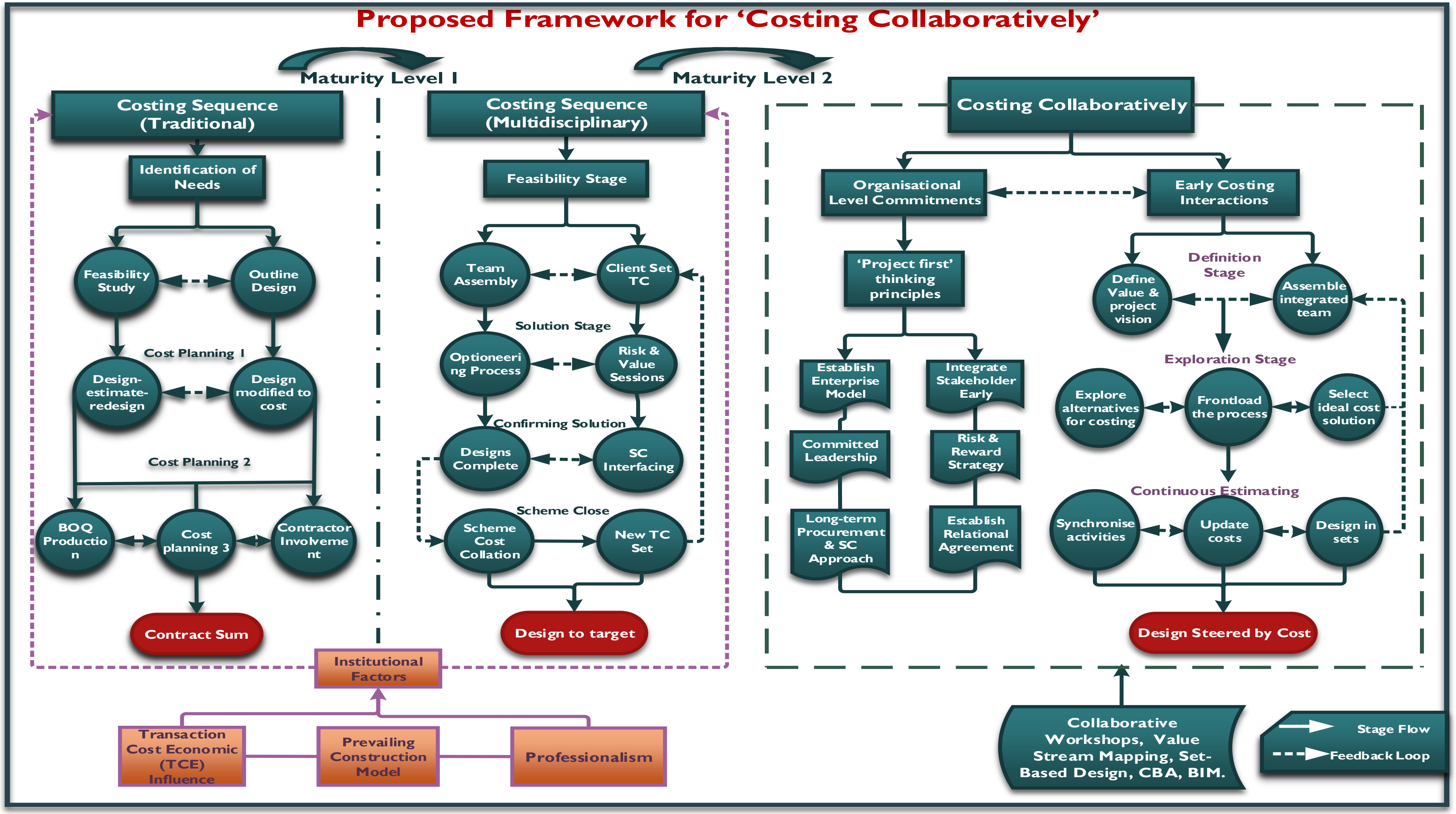


Figure 7-1: Proposed Framework for 'Costing Collaboratively'

7.2.7 Maturity Level 2: Costing Collaboratively (CC)

The component of CC is briefly described as follows:

Commitment at Organisational Level

Figure 7-2 illustrates the factors that need to be practiced at an organisational level to support CC. The purpose is to strengthen flow and value propositions i.e. the 'project first' thinking culture for transformational change in the UK construction industry.

Early Costing Interactions

These embody lean thinking, which drives early collaboration during costing activities amongst stakeholders.

Tools and Techniques

These are required for CC, which requires efficient flow and value creation path within the framework, thus maintaining trust and shared understanding amongst stakeholders.

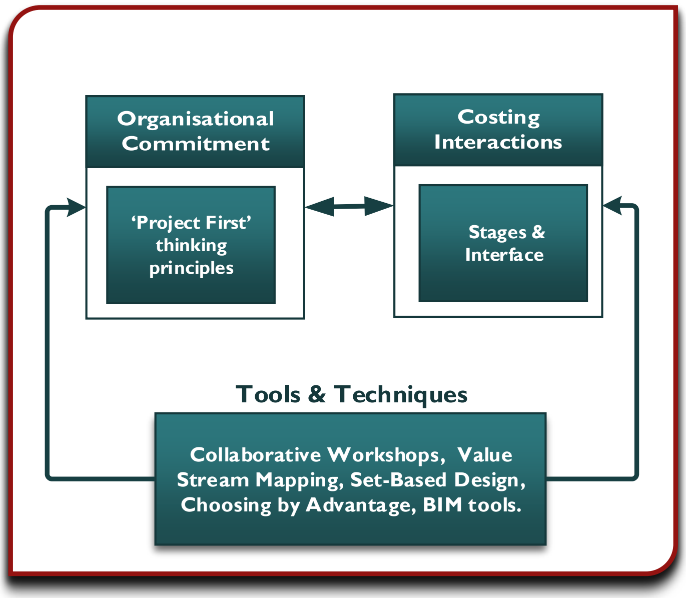


Figure 7-2: Components for 'Costing Collaboratively'

7.2.8 Costing Collaboratively: Guidance Note

A step-by-step description of the framework components is provided as follows:

Organisational Level Commitment

Commitments at organisational level are still central when embracing new concepts. CW is fading in construction largely because of commercial behaviours, lack of committed leadership, and clients preferring the lowest tender, whilst rewards are based on service provided by consultants. In seeking to understand and address the challenges posed by 'institutional' factors, additional commitment at organisational level is required to drive the culture of collaboration for systemic industry reforms. Accordingly, these are discussed under the 'project first' thinking strategy, which identified the following factors:

- Enterprise model
- Committed leadership
- Integrated stakeholders
- Long-term procurement and SC approach
- Mechanism for sharing risk/reward and;
- Trust and relational arrangement

These factors are further sub-divided into three key action steps at the organisational commitment level.

Step #1: Establishing an Enterprise Model with Committed Leadership

Traditionally, clients are not central in the prevailing model, cost and risk drivers of projects are not greatly understood, and rewards are based on service provided. Therefore, establishing an enterprise model becomes paramount. The onus here is to go beyond the traditional norm that allows commercial 'secrecy' to persevere, with high transactional characteristics as the principle means of securing project objectives. Hence, creating a system that allows stakeholders to offer innovative solutions through shared understanding to improve project deliverables should be prioritised (Liker and Morgan, 2006). For instance, there is now high demand in the UK construction industry to mirror manufacturing advances (Farmer, 2016; ICE, 2018); such movement would require committed leadership with high incentives and alignment to support these initiatives.

Ideally, this would need a system integrator (in this case a client), linking stakeholders' capabilities with the project value vision. This needs project teams, commercial and SCGs to work harmoniously where best value can be added (Ballard, 2016). Traditionally, teams are formed at different times, which makes it difficult to collaborate, particularly looking at interactions during costing, where perceptions vary and SCGs are not considered until solutions are identified. Hence, high performing enterprises need to be established to align the interests of individuals and organisations with that of the project. Thus, the model needs to operate efficiently to embed the cultures of learning and continuous improvement. This would enable stakeholders to understand each other's expectations, setting clear precedence for cost and risk drivers.

Step #2: Upfront Investment & Long-Term Supply Chain Approach

After identifying the governance strategy (enterprise model and committed leadership), the next step is to commit and integrate stakeholders in a timely fashion, particularly commercial & SC groups, by centralizing the procurement approach. As the traditional arrangement demarcates between design and construction, thus the presumption of best value delivery is by selecting the lowest cost qualified participants. Hence, to avoid that, all stakeholders need to align and integrate with the enterprise model so that cost predictability, team cohesion and frequent constructive dialogues are improved in order to achieve greater accountability and management.

Since the SCG covers over 60% of capital costs, the procurement approach needs to be centralised. This would bring about close collaboration with avenues to validate project constraints and opportunities (aggregating spending, optimising process, achieving target goals etc.). With this in place, the expectations of stakeholders would be understood and commercial interests would be aligned, reducing any frictions from the SCGs, thus allowing participants to utilise their expertise with that of the end-user in a manner that optimises performance.

Step #3: Establish Trust and a Relational Form of Contracting: Reward/Risk Strategy

Meaningful collaboration requires trust, where participants have a sense of ownership over the project and end-goals. Specific drivers for commercial actors on 'best-for-project' at an organisational level need to be identified, as traditionally, the contractual arrangements for cost consultants and SCG varied. This compels aligning commercial groups under a mechanism (risk/reward sharing), to support project outcomes rather than individual firms' contributions. This would ensure that project risks are accountable and not transferred. Thus, the approach needs to be captured under a relational contracting agreement, to allow collaboration, long-term relationships and shared accountability amongst participants. Hence, professionals (such as cost consultants (PQSs), designers, and construction lawyers) need to be party to this agreement, as this would ensure the team works as one to optimize value, reinforcing the culture of a single team and, most importantly, encouraging collaboration during a project's difficult stretches. Therefore, the use of a relational contracting agreement is advised here to put a handle on contractual behaviours that exist between upstream and downstream players, which need aligning with the organisational commitment strategies for CW to be sustained.

7.2.9 Early Costing Interactions

The early costing interactions identified the main stages that need to be created and practiced to support CC in practice. These need to be aligned with the organizational commitment factors for collaboration to thrive. The principles within TVD are embraced. These include:

- Definition stage
- Exploration stage
- Continuous estimating stage

Step #1: Definition Stage

To define the client's business case, there is the need to assemble stakeholders early. This would allow the client to set an allowable cost (AC), in contrast with the market cost (MC), where the difference will be used to develop an expected cost (EC). Assuming the validation is successful, the team will then set a target cost (TC). The purpose of this early interactions is to separate value added from waste to address what the client wants in terms of desirability, and what he/she can afford viability, using the necessary technology to aid delivery feasibility (Brown, 2009). Thus, this requires close collaboration, with key suppliers, owner, advisors (including QSs) and contractors working as one team. This collaboration is crucial, as both the client and stakeholder's value ambitions will then be understood (Alves *et al.,* 2017).

Step #2: Exploration Stage

Establishing the TC is in an effort to provoke innovation, which will create stretch goals for the team to achieve. Thus, this stage gives way for multiple rounds of discussions around the defined-value, needs and wants, and thoroughly exploring ways to achieve these goals. This means frontloading the development process where designers, builders and suppliers continuously explore a wide range of potential problems and alternative solutions, to take advantage of the collective knowledge of those who will deliver the project. Herein, the SCG should constantly challenge the client's assumptions on their needs, informing them about alternatives and associated costs. Thus, this exploration would narrow down the alternatives to a single solution, and the process needs to be supported with risk and value workshops.

Step #3: Continuous Estimating Stage

Once the solution cost has been established, the team needs to share input and maintain efficiency in the process, so that non-value adding activities are understood and streamlined. Thus, to facilitate this and achieve a value-based decision, the team's rolling estimates of costs should be routinely compared to the solution cost to assure project feasibility. This characterizes the technique of 'over the shoulder costing', allowing regular frequent estimate updates whilst also tracking specific variance of previous costs, and synchronizing activities to eliminate waste and update the stretch target.

All three stages need to conform to the business case in order to prevent wasteful redesign cycles. Therefore, the team should be able to reduce waste during costing iterations, thus design within the range of affordable cost solutions.

7.2.10 Tools and Techniques

The two framework components need to be supported by tools and techniques that promote innovation, enhance value and assist stakeholders in making collaborative decisions. Hence, these tools should encompass ***collaborative workshops***, ***value stream mapping***, ***set-based design***, ***choosing by advantage,*** and ***BIM.***

To achieve the desired level of commitment within organizations, there is the need to have collaborative workshops. These would allow owners/clients to understand how the team plans to deliver the project, with emphases on finding ***desirability***, ***viability*** and ***feasibility*** factors. This reiterates the need for a comprehensive team, so that the owner can articulate his/her value vision better, rather than defer to the solutions posed by in-house consultants based upon perceived expertise. Furthermore, tools like value stream mapping (VSM), set-based design (SBD), and choosing by advantages (CBA), need to be adopted in this approach.

Through the VSM exercise, waste embedded in the pricing elements can be minimized and costing processes optimized before committing to any solution. Similarly, the SBD, would allow multiple options to be explored simultaneously, whilst the team converges on what is perceived to be the best solution at the last responsible moment; these options need to be evaluated according to the importance of the advantages they offer relative to the set of factors that contribute value. Thus, the team collectively must be collectively aware of each cost forecast so that value can be optimized. Equally, using visual simulating technology (BIM) and decision-making tools like CBA, stakeholders would be able to understand the impact of their decisions on costs. Therefore, those entrusted to develop project costs need to interact in many ways, as this would promote rapid problem solving and breaking away from the traditional norms.

7.3 Evaluation and Refinement of the CC Framework

7.3.1 Rationale for the Framework Evaluation

The framework for 'Costing Collaboratively' was evaluated to achieve the following objectives:

- To confirm if the two component levels identified in the proposed framework are the core areas stakeholders need to focus on during CC.
- To assess the adequacy and completeness of each of the elements identified in the maturity levels (1 and 2).
- To evaluate the usefulness and relevance of the proposed framework.
- To identify areas that need to be removed, included, or improved.

Based on these evaluation objectives, questions were posed to the participants (see appendix).

7.3.2 Collaborative Costing Process Evaluation Method

The importance of evaluating research outcomes with participants cannot be over-emphasised. This exercise has been described as a good strategy, which guides the quality of research output and the interpretation of data (Bazeley, 2013; Silverman, 2013; Cresswell, 2007). Professionals and construction practitioners evaluated the proposed framework for CC, which involved the use of two methods: *focus group* and *semi-structured open-ended interviews*. The focus group session was undertaken with industry practitioners who had experience in lean construction and commercial management practices. The purpose of the session was to receive detailed feedback on the quality of the proposed framework (Appendix 7), and to make necessary corrections before sending the 'evaluation' invitations out to a sample of industry experts.

Focus group interviews are a well-rehearsed practice in the social science field. The process generally encourages people to discuss specific subjects, which highlights issues (norms, beliefs, values), common to the lives of all participants (Bloor *et al*., 2001). Accordingly, the researcher conducted a focus group session that took place in NTU, and lasted for about 45 minutes.

During the session, the author delivered a Power Point presentation to the participants about the aim and objectives of the study, and the proposed framework. The participants were put into groups and provided with printout copies of the framework, upon which they could comment. The process enabled the author to make some minor (but valuable) corrections to the framework. Following this, the author spent 5 minutes to capturing each group's conclusions and confirming the corrections made. An example of suggestions for correction from the groups includes:

> *"There should be a 'step' in the design delivery process of which collaborative cost estimating is a sub process to examine constructability of each of the designed solutions, and should be included alongside the development of the programme for construction phase."* **[David Haycock, Lean Practitioner, Mott MacDonald, Feb 2019]**

Another suggestion stated that:

> *"There should be an inclusion of time and risk as dimensions to collaborative costing approach, delivery risk model as an incentive, and means of diluting the advantages of individual parties for information power and alignment of scheme objectives and rewards."* **[Alan Mossman, the change Business Ltd Feb 2019]**

These assertions were made so that teams inspired to collaborate would have business case focus, investing into the value that need to be delivered, instead of relying on the traditional approach we often see in practice. Similarly, the tangible elements required to measure performance related outcomes from the whole team were mentioned, particularly regarding professional cost consultants. In addition, there were suggestions for the process to be iterative and the introduction of certainty outcome measures for the proposed framework. Thus, this was meant to allow far-reaching discussions during cost development, so that business benefits could be achieved. Indeed, understanding this type of collaboration needs to be all-inclusive (beyond what the client wants), in the same way, considering value expectations of consultants and SC members.

Consequently, the second stage of the evaluation consisted of open-ended semi structured interviews and surveys with the original study participants (SP) and non-study participants (NSP). This was done to understand the levels of difference in terms of perceptions from those who participated in the study and those who did not participate. The feedback from SPs provides internal validity, whilst that from NSPs supports the external validity. Silverman, (2011) stated that verifying research outcomes with the research participants further increases the confidence and the credibility of research results. However, Bazeley, (2013) cautioned that the feedback from the research participants alone may not necessarily be final, as there could be the possibility that the researcher's conclusions could differ from the respondents' views.

Eleven questions were developed (see Appendix 8) to evaluate the CC framework. The questions were structured and open-ended, to allow respondents to share their subjective views. The participants were drawn from the UK, US, and Europe; this was done to encompass a wider range of perceptions of the framework. However, because the study was conducted in the UK, the majority of the respondents were British. Each of these participants was provided with:

- An invitation sheet that outlined the purpose, and included details of, the evaluation process (See Appendix 6).
- A copy of the Power Point presentation used in the focus group session described above.
- A copy of the framework explanation note.

The evaluation feedbacks is presented and discussed below.

7.3.3 Characteristics of the Participants used in the Evaluation

The evaluation process consisted of seven main open-ended qualitative questions, where the respondents were asked to provide the author with their written feedback and evaluation. Written communication was chosen over face-to-face communication, to allow the participants sufficient time and space to evaluate the findings of the study appropriately, without being influenced or constrained by the interviewer's physical presence.

Table 7-1: Participants Used to Evaluate the Framework

Participant code	Position	Country of Practice	Years of experience in construction/manufacturing & other industries	Qualification
NSP01	Academia	UK	10+	Doctorate BEng
SP01	Lean Specialist	US	25+	BSc, MEng
SP02	Commercial Director	UK	28+	AIQS, ARICS
NSP02	Academia/Lean Practitioner	South Africa	18+	Doctorate
NSP04	Lean Expert	US	15+	BSc., MSc.
NSP03	Lean Consultant	Norway	15 - 20	BSc, MSc.

As mentioned previously, those that participated in the study were denoted with a code (SP) and the non-study participants with NSP. However, all had some level of experience in collaborative project delivery in construction, as shown in table 7-1. The respondents were drawn from academic disciplines, client, main contracting, and consulting organisations. This shows that the evaluation results would sufficiently represent the views of key practitioners the proposed approach is targeting. Altogether, six experts participated in the evaluation process. They were all purposively targeted based on their expertise, strategic view, and broad experience in construction practices. More information about their positions, years of experience and professional qualifications can be seen in table 7-1 above.

7.3.4 Discussions of the Evaluation Findings

Table 7-2 presents the responses received from the participants (SP and NSP) who evaluated the CC framework. Their responses were measured on a Likert scale 1 to 4 (where 1= very low coverage, 2 = low coverage, 3 = high coverage and 4 = very high coverage). The results indicated that there was no significant difference in their responses on the key aspects of the CC framework evaluated. The participants were also asked to provide suggestions for improving the proposed framework, future research directions, and potential practical implications.

Table 7-2: Results of the CC Framework Evaluation

	Aspects of the CC framework Evaluated				
Participant code	Appropriateness of maturity level 2 factors	Level of completeness of the institutional factors	Level of influence of the institutional factors on CW	Level of completeness of the entire framework	Relevance & representation of reality
NSP01	4	3	3	3	Yes
SP01	3	3	3	3	Yes
SP02	3	2	2	3	Yes
NSP03	3	3	3	3	Yes
NSP03	4	3	2	3	Yes
NSP04	4	3	3	4	Yes
Overall mean response	**3.5**	**2.83**	**2.6**	**3.2**	**Yes**

The mean response for the appropriateness of the maturity level 2 factors considered by both SP and NSP was 3.5. This shows that there is no significant variation in their responses in relation to the CC framework. It also means that both the SPs and NSPs believed that that the factors considered at maturity level 2 were comprehensive in relation to CC and commercial practices. This finding supports the internal validity and external validity of the proposed framework.

7.3.5 Appropriateness and Completeness of the Framework Components

The evaluation results revealed that both the SP and NSP believed that the maturity level 2 factors considered in the framework were essential areas of focus for stakeholders to achieved CC, with a total mean score of 3.5. The majority of the respondents also agreed that the ‘institutional’ factors considered are mostly responsible for CW issues. For example, the total mean responses for 'institutional' factors identified were 2.83, and 2.6. This shows that the key factors that would enable stakeholders to develop an understanding of the 'institutional' and commercial issues which hinders collaborative practices, are adequately considered in the proposed framework.

However, the level of coverage and response to of the 'institutional' factors seems to show the least response from the research participants, with a total mean response of 2.6. This could be due to the high expectations of the respondents regarding this. For instance, some of the respondents suggested on a step by step approach to how the framework will overcome the QS challenge, which is deeply ingrained in the 'institutional' system in the UK construction industry. However, this is not the aim of the proposed approach; moreover, Sarhan (2018) has already published the 'institutional' concept. Nonetheless, in response to this, a guidance note was developed to enable stakeholders to understand the steps required at each level (see Appendix 10). In addition, the results in Table 7-2 indicate that both the SP and NSP believed that the factors considered in the framework were comprehensive, with an average mean response of 3.2.

7.3.6 Relevance and Usefulness of the Framework

All of the respondents agreed that the proposed framework could support stakeholders to cost construction projects collaboratively. Since this question was open-ended, the respondents were able to share their views on the usefulness of the CC framework. Some of the respondents stated that:

"*Yes, the framework could be implemented with an internal and external facilitator.*" **[NSP, Lean Consultant, Norway].**

"*Yes, this will allow clients and decision makers to focus on the key issues and understand the difference between traditional costing and collaborative costing.*" **[NSP01, Academia, UK].**

The above statements clearly show that the proposed approach would be useful to construction stakeholders in terms of implementing the CC framework. However, some of the respondents recommended that the proposed approach should be used with the support of an experienced facilitator for maximum benefit. Here are some of the comments:

"The approach should be used with an experience facilitator." **[Commercial Consultant, UK]**

"As it stands, I would recommend a training for employees on the use of tools and techniques needed for embracing CC." **[Academia/Lean Practitioner, South Africa]**

The above statements indicate the need to engage experienced facilitators and construction practitioners to develop the approach further. More so, the majority of the respondents indicated that the proposed approach could be adopted/adapted in several places. This shows that the usefulness of the proposed approach is not just limited to the UK construction industry where the study was conducted. As some participants supports the assertions drawn from US, South Africa and Norway.

7.3.7 Improvements to the Proposed Approach and Future Research Directions

Two objectives of the evaluations were to identify areas that needs improving in the proposed approach, and future research directions. Some of the respondents suggested that an industry tailored guidance note should be developed to supplement the proposed approach.

Some of the respondents' statements were: "*It needs more explanation to all categories within the model; for example: first time thinking, institutional factors, optioneering, set-based design, etc. These could go in a table or appendix."* **[SP01, Lean Specialist, US]**

"There is the need to identify QSs' perceptions on the CC framework model and a deeper investigation of the technical, commercial and social/cultural factors inhibiting their engagement in CC or collaborative working in general." **[NSP01, Academia, UK]**

*"Going forward, the framework need to go beyond the expected costs at the end of design to the end of the project. As most projects run into cost issues during construction. To understand how we can set the right environment to help mitigate the issues raised."***[SP02, Commercial Director, UK].**

In response to some of the feedback on the need to support stakeholders' understanding of the CC framework, a guidance note (which is industry-tailored and describes each component and the step actions required at each stage) would be developed. It is worth mentioning that developing the CC framework beyond the expected cost was not an objective of this study. This is due to the limited period of the study and the methodology adopted, which is exploratory and descriptive rather than an action research.

7.4 Chapter Summary

This chapter focused on answering one of the objectives set out in this study: *how to guide stakeholders through the necessary steps to cost projects collaboratively in the UK construction industry.* The chapter established the rationale for developing the proposed approach, which also creates opportunities for commercial actors to be deeply involved in CW approaches in construction. The chapter showed how the current costing model (traditional and multidisciplinary) is impaired by the 'institutional' factors in construction, with less attention to other factors like commercial activities and behaviours in collaborative programmes. To address this gap, a framework for CC was proposed. The aim of the framework is to guide stakeholders (clients, designers, cost consultants, contractors and SCGs) through the necessary steps to cost projects collaboratively in the UK construction industry. The proposed approach consisted of maturity level 1, which covers the transition of costing interactions from traditional to multidisciplinary, but still affected by 'institutional' factors in construction; and maturity level 2, which depicts organisational level commitments and the interface to collaborate over costing supported by sets of tools and techniques that are needed for effective functioning.

The chapter showed that the maturity level 2 is the essential area to focus on in the implementation of CC. The chapter also highlighted the necessary steps actions to follow in order to understand the proposed approach. The steps actions required at each level were classified into organisational commitment factors and early costing interaction stages. The chapter demonstrated that the proposed approach would support industry-wide understanding of the CC approach in construction. This was based on the feedback received from the evaluation of the proposed approach. To further support this, it was suggested that an industry guidance note be developed to assist stakeholders in fully understanding the framework.

The evaluation results indicated that the issues covered in the proposed approach were adequate to support and guide construction stakeholders to understand what needs to be in place to cost projects collaboratively. Some of the feedback comments suggested that the approach could easily be adopted/adapted in other countries to support collaborative approaches for early costing development. It is worth noting that some of the evaluators were based outside the UK; this was because the author struggled to find respondents with vast knowledge on lean and integrated practices within the UK, and therefore contacted international participants. The next chapter will present the conclusion and recommendations of the study.

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

Chapter 1 covered the introductory part of this research study. Chapters 2 and 3 explored the literature review and the research background. Chapter 4 examined the methodology, and suitable strategies were selected and justified. The research process was covered in two stages: exploratory interviews and multiple case studies. Chapter 5 presented exploratory findings, analysis and summary of the first stage of the research process. Chapter 6 presented findings from the case studies as well as the cross-case analysis and discussions. Chapter 7 presented the development and evaluation of the proposed framework to address the key issues discovered.

This chapter captures the main findings, conclusions and recommendations of the study. Furthermore, the chapter discusses the conclusions and achievement of the research objectives, to highlight the contribution of the study. The limitations of the research are also presented. Finally, the chapter concludes with recommendations for further research, which are derived from the conclusions and limitations of the study.

8.1.1 Achievement of Research Objectives

The aim of this study was to develop a framework that would guide stakeholders to cost projects collaboratively, creating opportunities for commercial actors to be more deeply involved in CW practices in the UK construction industry. To achieve this aim, five objectives were developed, as illustrated in table 8-1.

The study used the data collected to develop the proposed CC framework. The study aggregated data from within the UK major sectors (building, highways, and infrastructure). This involved the use of interviews, documentary analysis, and case study investigation. Overall, 50 interviews were conducted and three in-depth case studies captured. Table 8-1 summarises how the study tackled each of the objectives.

Table 8-1: Summary of how the research objectives were achieved.

Objective	Research Objectives	Methods Used	Chapter
01	To critically review commercial practices within the prevailing UK construction system.	Extant literature review on past research and industry reports on project delivery performances within the UK construction industry.	Chapter 2
02	To explore the notion of 'costing collaboratively' in construction practices.	Review extant literature on collaborative practices, TVD and IPD case study applications and deduction of their impacts.	Chapter 3
03	To investigate the perceptions of 'costing collaboratively' in the UK using TVD as a guiding lens.	Conducted 27 semi-structured exploratory interviews with practitioners within the UK construction industry. This was then supplemented with three in-depth case study examinations, and data were gathered through interviews (23) and documentary analysis provided by the participants.	Chapter 5 and 6.
04	To examine commercial practices in traditional & multidisciplinary settings, identifying factors affecting CW in the UK construction industry.		
05	To develop and evaluate a framework that would guide stakeholders to cost projects collaboratively in the UK construction industry.	Development of CC framework based on the findings from stages 1 - 4. Stakeholders evaluated the framework.	Chapter 7

8.1.2 Literature Review

Objectives 1 and 2 were achieved through an extant literature review process, as presented in chapters two and three of the thesis. The details of these objectives are as follows:

Objective 1: Critically evaluate commercial practices within the prevailing UK construction model.

The aim of objective one is to review the UK construction business model and evaluate the separation of commercial functions from production activities during project delivery. This objective was accomplished, as the author reviewed various delivery routes adopted for project delivery, and contrasted them with lean project delivery approaches. The review discussed the factors deterring CW and implications arising from that.

Objective 2: To explore the idea of 'costing collaboratively' in construction practices.

This objective was accomplished, as the author reviewed the concept of collaboration and its relationship to the current costing practice in construction. The review enabled the study to draw on the TVD model as a guiding lens to explore how stakeholders costs projects collaboratively in the UK construction.

Objective 3: To investigate the perceptions of 'collaborative costing' in the UK construction industry using TVD as a guiding lens.

The aim of this objective was to gather industrial perceptions on CC and its development in practice. To achieve this objective, 27 semi-structured interviews were conducted, which elicited views from stakeholders in building and infrastructure sectors. In addition, three in-depth case studies were also carried out with 23 interviews, and the findings were triangulated to obtain a wider perspective. Objective 3 was achieved through exploratory interviews, which were discussed in section 5.1. This allowed the study to conduct an in-depth investigation with free flow of information from the participants. The rationale for their selection was discussed in section 4.5 of this thesis. Details of the process are presented in chapter five.

8.1.3 Case Studies

Three in-depth case studies were conducted to achieve to: examine commercial practices in traditional and multidisciplinary settings; and identify factors affecting CW in the UK construction industry. Findings from the cases were presented in chapter six, along with the cross-case analysis. The main objective of this investigation was:

Objective 4: To examine commercial practices, identifying ethical implications and factors affecting CW in the UK construction industry.

To achieve this objective, three in-depth case studies were conducted. In addition, evidence from the earlier semi-structured interviews was triangulated to obtain a wider perspective.

8.1.4 Framework Development & Evaluation

Objective five was achieved by the development of a framework, following the cross-case analysis and the exploratory investigations. The process was to ensure that the issues raised were captured and the proposed framework was improved, hence its evaluation by industry practitioners.

Objective 5: To develop and evaluate a framework for "costing collaboratively".

The aim of this objective was to develop a framework that would guide stakeholders' efforts to cost projects collaboratively during early stages. To do this, the principles embedded particularly in TVD (which encourage collaboration in costing) were embraced. Thus, three in-depth case studies were conducted over an 18 month period. The framework (non-prescriptive) was developed and evaluated by six industry experts. The framework developed comprised of two maturity levels. Maturity level 1 showed the transition of costing interactions from traditional to multidisciplinary, but still affected by indirect factors in construction. Maturity level 2 illustrated organisational level commitment factors and interfaces for collaborating over costing, supported by sets of tools and techniques needed for effective functioning. A guidance note highlighting the framework components, was developed (see Appendix 10).

8.1.5 Summary of Main Findings

The main findings of the study are summarised as follows:

- The demand for performance improvement and modernisation is not limited to the UK construction industry, but is a global phenomenon. The study discovered that, over the years, the much-adhered-to project delivery routes adopted have not comprehensively improved performances in the industry, because innovative concepts found in a lean system (e.g.; IPD, TVD, BIM) are not being implemented – thus confirming that construction activities are still functionally organised i.e. working in 'silos' with little or no concurrence. This shed light on why the term 'delivery' seemed to be considered as a type of transaction, rather than a process for moving facility from concept to customer. This continued to allow multiple interfaces within the delivery model, and commercial actors still operated in 'silos', with unnecessary transactional characteristics under a deficient system.

Consequently, this revealed poor understanding of construction as a 'collaborative production' from various stakeholders in practice.

- In terms of fragmentation, the study identified the separation of commercial functions from production activities. This illustrated why various parties in construction continue to adhere to the cultural system (illustrated in the business as usual model). Within these arrangements, the study recognised that cost consultants still operate in 'secrecy' outside production, which revealed implications that have consequential influence on commercial behaviours and impede CW.
- The study established that the UK construction environment still operates as a service providing industry. This was confirmed after reviewing the lean construction system, which is still largely regarded as SC management strategy in the UK. Nonetheless, the review showed how the three components within the IPD system (organisation, operating system and commercial terms) if combined could reinvigorate commercial practices in the traditional system.
- The study reviewed the concept of 'costing collaboratively'. This showed the dearth of collaborative approaches in the current practice. This examination indicated a growing trend, which showed that collaboration is a key and integral component required to transform the customary approach. The study made comparisons with the TVD model; this showed how the concept embraced collaborative principles during costing phases. More so, it revealed that TVD is not static, but has evolved, steering design to cost and eliminate waste in the process. This was demonstrated through the complementary principles found in TVD (BIM, SBD, CBA, and LPS amongst others). In contrast, the review showed that the RIBA Plan of Work model, which forms the basis for costing practices in the UK, does not support CW.
- The study identified the attributes that define the concept of 'costing collaboratively' in practice. This showed some distinctions with cost negotiating strategy. Accordingly, the study found that the current perceptions of CC seem to lean towards cost negotiation. In the same way, the prevailing factors that deter CC and influence commercial behaviours were identified, namely: erroneous assumptions and habituation, the inflexible roles of cost consultants, institutional

arrangements, clients' presumptions about QSs, construction sector dynamics, and commercial governance/protocols amongst others.

- The examined case studies revealed that TC are set by the client organisation independent of the project teams, and mostly use data from previous schemes to drive the client cost database. This means that the owners often set their project criteria often with no input from the delivery team or the SCG. This also suggests that SCGs are not aligned with the project team, hence why transactional behaviours and poor understanding of value creation persist during early costing activities.
- The study examined early costing activities within the multidisciplinary setting. The study recognised the lack of relational arrangements between the participants. Thus, the depth for collaborative dialogue between parties during costing was found to be weak, and risk & reward sharing strategies were not properly understood, especially amongst the tier-2 groups. The study also recognized factors that continue to influence commercial behaviours, including: safeguarding, custom and practices; leadership and bargaining power; and clients' perceptions of cost consultants. The study considered these factors vital, and they need to be addressed for CW to be sustained.
- The study also discovered some factors which are classified as support for commercial integration in CW programmes. These were triangulated from the exploratory investigation to the cases examined, and grouped as support at either organisational or project level to improve CW. The former includes cross-functional integration, enterprise model, relational contracting, and a centralised procurement approach; the latter comprises of client/stakeholder's interventions, RICS involvement, and academic alliance.

8.1.6 Main Conclusions of the Research

The main conclusions that can be drawn from the findings are as follows:

- The study brought some insights into how commercial practices and behaviours affect CW in the UK construction industry. These revealed why QSs in the prevailing system are hesitant to collaborate or support CW efforts in practice. Noticeably, within the deficient system, they are engaged differently and at different times, which is why they continue to lean towards their accustomed behaviours. Some of these behaviours were also discovered in multidisciplinary settings and the majority of these activities added no value to the overall production team. Hence, this implies that, without proper commercial integration into production activities, most of the barriers found to unsettle collaboration would remain, regardless of the environment.

- The emergence of the TVD concept has shown that the current costing practice needs to move from conventional to a more social-based approach to enable CW in practice. This highlights the importance of an integrated system away from the dominant one that focused on activity-to-activity thinking. This is because the separation of costing and design activities drives the expensive cycle of 'design-estimate-redesign', thus deterring value-adding opportunities. This also shows that the current practice needs a collaborative approach to support 'flow' and 'value' perspectives, for smooth running of production activities. More importantly, the transformational change required in the UK construction industry seems to hinge on collaboration, thus aligning commercial interests within the production system means CW would become mainstream.
- The study found some constituent elements that described stakeholders costing projects collaboratively, which include: target costing, all-inclusive value engineering, and optioneering. Using these principles, CC was defined as a process that incentivises stakeholders (upstream and downstream) around a wider scheme budget with sense of ownership, driving positive behaviours to achieve a desired cost outcome. This idea was explored to understand how the current practice is progressing. The findings showed that ideal CC is required to improve the existing approach, because the depth for collaborative dialogue with relevant parties is weak/lacking, thus risk & reward sharing strategies are not properly understood, especially within the tier-2 groups. Even though, the current approach showed progress where it revealed customer focus, design centred and somewhat cross-functional teams, it was still driven by price, and the limited understanding continued to affect the wider practice of collaboration in the UK construction industry. Thus, it would be even better if the principles found in TVD (such as SBD, CBA and relational contracts) were incorporated into the process of TC development. More so, if the wider teams were involved early (including the tier-

2 and commercial groups) to compensate for the lack of trade-specific and constructability input to inform the limited options that are not available during early costing interactions. Therefore, establishing this would further strengthen CW, as testament to the definition of CC. Upstream and downstream players need to have a sense of ownership and start from a position of transparency and sustainability, to eliminate any transactional characteristics in practice.

8.1.7 Research Contribution

The study set out to address the research questions posed in section 1.5 and restated here:

1. *What does 'costing collaboratively' mean?*
2. *What are the factors affecting CW that drive commercial behaviours?*
3. *How would the integration of commercial actors improve 'collaborative costing' approaches in the UK construction industry?*

The contribution of this research falls into two main categories: academic and practice. The first research question addresses the theory, whilst the second research question has practical implications.

Academic Contribution

As discussed in section 3, there are increasing numbers of research studies that have discussed commercial challenges and collaboration in construction. This is due to the persistent calls for modernisation within the construction landscape. However, the general focus has been on the implementation of enriched concepts, with less emphasis on factors deterring commercial alignment in wider CW in construction practices, particularly at conceptual stages.

The contribution of this research emerged from revealing the disconnect and lack of collaboration, particularly in commercial functions (costing & design) from the 'production' system in the UK construction industry. The study contributes to the limited literature on collaborative approaches in costing practices. This provides evidence through extant literature evaluation that explored TVD, signposting how the current practice (the UK approach) could transition to a more social approach to encourage industry-wide CW. Accordingly, this research was used to shed light on the degree of collaboration in multidisciplinary costing practices. This further contributes to theory by identifying key commercial behaviours that still affect transformational change in the industry from quantity surveying perspectives. The issues raised were used within the thesis in section 7.2 to develop a non-prescriptive framework for stakeholders to 'cost projects collaboratively'.

Contribution to Practice

One of the key issues that this research sought to address was exploring opportunities for commercial actors to be deeply involved in CW approaches. This is because the UK construction industry has limited examples where these actors are fully aligned to support wider collaborative practices in construction. Section 2.4.4 indicated some examples that highlight the current issues. This research provides a view on how fragmented commercial roles are within the prevailing UK business delivery model, which continues to deter efforts on transformational change in the industry. Following this, a framework was developed in section 7.2, which was based on the existing costing practices. It provides stakeholders (clients, designers, contractors, cost consultants, SCGs) with the opportunity to look at what needs to be in place to align commercial interests, and hence cost projects collaboratively in practice. Therefore, the study provides a simplistic and yet very effective approach for CC to improve the wider understanding of collaboration in the UK construction industry.

8.1.8 Research Publications

As part of the contribution of this research to the lean construction and project management field, the following papers have been developed and published from this research:

1. Conference paper: **Ahmed S.N**, Pasquire C, Manu E, (2017) Discrete Costing Versus Collaborative Costing Proc. 25th Ann. Conf. of the Int'l Group for Lean Construction, 4-12 July, Crete, Greece, 2017 (Published).

2. Conference paper: **Ahmed S.N**, Pasquire C, Manu E, (2018) Positioning Quantity Surveyors in a Production System. COBRA conference proceedings, hosted in conjunction with the annual built environment event, 24-25 April, London, UK (Published).

3. Conference Paper: **Ahmed S.N**, Pasquire C, Manu E, (2018) Evaluating Why Quantity Surveyors Conflict with Collaborative Project Delivery System. Proc. 26th Ann. Conf. of the Int'l Group for Lean Construction, 16-20 July, Chennai, India, 2018 (Published).
4. Conference Paper: **Ahmed S.N**, Pasquire C, Manu E, (2019) Exploratory Study of 'Costing Collaboratively' in the UK construction industry. Proc. 27th Ann. Conf. of the Int'l Group for Lean Construction, 1-7 July, Dublin, Ireland, 2019 (Published).
5. Journal Article: **Ahmed S N.**, Pasquire, C., and Manu E. (2020) Key Factors affecting Commercial Actors in Collaborative Working Practices: A UK Perspective. Journal of Financial and Property Management in Construction (Forthcoming).

8.1.9 Research Implications

Addressing the research questions in section 8.4 has wider implications for the aspiration of CW within the UK construction industry. The main implications discussed in this section of the thesis are on commercial behaviours and their impact on CW.

CW in construction, as discussed in section 3, is still patchy. The industry has, through different procurement protocols, attempted to address this by introducing integrated approaches to project delivery. Examples of such practices have been discussed in section 2.3. These efforts have improved somewhat the project delivery approach, but have not been able to deal completely with the issue of hierarchical fragmentation (commercial isolation). Various studies, as discussed in section 2.5, have lamented on this issue and linked this with fragmentation in the UK construction industry, as a major barrier to collaboration and innovation. The realisation and aspiration of the UK construction industry with regards to improving sustainable project delivery approaches has still not been achieved. This research contributes to this debate and efforts to improve commercial practices within the construction industry, by highlighting the faults of such separation in the business delivery model (section 2.4.4). The research also highlights issues and factors that needs to be addressed if commercial behaviours and CW challenges are to be overcome (chapters five and six). The development of a non-prescriptive framework for the wider practice of collaboration is also an effort directed at commercial integration in construction practices.

8.1.10 Research Limitations

Every research study has its limitations; this thesis is no exception. Thus, the main limitations for this study are as follows:

- The data gathered for this research mainly focused on upfront costing (e.g. through design). This implies that the 'collaborative costing' process explored did not capture practices from actual production process (e.g. construction and pre-fabrication) on final costs sufficiently. Future studies should consider this.
- The identification of the key factors influencing commercial behaviours did not sufficiently cover trust and risk dimensions as incentives to 'cost projects collaboratively'. Establishing this would offer improvement to the proposed framework. Future research should consider this.
- Whilst an effort was made to draw CC evaluators from across the globe to reflect a wider perspective, the majority of those who eventually participated were mainly practitioners from within the UK. Thus, this raised the question of culture and preference, which can influence judgement.
- This study was undertaken with three large UK multidisciplinary organisations that have started adopting integrated practices in costing. Findings from this research can therefore not be empirically generalisable throughout the wider UK construction industry. Application of findings would have to be restricted to cases that bear similarities to those reported in this study.

8.1.11 Recommendations for Future Studies

- This study has successfully explored and defined an approach for stakeholders to cost projects collaboratively in the UK to engender industry-wide collaborative practices. However, the study was only able to look at CC during initial project stages. Thus, if a project is delayed, as more than two thirds of projects are, there would be associated costs tied to this. Consequently, this drives behaviours to recover costs, due to low margins on projects. If the goal is to address both expected costs at completion of design and expected costs at the end of the project, future research needs to expand this into the construction elements of projects.

- Whilst this study focused mainly on the developed approach of CC (e.g. through design), further research needs to take this beyond the expected costs at the end of design, to the end of construction using the definition of CC. This would perhaps provide the empirical evidence required regarding how to create an environment that would mitigate early costing issues and intensify CW.
- Considering the increased call by the UK government for modernisation and sustainable project delivery strategies, future studies should compare QSs' core competencies and lean construction principles, and thus examine how they could be adapted to support CC in practice. It would also be helpful to identify QSs' perceptions of the CC framework model, and to conduct a deeper investigation of the technical, commercial and social/cultural factors preventing their engagement in CW in general.
- Also, considering the increased reports of commercial alignment in 'collaborative production' phases in construction, future studies are recommended to conduct an action research on factors that motivate members of the commercial groups and their behaviours in production within the UK construction industry, and relate these to this study's findings. This could provide a clear picture of the prerequisites for achieving alignment with greater success at the beginning of a project and at appropriate interim milestones; potentially, using the plan-do-check-act (PCDA) loop.

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APPENDICES

Appendix 1: Sample of Semi –structured interview guide

NOTTINGHAM TRENT UNIVERSITY

An exploratory study on quantity surveying practice and lean construction: expanding the collaborative system.

The aim of this research investigation is to gather knowledge and understand how Quantity Surveyors (QSs) roles can be transformed and incorporated into a collaborative system. This seeks to uncover the support needed by the industry and construction practitioners for a holistic collaboration in the processes of costing and risk management to improve construction productivity. It is expected that the research will develop a guideline model depicting new transformed QSs roles from the costing and risk management functions into the collaborative system.

Note: The results to be obtained through the interviews will only be used for this research study and will not be used for any other purpose. All responses remain completely confidential.

Section one: Background information of respondent:

Company Name...

Job title and description..

Years of experience & professional qualification..

What is the main activity of your business? (e.g. design, construction, or cost consultancy).

Section 2: This section attempts to explore and understand the approach to project delivery system and the level of collaboration in construction. It will also examine the wider role of QSs around costing process and risk management - and how these functions can be enhanced. Other aspect of the investigation will look at the barriers and challenges preventing the industry and the QSs towards collaborative system.

Collaboration

1. What do you understand by the term collaboration and collaborative working?
2. How would you characterise the state of collaborative working in the industry?
3. How do you think we can create a collaborative system (CS) where all the project participants' interest are aligned?
4. Do you think the QSs are important in a CS? Will it better if they are integrated and how?
5. So, how do you think they (QSs) can operate within a collaborative system?
6. Is collaborating same as negotiating or colluding? Do you think the QSs are not collaborating because of the fear of collusion?
7. What sort of competencies/skillsets and behaviours do you think the QSs need to transform their roles in a CS?
8. What do you think about a role-rotation for the QS professionals?
9. How do you think the QSs view themselves with the industry trends and innovations?

Project delivery approach

1. Construction system has two separate streams (i.e. production and risk-averse) why do you think is that?
2. In your opinion, do we need to change our mind-set on that approach?
3. Why do you think clients continue to use the services of QSs in a traditional manner?
4. Do you think that eliminating waste (as advocated in lean practice) is sufficiently accounted for and evaluated in the current QSs functions? Why and how can they improve on that?

QSs on costing management practices

5. The important function of QSs is to forecast the project cost. Do you think that current approaches in costing practice help to forecast in a satisfactory manner? How do you think that can be improved?
6. So, how do you approach costing process, who are involved? Is there any collaboration with the QSs during production related activities? What is preventing that?
7. How do you approach risk mgt process? Who are involved? What are the systems used and how is it organised?
8. What sort of role do you think the QSs could play in a joint risk mgt process?

Barriers and challenges for the industry and the QSs

1. Do you think there would be conflicts/challenges within a collaborative system if the QSs were incorporated?
2. How would you characterise the challenges encountered during costing and risk management process? are they people, process, management or technology related based on your experience?
3. How can the industry and QSs improved or overcome these challenges?

Appendix 2: Research Interview Consent Form

NOTTINGHAM TRENT UNIVERSITY

Research Project: An exploratory study on quantity surveying practice and lean construction: expanding the collaborative system.

Note: This consent form is to be retained by you and the researcher. At the completion of the research it should be dispatched in a secure fashion.

Relevant data will be collected via:

- Interviews
- Documentary evidence
- Observation

I agree to participate in the study

I understand that my participation is voluntary, that I can choose not to participate in part or the entire project and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

I understand that details of the material discussed are confidential and agree not to disclose any of the information given to any other party.

I agree to the interview being audio recorded for the interviewer's reference only. I agree to the use of anonymised quotes in this thesis and other academic publications

Participant's name…………………. Signature…........... Date…

Researcher: **Supervisory team:**
Sa'id Ahmed Namadi Professor, Christine Pasquire
Doctoral Researcher Dr. Emmanuel Manu
Nottingham Trent University
sa'id.ahmednamadi2015@my.ntu.ac.uk

Appendix 3: Sample of the Study Consent Letter Issued

NOTTINGHAM TRENT UNIVERSITY

Invitation to participate in research interview

Research Project: An exploratory study on quantity surveying practice and lean construction: expanding the collaborative system.

Researcher:	**Supervisory Team:**
Sa'id Ahmed N.	Prof. Christine Pasquire
	Dr. Emmanuel Manu

You are being invited to take part in a research study. Before you decide, it is important that you understand why the research is being undertaken and what it involves. Please take time to read the following information. Ask us if there is anything that is not clear, or if you would like more information. Finally, take time to decide if you want to take part or not.

Purpose of the study:

The aim of this research investigation is to gather knowledge and understand how Quantity Surveyors (QSs) roles can be transformed and incorporated into a collaborative system. This seeks to uncover the support needed by the industry and construction practitioners for a holistic collaboration in the processes of costing and risk management to improve construction productivity. It is expected that the research will develop a guideline model depicting new transformed QSs roles from the costing and risk management functions into the collaborative system.

Must I participate?

No. It is up to you to decide whether or not to take part. If you do, you will be asked to sign a consent form. You are still free to withdraw at any time without giving a reason.

What happens, if I participate?

You will be involved in an interview, which will take not more than 60 minutes

- The interview may be voice recorded
- The results will be used to develop a guideline model
- The data will be treated with anonymity and confidentiality

Are there any risks / benefits involved?

There are NO risks or monetary benefit involved in participating in this study. However, copy of the thesis or a summary of the major findings can be made available. Please provide an email if interested...

Will my taking part in the study be kept confidential?

All data will be coded and anonymised so that no individual can be identified in future publications.

Please retain a copy of this and the consent form and do not hesitate to contact us if you need further clarification on this.

Yours faithfully,

Sa'id Ahmed Namadi

Doctoral Researcher Nottingham Trent University

sa'id.ahmednamadi2015@my.ntu.ac.uk

Appendix 4: Open-ended Case Study Interview Guide

An exploratory study on collaborative costing approach: creating opportunities to improve accuracy and consistency in cost management.

This research aims to explore and understand how current cost management practice and collaborative approach in costing is understood in the UK construction industry. It seeks to uncover what collaborative costing is, what innovation would it bring to the role QSs and cost management, and better practice to support collaboration in construction. Equally, it seeks to identify the barriers, benefits, opportunities and ethical implications in early costing activities. The case study will enable the researcher to obtain information that will aid in developing roadmap guide that can improve QSs cost practices. It will also provide a guidance note to the RICS in response to the UK policy on collaborative procurement.

Note: The results to be obtained through the interviews will only be used for this research study and will not be used for any other purpose. All responses remain completely confidential.

Section 1:

This section attempts to obtain background information on the organizations and respondents participating in the study:

Company Name...

Job title and description..

Years of experience & professional qualification..

What is the main activity of your business? (E.g. design, multi-disciplinary, or cost consultancy).

Section 2: Perceptions on 'collaborative costing' process

This section attempts to explore how collaboration in costing/design process is understood, and determine the drivers and standards required to improve its maturity in the UK cost model.

1. What is your understanding on the term collaboration?
2. What are QSs early cost advice role in your org?
3. What do you think collaboration over costing activities would mean for commercial team/QSs?
4. Where does collaboration stops and where does collusion starts?
5. Are there aspects in your projects where commercial team are involved for cost development? What stage is that? Who are the key players in that process? In addition, what are the underlying factors that encourage this early engagement?
6. In your opinion, what is the difference between collaboration to develop costs and negotiating on cost price with other parties? What is the boundary here?

Section 4: Views on the current costing approach & challenges

This section seeks to identify the underlying barriers and ethical implications from costing approach on commercial functions.

7. Based on your experience, what do you think are the issues with the current costing approach in the industry?
8. What are the commercial barriers that are in play affecting collaborative arrangements in projects/programme? In addition, how can these be overcome?
9. What are the implications of these barriers on project performance and behaviours?

Section 5: Supports required and opportunity for collaboration during costing

This section explores and seeks to understand the opportunities for early collaboration during costing and design activities, and what it would add to the cost adviser's roles.

10. What opportunities does early collaboration in costing presents to the teams in terms of minimizing cost disparities during feasibility, tender etc.?
11. Early team integration and commercial engagement is crucial to this approach, what kind of support do you think cost advisers/QSs etc., need to flourish in this arrangement?
12. What form of support do you think is required from the industry at project, organisational and external level to allow for these innovations?

Appendix 5: Approval Letter from College Ethical Committee

NOTTINGHAM TRENT UNIVERSITY

Ethical Approval

DS Dossor, Sarah
Tue 25/10/2016, 10:20
Ahmed Namadi, Sa'id 2015 (PGR); Pasquire, Christine; Manu, Emmanuel

Reply

Dear Sa'id
I am delighted to confirm that your application for ethical approval for Lean in Quantity Surveying has been approved. On behalf of the Joint Inter College Ethics Committee I would like to take this opportunity to wish you every success with the project.
Best regards,

Sarah Dossor
Research Office Team Leader
Arkwright 204
College of Art, Architecture, Design and Humanities
Nottingham Trent University
50 Shakespeare Street
NOTTINGHAM
NG1 4FQ

Tel: 0115 848 2393
Fax: 0115 848 4298
Email: sarah.dossor@ntu.ac.uk
www.ntu.ac.uk

JICEC Checklist approved_ 'Lean in Quantity Surveying'

2

Wragg, Claire
Mon 24/10/2016, 12:30
Ahmed Namadi, Sa'id 2015 (PGR); Pasquire, Christine

Reply

Draft Interview Question... 16 KB

JICEC Checklist 2015-16.... 63 KB

2 attachments (79 KB) Download all Save all to OneDrive - Nottingham Trent University

Action Items

Dear Sa'id,

I am pleased to inform you that your Ethical Clearance Checklist attached and entitled : 'Lean in Quantity Surveying' has been approved by Professor Michael White, Chair of the Joint Inter-College Ethics Committee (JICEC) In Art, Architecture, Design and Humanities on 19th October 2016.

Please can you sign the amended JICEC form attached? Please bring a copy to my office or scan a copy in.

Thank you.

Kind Regards,

Claire

Claire Wragg
Research Administrator

Appendix 6: Evaluation Invitation Sheet (Qualitative) Questionnaire

Exploratory Study on Collaborative Costing Process in the UK Construction Industry

Researcher	Sa'id Ahmed Namadi, PhD Candidate, MSc Construction Mgt
Contact details	Email: said.ahmed@ntu.ac.uk
Programme of study	PhD in Construction Management
Faculty/University	Centre for Lean Projects, School of Architecture Design and the Built Environment, Nottingham Trent University, United Kingdom
Project supervisors	Prof. Christine Pasquire, Director of the LCI-UK Dr. Emmanuel Manu, Senior Lecturer at NTU

Dear Participants,
You are invited to evaluate and validate a proposed framework that provides new perspective on early collaboration and costing approach. The devised framework forms part of a PhD dissertation at Nottingham Trent University, which aimed to gather knowledge around the understanding of 'collaborative costing' process and how it is currently applied in the UK construction industry. The underlying premise is that if we understand the principles and drivers for collaboration, then 'collaborative costing' approach may be improved and more widespread. The developed framework is based on the findings of the following completed activities:

- Data obtained from three specific case studies from major infrastructure sector in the UK (18 interviews + document reviews).

- 25 in-depth interviews with senior directors, managers, cost consultants, Lean construction practitioners and other professionals within the UK construction industry.

The interview process will be recorded and would take no more than 30 minutes, however, you can decline to partake or withdrew your interview information before the thesis is publish if you so wish.

Contact for Further Information
Professor Christine Pasquire
Head of the Centre for Lean projects and Director of the LCI-UK
Nottingham Trent University
School of Architecture, Design and the Built Environment
Shakespeare St, Nottingham, United Kingdom
NG1 4FQ
Tel: +44 (0) 115 848 2095
Email: christine.pasquire@ntu.ac.uk

Thank you for taking the time to read this information sheet
Date
March 2019

Appendix 7: Framework Evaluation Questions on Focus Groups

Framework Evaluation Questions

The aim of this structured interview is to evaluate and validate the developed framework on 'collaborative costing' process in terms of its relevance, completeness, representation of reality, and feasibility.

Please refer to the schematic diagram on the framework guide. Kindly provide us with feedback on the developed framework by answering the following questions:

1. How well do the factors and elements identified (in the framework) describe collaborative costing and commercial management?

2. To what extent do the indirect factors influence collaborative working and commercial practices?

3. What is missing from the recommendations put forward on the organisational commitment factors and process for costing?

4. How could the proposed framework be improved to highlight important issues related to collaborative costing and commercial management?

5. What performance criteria should cost consultants risk/reward be measured on?

6. What additional elements are required to design to target?
7. Can you please provide us with your suggestions for any of the following:

   - Improving the developed framework?
   - Future research directions?
   - Potential implications on practice?

Thank you for your invaluable insights and contribution to the study.

Sa'id Ahmed.

Appendix 8: Open-ended Evaluation Questions for Industry Experts

Structured and Semi-Structured Survey to Evaluate and Validate Framework for 'Costing Collaboratively' in the UK Construction Industry

Researcher	Sa'id Ahmed Namadi, PhD Candidate, MSc Construction Mgt
Contact details	Email: said.ahmed@ntu.ac.uk
Programme of study	PhD in Construction Management
Faculty/University	Centre for Lean Projects, School of Architecture Design and the Built Environment, Nottingham Trent University, United Kingdom
Project supervisors	Prof. Christine Pasquire, Director of the LCI-UK Dr. Emmanuel Manu, Senior Lecturer at NTU

Dear Participants,
You are invited to evaluate and validate a proposed framework for 'costing collaboratively'. The purpose of the framework is to guide stakeholders (client, designers, cost consultants, contractors and supply chain groups) through the necessary steps to cost projects collaboratively in the UK construction industry. The developed framework is based on the findings of the following completed activities:

- Data obtained from three specific case studies from major infrastructure sector in the UK (18 interviews + document reviews).
- 25 in-depth exploratory interviews with senior directors, managers, cost consultants, Lean construction practitioners and other professionals within the UK construction industry.

Background of research participants:

1. Background: Academia **[ ]** Industry **[ ]**

2. Years of experience in collaborative practices…………

Years of experience in construction……………

3. Country: …………… Highest educational qualification………………………..

Evaluation Questions:
Having studied the proposed framework for CC (attached). Please rate the following questions regarding the approach on scale of 1 to 4. Indicate your response by inserting the appropriate number in the box provided and comments as appropriate.

Description of scale: 1 = Very low coverage 2 = Low coverage 3 = High coverage 4 = Very high coverage

4. Based on your experience how would you rate or describe the appropriateness of maturity level 2 factors identified as essential area of focus for CC practice in the proposed framework **[ ]** ***N.B:*** *maturity level 2 in the proposed approach refers to the essential stages where stakeholders and commercial actors require supports for CC practice.*

Please insert comments if any:

5. Based your experience, please rate the level of completeness of the institutionalized issues considered to be affecting traditional/multidisciplinary costing approach: **[ ]**

Please insert comments if any:

6. In your opinion, to what extent do the 'institutionalized' factors identified influence collaborative working and commercial practices. (Please use the scale below)
[ ]
4= completely responsible, 3= mostly responsible, 2 = somewhat responsible, 1 = least responsible

Please insert comments if any:

7. How easily can the proposed approach be understood (please use the scale below) **[ ]**
1= Very difficult to understand 2 = Difficult to understand 3 = Easy to understand 4 = Very easy to understand.

Please insert comments if any:

8. Do you think the proposed approach would in any way support CC in construction? Yes/No

Please give reasons for your comment:

10. What do you think is missing from the factors put forward for organisational commitment and early costing interactions?

Please give reasons for your comment:

11. How could the proposed approach be improved to highlight important issues related to costing and collaborative practices?

Please give reasons for your comment:

12. Please provide us with your suggestions for any of the following:

- Improving the developed framework?
- Future research directions?
- Potential implications on practice?

Please insert comments:

Thank you for your invaluable insights and contribution to the study.

Appendix 9: Data Analysis Output

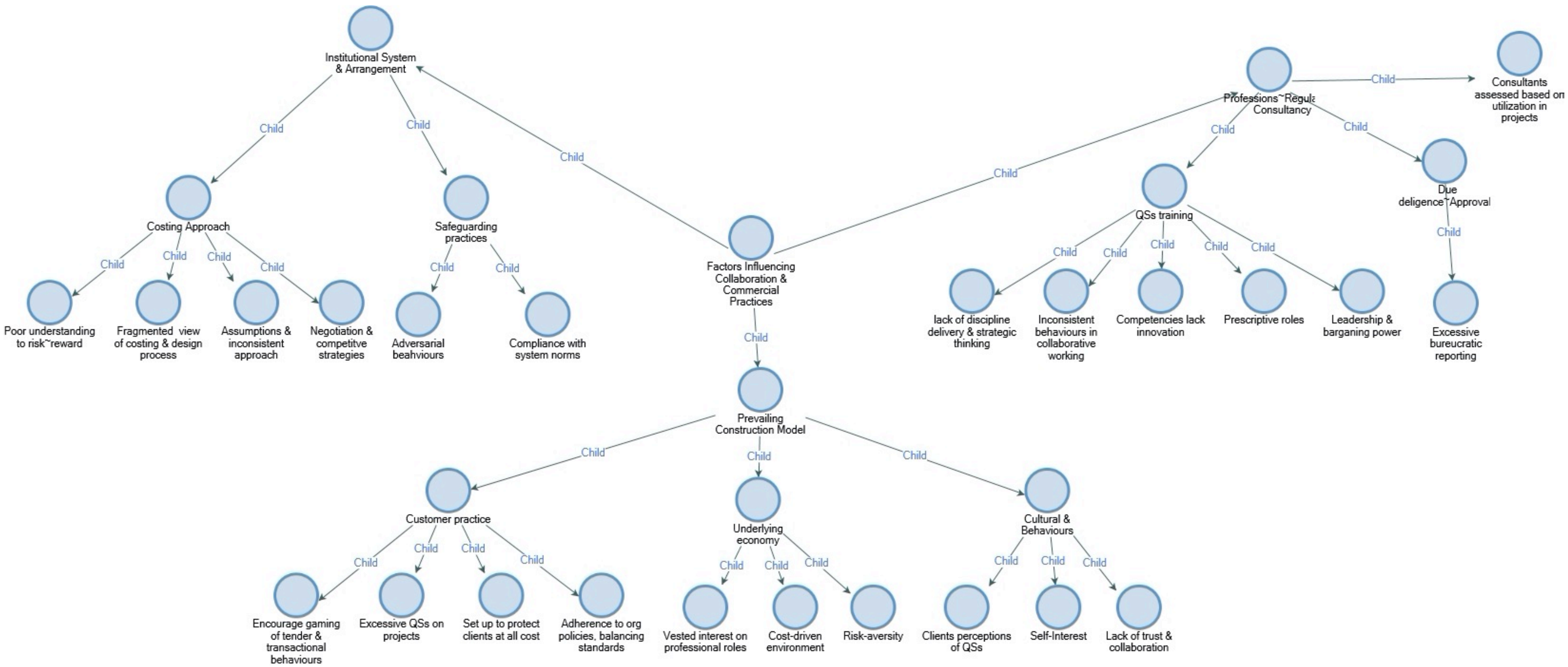

Figure: Data Analysis Output

Appendix 10: Framework Description Notes

Centre for Lean Projects
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TRENT UNIVERSITY

Framework for 'Costing Collaboratively'

Sa'id Ahmed Namadi, Christine Pasquire
& Emmanuel Manu
NOTTINGHAM TRENT UNIVERSITY

Introduction

Although collaboration has been recognised as a necessary component of success in the modern construction industry, concepts like building information modelling (BIM), integrated project delivery (IPD) and target value design (TVD) are still emerging in the construction landscape. This study is proposing a framework to enhance integration by guiding effort to cost projects collaboratively during their early stages. To do this the principles embedded particularly in TVD to encourage collaboration in costing are embraced. The main purpose of the framework is to guide stakeholders (client, designers, cost consultants, contractors and supply chain groups) through the necessary steps to cost projects collaboratively in the UK construction industry.

Why 'Costing Collaboratively' is required

According to Challender, *et al;* 2016, collaborative working (CW) is fading within the UK construction industry largely because of commercial behaviours. These behaviours are reinforced by the prevailing procurement protocols and the 'institutional' factors that surround the prevailing project delivery approach in UK construction. Consequently, construction clients and supply chain organisations struggle to realise the full benefits of CW. These commercial behaviours create costing approaches marred with irregularities and uncertainties with little shared understanding amongst stakeholders. The prevailing approach is based on the RIBA plan of work, which is discrete, sequential and favours competitive tendering. This guides stakeholders within a narrow view that considers costing and design activities as separate functions. Conversely, the integration of design and construction creates opportunities for commercial actors to be more deeply included in collaborative working approaches thus removing a major barrier to the performance improvements demanded in successive UK Government reports.

What is 'Costing Collaboratively'?

In the exemplar of TVD, it is called 'over the shoulder costing' meaning that the trade contractor looks 'over the shoulder' of the specialist designer to provide concurrent cost and buildability advice as the work is designed, detailed and finalised. It relies on co-location of upstream and downstream actors either virtually (through BIM) or physically to ensure real time conversations placing costing as part of design. This means project design is steered by cost removing wasteful redesign as a result of budget checking as a secondary estimating/cost checking process. It requires a changed mind set and the development of new skills.

Overview of the Framework for 'Costing Collaboratively'

Figure 1 illustrates the schematic diagram of the proposed framework for costing collaboratively. It shows the journey from the prevailing approach (traditional) through an interim stage (multidisciplinary) to a mature stage (collaborative).

Maturity level 1, the transition of costing interactions from traditional to multidisciplinary still affected by 'institutional' factors in construction.

Maturity level 2, organisational level commitments and the interfaces for collaborating over costing supported by sets of tools and techniques needed for effective functioning.

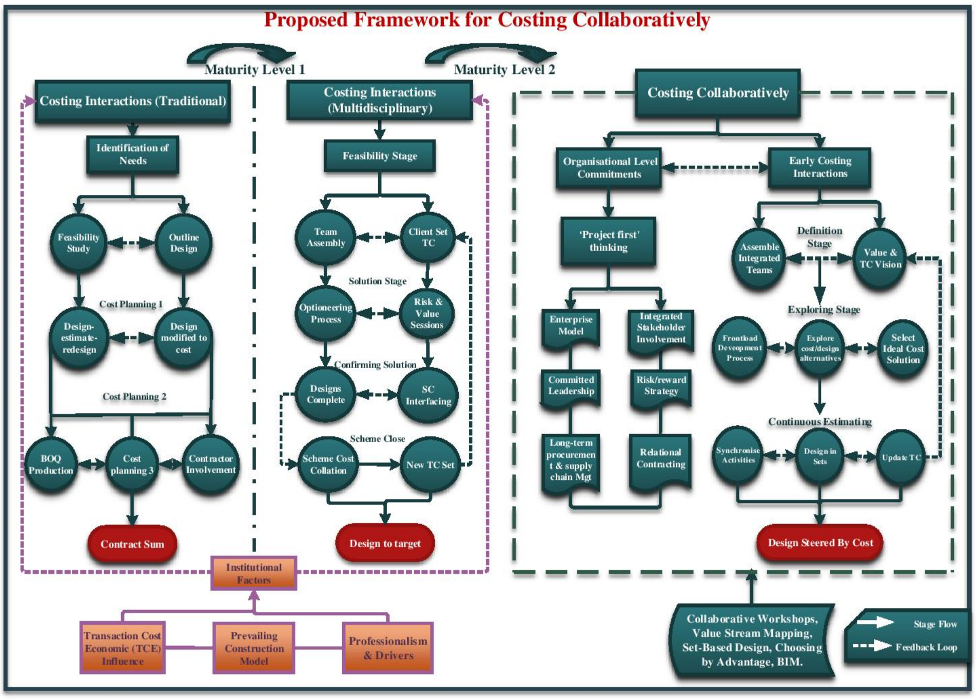

Figure 1: Proposed Framework for 'Costing Collaboratively'

Explanation of the framework components

Maturity Level 1: Costing Interactions: traditional and multidisciplinary

Institutional Factors *(the way we do business)*: this still affects CW with undue influence on commercial practices. Factors under these include *transaction cost economic (TCE) influence, the prevailing construction model and professionalism.*

Transaction Cost Economic Influence: These have several elements that deters CW namely:

- Safeguarding/ custom and practice
- Isolated (silo) practice and short-term focus
- Bargaining power among consultants

For example, bargaining power among consultants sees architects dictating the use of overly prescribed design specifications, QSs convincing clients to include blanket contingencies in their budgets and consequently being reluctant to share with their counterparts. Similarly, in the traditional practice, costing is subsumed with erroneous assumptions and normally carried out under pressure, consultants protect their role through 'secrecy' with budgets fixed even when too little information is available at the outset. This creates 'guess-work' and inconsistent decisions managed through a risk contingency that provides money to safeguard the parties by concealing waste rather than reveal it and removing it. These stem from the TCE influence, which act against CW increasing commercial pressure and in turn stifling innovation.

The Prevailing Construction Model: This stems from the 'institutional' system establishment that reinforces traditional procurement protocols, thus encouraging commercial behaviours in practice. Factors under this include:

- Fragmented roles and professional hierarchies
- 'Survivalist' mentality
- Cost-driven environment

The prevailing model has long been fragmented, which typifies the 'survivalist' mentality where each professional occupies a well-defined position within the hierarchy of powers: architects at the top and their supporting artisans at the bottom. This mentality allow commercial actors in both traditional and multidisciplinary settings to persist with due diligence and bounded by the rationality of protecting themselves and their clients as all cost. The implication is that these actors continue to exhibit 'win-lose' mentality at the expense of CW. Invariably, this encourages gaming of tender process driving opportunistic behaviours in practice. Consequently, these practices leave cost consultant disconnected from collaboration in projects.

Professionalism and drivers: This centres on what drive consultants, in particular (QSs), and how their trainings and backgrounds affects collaborative initiatives. This has factors like:

- Vested interest of professional roles
- Excessive bureaucratic roles in projects
- Clients perceptions of cost consultants (QSs)

These factors exert negative pressure on CW, for example, the role of cost consultants is too prescriptive and rigid, mostly confined by custom and practice rather than the interests of the project. Thus, during tender process, the QSs point of view is generally to read, understand and confirm the brief driving likewise their costing activities become affirming rather than contesting for best value options. This epitomises how they are employed, largely to inform an intelligent client, thus, reluctant to challenge their prescriptive roles, thus limiting their input to CW. More so, because consultants generally are assessed based on how they are utilised in projects instead of being valued according to their performances. Hence, their disinterested view in collaboration. This also feeds into how clients perceive the role of QSs, where they traditionally engage them to settle commercial disputes. Regardless of the environment, they still conform to conventional protocols, custom and practice, maximising their positions and fees.

Maturity Level 2: Costing Collaboratively

The component of CC is briefly described as follows:

Organisational Level Commitments: These illustrate the factors that need to be practice at organisational level to support CC. The purpose is to strengthen the culture of 'project first' thinking for transformational change in the UK construction industry.

Early Costing Interactions: These embodied lean thinking, which drive early collaboration during costing activities amongst stakeholders.

Tools and Techniques: These are required for CC, which need efficient flow and value creation path within the framework, thus maintaining trust and shared understanding amongst stakeholders.

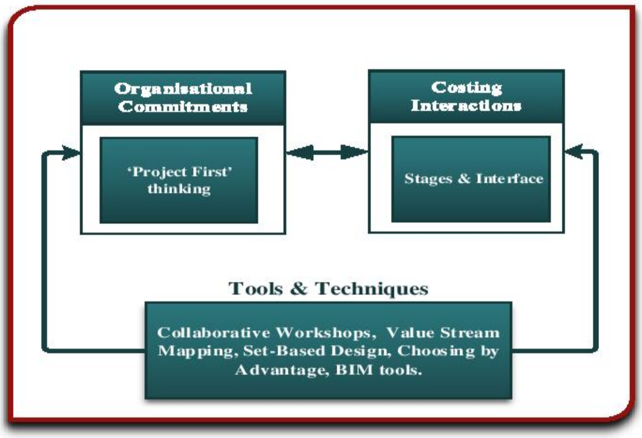

Figure 2: Components for 'Costing Collaboratively'

Costing Collaboratively: Guidance Note

A step-by-step description of the framework components is provided as follows:

Organisational Level Commitments

Commitments at organisational level is still central when embracing new concepts. CW is fading in construction largely because of commercial behaviours, lack of committed leadership, clients preferring lowest tender, while rewards are based on service provided by consultants. In seeking to understand and address challenges posed by the 'institutionalized' factors, additional commitment at organisational level are required to drive the culture of collaboration for systematic industry reforms. Therefore, the following factors should be embraced:

- Enterprise model
- Committed leadership
- Integrated stakeholders
- Long-term procurement & supply chain approach
- Mechanism for Sharing risk/reward and;
- Trust & Relational agreement

These factors are further sub-divided into three key action steps at the organisational commitment level.

Step #1: Establishing Enterprise Model with Committed leadership

Traditionally, clients are not central in the prevailing model, costs and risks drivers of projects are not greatly understood and rewards are based on service provided. Therefore, establishing an enterprise model becomes paramount. The onus here is to go beyond the traditional norm that allow commercial 'secrecy' to persevere with high transactional characteristics as the principal means of securing project objectives. Hence, creating a system that allow stakeholders offer innovative solutions through shared understanding to improve project deliverables should be prioritised. For instance, there is now high demand in the UK construction industry to mirror manufacturing advances, such, movement would require committed leadership with high incentives and alignment to support these initiatives.

Ideally, this would need system integrator (in this case client), linking stakeholder's capabilities with the project value vision. This needs project teams, commercial and supply chain groups (SCG) to work harmoniously where best value can be added. Traditionally, teams are form at different times, which is difficult to achieve the required level of collaboration, particularly looking at interactions during costing; where perceptions varied, and SCG are not considered until solutions are identified. Hence, high performing enterprise need to be establish to align the interests of individuals and organisations with that of the project. Thus, the model need to operate efficiently to embed the culture of learning and continuous improvement. This would enable stakeholders to understand each other's expectations, setting clear precedence for cost and risk drivers.

Step #2: Upfront Investment & Long-Term Supply Chain Approach

After identifying the governance strategy (enterprise model and committed leadership), next is to commit and integrate stakeholders timely, particularly commercial & SCG by centralizing procurement approach. As the traditional arrangement demarcates between design and construction, thus, the presumption of best value delivery is by selecting the lowest cost qualified participants. Hence, to avoid that, all stakeholders' needs to align and integrate with the enterprise model so that cost predictability, team cohesion and frequent constructive dialogues are improve to achieve greater accountability and management.

Since SCG covers over 60% of capital costs, procurement approach need to be centralised. This would bring about close collaboration with avenue to validate project constraints and opportunities (aggregating spending, optimising process, achieving target goals etc.). With this in place, the expectations of stakeholders would be understood, commercial interest will be aligned reducing any frictions from SCG, thus allowing participants to utilise their expertise with that of the end-user in a manner that optimise performance.

Step #3: Establish Trust & Relational form of Contracting: Reward/Risk Strategy
Meaningful collaboration require trust where participants have a sense of ownership over the project and end-goals. Thus, specific drivers for commercial actors on 'best-for-project' at organisational level need to be identified. As traditionally, the contractual arrangement for cost consultants, and SCG varied. This compels aligning commercial groups under a mechanism (risk/reward sharing), to support project outcomes rather than individual firm's contributions. This would ensure that project risks are accountable not transferred. Thus, the approach need to be captured under relational contracting agreement, to allow collaboration, long-term relationships and shared accountability amongst participants. Hence, professionals like cost consultants (PQSs), designers, construction lawyer's need to be party in this agreement, as this would ensure the team work as one to optimize value, reinforcing the culture of single team and most importantly, encourage collaboration during project's difficult stretches. Therefore, the use of relational contracting agreement is advised here to put a handle on contractual behaviours that exists between upstream and downstream players, which needs aligning with the organisational commitment strategies for CW to be sustain.

Early Costing Interactions
The early costing interactions identified the main stages that need to be created and practiced to support CC in practice. This need to be aligned with the organisational commitment factors for collaboration to thrive. The principles within TVD are embraced. These include:

- Definition stage
- Exploration stage and;
- Continuous estimating stage

Step #1: Definition stage
To define the client's business case, there is the need to assemble stakeholders early. This would allow the client to set an allowable cost (AC), in contrast with the market cost (MC), where the difference will be used to develop an expected cost (EC). Assuming the validation is successful, the team will then set a target cost (TC). The purpose of this early interactions is to separate value added from waste to address what the client wants ***desirability,*** what he/she can afford ***viability***, using the necessary technology to aid delivery ***feasibility***. Thus, this require close collaboration with key suppliers, owner, advisors (including QSs) and contractors working as one team. This collaboration is crucial, as both the client and stakeholder's value ambitions would be understood.

Step #2: Exploration Stage
Establishing the TC is an effort to provoke innovation, which will create stretch goals for the team to achieve. Thus, this stage gives way for multiple round of discussions around the defined-value, needs and wants, and thoroughly exploring ways to achieve these goals. This means frontloading the design development process where designers, builders, and suppliers continuously explore wide range of potential problems and alternative solutions to take advantage of the collective knowledge of those who will deliver the project. Herein, SCG should constantly challenge the client's assumptions on their needs, informing about other

alternatives and associated costs. Thus, this exploration would narrow down the alternatives to a single solution, and the process needs to be supported with risk and value workshops.

Step #3: Continuous Estimating Stage
Once the solution cost has been established, the team need to share input and maintain efficiency in the process so that non-value adding activities are understood and streamlined. Thus, to facilitate this and achieve value-based decision, the team's rolling estimates of costs should be routinely compared to the TC to assure the project feasibility. This characterize the technique of 'over the shoulder costing', allowing regular frequent estimate updates whilst also tracking specific variance of previous costs. Accordingly, designing in sets, synchronizing activities to eliminate waste and update TC. All the three stages need to conform to the business case, for it to prevent wasteful redesign cycle. Therefore, the team should be able to reduce waste in costing and design iterations, thus, design within the range of affordable cost solution.

Tools & Techniques
The two framework components need to be supported with tools and techniques that promote innovation, enhance value and assist stakeholders to make collaborative decisions. Hence, these tools should encompass ***collaborative workshops, value stream mapping, set-based design***, ***choosing by advantage*** and ***BIM.***

To achieve the desired level of commitment at organizations, there is the need to have collaborative workshops. This will allow owners/clients understand how the team plan to deliver the project, with emphasis on finding ***desirability***, ***viability*** and ***feasibility*** factors. This reiterate the need for a comprehensive team, so that the owner can articulate his/her value vision better, rather than defer to the solutions posed by in-house consultants based upon perceived expertise. Furthermore, tools like value stream mapping (VSM), set-based design (SBD), and choosing by advantages (CBA), need to be adopted in this approach.

This is because through VSM exercise, waste embedded in the pricing elements can be minimize and costing process optimize before committing to any solution. Similarly, the SBD, would allow multiple options to be explored simultaneously, while the team converge on what is perceived as the best solution at the last responsible moment, these options need to be evaluated according to the importance of advantages they offer relative to set of factors that contribute value. Thus, the team collectively must be aware of each cost forecast so that value can be optimized. Equally, using visual simulating technology (BIM) and decision-making tools like CBA, stakeholders would be able to understand the impact of their decisions on costs. Therefore, those entrust to develop project costs need interaction often in many ways, as this would promote rapid problem solving and breaking away from the traditional norms.

Appendix 11: Methodology Constructs : Research Questions

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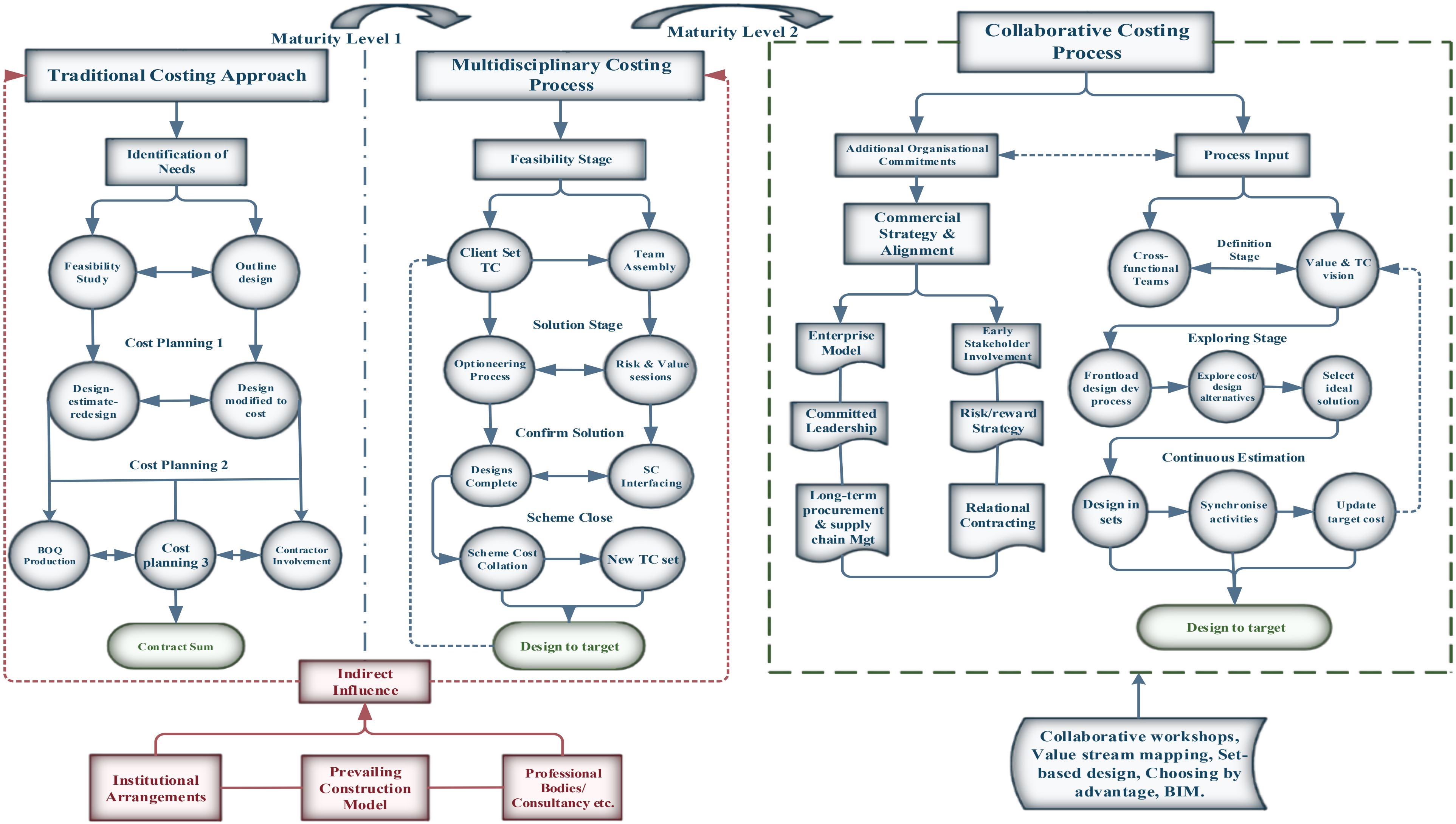
	Key literature where constructs arose	**Objectives**
What would 'collaborative costing' mean?	Laryea & Watermeyer 2010; Jung et al, 2010; Ballard & Pennanen, 2013; Love et al, 2017; Shalpegin et al, 2018; Macomber et al, 2007; Grau, 2019; Ballard and Tommelein, 2016; Pishdad-Bozorgi & Karasulu, 2013; Salam *et al.,* 2019; Ballard, 2008; Sunil et al, 2011; Hanid et al, 2014; Marchesan and Formoso, 2001; Kaushik, et al, 2015;	To understand the perceptions of CC and improve consistency and reliability in costing practices.
What are the challenges hindering collaboration and shared understanding within the UK construction industry?	Pasquire et al, 2015; Sarhan et al, 2014; Zimina et al, 2012; Eriksson and Laan, 2007; Ballard and Howell, 2004; Gomez et al, 2019; Flyvbjerg 2008; Elfving *et al.,* 2005; Kern & Formoso, 2004; Farmer, 2016; Common et al, 2000; Sarhan and Fox, 2013; Rahman and Alhassan, 2012; Sarhan, 2018; Fellow et al, 2003; Gottlieb & Haugbolle, 2013; Rameezdeen and Rodrigo, 2013;	To review commercial practices/behaviours and promote collaboration and shared understanding within the prevailing construction model.
How can we incorporate commercial actors in a collaborative production system?	Farmer, 2016; Ghasemi & Becerik-Gerber, 2011; Love et al, 2010; Bertoni et al, 2015; Challender et al, 2014; Pasquire et al, 2015; Marchesan & Formoso, 2001; Zimina et al, 2012; Koskela et al, 2002; Koskela & Ballard, 2012; Lloyd-walker, 2014; Bertelsen & Koskela, 2002; David & Alves, 2019; Sunil *et al.,* 2011; Ballard, 2011; Rahman and Alhassan, 2012; Ballard & Tommelein, 2016; Perera et al, 2011; Brien et al, 2014; Mbachu & Frei, 2011;	To understand what drive QSs in construction practices to create opportunity to align them in collaborative practices in the UK construction industry.
How would stakeholder's costs projects collaboratively in practice?	Macomber et al, 2007; Grau, 2019; Ballard and Tommelein, 2016; Simonson, 2016; Zimina et al, 2012; Ballard, 2011; Kuo and Wium 2013; Ballard and Reiser, 2004; Alfonso, 2012; Sarhan et al, 2017;	To understand the notion of CC from practice; to identify and shed light on factors affecting commercial actors and to develop a simple framework for collaborative costing.

Appendix 12 : Framework Evaluation Exercise : Before Evaluation



Appendix 13 : Framework Evaluation Exercise : After Evaluation