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PROBLEM REPRESENTATIONS AND COLLECTIVE MIND WITHIN NETWORKS

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Abstract

This dissertation is primarily motivated by the shortage of research in business network context that focuses on explaining how shared understanding and collective cognition develop in business relationships. The study is rooted in a broader research agenda that investigates the interplay between human cognition, action, and outcome. However, despite the central position of this body of work within the context of relationship management, the conceptual evolution has been mainly about individual subjective cognition – e.g. manager's network insights or network picture. Consequently, marketing scholars have invested a considerable research effort in individuals and dyads with relatively limited attention to the overall networks' collective perspectives.

The aim of this dissertation is, therefore, to empirically investigate the process of forming a collective mind as an outcome of collaborative actions in business networks. The formation of collective mind has been previously studied within intraorganizational settings. However, conducting such investigation within a network context could shed more light on scholars' understanding of the concept, while also having far-reaching managerial implications and theoretical significance. For instance, in construction projects, any mindless interrelation between project teams could slow down project outcomes, result in unnecessary coordination costs, and potentially lead to an unhealthy and uncertain work environment. And from a theoretical standpoint, the concept of collective mind enables the amalgamation of subjective (individual) network pictures into the inter-subjective network processes that are jointly experienced by network actors. Therefore, the study elucidates the dynamic nature of business relationships by incorporating opinions and perspectives from multiple network members. Moreover, a team level concept – interfirm problem representations (IFPR) – is also developed to illustrate how a diverse range of localized mechanisms, rules, and resources are combined and synergised by network actors to facilitate the establishment of a unified perspective at different decision episodes.

Two research questions were investigated in this dissertation, which involves the use of qualitative evidence and necessary condition analysis. For the qualitative

data, a case study research strategy is utilized to capture any contextual factors that might be influencing the actions and decision making of network actors in different social settings. Observation of three different construction project teams was conducted over a period of eleven months. During the period, a total of forty-three project team meetings were attended and thirty-two face-to-face interviews conducted across the three project teams.

Furthermore, a structured questionnaire was used to collect specific data which aligns with the logic of NCA – that is, necessary condition analysis. The data collection for NCA involved the construction project actors who were also interviewed for qualitative data. The qualitative data were organised on NVivo and analysed using DREIC model and temporal bracketing strategy. NCA software was used for the necessary condition analysis, which focused mainly on the second research question of the dissertation. Inspired by the critical realist's view of social reality, the DREIC model facilitated the presentation and structuring of the research findings. It also enables the study to effectively highlight the causal linkages between events, agentic actions, and the underlying structures enabling or constraining the actions.

Discussion of the research findings results in the development of a revised framework for collective mind indicating how network actors manage and respond to social contingencies while using IFPR as a benchmark for defining acceptable actions. The framework also highlights the structural and relational mechanisms moderating the interaction processes between the project partners. The study identifies five antecedent conditions that are required to establish and maintain a collective mind between network actors. Lastly, this dissertation advances earlier assumptions on shared cognition and knowledge sharing by demonstrating that the reciprocal interplay between cognition and actions only leads to collective mind if there is an appropriate communication pathway for sharing knowledge across network boundaries. The study ends by presenting the theoretical and managerial implications of the research findings and concludes with some recommendations for future research.

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List of abbreviations

- IFPR Interfirm Problem Representations
- OGC Office of Government Commerce
- RIBA Royal Institute of British Architects
- CDM Construction Design and Management Coordinator
- NCA Necessary Condition Analysis
- TMSA Transformation Model of Social Activities

- DREIC — Description Retroduction Elimination Identification and Correction
- DTM — Design Team Meetings
- CEPM — Client and End-user Progress Meeting
- CoW — Clerk of Works
- CE — Ceiling Envelope technique
- CR — Ceiling Regression technique
- RDD — Reviewable Design Data

Simplified definition of key concepts

no	Concepts	Definitions
1	**Collective mind**	*A process in which members of a multidisciplinary team working on a joint project perform their tasks heedfully [i.e. mindfully] in order to establish and maintain predictive knowledge throughout the project implementation process.*
2	**Coordination**	*An evolving process in which members of a multidisciplinary team [or other forms of organisation] actively and collectively manage or monitor each other's actions, activities, resources and interdependencies with the sole purpose of effectively delivering their shared objectives.*
3	**Inter-cognitive representations**	*Tangible or intangible artefacts that facilitate the establishment of shared understanding between members of a multidisciplinary or cross-functional team.*
4	**Interfirm problem representations**	*A collection, collation, or systematically curated database of organisation artefacts that are specifically developed as a unified reference point for coordinating actions, solving unique problems, and establishing shared understanding between members of a multidisciplinary team or organisation.*
5	**Knowledgeability**	*It is a process of knowledge production, reproduction and [potential] transformation that manifests in practice when social actors intentionally and purposefully draw resources from rules and other organisation artefacts to solve existing or new problems.*
6	**Predictive knowledge**	*Abilities that enable members of an organisation working on a shared project to effectively and [almost] accurately predict each other's actions or intentions – especially for actions and intentions relating to overlapping or interfaced activities.*
7	**Knowledge boundary**	*The extent to which a member of an organisation understands the area of specialisation or specialised languages of other members of the organisation with whom his/her tasks overlap.*

8	**Boundary Spanners**	*Designated experts with specialised trainings or abilities to bridge the potential knowledge holes/gaps that tend to inhibit the establishment of shared understanding between members of a multidisciplinary team.*
9	**Boundary objects**	*Artefacts or resources that are used to visualise and simplify complex tasks in order to facilitate knowledge sharing, coordinate actions, and establish shared understanding between members of an organisation [or a multidisciplinary team]. The IFPR explained above is an example of a database of boundary objects that are collated for a specific goal.*
10	**I-centric disposition**	*A pattern of behaviour signalling that an individual who is a member of a team is only concerned with own interests and therefore conducts his/her activities without considering the implication on others or on the team's shared goals.*
11	**We-centric disposition**	*A pattern of behaviour signalling that an individual who is a member of a team is constantly, carefully, and mindfully evaluating the implications of his/her actions on the overall team's goals and objectives.*
12	**Representing or Representation**	*A team member's perception, imagination, and understanding of how different events [expected or unexpected], roles, positions, and activities relating to the team's shared goals are connected. Representation shapes what a team member expects from the team, and how they define their own actions in relation to others'. In other words, representation has a major impact on the development and maintenance of predictive knowledge between team members.*
13	**Routine**	*A regular pattern of interactions or events that is pre-planned by a team for the purpose of coordinating, supporting, regulating, and monitoring team members' (in)actions.*
14	**Intention**	*A team member's motivation for actions as well as their desired outcome or how they expect the consequences of their action to affect other team members.*
15	**Concept design**	*A concept design is the early stage of a construction plan, and it usually helps the architect to mentally process the client's design intent for a building project. A concept design also captures the broader requirements of the physical and environmental structures close to the building project.*
16	**Technical design**	*Technical design is a more advanced stage in construction, and it encompasses all the design activities that are done by the design engineers, design consultants, and subcontractors. The technical design is a process of adding more specific details to the concept design and incorporating the different design elements from the engineers and design specialists in preparation for the actual construction of the building project.*
17	**Design development**	*The design development is a collaborative process in which construction professionals progressively adapt the design details and specifications to accommodate changes in client needs and industry regulations, which also includes negotiating for any previously overlooked design elements.*
18	**Employer's requirement**	*Employer's requirement is a collection of building sketches, drawings, and layouts which specifies the expectation of the client regarding the different features of the building project, and also defines how to handle unknown risks once the principal contractor takes on the design responsibilities.*

19	**Contractor's proposal**	*The contractor's proposal is a tender document issued by competing contractors. It is a comprehensive plan indicating the minutiae details and multiple options and potential strategies for fulfilling the conditions of each item in the employer's requirement, which also includes prices and risk management options.*
20	**Contract negotiation**	*Contract negotiation is a process where the principal contractor and the project client – and, possibly, the architect and some other design consultants – decide the terms and conditions of the building project, which includes agreeing on project price, payment strategies, responsibility allocation, and project completion time.*
21	**Novation agreement**	*Novation is essentially a change in contractual agreements which necessitates the switching of roles of design consultants – particularly, the architects and design engineers – from the client to the contractor side. With a novation agreement, the technical design done after contract negotiation (i.e. post-contract) would be undertaken by the same consultants who did the concept design before the contract negotiation (i.e. pre-contract).*
22	**Value engineering**	*Value engineering is an analytical and methodical process of cutting project costs as a response to unwanted problems - e.g. a change in the cost of materials that places unwanted burdens on the project budget. The process requires a lot of deliberation and compromise between the project partners who are not only engaging in a cost-cutting exercise but, more importantly, must ensure that they adhere to regulations and protect the integrity and quality of the building project.*
23	**Tender**	*Tender is a part of early-stage contract negotiation, which specifically relates to the contractor's submission of quotations to provide rough estimates of project costs in response to an open invitation from the project client or beneficiary.*

Chapter 1 - Introduction

The goal of this study is to empirically investigate the process of forming a collective mind as an outcome of shared actions in business networks. The primary motivation for this research project is the fact that the issue of shared understanding and collective cognition has suffered limited research investment in industrial marketing literature (Mouzas and Henneberg, 2015). Over the last two decades, there has been a significant academic discussion regarding the interplay between cognition and actions (Mattsson, Corsaro and Ramos, 2015). However, previous research in the business network context appears to have paid more attention to individual cognition over collective cognition (Mattsson, Corsaro and Ramos, 2015; Mouzas and Henneberg, 2015). By utilising individual cognitive framing (e.g. manager's network picture) as the only unit of analysis to understand how managers make sense of their social world, scholars have not been able to offer sufficient explanation on how shared understanding develops during social interactions (Ford *et al.*, 2003; Mouzas, Henneberg and Naudé, 2008; Mouzas and Henneberg, 2015).

On the one hand, this is as a result of the bounded rationality of humans in information processing as well as the possibility of errors and biases in their decision-making processes (Simon, 1979, 1991; Foss, 2003; Kahneman, 2003). Hence, it is unsurprising that reliance on managers' perception of network picture offers an incomplete explanation on how collective views develop in business relationships (Mattsson, Corsaro and Ramos, 2015; Mouzas and Henneberg, 2015). On the other hand, individual sensemaking and sense-giving usually involve interactions between multiple agents – e.g. managers and subordinates, work colleagues, salespersons and customers (Polanyi, 1967; Gioia and Chittipeddi, 1991; Weick, 1995). Due to the dialogic and social nature of sensemaking, it becomes necessary to conduct a multi-level investigation involving social actors at different interaction episodes. Moreover, a multi-level investigation is required to provide a comprehensive account and more balanced knowledge of how shared understanding or collective decision-making develop in business networks (Gittell and Weiss, 2004; Mouzas and Henneberg, 2015).

The work of Mouzas and Henneberg (2015) was arguably one of first scholars' attempts to explain how the interplay between individual perception and inter-cognitive representations form the basis for collective decision making in business relationships (Mouzas and Henneberg, 2015). In their conceptual paper, the authors identified four types of inter-cognitive representations – namely, manifestations of consents, legally binding contracts, industry standards, and explicit regulations – shaping and being shaped by social interactions at both dyadic and business network levels. Hence, inter-cognitive representations vis-à-vis rules and social interactions function as the frames of reference upon which shared understanding develops in network relationships (Mouzas and Henneberg, 2015). Although this framework provides a vital foundation for investigating the process of forming a collective mind in business networks, its empirical application can be challenged by two main shortcomings.

Firstly, by focusing exclusively on rules and standards, the framework is only able to explain how shared understanding – a precondition for collective mind – is achieved during periods of stability and routinized interactions between network actors. Hence, the framework may not be able to offer practical guidance during problem situations that are not stipulated in the rules. Prior research has shown that rule-based structures usually collapse during a crisis or unfamiliar situations (Weick, 1993); an argument that is widely held among the proponents of practice-perspective of the coordination literature (Bechky, 2006; Bruns, 2013). A notable example is a work done by Faraj and Xiao (2006) in which the authors found out that medical specialists tend to break protocols and intuitively improvise alternative practical solutions when dealing with non-routine medical trauma situations.

Secondly, the framework highlighted the importance of interactions between agents without addressing the knowledge (or lack of it) that each agent brings to the network or the agents' purpose for interaction. Prior research has shown that a priori knowledge and shared history play important roles in social interactions because they determine the ease or complexity of information flow between agents (Srikanth and Puranam, 2011). Accordingly, during cross-boundary or interfirm interactions involving agents from diverse knowledge domains, there

is a potential for the “curse of knowledge” to inhibit the flow of communication (Heath and Staudenmayer, 2000).

Based on assumptions from the knowledge sharing literature, such distortion in communications may be as a result of the potential differences in the domain-specific meanings, norms, and interests of the interacting agents (Pinto, Pinto and Prescott, 1993; Kellogg, Orlikowski and Yates, 2006). Hence, the creation of shared understanding in such situations requires the transformation of novel knowledge in a way that addresses the political interests of all the interacting parties (Carlile, 2004).

Therefore, the limitations of the inter-cognitive framework herein discussed and the fact that most of the studies on knowledge coordination have been conducted within the context of intra-organization relationships (Larsson and Bowen, 1989; Gittell and Weiss, 2004; Kellogg, Orlikowski and Yates, 2006), are the knowledge gaps that the current study intends to fill. Also, the concept of knowledgeability has been borrowed from structuration literature (Giddens, 1984) to extend the conceptualization of knowledge beyond the explicit/tacit dichotomy as presumed by many scholars (Dyer and Nobeoka, 2000, p. 348; Möller and Svahn, 2004). An extension from the dichotomy is important because such a reductionist view tends to position knowledge as (1) tacit know-how of individuals within an organization – the emphasis here is on the difficulty of transferring knowledge from person-to-person. (2) Knowledge is also seen as codified information that can be readily transferred between organization members (Grant, 1996; Kogut and Zander, 1996). While these two views tend to pay cognisance to knowledge transfer between actors, there appears to be less emphasis on how knowledge is both created and manifested in an ongoing practice, as well as in social embeddedness and exchanged experiences between network actors (Dyer and Nobeoka, 2000; Blazevic and Lievens, 2008; Wenger-Trayner *et al.*, 2015).

Likewise, as implied by the tacit/explicit conceptualization, knowledge is assumed to be something that is "somehow available" or "already possessed" by members of the organization. Hence, it is regarded as a resource that can flow between network actors through routinized mechanisms (Dyer and Nobeoka,

2000) rather than something that is inherently ambiguous, indeterminate, and constantly evolving (Tsoukas, 1996; Anand, Glick and Manz, 2002; Wenger-Trayner *et al.*, 2015).

The structuration literature adds value to this study because of the duality of structure and agency which tends to accommodate both the routinized (vis-à-vis structure) and the non-deterministic or contingent nature of knowledge (vis-à-vis agency) (Archer, 2000a). Critical to the structuration view is the conceptualization of knowledge in relation to the evolving social practices as well as human actions and interactions with their natural environment (Archer, 2000a; Sayer, 2011). This view also emphasizes the intention of humans during interactions (Sayer, 2011), which becomes essential for the current study because of the attempt to introduce human purposive intention as a valuable addition to the ongoing debate regarding the interplay between cognition, action and outcome. By combining assumptions from the coordination, knowledge sharing, and structuration literature with the foundational work on inter-cognitive representations, the study sheds more light on how a collective mind develops in business networks – thereby, extending the work of Weick and Roberts (1993).

More specifically, the dissertation contributes to the ongoing discussions on shared cognition and knowledge sharing literature by demonstrating how the reciprocal interplay between individual cognition (e.g. perception or intention) and collective actions, leads to the formation of a collective mind in temporary business networks (Weick and Roberts, 1993; Mattsson, Corsaro and Ramos, 2015). A much broader contribution of the study relates to the theory of change in business networks (Fonfara, Ratajczak-Mrozek and Leszczyński, 2018). The study develops a framework of collective mind from multi-level data involving, individual, team, and structural levels of analyses. Against the backdrop of existing assumptions which typically give primacy to humans as the only agents of change (Halinen, Salmi and Havila, 1999; Harré, 2002; Corsaro and Snehota, 2012), findings from the study also highlighted the performative role of industry regulations as crucial change drivers in network interactions. It was shown in this study how a change in industry regulation could trigger unanticipated

changes in network interactions. Therefore, by taking a holistic view in the investigation of change in project teams, the dissertation uncovers three underlying generative mechanisms, namely, milestone invocation mechanism, carrot and stick mechanisms, and cofacilitation mechanism. These mechanisms enable construction professionals to make sense of their joint activities while effectively and proactively managing change in the face of uncertainties.

Lastly, this dissertation also enriches and adds new insights to the foundational work on collective mind (Weick and Roberts, 1993) in two valuable ways. Firstly, the study identifies and confirms the bottleneck conditions that could potentially constrain the maintenance of collective mind between network actors. Specifically, in addition to two antecedent conditions from the original framework, this dissertation identified three more conditions shaping the formation of a collective mind in the business network context. Secondly, the study shows the relative importance of each antecedent condition in achieving different desired levels of a collective mind and highlighted their implications on the activities of construction professionals. This dissertation draws vital managerial suggestions from the findings and theoretical discussions and concludes with some recommendations for future research directions.

1.1 Aims and objectives of the study

The first aim of this study is to empirically investigate how a collective mind is formed as an outcome of collective actions between construction project teams. The second aim of the study is to utilise the implementation processes of construction projects as case contexts for identifying the conditions that are necessary for the formation of a collective mind in temporary business networks. The objectives of the study are as follow:

- develop a framework that shows how network members collectively deal with unfamiliar (unforeseen) events or unpopular actions that threaten the effective implementation of their routines and the attainment of their collective goals:
- explore how a combination of representations (including boundary objects, boundary spanners, and standardized representations – e.g.

industry regulations) is utilized by project teams to coordinate actions and stimulate shared understanding between the project members:

- to gain a better understanding of how the intentions (cognition) of each member of a construction project influence their attitudinal disposition and actions towards the attainment of the collective goals (outcome) of the entire project team, and:
- to identify the conditions that must be present to achieve different desired levels of collective mind between the project teams.

1.2 Structure of the thesis

The dissertation is made up of 10 chapters – this introduction chapter included.

Chapter 1 (i.e. introduction) introduces the research background and motivation for the study. The current state of knowledge relating to the key concept being investigated (i.e. collective mind) was discussed. Existing research gaps leading to the research aims and objectives were also highlighted. Potential avenues for contributions were enunciated.

Chapter 2 (i.e. literature review) focuses on the key literature that are deemed relevant for developing a conceptual framework of collective mind in the context of business networks. The chapter starts with the definition of collective mind and positions the discussion within the context of interorganizational sensemaking to extend the work of Weick and Roberts (1993). The discussion of interorganizational sensemaking is followed by a presentation of how coordination processes shape social actions. The implications of different coordination mechanisms in fostering or limiting the exercise of freedom by social actors are also presented. The central argument relating to coordination, as presented in this study, is how to establish control in complex business settings without necessarily limiting social actors from responding to unanticipated challenges – especially, the social challenges that may be consequential for smooth interrelations between interdependent actors. The chapter advances with a discussion on how knowledge sharing may be conditioned by the types of boundaries (tangible or intangible) between social actors.

The chapter introduces the concept of knowledgeability from structuration theory to demonstrate that the problem of social interactions is not only concerned with knowledge sharing but, more importantly, on the continuous struggle by interdependent actors to create knowledge that is representative of the diverse and potentially conflicting interests that tend to exist in their social space. Next, the chapter presents IFPR as a social mechanism used in complex business settings for the following reasons. (1) To align conflicting interests between actors. (2) To facilitate knowledge production, reproduction, adaptation, and transformation. (3) To minimize the effects of knowledge boundary that typically complicates interactions. The theoretical framework for the study is then presented. The framework shows how collective mind could be maintained through the interplay between knowledgeability, coordination and IFPR. The chapter ends by presenting the two research questions resulting from the extensive literature review.

Chapter 3 addresses the different philosophical positions that could potentially support the development of robust research design. The chapter shows positivism and constructionism as inappropriate for the research goals of this study and presents critical realism as a justified philosophical approach. One of the key characteristics of critical realism is the separation of structure and agency as entities with distinct social origins and causal powers. These characteristics are consistent with the theoretical framework of collective mind, which explains the mutually reinforcing system between human knowledgeability (i.e. the agency to act consequentially with intentions) and IFPR. On the one hand, IFPR functions as a structural mechanism shaping permissible actions and the establishment of shared understanding between project team members. On the other hand, depending on their social circumstances, the continuous interaction between the project team members could potentially (re)produce or even transform the content of the IFPR.

Chapter 4 focuses on research design and methodology. The chapter commences with a presentation of the case study as an appropriate research strategy for this dissertation, and it also highlights how the design decisions fit into the methodological framework of critical realism. In the next section of the chapter,

the implication of the realist's stratified reality on key design decisions was discussed – e.g. relating to the selection of cases and case contexts, definition of the unit of observation and unit of analysis. Next, the chapter justifies the use of interviews, observation data, and document analysis as suitable approaches for addressing the research questions and objectives. Following this, is a discussion regarding the role of Bhasker's TMSA model in the process of data collection. The chapter ends with an explanation of how DREIC model and temporal bracketing strategy inform the design of the method for data analysis.

Chapter 5 discusses the role of NCA in addressing the second research question of this dissertation. This chapter begins with a brief introduction of the underlying logics of NCA. Next, the chapter presents the potential necessary conditions for collective mind. Following this, the chapter analyses the process of developing the scales of measurement for each of the condition variables. This chapter also explains the design of the questionnaire for collecting data for the NCA.

Chapter 6 explains the storage, management, and analysis of the qualitative data from interviews, observations, and project documents. The chapter details the process of coding the qualitative data on NVivo and also presents the outputs of the coding process. This chapter ends with a mind map indicating the four additional mechanisms – i.e. shared understanding, coordination, compliance, and interest alignment – that influence the maintenance of collective mind in project teams.

Chapter 7 focuses on elaborating the findings from the coding of qualitative data. The elaboration includes an extensive discussion on how project teams establish shared understanding, coordinate actions, and align conflicting interests between the team members with the ultimate goal of maintaining collective mind throughout the project implementation process. The discussion of findings also covers how the industry rule functions as a regulatory framework or social structure in enabling or, in some instances, limiting project implementation processes. This chapter ends with an explanation regarding the use of compliance (e.g. with industry regulations) as a leverage to motivate collective actions or settle disputes between team members.

Chapter 8 presents the results and findings from the NCA. The NCA outputs reveal the degree of importance of each of the variables in achieving different levels of collective mind in project teams.

Chapter 9 consolidates the findings from qualitative data and NCA. These consolidated findings facilitate the development of a comprehensive and robust causal explanation for the maintenance of a collective mind in project teams. This chapter highlights and explains the "real" generative mechanisms causing the events that the project teams jointly experienced. The consolidated findings also enable the development of an explanatory framework for collective mind, and this serves as an update to the initial theoretical framework.

Chapter 10 presents the implications of this research to the field of industrial marketing and practitioners in project teams. A particular contribution is how the causal explanation and framework of collective mind exposes potential limitations in the existing theory of shared cognition and knowledge sharing. The study also contributes to the literature of change in a business network context. This chapter ends with a presentation of the practical implications of the study. This study provides suggestions for potentially improving interrelations in project teams that are engaging in long-duration projects.

Chapter 2 – Literature review and theoretical framework

This chapter discusses the work of Weick and Roberts (1993) and highlights the three essential factors (representing, contributing, subordinating) for maintaining a collective mind in intraorganizational settings. Next, the chapter positions the discussion within the context of interorganizational sensemaking, which then provides theoretical insights on how business network actors develop and maintain a collective mind. Consequently, the chapter uncovers three additional factors (i.e. adaptive coordination, shared understanding, and aligning conflicting interests) that are particularly relevant for developing a collective mind in business networks. The chapter then presents the three additional factors within the context of knowledgeability and knowledge sharing literature to gain more theoretical insights. Moreover, this dissertation develops the concept of interfirm problem representations to provide more explanations regarding the role of adaptive coordination in the interrelation processes between business network actors. Therefore, by integrating ideas from the different streams of research, and also borrowing knowledge from the field of philosophy, this dissertation presents a preliminary framework which explains the process of developing a collective mind in business networks.

2.1 Collective mind through the lens of interorganizational sensemaking

Weick and Roberts define collective mind as *"a pattern of heedful interrelations of actions in a social system"* (Weick and Roberts, 1993, p. 357). As this definition implies, the mind exists in the care and attention with which social actors jointly conduct their shared activities. Hence, the mind inherently is in the ongoing interactions between network actors. Because the implementation of interdependent actions is not always in the same physical environment or social context, researchers tend to contend that network actors draw on different contextual resources to fulfil their tasks (Tsoukas, 1996). Therefore, one could see the mind as a distributed system, and the external resources that are shared by social actors (e.g. annual reports, memos, plans, and contractual agreements) as an extension of the mind (Tsoukas, 1996; Bardone and Secchi, 2009; Mouzas and Henneberg, 2015). According to Weick and Roberts (1993), for distributed actions to converge into a collective mind, three conditions must be satisfied.

That is, an individual actor within a business network must be *contributing*, *representing*, and *subordinating* to the requirements and expectations of other network actors.

"Contributing" refers to the action of each business network actor carried out to fulfil the network goals. Heedful actions are the actions that capture the collective aspirations of the network members. "Representing" is the imagination of a network actor regarding the interconnections between actors and activities within the network. As a result, representing tends to shape the expectations of network actors, and how they define their actions in the overall context of the network goals. "Subordinating" is the continuous effort of each network actor to align their actions with pre-defined network requirements. Any network actions that are non-subordinating tend to create uncertainty in the interrelation of shared tasks. Therefore, in an ideal world, mindful contributing, representing and subordinating enable network actors to work simultaneously "alone" together (Bruns, 2013) without disrupting their workflow or jeopardizing the coordination of their interdependencies.

Moreover, individual action is said to enact collective mind if it converges with, supplements, assists, and becomes defined by the expected requirement of the network (Weick and Roberts, 1993, p. 365). However, Weick and Roberts cautiously added that convergence of actions is only possible if the representation*s* of actors are structurally similar. Any unresolved difference between the representational frameworks of the network actors could lead to a variation of heeds and a potential loss of mind due to errors.

Whereas Weick and Roberts observed collective mind within intraorganizational context, the current dissertation focuses on business networks as a context for theoretical exploration. Because of the different contextual dynamics, additional factors might shape the formation of collective mind in a business network environment. Therefore, the current dissertation hopes to expand the work of Weick and Roberts by positioning the discussion within the context of interorganizational sensemaking. Sensemaking is a potentially useful concept for theoretical elaboration because – similar to collective mind – its enactment takes place through a web of interconnected actions to manage ambiguities or

interruptions in network actions and processes (Weick, Sutcliffe and Obstfeld, 2005; Hopkinson, 2015). In this dissertation, interorganizational sensemaking refers to an ongoing process through which social actors with different professional backgrounds and interests jointly interpret their collective experience and actions by constructing, negotiating, and maintaining a shared sense of meaning (Gioia and Mehra, 1996; Gephart, Topal and Zhang, 2010; Medlin and Törnroos, 2014). This definition accentuates the three core elements of sensemaking, namely, frames, cues, and connections (O'Connell, 1998; Weick, 2011). Frames are the systems of belief or mental model embedded in the identity and professional affiliations of social actors, which tend to shape how mutual expectations evolve in network interactions. Cues are the events that network actors jointly experience as they implement their shared tasks. Confusions and process interruptions arise when network actors are unable to connect current experiences (cues) with past expectations (frames).

More specifically, any misalignment between frames and clues usually leads to a loss of intelligence (or loss of mind) as events become inexplicable and incomprehensible (Weick, 2002, 2009). Restoring sense in such a situation would require network actors to renegotiate shared meaning by re-establishing connections between past expectations and new experiences (Konlechner *et al.*, 2019). When they notice inconsistencies or breaches in their joint actions, network actors initiate a sensemaking process by bracketing specific cues from their endless streams of experiences to gain a better understanding of what has been happening within the network (Weick, Sutcliffe and Obstfeld, 2005; Weick, 2011). Next, they search their repertoires of frames to identify the most logical framework for explaining and making sense of the bracketed clues (Seidl and Werle, 2018). However, considering the diversity of professional backgrounds in a typical business network, one of the challenges that complicate interorganizational sensemaking is the difficulty to reach a consensus regarding the most appropriate frames to interpret evolving cues. Among other things, process complication arises as a result of conflicting interests which trigger power struggle between the network actors as they attempt to redefine their confusing situation by persuading each other to adopt a specific frame as the

most plausible explanation for their collective experience (Gephart, Topal and Zhang, 2010; Jørgensen, Jordan and Mitterhofer, 2012; Seidl and Werle, 2018).

To put these assumptions in the language of collective mind, heedful representing (i.e. framing and reframing of experiences), contributing (negotiating with and persuading colleagues to adopt a particular course of action), and subordinating (connecting frames and cues) enable network actors to avoid interruptions and manage any form of confusions in their interdependent activities. Moreover, as the discussion so far indicates, what seems to be another potential factor for collective mind is the *alignment of interests* between network actors. Recent research in the interorganizational sensemaking literature shows that when interests do not align, communication breaks down, people lose a sense of mutual appreciation and unified direction, and interconnectivity between actions disintegrates as isolated objectives override shared goals (Seidl and Werle, 2018). Evidently, interest misalignment leads to conflicting priorities and creates a divergence in the patterning of experiences (or actions) within a business network, thereby complicating the maintenance of heedful interrelations between the network actors. Weick (2009) asserts that less connectivity (i.e. divergence) between network actors is indicative of less intelligence, which increases the possibility of misdiagnosis and errors in the interpretation of cues.

The discussions so far highlight the social character of sensemaking and also emphasize the need for ongoing conversations in establishing shared meaning and convergence of views between network actors. The dialogic nature of sensemaking process is evidence that network actors do not only make (create) but also communicate (give) sense during social negotiations and conversations (Gioia and Chittipeddi, 1991; Medlin and Törnroos, 2014). The intensity of such negotiation and the power games that characterize its enactment may warrant the inclusion or exclusion of the contributions of some network actors. Inclusion and exclusion depend on the perceived relevance of contributions to the currently dominant beliefs about the collective goal of the network actors (Hopkinson, 2015). Moreover, the decision to include or exclude contributions may lead to confrontation between network actors. However, confrontations may not

generate negative experience and might be crucial for improving collaboration and change management practices in the business network environment (Seidl and Werle, 2018). Furthermore, confrontation tends to create a sort of disturbance which interrupts the order of things as we know it and, therefore, serves as an opportunity to jointly make sense of ambiguities during a conversation (Langenberg and Wesseling, 2016).

One of the social infrastructures for conversations and sensemaking is the face-to-face meetings between network actors. Because of the diverse knowledge domains in a business network, capturing the frame of mind (perspectives) of network actors during face-to-face meetings typically requires some form of shared representation or collective picturizing. Arguably, the picturization of conversations enables network actors to understand (see) the private thoughts that guide actions in a business network. This mode of thinking is well synthesized in Weick's notable phrase, "*how can I know what I think until I see what I say?*" (Weick, 1995, p. 61). Importantly, the phrase accentuates the social elements of sensemaking and echoes the significance of externalising and concretising the mental model of network actors. Hence, it makes sense that shared representations are gaining prominence in academic debates as crucial elements for creating plausible images that facilitate collective rationalisation of ambiguous situations (Gephart, Topal and Zhang, 2010). For instance, recent research in industrial marketing indicates that shared representations, e.g. documenting agreements by signing business contracts, facilitate sense sharing between network actors (Mouzas and Henneberg, 2015). Research in sensemaking literature also demonstrates the usefulness of representational artefacts (e.g. planning documents and formal reports) as tentative reference points for guiding and evaluating actions in dynamic network environments (Bowman, 2016; Seidl and Werle, 2018). Therefore, as network actors continue to draw inferences from the same cognitive resources or representations, they gradually develop shared beliefs about the network environment, and their interpretation of social cues begins to converge (Porac, Thomas and Baden-fuller, 1989; Weick, 1995).

The collection of ideas in this chapter suggest that sensemaking processes can function as a springboard for productive actions when the ongoing conversations between network actors focus on enacting plausible stories that satisfy collective interests (for the time being), rather than the pursuit of perfection or accuracy, which may cripple action instead of enabling it (Weick, Sutcliffe and Obstfeld, 2005; Weick, 2009; Seidl and Werle, 2018). Regarding the role of conversation as an interaction site for sensemaking and sense-giving, one additional issue is worthy of further elaboration. The issue relates to the structure of decision-making during sensemaking conversations. According to Weick, the structure of decision making could embody either deference to expertise or deference to authority (Weick, 2010).

When there is deference to authority, the decision structure is centralised, and consequential decisions are made mainly by the network actors having positional authority. Conversely, when there is deference to expertise, the decision structure is decentralised, and network actors with the most appropriate technical knowledge for any emerging cues tend to lead the decision-making process. Because different expert knowledge is suitable for different problem situations, deferring decisions to experts enables network actors to dynamically adjust their interconnectivity and the structure of their network when responding to emerging cues (Weick, 2009). More specifically, by allowing decisions to migrate to the people with the appropriate expertise, network actors can make sure that the right people are at the right place at the right time – which then affects the quality and dynamics of the sensemaking process (Czarniawska, 2010; Seidl and Werle, 2018). Therefore, Weick considers migrating decisions to experts as a more mindful practice because it enables the processing and interpretation of cues to be more fully grounded in expertise and experience (Coutu, 2003; Weick, 2009). One additional benefit of deferring decisions to experts is that the practice creates an adaptive environment where network actors listen to each other and pay attention to the emerging patterns of cues (Weick, 2009).

Contrarily, deferring decisions to authority creates less heedful interrelations between network actors because in such situations people with more dominant

positions are more likely to tune out interpretations that do not confirm their biases (Weick, 2010). The challenge with this decision-making structure is that what appears to be a plausible story for the dominant actors may be implausible for other network actors (Weick, Sutcliffe and Obstfeld, 2005). Therefore, when the more dominant actors impose their interpretations and views on the other network actors, it becomes highly likely to overlook some valuable signals from the network environment. Furthermore, there could also be less updating of the mental models (frames) of network actors because such situations foster mindless actions and encourage normalising of clues – i.e., it increases the possibility to interpret non-routine problems as if they were routine (Weick, 2009). Put differently, when updating of frames are infrequent, and communication becomes a box-ticking exercise rather than an opportunity for a retrospective re-evaluation of past actions, or space for analytical thinking and ongoing coordination; then shared representation becomes detached from the current reality of the network environment. Moreover, in such situations, people miss seemingly small but significant cues and, consequently, actions become mindless as errors accumulate (Weick, 2009, 2010).

The takeaway from these discussions is that network actors are in a constant state of becoming as a result of the emerging realities in their environment, which tends to affect them in several ways. Firstly, their continuous adaptation to new social cues affects the actor's roles or identities within the network. Secondly, the network actors regularly update their cognitive framework and structural interdependence to adapt to their dynamic network environment. Without frame updating and structural rearrangement, network actors would develop a false sense of stability and overlook new social cues. Which then heightens the potential for normalising as the network actors become less attentive to equivocality or ambiguity, and interrelations become less heedful between them. These arguments justify the need for an intentional, ongoing, and adaptive coordination mechanism to sustain network interactions while avoiding preventable failures. It also aligns with the assumption that collective sensemaking is attainable when a reciprocal enactment of both the network and the environment relies on ongoing communication between relevant network

actors (Weick, 1995; Medlin and Törnroos, 2014; Seidl and Werle, 2018; Konlechner *et al.*, 2019).

An ongoing communication or interaction organised between the right network actors and designed as feedback or process monitoring system would tend to sustain a sense of shared understanding within the network and also prevent the escalation of small errors into consequential outcomes. The argument here is that ongoing negotiation for a *shared understanding* and *adaptive coordination* would enable the network actors to tease out confirmation bias and misinterpretation of cues. Furthermore, a lack of shared understanding can make it difficult for network actors to predict each other's actions. And such a situation could lead to process errors and coordination failures (Srikanth and Puranam, 2014). An increase in process errors increases variations in the heeds with which network actors conduct their activities, which then influences the level of the collective mind that is attainable in the network (Weick and Roberts, 1993). Through the process of negotiating for a shared understanding and adaptive coordination practices, network actors could facilitate early identification of dispositions that encourage self-centeredness – or *tunnel vision* in Weickian language – thereby, preventing the enactment of a flawed collective mind (Weick, 2009).

In summary, this chapter starts with the foundational work of Weick and Roberts and identifies three factors (i.e. representing, contributing, and subordinating) that are essential for maintaining collective mind in intraorganizational settings. However, by positioning the discussion within the context of interorganizational sensemaking, the study uncovers three additional factors – namely, coordinating, aligning conflicting interests, and shared understanding. These new factors would be the focus of further discussions in the subsequent chapters. This dissertation discusses shared understanding and aligning conflicting interests within the context of knowledgeability and knowledge sharing literature to further elaborate on the role of expert knowledge in interorganizational sensemaking vis-à-vis collective mind. However, regarding adaptive coordination, the role of representational artefacts in documenting, adapting,

editing, and updating experiences is more fully discussed by developing the concept of interfirm problem representations (IFPR).

IFPR is the material and interaction space that synthesises the mental models of network actors as it captures emerging cues and is adapted when new meanings or interpretations of the network environment come to the fore. A common theme among scholars is that *"there is no timeout from sensemaking"* (Weick, 2011, p. 146). Another notable assumption relating particularly to prospective sensemaking is that ongoing construction of shared meaning between network actors relies on the interplay between conversational practices and material artefacts (Gephart, Topal and Zhang, 2010; Konlechner *et al.*, 2019). *"Prospective sensemaking is an attempt to make sense for the future … and it can involve the projection of idealistic symbols and images to represent aspirations"* (Gioia and Mehra, 1996, p. 1229). Therefore, the representational and adaptive nature of IFPR enables it to function as a frame of reference for maintaining a sense of stability without evoking a false sense of finality to the sensemaking process. That is, IFPR is adaptive in the sense that network actors can continue to update it as they encounter, isolate, negotiate, and agree on new social cues. More details on these highlighted issues in the ensuing chapters.

2.2 Coordination literature – A specific focus on knowledge coordination

To gain a comprehensive understanding of how knowledge is coordinated in business networks, it is important to explore different theoretical lenses of coordination and to observe possible overlaps as well as differences between them. The coordination literature is divided into two main approaches – namely, formalization and informal or interactionist approaches. These two approaches are deeply rooted in the organization theory and social network theory, respectively (Tsai, 2002; McEvily, Soda and Tortoriello, 2014; Ben-menahem *et al.*, 2016). As the name implies, the formalization approach relies on a centralized or hierarchical organization structure. Hence, the locus of decision making is concentrated at the top of the organization or vested with team leaders in the case of team-based structures (Hollenbeck *et al.*, 2011). However, the informal approach is based on a decentralized decision-making system, and social structure emerges as a result of interpersonal interactions between

organization members (Tsai, 2002). Such interpersonal relationships may even span across organization boundaries; thereby, resulting in networks of relationships (Brass *et al.*, 2004; Gittell and Weiss, 2004).

Traditionally, researchers tend to study these two approaches in contrast. For example, some scholars in the formalization camp have shown that a highly centralized structure usually prevents managers' flexibility in making on-the-spot decisions when they encounter complexities and ambiguities in the network environment (Bigley and Roberts, 2001; Tsai, 2002). Similarly, scholars in the interactionist camp have also argued that weak interpersonal ties in interunit or interorganizational relationships tend to limit the extent to which complex knowledge can be shared between network actors (Brass *et al.*, 2004). However, in more recent years, researchers are beginning to realize that the juxtaposition of formal and informal approaches has created a disconnect between the two streams of research (McEvily, Soda and Tortoriello, 2014). Hence, rather than taking a side, scholars are advocating for a more hybrid analysis, which exploits the overlaps between the two approaches (Bechky, 2006; McEvily, Soda and Tortoriello, 2014). As highlighted in previous studies, irrespective of which of the two approaches adopted, the central tenet of coordination is the management of dependencies between three main variables – namely, tasks, resources, and actors (Grandori, 1997).

Coordination theorists regard the management of such dependencies as an ongoing complex process that is open to multiple predesigned contingencies (Crowston, 1997). The practice-perspective of coordination, however, argues that inter-tasks and inter-agent contingencies are not only multiple but also sometimes unprecedented (Bruns, 2013). However, the proponents of formalization approach, e.g. organization design and structural contingency theorists (Galbraith, 1974; Pennings, 1975), suggest that coordination is subject to pre-planned structures such as protocols, schedules, routines, standards, and hierarchy. These pre-planned structures are seen as important factors that are shaping shared perspective and interdependencies between actors in an organization (McEvily, Soda and Tortoriello, 2014). Because the theories are deeply rooted in manufacturing organizations which are traditionally

hierarchical in nature, they do not take into consideration how new forms of organizations (e.g. project teams) which are temporal and less structurally rigid, are coping with their coordination problems (Bechky, 2006).

Hence, a central claim by actors in the formalization camp is that firms can rely on pre-planned programs as long as organization activities and environmental or technological conditions are predictable (Galbraith, 1974; Pennings, 1975). However, there should be a shift from planned programs to informal approaches (e.g. mutual adjustment) when the organization hierarchy becomes overloaded with the complexities of interdependencies between agents or when environmental uncertainties get out of control (Galbraith, 1974; Pennings, 1975; Grandori, 1997). Therefore, scholars subscribing to this view tend to rely on its underlying assumptions when offering managerial recommendations. For instance, when Tsai (2002) finds out that hierarchical structure alone cannot yield knowledge convergence in an organization where knowledge is distributed asymmetrically, he suggests that such organization could ensure an even distribution of knowledge by reducing hierarchical constraint while increasing interunit social interaction (Tsai, 2002). Other research also supports that firms can increase interunit interactions through the creation of cross-functional teams (Pinto, Pinto and Prescott, 1993). Fundamentally, this coordination approach suggests a trade-off between formal and informal structures.

Conversely, the proponents of the practice-perspective of coordination argue that complex and unpredictable situations do not necessarily demand to alternate between formal and informal coordination approaches, but present organizations with the coordination challenges of ensuring control in the face of difficulties while simultaneously allowing sufficient flexibility for agents to make timely and situation-specific decisions (Faraj and Xiao, 2006). Hence, rather than focusing exclusively on the role of rules and structure in explaining the coordination of activities; the central tenet of the practice-perspective is the emphasis on the reality of unplanned contingencies in social relations. Furthermore, the practice perspective gives prominence to the agency of network actors that enables them to make a practical and normative judgement in

response to the emerging demands in their environment (Emirbayer and Mische, 1998).

Therefore, by subscribing to the practice perspective, this dissertation can observe the everyday practices of network actors in selected social settings as they evolve and are interrupted or even terminated under different contingencies (Hutchins, 1995; Kellogg, Orlikowski and Yates, 2006). Moreover, observation of everyday practice will provide contextual evidence on how network actors from diverse knowledge domains collectively navigate different contingencies to achieve their shared goals (Kellogg, Orlikowski and Yates, 2006).

2.2.1 Coordination mechanisms and practices

Coordination mechanisms are tools that organizations use to integrate resources and activities and for managing interdependencies between social actors (Crowston, 1997). The practice-perspective of coordination, to which this dissertation subscribes, suggests two different process view of coordination, namely, administrative coordination and expertise coordination (Faraj and Sproull, 2000). Administrative coordination is a formal mechanism involving the use of practices such as budgets, staffing tables, review meetings and critical-path analysis to manage resource dependencies and ensure goals attainment for routine tasks (Faraj and Sproull, 2000). The expertise coordination, on the other hand, is required for managing knowledge interdependencies, especially for accomplishing complex tasks that require sophisticated intellectual inputs (Faraj and Sproull, 2000).

The separation of knowledge coordination from activity coordination differentiates the practice-perspective from the classical information-processing and organization design perspectives (Galbraith, 1974; Pennings, 1975). For instance, the classic view has two main coordination mechanisms. Firstly, reducing the need for information by dividing tasks and allocating resources through plans, schedules, and standards. Secondly, facilitating access to information through co-location to enrich face-to-face interactions between agents (Puranam, Alexy and Reitzig, 2014, p. 166). By extensively focusing on information flow while placing relatively less emphasis on the knowledge of the

agents, these two mechanisms tend to correspond mainly with the administrative coordination perspective.

As already established in the situated learning literature, mechanisms such as co-location may not necessarily improve coordination efficiency, or even facilitate the development of shared understanding between network actors. Moreover, learning is not enhanced simply by bringing people together but by exposing them to different kinds of environments and tools that will increase their problem-solving capabilities (Tyre and von Hippel, 1997, p. 71). Therefore, expertise coordination is crucial because it facilitates tasks completion and the management of knowledge interdependencies between network actors – e.g., by directing the attention of the network actors to the location of expertise as well as where such expertise is needed and how to bring the expertise to bear (Faraj and Sproull, 2000, p. 1554).

Thus, the potential for effective coordination of actions increases when there is sufficient mutual knowledge between network actors, which enables them to predict each other's actions (Kotha, George and Srikanth, 2013). In the absence of such predictive knowledge coordination failure – manifesting as ineffective communication and knowledge transfer, misunderstanding and poor activity alignment – is almost inevitable (Puranam, Raveendran and Knudsen, 2012; Srikanth and Puranam, 2014, p. 1253). A recent study by Ben-Menahem et al., (2016) shows that team-based formal structure involving autonomous actors[1] is essential in ensuring sufficient information exchange and knowledge integration between the team members because it enables the development of predictive knowledge.

2.2.2 Coordination of social actions shaping and being shaped by knowledge boundaries

Coordination is achieved as an outcome of interdependent activities, resources, and actions when there is evidence of sufficient predictive knowledge between network actors (Srikanth and Puranam, 2014). Moreover, to identify the

[1] The team members are autonomous in the sense that the decision relating to team structure formation and adjustment is decentralized and informally arranged by members in accordance with the knowledge requirements of different situations.

effectiveness of coordination mechanisms, it is imperative to consider the following factors – namely, the complexity of information, the structure of knowledge, configuration of interdependence, and the structure of interests between the network actors (Grandori, 1997). Regarding these highlighted factors, Carlile (2004) developed an integrative framework comprising three knowledge boundaries – namely, syntactic or information processing boundary, semantic or interpretive boundary, and pragmatic or political boundary. Relating, respectively, to the knowledge boundaries are knowledge transferring, translating, and transforming processes (Carlile, 2004).

At the syntactic boundary, information is least complex and interacting agents, usually within similar knowledge domain, tend to rely on common lexicon (Kellogg, Orlikowski and Yates, 2006). Knowledge then becomes an object or thing that network actors can transfer and store readily (Carlile, 2004). However, knowledge transmission becomes more complicated when information has the potential for multiple translations and meanings between network actors (Kogut and Zander, 1996). For instance, this could be as a result of the novelty of the information or the existence of diversified knowledge domains (Carlile, 2004). Therefore, this boundary requires the process of translating to create shared meaning and reconcile the interpretive differences between the network actors (Carlile, 2004; Kellogg, Orlikowski and Yates, 2006).

Furthermore, ensuring and maintaining shared understanding in an interorganizational relationship is an ongoing process. This process may involve, among other things, the use of boundary objects (e.g. technical drawings and prototypes) and problem representations (e.g. a knowledge bank or physical problem space) in intraorganizational communications (Simon, 1991; Carlile, 2004). It may also involve the use of boundary spanners (e.g. project champions or project managers) in network relationships (Gittell and Weiss, 2004). One of the roles of boundary spanners is to act as network insiders by engaging in a purposeful and goal-oriented interaction with any new network members, such as the project customers. Such purposive interactions form the basis of developing familiarity and for building a transactive memory in business relationships – *i.e., a shared cognitive system that team members collectively*

develop to encode, store, and retrieve information in different domains (Peltokorpi, 2014, p. 445). Moreover, during such interpersonal interactions, boundary objects and representations may be jointly developed as reference points for coordinating, aligning, and distributing tasks. And for directing information sharing to establish shared understanding and meanings (Okhuysen and Bechky, 2009).

Interestingly, boundary objects, boundary spanning, and the use of representations may not always result in shared meaning in interfirm relationships – e.g., because of potential confrontation and contestation between various interest groups (Carlile, 2004; Faraj and Xiao, 2006). Moreover, in business networks, this may also be due to the lack of a unified system of authority between the network actors (Kellogg, Orlikowski and Yates, 2006). Or as a result of epistemic differences, reputation stakes, and blame apportionment between them (Faraj and Xiao, 2006, p. 1155). Tagged by Carlile (2004) as a pragmatic boundary, such a situation requires a process of transforming novel knowledge into common knowledge in a way that satisfies the different political interests and knowledge domains of the network actors (Carlile, 2004).

An empirical study of a medical trauma centre indicates that such political boundaries result from the novelty of events which demands dialogic coordination practices such as epistemic contestation, joint sensemaking, cross-boundary intervention and protocol breaking (Faraj and Xiao, 2006, p. 1155). A similar study that investigates the process of knowledge creation and sharing between new drug discovery teams also indicates that specialists engage in informal coordination practices – namely, anticipatory conforming, workflow synchronization, and cross-domain triangulation. According to the authors, specialists tend to compromise their domain-specific standards to satisfy cross-domain requirements, while also ensuring uninterrupted workflow and clarity of meaning across knowledge domains (Ben-menahem *et al.*, 2016).

While the above empirical works exemplify how specialists develop collective cognition and interrelate heedfully in health-related fields, little is known how such practices could manifest in other business contexts and network relationships. For instance, it is still unclear how a collective mind develops in

business networks comprising of actors from widely distributed fields (Mattsson, Corsaro and Ramos, 2015; Mouzas and Henneberg, 2015). The discussions so far in this dissertation indicate that the challenges of developing a collective mind, vis-à-vis shared understanding between network actors, is more evident during non-routine situations.

To this end, the goal of this dissertation is to investigate the process of forming a collective mind in temporary business networks.

Temporary business networks are particularly useful because they are a unique type of business networks which have time constraints and tend to operate in non-routine situations. Members of such business networks usually *lack familiarity and have competing loyalties* (Peters and Pressey, 2016, p. 301). Hence, this dissertation develops the concept of interfirm problem representations as an adaptive and cross-domain coordination mechanism to guide this research inquiry. This dissertation also adopts the concept of knowledgeability from structuration literature to incorporate human purposive intention into the ongoing discussion. These two concepts will, therefore, be the focus of the next sub-chapters.

2.3 Knowledgeability – A structuration perspective

The central argument behind the concept of knowledgeability wraps around the assumption that human beings typically act purposively in their day-to-day activities. As knowledgeable agents, humans possess the ability to recount extensively on the reasons for their actions if asked to do so – which, according to Giddens, includes *lying about them* (Giddens, 1984, p. 3). Hence, concerning their day-to-day activities, Giddens regards all human beings as knowledgeable social actors who are consciously aware of the conditions and consequences of their actions (Giddens, 2013, p. 281). Following these assumptions, knowledgeability refers to *"the knowledge individuals have of the circumstances of their actions and the rules they follow*" (Berends, Boersma and Weggeman, 2003, p. 1040). As purposive and knowledgeable individuals, human beings depend on three forms of consciousness – namely, discursive consciousness, practical consciousness, and unconscious motives or cognition. Except for the

unconscious motives, Giddens asserts that human consciousness is difficult to distinguish – "*there are only the differences between what can be said (discursive) and what is characteristically simply done (practical)"* (Giddens, 2013, p. 7).

Giddens' framework on humans' consciousness appears to be overly simplistic or at least tends to overlook crucial factors. The first factor is human's innate planning capability, and the second is the possibility of interconnections or even contradictions between multiple human intentions and motives. Regarding planning, human's consciousness does not only relate to what they do, and what they can discuss but also include what they intend for the future (Bratman, 2000). It is these planning qualities that enable network actors to organize temporally evolving activities and conduct such activities coherently and consistently. However, the planning capability of network actors is complicated during social interactions involving multiple agents that are engaging in cross-temporal and overlapping activities. Hence, to ensure a sufficient level of stability in their social interactions, knowledgeable individuals routinize their daily activities by employing typified schemes or formulae (Giddens, 1984, p. 22). By engaging in routines, network actors can structure their thought and concentrate their attention during social encounters (Heimer, 2001). Studies have shown that routinization reinforces positive relationship outcomes (Lee, Johnson and Tang, 2012).

However, despite its importance in ensuring stability and avoiding unnecessary anxiety during social interactions (Giddens, 1984; Turner, 1986); routinization does not account for unforeseen events that are either outside the planned actions or immediate control the network actors. Hence, when conducting temporally extended activities, there is a tendency that certain actions – *either intentional or unintentional* – could lead to unintended consequences that may threaten the accomplishment of intended goals (Bratman, 2000). According to scholars of bounded rationality, the inability to accurately predict future consequences of actions is due to two main reasons (Simon, 1993).

Firstly, humans generally lack the knowledge of all the alternatives that are available for action and they only rely on incomplete and uncertain knowledge

about their environmental variables, both present and future, that will determine the consequences of their actions. Secondly, even if they have perfect knowledge, humans lack the requisite computational capacity for optimal choice (Simon, 1993, p. 156). Thus, to overcome their limitation and ensure social competitiveness, humans need to be docile. Docility refers to humans' tendency to rely on information that is gathered from and shared through social channels as the basis for their choices (Simon, 1993; Bardone and Secchi, 2009).

Therefore, from business to business point of view, it could be argued that any organization initiatives that encourage information sharing beyond organization boundary could provide a plausible impetus for knowledge creation and expansion. The organization initiative could be a marketing activity that is specifically targeted at promoting or facilitating collective sharing of knowledge within an organization and with other external market actors (Peters, Gassenheimer and Johnston, 2009). In this way, new knowledge will emerge through social interactions and external learning (Bierly and Chakrabarti, 1996; Raza, Kausar and Paul, 2007).

Moreover, during information gathering and sharing, network actors tend to exploit external resources (material/non-material, human/non-human) by delegating certain cognitive functions to the artefacts in the network environment (Secchi and Bardone, 2009). Hence, it is safe to assume that social interaction in a network environment is constantly shaping, and is being shaped by, the existing structural properties (i.e. rules and resources) in the network environment. This continuous and bi-directional cycle of constructing and reconstructing social structure through the interactions between knowledgeable humans is the central thesis of structuration theory (Giddens, 1984; Berends, Boersma and Weggeman, 2003).

2.3.1 Reconceptualising knowledgeability – An extension from structuration

From the perspective of structurationists, organizational structure exists as a duality, which implies that structure is both the medium and the outcome of human activities, which it recursively organizes (Giddens, 1986, p. 533). This duality provides a better explanation for the mutually reinforcing relationship between structure and agency. On the one hand, humans gain their capacity to

act (agency) from the pre-existing structural properties (rules and resources) in their social space. On the other hand, they continuously reproduce or even transform the social structure through their actions or practices (Sewell, 1992; Berends, Boersma and Weggeman, 2003; Fuchs, 2003). Arguably, this characterization of the structure-agency relationship tends to position knowledge acquisition as a contextual process that continually evolves as a result of practices that network actors implement to achieve specific ends (Peters, 2012). Moreover, this duality also offers two inferences relating to knowledge production in network relationships.

Firstly, the evolving interrelation between structure and agency suggests that knowledge production is both temporal and historical, spanning across space and time. Because of its interactive and practice elements, human knowledgeability tends to have more potential to expand through the process of socialization rather than through explicit training (Chia and Holt, 2008, p. 481). Furthermore, knowledgeability could be said to be a form of demonstrative knowing or embodied cognition that could sometimes not be expressible in words (Harquail and King, 2010; Gherardi and Rodeschini, 2016). However, it can be transferred by a human agent from one situation to another – e.g. during job rotation in an organization (Tomlinson, 1999). Hence, one can draw an inference that the most salient knowledge is tacit in nature which enables agents to make "sensible" and prudent decisions as well as context-specific actions towards the attainment of their goals (Nonaka and Toyama, 2007). Consequently, *"the process of knowing-in-practice should be described not only as entangled with doing, but also concerning sensible knowing and embodiment"* (Gherardi and Rodeschini, 2016, p. 269).

Secondly, to define human knowledgeability holistically, accessibility and exposure to complex, unconventional tasks are equally as important as the ability to demonstrate knowledge in practice (Thompson, Warhurst and Callaghan, 2001). In other words, human knowledgeability is brought to a test whenever they face unpredictable circumstances outside of their regular routines, for which they cannot avoid taking a stand. Hence, the ability to make sense of complex situations promptly and to offer an effective solution is essential in explaining

human knowledgeability (Coghlan, 2011; Shotter and Tsoukas, 2014). Sensemaking and the ability to jointly offer practical judgement (*i.e. phronesis in Aristotle's term*) in difficult circumstances are the most important prerequisite for success in business networks (Flyvbjerg, 2004, p. 285). However, despite the importance, joint sensemaking is complicated by the need to access and share intelligent information that is predominantly tacit in nature. According to Simon (1991), one of the structural mechanisms for assessing such "hard-to-reach" knowledge is through a system of problem representation.

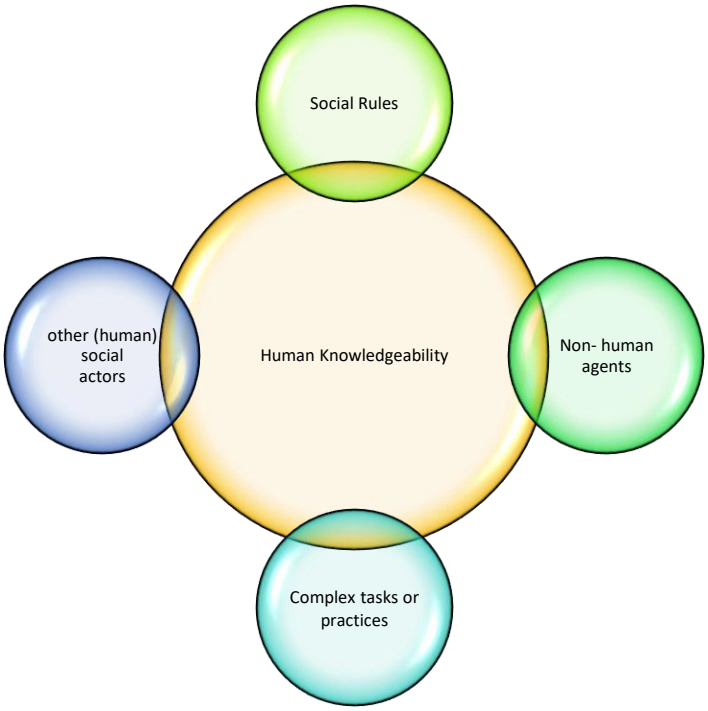


Figure 1. *Sphere of Knowledgeability of Human Beings*

As indicated in the discussion so far, it is evident that knowledge is never static, but continuously evolve as knowledgeable humans continue to engage in social interactions. Moreover, by sharing information and engaging in joint sensemaking, network actors can readily access the social rules and resources available in their network environment – which will eventually inform or expand their knowledgeability. Furthermore, through information sharing and joint sensemaking, a network actor is more likely to be conscious of how their actions influence, or is being influenced by, the behaviour and actions of other network actors. As they continue to interact, network actors tend to develop a sense of familiarity, trust and, potentially, friendship with their interacting partners

(Selnes and Sallis, 2003). The familiarity then affects how they either meticulously care for or nonchalantly take the conditions and consequences of their actions for granted.

Thus, contrary to the earlier assumptions in the structuration literature, knowledgeability is not a "*given*" and should not be regarded as the knowledge network actors already **"***have"* (Berends, Boersma and Weggeman, 2003, p. 1040). This dissertation refers to knowledgeability as a cognitive process of knowledge production and reproduction through human interactions that are simultaneously facilitated and constraint by four different factors (see figure 1). Firstly, knowledge production is affected by the awareness of network actors about the conditions and consequences of their actions as well as the dynamic social rules in the network environment. Secondly, knowledge production is affected by the accessibility of network actors to complex tasks which force them to personally figure out or seek alternate solutions outside their routinized practices. Thirdly, knowledge production is affected by their interaction with other network actors (human), and fourthly, their interaction with non-human agents (e.g. shared representations) to make sense of task ambiguities. Therefore, this definition suggests that research attention should focus not on human knowledgeability *per se,* but on the changes in the sphere of knowledgeability over time.

2.3.2 A summary of different philosophical positions regarding human mind/knowledgeability

As indicated in table 1 below, this dissertation groups the different versions and conceptualisation of knowledgeability in extant literature into four main categories. That is, the table contains concepts relating to the foundation, scope, and limit of human knowledge, as well as the position of the human mind in knowledge acquisition. The first set of philosophical ideas relating to knowledgeability (table 1) is under the category that Blackburn (1999) regards as the "*interventionist control*". The interventionist control positions the mind as a ghost-in-the-machine, which is *"distinct from the causal order of nature, yet mysteriously able to alter that order"* (Blackburn, 1999, p. 96). As the definition implies (table 1), Bourdieu's "habitus" tends to engineer the production and

reproduction of human social conditions and could be regarded as a kind of ghost outside the body because the humans appear to have no control over it.

However, the second categories of concepts relate knowledge application to human practices (Gherardi and Rodeschini, 2016), and knowledge coordination to the immaterial or abstract computation in the human mind. Hence, in this group, cognitive processes take place in the head in the form of conscious (or unconscious) reflection (Giddens, 1984). Arguably, authors in this category subscribe to the individualist philosophical assumption that tends to position the mind as a thing that begins and ends in the head (Wilson, 2004). By restricting cognition to consciousness (or unconsciousness), this group limits the mind to the head because it is improbable for consciousness to exist outside the body (Clark and Chalmers, 1998).

Table 1. *Key concepts in extant literature relating to human mind or knowledgeability*

Author(s)/Year of publication	Concept	Definition	Philosophical tribe
Bourdieu, 1984	Habitus	*Habitus is a kind of transforming machine that leads us to reproduce the social conditions of our own production, but in a relatively unpredictable way, in such a way that one cannot move simply and mechanically from knowledge of the conditions of production to knowledge of the products."* (Bourdieu, 1984, 1993, p. 87)	**Interventionist control**
Giddens, 1984	Knowledgeability	*"Everything which actors know (believe) about the circumstances of their action and that of others, draw upon in the production and reproduction of that action, including tacit as well as discursively available knowledge" (pg. 375)*	**Individualism**
Berends et al., 2003	Knowledgeable/ knowledgeability	*"Knowledgeability refers to the knowledge individuals have of the circumstances of their actions and the rules they follow" (pg. 1040)*	
Arjoon, 2009	Common sense	*"In the philosophical sense, common sense signifies a virtue (intuition) of the intellect or mental habit of thought and consequent action, based not only on experience of the demands of ordinary daily situations, but on those experiences shared by all"* (Arjoon, 2009, p. 212)	
Gherardi & Rodeschini, 2016	Knowing-in-practice	*"Knowing in a texture of practices means the activation of several professional knowledges by all the participants. Each of them takes part in the process for the purpose at hand without it being necessary for anybody to master the whole of it. This knowing-in-practice is sometimes mobilized in discursive practice, especially when it is openly discussed and contested; more often it is pre-verbal, tacit, and personal." (pg. 280)*	
Polanyi, 1967	Tacit knowing: Sense-giving/Sense-reading	*"Suppose we travel in a country we have not visited before. By the end of a morning we will be full of new experiences and may report them by letter to a friend so that he may read our message and try to understand our experiences. This is a sequence of three integrations. The first is an intelligent understanding of sights and events (sense reading), the second the composing of a verbal account of this experience (sense giving) and the third the interpretation of this verbal account with a view to reproducing the experience which it reported (sense-reading)." (pg. 305-306)*	

Harquail & King, 2010	Embodied cognition	*"Embodied cognition assumes that an individual continually reconstructs or construes and expresses the concepts that he or she uses to understand their world depending upon the explanatory task at hand, the array of available multimodal information, the individual's vantage point, and their skill with particular embodied capacities. In addition, this knowledge that cannot always be expressed verbally resides in our bodies." (pg.1620)*	**Externalism**
Gioia & Chittipeddi, 1991	Sense-giving	*Sense-giving is concerned with the process of attempting to influence the sensemaking and meaning construction of others toward a preferred redefinition of organizational reality. (pg. 442)*	**Active Externalism**
Weick, 1995	Sensemaking	*"Sensemaking can be viewed as a recurring cycle comprised of a sequence of events occurring over time. The cycle begins as individual form unconscious and conscious anticipations and assumptions, which serve as predictions about future events. Subsequently, individuals experience events that may be discrepant from predictions. Discrepant events, or surprises, trigger a need for explanation, or post-diction, and correspondingly, for a process through which interpretations of discrepancies are developed." (pg. 4)*	
Tsoukas, 1996	Distributed knowledge systems	*"The organizational problem firms face is the utilization of knowledge which is not, and cannot be, known by a single agent. Even more importantly, no single agent can fully specify in advance what kind of practical knowledge is going to be relevant, when and where. Firms, therefore, are distributed knowledge systems in a strong sense: they are decentred systems, lacking an overseeing mind. The knowledge they need to draw upon is inherently indeterminate and continually emerging; it is not self-contained." (pg. 11)*	
Bardone & Secchi, 2009	Distributed cognition	*"The distributed cognition approach is based on the idea that external resources shape the individual's cognitive system. This activity results from the interplay between internal and external resources. This is a "smart" interplay (Clark & Chalmers, 1998) in the sense that it is something dynamic and ongoing that allows the individual to get solutions that remain obscure instead. (pg. 196)*	

The third category claims that the ability of the human body to sense and feel things is instrumental in integrating and projecting meaningful interpretation of the world (Polanyi, 1967; Harquail and King, 2010). Hence, while the authors in the second category above have adopted the Cartesian philosophy of mind-body dualism; this third category follows the externalist view that tends to position the mind and the body as being embedded. Consequently, this group regards knowledge as being enmeshed in the social and physical world in which it is acquired (O'Malley *et al.*, 2009, p. 152).

The fourth category also adopts the externalist view of mind-body embeddedness. However, the authors in this group extend the definition of "externality" beyond the human body to include both abstract and material objects in human social environments (Tsoukas, 1996; Bardone and Secchi, 2009). The authors also acknowledge the role of symbolic signals and environmental cues that network actors use to generate meaning and enact their social world through perceptual observation and conversational practices (Gioia and Chittipeddi, 1991; Weick, 1995). The central thesis in this group, i.e. active

externalism group, is that the environment is not merely a passive object upon which humans act. But an extension of the mind, which provides humans with the tools for thinking. And, in a way, shapes the human cognitive system (Bardone and Secchi, 2009).

The above categories suggest that the evolution of concepts relating to knowledgeability has not been linear over the last five decades. The different authors appear to be subjective in the choice of philosophies that underpin their studies, which may be due to a lack of prevailing philosophical viewpoint among academics. Nevertheless, many of the authors have subscribed to the individualistic position. The individualist position undermines the central role of the human body in knowledge generation and in transmitting meaningful cues between agents. As indicated in figure 1 above, this current study subscribes to the active role of the human body with regards to their knowledgeability. The study also takes cognisance of the position of the social environment and the structural properties that shape humans' sphere of knowledgeability. Hence, relating to knowledgeability, it is logical to position this doctoral study with the "active externalism" philosophical viewpoint.

2.4 Interfirm problem representations (IFPR) – A collection of boundary objects (BOs)

The theoretical foundation for IFPR partially originates from the concept of *problem representation* adopted from the work of Simon Herbert (Simon, 1991). In Simon's view, organizations usually comprise of entities with potentially diverse and conflicting cultural perspectives. Multiple cultural perspectives within an organization typically complicate the establishment of a shared understanding of organizational goals (March, Sproull and Tamuz, 1991; Simon, 1991). Therefore, to establish a converged perspective between its members, organizations must create a unifying set of problem representations. Simon defines problem representation, at the organizational level, as a problem space or knowledge bank where members of an organization can search selectively during different daily encounters to obtain a satisficing solution for their problems (Simon, 1979, 1991).

As a unifying symbol that promotes self-learning and shared understanding between members of the organization, problem representations can function as (inter)organization artefacts or heuristic systems upon which shared memories develop (Okhuysen and Bechky, 2009; Mouzas and Henneberg, 2015). However, to function effectively, the content of problem representation must be matched with the social cues in the environment in which the organization is situated (Todd and Gigerenzer, 2003). By regularly matching the content of problem representation with social cues, organization members can make more sense of their environment and also reduce complexities in their daily lives.

Due to social dynamism, the problem representation may not always contain an accurate depiction of the environment (Weick, 1993). Because of their social entanglements (Kirsh, 2006), organization members can consistently adapt to the rapidly changing environment through face-to-face interactions. Therefore, to understand how problem representation functions at the organization or inter-organizational level, it seems relevant to start the discussion from the level of an individual agent within the organization. The theory of social psychology and cognition provides a starting point for understanding how individuals form their representations. According to this school of thought, individual organization member creates problem representations about things in their social environment through different modes of computational processes of assimilation (Wilson, 2004). Accordingly, they develop a perceptual understanding of social cues by creating internal codes or symbols that correspond to different objects in their environment (Wilson, 2004).

Some sociology scholars also subscribe to the idea that the environment is an object of human perception (March, Sproull and Tamuz, 1991). However, rather than computational processes, these authors argue that culture is the factor that influences the human interpretation of their environment, and this often leads to the existence of multiple interpretations and conflicting interests within an organization (March, Sproull and Tamuz, 1991). Furthermore, the problem of representations is evident when there are conflicting goals between the various units of an organization (Simon, 1991). Hence, organizations tend to rely on and exploit formal structure (such as routines, groups work), and informal or

relational factors (e.g. stories, informal conversations) to create shared memories and collective schemas between its members (March, Sproull and Tamuz, 1991; Simon, 1991; Mattsson, Corsaro and Ramos, 2015).

Therefore, it is viable to argue that representation is not given to humans, but they derive it from the exploitation of the social structures and cognitive artefacts in their environments through the process of acting and perceiving. The advocates of action ontology extend this view by arguing that the interactions between the organization and the environment are not one way but bi-directional. In their view, the knowledge required for problem-solving is distributed between humans and non-human actants such as computer programs, robots, measuring apparatuses, and manuals with formal guidelines (Heylighen and Beigi, 2016). Hence, organization members exploit resources in the environment to make decisions and navigate their routines. In a way, organization members do not only perceive their environment, but they also enact it through their actions with which they tend to bring events and structures into existence (Weick, 1988). However, a noteworthy argument here is that the mental representation of organization members also changes when they integrate cues from human-to-human interactions and the heuristic resources in the environment, and this enables them to carry out tasks that would have been difficult otherwise (Bardone and Secchi, 2009). Therefore, one can regard organization members as both the products and producers of their environment (Wood and Bandura, 1989).

The arguments so far are analogous to the cycle of tacit knowing in which organization members utilize their sense organs to understand and experience their environment through the process of sense-reading (Polanyi, 1967). And according to Polanyi, sense-reading is followed by sense-giving, e.g. when an organization member reports a personal experience to their colleague through an act of *conceptual subsumption.* Conceptual subsumption involves the use of universal terms (e.g. nature, culture, and language) to convey the tacit meaning of an experience (Polanyi, 1967, p. 310). Hence, the cycle of tacit knowing ends in shared meaning if the receiver of the report captures and assimilates its content

through the process of tacit integration and sense-reading (Polanyi, 1967, p. 310).

While the process of tacit knowing seems logical, it becomes only practical in situations in which the communicating parties exist in the same universe, in which the language of communication can be easily decoded – e.g. through *conceptual exemplification* (Polanyi, 1967, p. 310). Perhaps, this framework could be a basis for developing problem representation within an organization with common professional language and a centralized system of authority. For example, studies following similar assumptions have shown how CEOs and other top managements utilize sensemaking and sense-giving processes to persuade their subordinates to adopt changes to organization visions and goals (Gioia and Chittipeddi, 1991). However, it may be quite problematic in interfirm business relationships because of the possibility of power tension and distortion of communication between the business partners – especially, if the business relationships involve network actors with different operating language and business culture.

Therefore, in interfirm relationships, IFPR must account for, and also systematically integrate, the diverse environmental and social-material artefacts of the interacting firms. The requirement to integrate multiple socio-material objects across organization boundaries into IFPR raises some empirical questions. For example, how could network actors effectively develop and utilize IFPR in a way that satisfies the different political interests and multiple knowledge domains that are present in the network? A similar question raised by Simon (1991), is regarding how organizations acquire such problem representation(s), and how its content can be accessed and transmitted from one part of the organization to another. These questions are fundamental research problems for understanding how firms deal with the complexities of managing discrepancies in representations, especially in interfirm engagements and business networks.

2.5 The interplay between IFPR, knowledgeability, and coordination vis-à-vis shared understanding and collective mind – A theoretical framework

As argued in the previous chapters, this dissertation takes the position that a network actor is knowledgeable with regards to their professional practices and routinized actions (Giddens, 1984). This practice-based knowledge production process faces a test when network actors encounter an unfamiliar task that is outside of their routines – for which they cannot avoid taking a stand (Coghlan, 2011; Shotter and Tsoukas, 2014). The network actors' actions or inaction in such a situation usually determine the changes in their sphere of knowledgeability. As a proponent of active externalism philosophy (Clark and Chalmers, 1998), this dissertation subscribes to the assumption that knowledgeable network actors rely not only on social interaction and joint sensemaking with their cohort to solve their difficult tasks. But more importantly, they depend on external network actors in theirs and other professional fields (Selnes and Sallis, 2003).

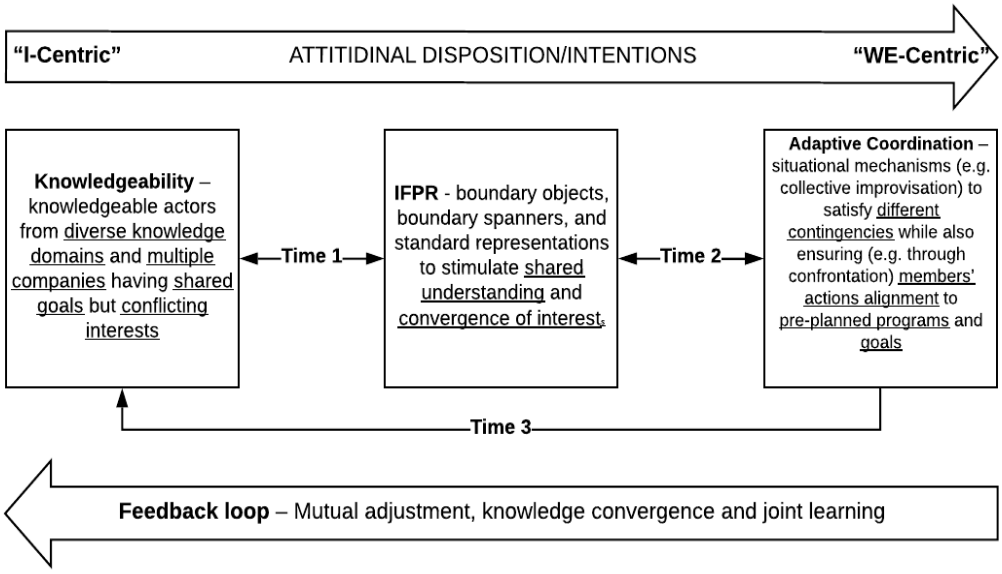


Figure 2. *A theoretical framework of collective mind in business networks*

Furthermore, they utilize knowledge artefacts and problem representations in their network environment as potential sources of knowledge or external memories. And such knowledge artefacts may also be from within or outside their professional field or knowledge domain (Carlile, 2004; Bardone and Secchi, 2009). By taking this notion beyond the perspective of a single network actor and, therefore, incorporating difficult tasks or events that are jointly faced

by multidisciplinary network actors; this dissertation unravels further complexities. For instance, this dissertation investigates situations where a business network comprises of actors from diverse professional backgrounds with exceptional circumstances that warrant occasional changing of the structure and composition of the network actors. An investigation of such temporary business networks has received limited academic investment in industrial marketing literature (Peters and Pressey, 2016).

Arguably, the design teams of construction projects are typical examples of temporary business networks. As a standard network condition, the position of the design team relating to other construction professionals is usually predefined (OGC, 2007; RIBA, 2013; Peters and Pressey, 2016; DBWiki, 2017)[2]. Other professionals in the construction projects include consultant team, contractor team, project management team, client champions, and suppliers (OGC, 2007; DBWiki, 2017). However, a typical design team usually includes lead designers, architects, structural engineers, service engineers and specialist designers. Activities that are carried out by the design team members are linked either as outputs of or inputs to the activities of the other teams in the extended social network of the specific construction project (OGC, 2007; RIBA, 2013; Peters and Pressey, 2016; DBWiki, 2017). Based on perspectives from the knowledge sharing literature, two potential problems can arise in such reciprocally interdependent teams during network interaction.

Firstly, at the earliest stage of team formation and interactions (e.g. time 1 in figure 2 above), despite the requirements to work together as a team, the loyalty of each actor and their commitment to act will likely focus on their respective company's interests or the fulfilment of personal objectives. Secondly, the differences in the background knowledge and professional language of the team members may complicate shared understanding as well as the development of shared meaning during communications (Peters, Gassenheimer and Johnston, 2009; Peters, 2012; Ben-menahem *et al.*, 2016). The establishment of shared understanding may be further complicated if members of the team have not

[2] RIBA is an acronym for Royal Institute of British Architects. The RIBA Plan of Work is a comprehensive document that is used by Architects and other actors in the construction industry as a shared framework for the organisation and management of building projects. RIBA provides a common reference point in mapping construction processes and stages.

previously worked together (Srikanth and Puranam, 2011; Peters and Pressey, 2016). Hence, to work together effectively and facilitate joint sensemaking of their shared tasks (Weick, 1995), the team will be forced to rely on a unifying frame of reference, which they will potentially create together.

This dissertation groups the unifying frame of reference into two different categories. The first categories are the boundary objects such as technical or structural drawings, Building Information Modelling, and a shared IT system (Carlile, 2004; Kellogg, Orlikowski and Yates, 2006; OGC, 2007; RIBA, 2013). The second categories are standardized representations such as legally binding contract, industry regulations, and industry standards (Mouzas and Henneberg, 2015). To contextualize the contents of the standardized representations and facilitate ongoing communication between its members, the project team also appoints some individuals with cross-boundary knowledge (e.g. project managers, lead designers, architects, and client champions) to function as boundary spanners (Gittell and Weiss, 2004; RIBA, 2013; DBWiki, 2017). Fundamentally, the boundary spanning role is to act as *a conduit* by connecting and linking the members of the teams through a series of interpersonal interactions.

Collectively, this dissertation regards the highlighted boundary objects and standardized representations as empirical examples of interfirm problem representations (IFPR). The contextualization and meaning generation processes of the content of IFPR are shaped by the knowledge of the boundary spanners and complicated by the diversity of professional knowledge within the project team. Therefore, from a cross-professional boundary perspective, what seems to be the most crucial factor for developing a collective or transactive memory is the knowledge management processes between the project team members. It is, however, noteworthy to emphasize that the outcome of the knowledge management process is contingent on the cross-boundary resources or the contents of the IFPR that is available to, and jointly created by the project team members. Hence, the arrow between knowledgeability and IFPR in time 1 (figure 2) is not necessary to show causation but to indicate that knowledgeability and IFPR are mutually reinforcing. However, as the project

team continues to use the IFPR as a unifying frame of reference, e.g. after finalizing the project briefs in time 2 (figure 2), their mental model will begin to converge. A convergence in their mental model is an indication of the development of a sense of familiarity between the team members' attitudinal dispositions, and this will guide their further negotiations in two possible ways.

Firstly, the sense of loyalty of each project team member (henceforth, network actors) may begin to shift from personal to team interest. In such a situation, the network actor will meticulously-care-for the shared interests of the project, which is an indication of the emergence of a collective mind. Or at least a shred of evidence indicating that each network actor's self-perception is shifting from isolated "I" to "I" as a team representative. This type of behavioural shift could be due to the network actors' dependence on each other, e.g. for reputation building and validation of self-worth. It could also be an avenue for the network actors to demonstrate their commitment to the effective continuity of the collective social practices of the business network (Sayer, 2011). This dissertation refers to such commitment to the collective goals of the business network as a *"we-centric disposition"* by each network actor (figure 2). We-centricity enables each network actor to conduct their activities as though they were a group. Thus, creating a work environment in which network actors work simultaneously "alone" together (Bruns, 2013) without disrupting their workflow or jeopardizing the coordination of their interdependencies.

Secondly, the sense of loyalty may remain tied to personal interest, at least for some members of the team. In such a situation, network actors are likely to nonchalantly-take-for-granted the collective interest of the group and, in worse cases, may exploit the existing "friendship" with other network actors to exhibit opportunistic behaviour (Selnes and Sallis, 2003). This dissertation refers to such opportunistic or exploitative behaviours as *"I-centric disposition"* by each network actor (figure 2). Among other things, I-centricity could potentially complicate the coordination of interdependencies between network actors, and also disrupt the consistency of their shared activities. Moreover, I-centric disposition tends to foster heedless interrelations between network actors, and could over time interrupt the process of developing a collective mind in the

business network (Weick and Roberts, 1993). Therefore, to re-establish heedful interrelations between the network actors, or at least understand why certain actors might act in unexpected ways, the intentions that motivate I-centric dispositions would need to be investigated.

2.5.1 Human intentions and collective mind – An elaboration of the theoretical framework

Intention refers to the state of mind which inherently connects with two social events – that is, intentional actions and coordination plans – that tend to shape the interrelation processes between network actors (Bratman, 1999). Hence, to achieve consistency and to ensure a reasonable level of stability in managing reciprocal interdependence in business relationships, the intentions of the network actors need a consistent level of coordination. As presented in earlier discussions, some organization scholars argue that standardized coordination mechanisms such as routines and schedules enable network actors to achieve consistencies and stability in their social engagements (Galbraith, 1974).

However, this dissertation contends that reliance exclusively on standardized mechanism can only offer a partial explanation of how network actors handle unplanned events that demand a mindful and cautious disposition. Moreover, to maintain a collective mind in network processes, network actors must account for and be consistently ready for unplanned events. Being mindful of unplanned events implies that network actors consistently engage in ongoing interpersonal coordination, which then enables them to achieve external consistency and to maintain a collective mind across the network boundaries. Moreover, to avoid errors and sustain predictive knowledge between the network actors, intentional actions need to be deliberate and carefully evaluated during interpersonal coordination.

Therefore, because it is process-oriented, a collective mind cannot be regarded as something that has happened at a particular point in time, but a pattern of actions that is happening over an extended period. The ongoing and continuous nature of a collective mind is also partly because network actors are not immutable or omniscient (Simon, 1979, 1991). Thus, rather than having a fixed state of existence, network actors are said to be in a state of constant "becoming";

a becoming that depends on the contingencies that they encounter in their daily lives (Sayer, 2011). A collective mind is, therefore, ongoing and continuous because the innate properties that presuppose the capacity of network actors to act or act in certain ways exist in what Margaret Archer regards as "potentia"; a potentia that is waiting to be activated by their relations with the natural, practical and social orders in the network environment (Archer, 2000a, p. 189).

This processual and non-deterministic view of human nature creates a blessing-curse duality for a collective mind in network interactions. On the one hand, the difficulty of capturing a specific episode that one could rely on as absolute evidence of the existence of a collective mind raises a methodological problem of measurement. On the other hand, because of its ongoing and continuous nature, investigating collective mind as a research outcome could also enable the exploration of how network actors manage and cope with different contingencies and challenges during the execution of their interconnected events. For instance, the theoretical framework of collective mind (figure 2) indicates that during time 3, adaptive coordination will necessitate a series of planning and re-planning activities between network actors. Hence, the (re)planning activities will potentially result in the readjustment of the content of IFPR, e.g. by changing the boundary spanners, updating the project execution plans, or adjusting the composition of project team members (Gittell and Weiss, 2004; RIBA, 2013; DBWiki, 2017).

However, if not well sanctioned or properly communicated to any *"newcomers"* in the network, readjusting and re-planning of IFPR could result in the implementation of actions that deviate from predefined plans, which is what Weick and Roberts (1993) referred to as heedless interrelations. Moreover, a lack of proper communication of changes could lead to possible misunderstanding of the interpretive schemas that underlie the updated IFPR (Peters, Gassenheimer and Johnston, 2009). Therefore, the happenstance of a collective mind, as a research outcome, could be treated as an investigation or observation of coordination problems. However, while coordination problems may threaten the existence of predictive knowledge between network actors

(Puranam, Raveendran and Knudsen, 2012), it does not necessarily indicate that a collective mind is absent.

The above conclusion is especially true if the action(s) leading to the coordination problems are taken mindfully by specific network actor(s) to satisfy the collective interests of the entire business network. Pragmatically, without readjusting the IFPR or project plans, certain situations may still warrant deviation from pre-planned programs. And as rational agents with capacity for practical reasoning and reflexivity, network actors may improvise and compromise commonly accepted norms to satisfy what different situation demands (Giddens, 1984; Archer, 2000a; Faraj and Xiao, 2006; Sayer, 2011). However, when such deviation leads to major changes in plans and threatens the predictability of actions between the network actors (Puranam, Raveendran and Knudsen, 2012), or conformity to industry standards (Mouzas and Henneberg, 2015), then confrontations may arise.

Examples of confrontations in construction projects are design and technical queries (RIBA, 2013). As a dialogic coordination mechanism, such technical query functions as a feedback tool (figure 2), which allows the challenged or alienated network actor(s) to provide justifiable reasons for their actions. A potential reason could be that the challenged network actor(s) have acted with a future-directed intention which offers benefits that outweigh the pre-planned actions or acceptable rules of engagement (Bratman, 1999). As long as the network team accepts the reasons, a collective mind is arguably in existence. Therefore, as network actors continue to confront, challenge, and persuade each other, their (collective) knowledge of the network environment and business processes will begin to converge. And individual actor will likely engage in activities with a sense of "we-*ness*" rather than focusing on satisfying self-interest.

2.5.2 Research questions (RQs)

Two main questions will guide the empirical investigation in this dissertation. The two research questions (RQs) are the outcome of the research gaps in the theoretical discussions regarding the process of forming a collective mind through the interplay between knowledgeability, coordination, and IFPR.

- RQ1 - How do temporary business networks [whose members potentially have conflicting interests and loyalties] utilize interfirm problem representations to coordinate actions, establish a shared understanding, and alignment of interests between the network actors?
- RQ2 - What levels of subordinating, contributing, and representing as well as shared understanding, coordination of actions and alignment of interests, are necessary to maintain a collective mind between network actors?

Regarding the RQ1, it is noteworthy to clarify that the question comprises of three different but interconnected parts. Firstly, how do business actors utilize IFPR to coordination the actions of each other? Secondly, how do business actors use IFPR to ensure they understand each other? Thirdly, how do business actors use IFPR to ensure their interests are aligned. A further discussion of each question is available in chapter six.

Regarding the RQ2, it is also noteworthy to clarify that the additional factors that the question highlights results from the discussion of collective mind within the context of interorganizational sensemaking. These factors are potential avenues to test and potentially extend the initial assumptions in the work of Weick and Roberts (1993) regarding the formation of a collective mind in intraorganizational settings.

Chapter 3 – Philosophical approaches, research methodology, and research design

This chapter presents three interrelated decisions that enable the development of a philosophically consistent research design that can effectively answer the two research questions of this dissertation. The first decision relates to how this dissertation captures the nature of social reality regarding the formation of a collective mind in temporary business networks (ontology). The second decision relates to how this dissertation defines and captures scientific knowledge regarding the criteria of causation that enable the collective mind of network actors to manifest the way it does (epistemology). However, the third decision relates to how this dissertation uses different methodological tools and research approaches to obtain empirical data for assessing and measuring the collective mind of network actors (methodology). Hence, by reflecting on the ontological, epistemological, and methodological issues, this chapter concludes with a discussion of the research strategy, data collection, and analysis processes.

3.1 Philosophical approaches – An overview of different ontological positions in (inter)organizational studies

Although there is a variety of positions regarding the nature of social reality and the activities of network actors, one can subsume these positions under two main continuums – namely, objectivism and subjectivism (Bourdieu, 1989; Cunliffe, 2011). The objectivist end of the continuum treats social facts or social realities as concrete objects of knowledge which are not mind-dependent but tend to shape, in a deterministic way, the behaviours of network actors (Bourdieu, 1989). To this end, objectivists regard scientific knowledge as a real entity with observable and measurable regularities, laws, and patterns (Cunliffe, 2011). In direct contrast, the subjectivist end of the continuum does not share an assumption of a mind-independent reality. Researchers adopting this view regard social reality, and even network actors' collective existence, as the figment of human imagination or a representation of the human mind. The subjectivists, therefore, regard network actors as independent and creative agents capable of giving meaning to their network environment, and knowledge is simply a

product of personal experience generated in their individual or collective endeavours (Bourdieu, 1989; Cunliffe, 2011).

These two positions reflect the realists and relativists ontologies. For instance, realists, at least in some of its many variations, share an objectivist view of reality with a claim that social reality exists independent of human cognition, and that there is only one truth waiting "out there" for discovery by utilizing scientific methods (Bourdieu, 1989; Easton, 2002; Johnson *et al.*, 2006). Arguably, such a claim of an external (mind-independent) reality confines realists to objectivism because of the logical impossibility to conflate a claim of a neutral observation language and constant conjunction of nature with an assumption that reality is a figment of human imagination (Johnson *et al.*, 2006). There is, therefore, one crucial difference between realists and relativists. On the one hand, at least for naïve realism, realists assume that there is a single reality that can be fully grasped by scientific methods. However, on the other hand, relativists repudiate the realist assumptions with a pluralist claim that there are both multiple truths and multiple realities. Therefore, from the perspective of relativists, knowledge is socially constructed and needs social evaluation (Easton, 2002).

While the difference between realist/relativist or objectivist/subjectivist continuums appears to be apparent, some scholars (noticeably, Bourdieu, 1989) contend that there are strong overlaps between the underlying assumptions of these philosophical views – even if the proponents of each view deny such possibility. For instance, the social reality of the objectivists is not entirely independent of the mind because the position of network actors always guides their perceptions, and the perception shapes their view of reality (Bourdieu, 1989, p. 18). This assertion challenges the claim that any knowledge can be absolute, a claim that forms the heart of the realists' research traditions (Easton, 2002). However, it also poses a problem for the relativists because if all knowledge is relative to the position of a network actor, then by whose standard can researcher measure the validity of scientific knowledge? (Easton, 2002; Cunliffe, 2011). The philosophical debates relating to how to capture and validate scientific knowledge will be the focus of the next chapter.

3.2 Philosophical approaches – Exploring the appropriate epistemological position for the study

As aforementioned, epistemology is a philosophical position regarding the nature of scientific knowledge about organizational phenomena and social reality. There are numerous examples of epistemological positions in both natural and social research fields. Some notable examples are positivism, postmodernism, interpretivism, critical theory, critical realism, social constructionism, and pragmatism (Cassell *et al.*, 2006; Brodie *et al.*, 2017; Nenonen *et al.*, 2017). These epistemological views have direct linkages to the objectivist and subjectivist or realists and relativists ontologies. For instance, while positivism relates to the objectivist/realist position (Bourdieu, 1989), social constructionism and interpretivism are under the subjectivist/relativist umbrella (Cunliffe, 2011). In the subsequent subchapters, this dissertation presents some arguments and justifications for the most appropriate epistemological view for studying a collective mind in temporary business networks.

3.2.1 Positivism – Why a positivist approach is not appropriate for this study?

The positivists' epistemological stance is nomothetic in nature, which means that researchers subscribing to this position share the view about the external existence of law-like regularities in both natural and social world from which one can derive scientific explanatory and predictive knowledge (Easton, 2010). Accordingly, the basis of causal explanation – from a positivist standpoint – is based on the supposed constant conjunction of nature. For instance, a positivist would claim that events that regularly occur in sequence explain each other (Bhaskar, 1989; Easton, 2010). Consequently, to avoid disrupting the regularities of nature or contaminating research data, researchers adopting a positivist view are expected to be separated from their research objects (Johnson *et al.*, 2006).

To put the positivist view in the context of this dissertation, separation of the researcher from the research objects may not necessarily be efficient in studying the collective mind of network actors, which is an ongoing and emerging social phenomenon that requires a dialogic social evaluation. As posited by Johnson

et al., (2006), the positivist approach to knowledge production that robs researchers and the researched of any epistemic reflexivity could only be appropriate for non-sentient objects, such as characterized the natural science research domain. By rejecting the reflexivity of the researcher and the researched as a crucial element of scientific knowledge, the derived knowledge from a positivist researcher (e.g. by logical empiricists) is mainly predictive, lacking the explanatory power to justify or explain why events occur or why people do the things they do (Sayer, 1992; Easton, 2002, 2010).

Hence, to generate useful knowledge that corresponds to the research objectives and questions, this dissertation investigates the collective mind in temporary business networks by engaging in direct interaction with the network actors. Unlike the positivist approach, constructionism, interpretivism, and critical realism all allow the social elements of obtaining and evaluating scientific knowledge by researchers. Therefore, the focus of the subsequent chapters is to justify which of these socially-oriented epistemologies is most appropriate for investigating the collective mind of network actors.

3.2.2 Constructionism – Making a case for the limitation of the constructionists' approach

There is hardly any feature that encapsulates the constructionists' philosophical positions (Searle, 1995; Prawat, 1996; Burr, 2015), which is evident in its multiple interpretations as well as the array of labels utilised by scholars when presenting and defending their positions. For instance, constructionism (Searle, 1995), constructivism (Prawat, 1996; Mir and Watson, 2000) and social constructionism (Berger and Luckmann, 1966, 2011; Lincoln and Guba, 1985; Crotty, 1998) are some of the labels used in philosophical debates. Despite these differences, one can subsume the central arguments of constructionism under what Berger and Luckmann (2011, p.51) tagged as "*the two of the most famous and most influential marching orders*" for sociology.

The first marching order is the Durkheimian view and is considered the most fundamental rule of sociology, which implies some level of objective facticity of the society by considering "*social facts as things*" (Berger and Luckmann, 2011, p. 51). The second marching order is the Weberian view which considers

the society as an "*object of cognition*" that social actors inherit historically and through social culture (Berger and Luckmann, 2011, p. 51). The research implication of the historical and the cultural elements of the objects of cognition is that researchers cannot study a social phenomenon outside of its context of occurrence (Lincoln and Guba, 1985). Moreover, the contextual nature of a research phenomenon imposes stringent requirements on the researcher who, rather than acting as an external observer, must jointly engage in the production of a socially acceptable knowledge with the researched (Mir and Watson, 2000; Burr, 2015). The main commonality between the two views is the perceived mind-world dichotomy that their assumptions imply (Prawat, 1996).

Whereas, the Weberian view tends to suggest an immaterial (rationalists or mental) state of acceptable knowledge – an assumption that regards knowledge or the mind as something that exists in the head. The Durkheimian view, arguably, accommodates a materialist (somewhat *naïve* realist) view of knowledge as "something concrete" that exists outside of the skin. To follow the Weberian view in research is to permit, as valid knowledge, any individual observation that is coherent with a generally accepted norm, or an observation that is provable within some given theory. Conversely, in the Durkheimian view, a piece of scientific knowledge will be deemed valid or acceptable only if it corresponds to some external reality or truth (Lincoln and Guba, 1985; Prawat, 1996). Consequently, two versions of constructionism could be said to have emerged from these seemingly parallel continuums. The progenies of the Durhemian view (e.g., Searle, 1995) appear to be on the objectivist/realist end of the continuum while the followers of the Weberian view (e.g., Crotty, 1998), could be said to be on the subjectivist/relativists or antirealists end.

Scholars like Berger and Luckmann (1966) tend to maintain that both approaches (objective and subjective) are not contradictory as they appear to be but rather exist as a duality. Hence, these sets of scholars push for the conflation of the objective facticity and subjective meaning generation features of the society. According to Berger and Luckmann (1966), the aggregation of this dual character of the society makes its "*reality sui generis*". It is noteworthy to mention that what Berger and Luckmann regard as objective facticity (i.e. social

institutions such as language) is still a product of man, and this is because of the assumption that objects in the world are not inhered with any meaningfulness outside of human consciousness waiting to be discovered by man (Crotty, 1998). Realist constructionists like Searle (1995) also consent to the argument of a subjective existence of institutional facts. However, such authors maintain that there are "*things*" (e.g. nature) – with social implications – that do not gain their existence as a result of human knowledge.

Despite the general ontological assumption that reality (and obviously knowledge) is a construction of network actors, what constitutes the content of such reality or acceptable as a scientific knowledge remains a bone of contention among the different versions of constructionism. At the relativists' camp, a key assumption is that researchers can never fully know reality because multiple realities are resulting from the infinite number of constructions by network actors (Lincoln and Guba, 1985). Hence, the research goal of scholars that subscribe to this view would be to gain a deeper understanding of how network actors perceive and ascribe meaning to their social engagements (Burr, 2015). Because network actors continue to reshape and adjust their orientation during social interactions, their reality is never static. Therefore, rather than focusing on social structure as the unit of observation or analysis, subscribers of a relativist view tend to focus on the dynamic social processes that characterise knowledge production, transmission, and maintenance (Crotty, 1998).

While the relativists in the above discussions tend to favour subjective head knowledge and experience of individual network actor, antirealists subscribe to the notion that knowledge is not a property of any individual (Burr, 2015), but rather a property of the collective network actors that manifests in discourse and dialogue (Prawat, 1996). Because of this linguistic determinism, antirealists reduce social reality or even the mind to the content of language that people exchange during interaction (Gergen and Thatchenkery, 1996). Even Scholars like Rom Harré, went as far as to claim that *"rules, customs, and conventions cannot be reified into concrete ontology as though they can possibly exist outside of consciousness or outside of the practices they guided"* (Harré, 2002, p. 215). It is important to note, at this juncture, that there are many doctrines (e.g.

structuralism, poststructuralism, and some aspects of postmodernism) at the antirealist's camp (Mingers, 2014) which tend to focus on discourse as the source of valid knowledge, and such doctrines generally reject the existentialists' claims of things as concrete beings. However, there is one version of antirealist constructionism that tends to stand out, and this dissertation refers to it as social constructionism (Crotty, 1998).

Rather than focusing mainly on discourse, social constructionists posit that meaningful reality is not something that individual network actor creates through a subjective perception, but through an ongoing "*intersubjective*" social interaction between multiple network actors (Searle, 1995; Prawat, 1996; Crotty, 1998; Cunliffe, 2011). Therefore, the focus of social constructionist researchers is to investigate how network actors ascribe meaning to things or cues in the network environment through social interactions (Prawat, 1996). What clearly distinguish the realists' constructionists from both antirealists and relativists is the obvious demarcation between brute fact and institutional facts in this camp (Searle, 1995). Furthermore, rather than multiple realities, the realist constructionists subscribe to the notion of a single reality that is independent of human knowing, preferences, opinion, or volition (Searle, 1995; Berger and Luckmann, 2011). Hence, this view is positioned, methodologically, as ontological realism and epistemological relativism (Mir and Watson, 2000). Despite the ontological realism position which suggests mind-independent reality (i.e. brute facts), researchers in this camp contend that certain things in the world (institutional facts) only exists based on human agreement (Searle, 1995).

Because institutional facts usually predate any network relationships, it tends to have coercive power over network actors and limit their choices during social interactions. However, constructionists would not allude such coercive power to causal efficacy. For instance, according to Rom Harre, rules and acts are mere discursive products. Hence, the only powerful particulars and efficacious agents are the people engaging in social interaction (Harré, 2002, p. 117). By claiming that network actors are the only powerful particulars, constructionists like Rom Harré are, arguably, underplaying the knowledge enrichment that researchers

can derive through the acknowledgement of social structure as real entities of causation.

The problem of side-taking (e.g. between objective-subjective, man-society) seems to stem from the philosophical root of the field of sociology earlier mentioned – that is, the Weberian and the Durkheimian view. A similar problem is obvious in the Cartesian mind-body dualism, and this has serious implication on social research programs. The propositions submitted by Berger and Luckmann (2011) for the conflation of both views do not seem to provide sufficient justification as the authors still appear to condition the *sole* primacy of causation to human agency. Some constructionists' scholars – with a particular interest in actor-network-theory – have also attempted to overcome the dualism by proposing a "hybrid" view of the world (Murdoch, 2001).

The central tenet of the actor-network-theory is that the motivation for social actions, and equally social change, is not only driven by humans but results from the collective engagement of interdependent social actors which include both human and non-human agents (Murdoch, 2001). While the actor-network position enriches "things" with an agency by avoiding the dualistic "side-taking" that characterise the different versions of constructionism so far discussed, it also points to the possibility that non-human agents possess the ability to actively and "purposefully" motivate social action or change. The implication of such assertion, as argued by Bruno Latour, is that "*purposeful action and intentionality may not be properties of objects, but they are not properties of humans either. They are the properties of institutions, of apparatuses, of what Foucault calls dispositifs'* (Latour, 1999; Murdoch, 2001, p. 119).

By stripping off intentionality from humans, social analysis becomes arguably tedious. Furthermore, it appears that the supposed solution of the actor-network-theory for the existing subject-object duality would result in fluidity of the distinct ontological status of each social actor (either human/non-human or structure/agency). It then raises a question of how to conduct a social research program in a way that allows (1) a simultaneous but separate existence of structure and agency, and (2) the collective existence and interdependencies of structure and agency, without committing the blunder of dualism. It is evident in

the discussion so far that the different versions of the constructionist view may not provide a satisfactory answer to this question.

These highlighted limitations render the constructionists' view of science inadequate for this doctoral dissertation. The constructionists' views do not align with the process of forming a collective mind in business networks, which involves an ongoing interplay between IFPR (social structure) and knowledgeability (human agency). This dissertation also highlights the separate roles of social structure and human agency in causing social transformation (see figure 2). The constructionists and structurationists do not share this view, as they tend to assume that social structure and human agency are inextricably intertwined (Giddens, 1984; Peters *et al.*, 2013). Therefore, critical realism appears to be the most appropriate philosophical position that offers sufficient support to develop the methodology for this doctoral dissertation.

3.2.3 Critical realism – A philosophical guide for research design in this study

The Bhaskarian view of critical realism subsumes two different but complementary aspects of realism, namely, transcendental realism and critical naturalism. Whereas transcendental realism focuses on general philosophy of science, critical naturalism focuses on the theory of human sciences (Bhaskar, 1989, p. 190). Therefore, in the current chapter, any mention of critical realism, realist social science or realism would refer to either of both approaches, without necessarily indicating which. The transcendental realism and critical naturalism are crucial foundations for any conception of realists' science, be it natural or social. Hence, it would seem unnecessary belabouring to attempt to isolate arguments from each approach.

A key point of departure in the realist account of science is the acceptance of a relativist view of scientific knowledge as socially and historically generated. Moreover, realists do not confine the ontological domain strictly to constant conjunction of observable/perceivable events or lived experience of agents, which are the philosophical mistakes of empiricists/positivists and constructivists/phenomenologists, respectively (Mingers, 2000, p. 1261). Consequentially, the objects of realists' investigations are not the patterns of events or the experiences of agents per se, but the real objects (i.e. generative

mechanisms) at the ontological domain of reality. According to the realists, these generative mechanisms possess intrinsic properties and tendencies capable of activating and causing events or social changes to happen under certain conditions (Sayer, 1992).

As a result, realists' account of the existence of any humanly imaginable objects, or even unimaginable for that matter, does not depend on how perceptible the objects are, but rather on their causal tendencies and liabilities. Therefore, unlike the positivists or empiricists, whether an object is perceivable or not, it exists as long as it influences social actions or possesses the capability of "doing" (Bhaskar, 1998; Outhwaite, 1998; Mingers, 2000). The causal efficacy that inheres in any social entity is similar to what Giddens (1984) regarded as an agency, only that in the realists' account such agency is as real in humans as it is in the social structure. Hence, the focus of realists on the causal efficacy of generative mechanisms at the ontological domain implies that reality cannot be exhausted simply by interviewing people to capture their experiences. Moreover, people's account of their network environment is limited to their vantage point, which is neither accurate nor complete (Archer, 2000b, p. 469).

The methodological implication of the fallibility and corrigibility of agents' view of reality necessitates a multi-layered research investigation that transcends from the level of agent's knowledge of a particular phenomenon (e.g. events) to the structures or mechanisms that generate it (Bhaskar, 1998). As evident from these assumptions, capturing the causal mechanisms generating social actions (or inactions) or obtaining a holistic view of social reality would require a research strategy that considers contextual factors as well as multiple sources of data as key elements of scientific knowledge. Case study research strategy provides such possibilities because it allows researchers to investigate social phenomenon within their real-life context with a particular focus on unveiling the contextual conditions that bring events to bear (Yin, 1994). Since this dissertation focuses on investigating the situational mechanisms and influential contingencies that permit, inhibit, interrupt, or terminate the formation of collective mind in a temporary business network; case study appears to be the most logical research strategy (Harrison and Easton, 1998).

Chapter 4 – Case study research strategy

To capture and understand, or even possibly explain the contingent and messy state of situated actions, as well as the subjective experiences that characterise business networks; a researcher must design a case study in a way that allows them to have close access to events as they unfold. Moreover, through an in-depth investigation of the network actors over a period, the causal links between the chain of events in the process of forming a collective mind can be identified. A researcher can design a case study in multiple ways, and the crucial factors affecting the design are the nature of the research question (s) and the research phenomenon (Yin, 1994). Generally, the research design could be a single case or multiple cases and could focus on single or multiple levels as well as units of analysis (Eisenhardt, 1989; Yin, 1994). A case study is useful, particularly for realists, as it enables them to produce explanatory knowledge by asking the "why" and "how" questions rather than focusing on event regularities and frequencies of incidence within and between cases (Tsoukas, 1989; Yin, 1994; Harrison and Easton, 1998).

In this dissertation, the phenomenon under investigation (i.e. collective mind) is processual and social, and its investigation would be incomplete by focusing *only* on the perception of the individual network actors of the temporary business networks. Moreover, as the two research questions of this dissertation indicate, the study has two overlapping agenda. On the one hand, the study focuses on the human element of interactions relating to how a potential inconsistency in the isolated interests, intentions, and situated actions of each network actor may generate social tensions, misunderstanding, and coordination problems at the network level. On the other hand, the study investigates how social structures in the form of shared representations and IFPR may be triggered to ensure a consistent and continuous pattern of heedful interrelations between the network actors. Therefore, the design of the case can be said to be multi-layered and comprises individual, structural, and network levels of analyses.

4.1 Case context, unit of analysis, and unit of observation

It is noteworthy to start by highlighting that the researcher has written some sections of chapter four in the future tense in the spirit of abduction, which suggests that before actual data collection a researcher can start by developing a hypothesis about the social phenomenon they are investigating (Mingers, 2014). Hence, some sections in chapter four are a presentation of hypothetical reality which aligns with the theoretical discussion regarding the collective mind of network actors. As a philosophical position, which is both value-laden and theory-laden, critical realism supports the abductive approach of hypothesizing from theory to guide the actual data collection (Easton, 2010; Mingers, 2014).

The groups that this dissertation investigates are the design teams working on construction projects. This decision is motivated by the understanding that construction teams are usually multidisciplinary in nature with possible conflicting views of expected modes of operation. Moreover, because of external complexities, the different conditions for construction projects cannot be planned holistically, which tends to open up possibilities for unplanned, or even unprecedented, contingencies during project implementation. Therefore, rather than being the actual case to be studied, *the construction project is considered as a potentially fruitful research context to elaborate network theory in industrial marketing*. It is worth mentioning that the focus of theoretical elaboration is broadly related to understanding stability and change in business network processes. And more specifically, this dissertation hopes to shed more light on how temporary business networks respond to different contingent conditions and conflicting views while maintaining heedful interrelations between the network actors.

Having considered the construction projects to be the case contexts, the question remains what the actual cases to be investigated are? According to Yin (1994), the problem of case definition directly links to the unit of analysis – which could be an individual, social groups, events, or other abstract entities. Since the phenomenon of the collective mind of network actors is social and action-oriented, *it seems logical for the unit of analysis to be the ongoing interactions between the construction project team members*. The study takes a relational

approach to understand social events and situated actions of network actors within the same business network (Araujo and Easton, 2012). What this means is that the effort of the current empirical investigation is to understand how the relationship (i.e. social structure) between the team members evolves, and how the shared structural property (i.e. IFPR) potentially conditions the team's joint navigation through their routines as well as different contingencies.

Based on theoretical knowledge (see figure 2), it is expected that the project teams would utilize interfirm problem representations to achieve the desired level of relational stability and unity of focus, while also engaging in collective improvisation (i.e. shared agency) to adapt to different situational (i.e. contingent) demands. This argument implies that social structure is a legitimate object of investigation which possesses *real* generative power and tendency to shape social actions without necessarily determining it (Tsoukas, 1989; Araujo and Easton, 2012). For instance, the internal relations between the project team members – which is imposed on them by their interdependent roles and positions as well as expected project responsibilities – essentially create an interactive social space in which the action of a team member impacts the actions of other team members. And over time, actions and reactions would continue to reproduce and possibly transform the structure of the relationship between the team members.

Regarding the observation and analysis of causality between events or between team members' actions; causal power or liabilities would be treated as manifesting in social relations rather than experienced as isolated properties (Archer, 1996; Porpora, 1998). More so, during observations and analysis, causal power and liabilities would be evaluated as tendencies which can exist whether or not they are being exercised or suffered (Bhaskar, 1989, 2009; Sayer, 1992). The empirical implication of this mode of thinking is that this dissertation would direct the effort of observation and analysis at two main issues. Firstly, observation and analysis will focus on uncovering the causal powers and liabilities relating to the relational structure that exists between project teams. Secondly, the research effort will focus on identifying the contingent conditions

that must be triggered to develop and maintain a collective mind between the project team members (Sayer, 1992; Archer, 1996).

4.1.1 How does the critical realists' stratification of social reality shape the definition of the unit of observation and unit of analysis in this dissertation?

This study acknowledges that the existence of any causal power and liability is independent of and separate from its effect or how network actors experience it (Sayer, 1992). The view taken by this dissertation aligns with Bhaskar (2009)'s three distinct strata of reality, namely, the domain of the real, actual, and empirical. The domain of "the real" exists at the intransitive layer of reality and comprises of the social structures and generative mechanisms that are relatively autonomous to the human conception of them, and also irreducible to the pattern of events or social discourses that arise through human interactions (Bhaskar, 1989, 2009). However, the domain of "the actual" comprises of the events that social structures and generative mechanisms produce, and through social interactions, humans capture and experience the events at the domain of "the empirical".

The above stratification of reality into three distinct domains have a notable implication for this dissertation, particularly regarding the decision about the unit of observation and analysis. That is, because of the stratified nature of reality and the fact that social structures have distinct existence, humans cannot completely or wholly grasp the full extent of events in their experiences. As a result, one cannot analyse information or knowledge obtained from direct human experiences as an ontological statement (Bhaskar, 2008). Moreover, Weick's work on sensemaking has also highlighted the potential implication of confirmation bias in human relations and caution social actors to avoid accepting the human interpretation of their experiences at face value (Weick, 2010). Weick further suggests that social actors can tease out a wishful interpretation in social negotiations by enacting doubts in their evaluation of experience (Weick, 2010). Therefore, while this dissertation considers the experience of each network actor *(i.e. interview data) as the primary unit of "empirical" observation*, it does not regard such experience as an accurate representation of the collective reality of the entire business network of construction professionals. Hence, the dissertation starts its evaluation by capturing a wide range of issues such as the project team

member's perceptions of events, perception of change, perception of other members' actions, perception of joint knowledge sharing and learning, and perception of relationship outcomes. However, the dissertation also captures how the team members collectively rationalise (i.e. reason-giving) the causes of specific actions and events (Araujo and Easton, 2012; Corsaro and Snehota, 2012; Ryan *et al.*, 2012).

Additionally, this dissertation also conducts direct observations (e.g. observation of project meetings and project site visits) and analyses project documents to capture the domain of the actual – that is, to observe actual events as they unfold (Sayer, 1992; Mingers, 2014). In this way, *direct observation and document analysis are considered as the unit of observation of "the actual".* The combination and comparison of data from both actual and empirical units of observation are expected to provide some useful, although possibly conflicting, explanations for how and why events and actions are patterned in the way they do, and how stability and change endure in the teams' relationships.

As mentioned earlier, the realist approach to social research places theory at the centre of empirical knowledge production – i.e. critical realism approach is theory-laden and value-laden (Bhaskar, 1989). Therefore, this dissertation is utilizing the tentative framework of collective mind (see figure 2) as the primary cognitive resources to tease out wishful interpretations of experience or eliminate explanations with limited justifications. It should be clarified that the use of the framework in this manner is not to imply a deductive mode of inference because the framework is not intended to be an actual representation of reality but a starting point. It is therefore expected that new causal elements that are invaluable for further development or correction of the framework would be discovered in the course of the empirical investigation and analysis (Dubois and Gadde, 2002, 2014; Mingers, 2014).

4.2 Single or multiple cases - A justification for multiple case study

As aforementioned, case study research strategy could be either single or multiple cases (Eisenhardt, 1989). Whichever of these two approaches to be selected should be determined by what questions an investigator intends to

answer, and the nature of the phenomenon under investigation (Eisenhardt, 1989; Yin, 1994). In a realist process research, such as this dissertation, a purposeful decision must be made on the depth and richness of empirical information required to arrive at a satisfactory explanation for the phenomenon of inquiry (Tsoukas, 1989). Some scholars have continuously advocated for a single case research design as the more appropriate approach when the goal of the research is to develop an in-depth understanding of specific case contexts (Dubois and Gadde, 2002, 2014; Bizzi and Langley, 2012). The single case design has also been argued, from a positivist standpoint, to be appropriate when the particular case, or specific features of the case, is critical in testing a well-formulated theory (Yin, 1994).

Moreover, single case studies could also be considered in an extreme situation relating to an event that has never happened before or in a situation where a researcher has a unique opportunity to gain access to a revelatory case that was previously inaccessible to research investigation (Yin, 1994, pp. 38–40). Though there is a huge debate around this argument (Dubois and Gadde, 2002, 2014), the main limitation of a single case is that the knowledge generated from such studies may be too descriptive and situation-specific. Hence, a single case study may have a limited explanatory potential for a more general theory, especially because of the lack of varieties between the phenomenon under investigation and its contextual boundaries (Aaboen, Dubois and Lind, 2012; Bizzi and Langley, 2012).

Conversely, in multiple case studies, the same phenomenon can be investigated within different contexts, and such can result in a better and more robust understanding of the dynamic nature of the phenomenon (Aaboen, Dubois and Lind, 2012). Furthermore, multiple cases allow the identification of different configurations of contextual conditions and generative mechanisms as well as contingencies and deep processes shaping outcomes in different situations (Harrison and Easton, 1998). Since contextual conditions are pertinent in understanding the process of forming a collective mind in temporary business networks, it becomes necessary to adopt a multiple case study approach in this dissertation. It is crucial to emphasize that the choice and analysis of multiple

cases in this dissertation are not based on the replication logic as advocated by Yin (1994) and Eisenhardt (1989) – that is, the goal is not to use findings from one case to confirm or reject findings from other cases. In this dissertation, multiple cases (project teams) are not selected to identify similarities between cases, but to understand and possibly explain the different patterns of behaviours resulting from the deep processes and contingencies shaping relationships in different project contexts.

However, some degree of comparison between cases is still required to systematise data collection and analysis, and to achieve some focus in the way each project team is approached. According to Harrison and Easton (1998), by utilizing a standardised system of comparison, changes within and between cases – *e.g., relating to how different contextual conditions and mechanisms, when activated (or not), influence outcomes* – can be tracked over time. In this dissertation, two standardization instruments are utilized – namely, the theoretical framework of collective mind (see figure 2) and the project RIBA[3] stages. The theoretically derived framework of collective mind is used both to guide the data collection and to systematise data analysis, and this is done by using abduction as the mode of inference. Which means that the core aspects of the network complexity would be considered, but this will be done without rejecting or undermining competing explanations that could enhance the understanding of how collective mind develops in temporary business networks (Dubois and Gadde, 2002, 2014; Aaboen, Dubois and Lind, 2012; Ryan *et al.*, 2012; Nenonen *et al.*, 2017).

The RIBA, which is an industry framework for standardised stages in construction projects, is used for three purposes. (1) To demarcate entry point and scope of coverage of the selected construction projects (i.e. to define spatial boundary). (2) To tentatively define the network boundary for respondents that would be included in the data collection and analysis. (3) To provide a standardised but provisional assessment of the implication of time on relationship emergence between team members (i.e. defining temporal

[3] RIBA is an acronym for Royal Institute of British Architects. The RIBA Plan of Work is a comprehensive document that is used by Architects and other actors in the construction industry as a shared framework for the organisation and management of building projects. RIBA provides a common reference point in mapping construction processes and stages.

boundaries) (Bizzi and Langley, 2012). For instance, by selecting the design phase of the construction project as a project context, only the design teams, and any project participants whose actions (or inaction) directly affect project design would be considered in boundary definition. However, the network boundary has to be defined retrospectively because of the possibility of new members joining the team at different points in time and the likelihood that some members might terminate their contract before the end of the design phase (Aaboen, Dubois and Lind, 2012; Halinen, Medlin and Törnroos, 2012; Ryan *et al.*, 2012; Halinen, Törnroos and Elo, 2013).

Therefore, in line with the above conditions, this dissertation has selected three project teams for investigation. The choice of three project teams is not to gain statistical inference or to identify frequencies of incidence (Eisenhardt, 1989; Yin, 1994) 1994). Case selection was primarily driven by the theoretical goals of the study. That is, project teams were selected because they fit the research criteria of this dissertation and also because they can provide sufficient data that could directly address the research objectives and questions. One major challenge which massively influenced case selection was the difficulty to gain access to some project teams. However, by selecting project teams in multiple project contexts and at different RIBA stages, this dissertation achieves the following. (1) Increases the variance between team compositions, (2) observes project actors with different experiences, (3) interacts with project teams at different stages of relationship development, and with different levels of project complexities. All these highlighted factors have implications on the depth, degree, and pattern of interactions between team members (Aaboen, Dubois and Lind, 2012; Ryan *et al.*, 2012; Ben-menahem *et al.*, 2016). More details of the sampling and case selection in the next sub-chapter.

4.2.1 Sampling and case selection

Following the general practice in qualitative process research (e.g., Bizzi and Langley, 2012; Dubois and Gadde, 2014), this dissertation uses a theoretical sampling process for case selection, which means that the cases were purposefully selected because of their suitability and relevance for the theoretical goals and objectives of this dissertation not because they are representatives of

a specific population (Eisenhardt, 1989; Blazevic and Lievens, 2008). Because of appropriateness for the research questions and objectives, the initial case targets were the design teams in construction projects and drug discovery teams in pharmaceuticals. These teams are useful for the theoretical purpose of this dissertation, which is to understand the formation of a collective mind in network relationships. Both the design teams and drug discovery teams are temporal networks that are typically set up for a particular project and tend to dissolve once the project is over. Moreover, the teams are usually multidisciplinary in nature, which provides an opportunity to explore and understand the tensions that may arise as a result of the diverse professional backgrounds in the teams. Furthermore, due to their temporary nature, both drug discovery teams and design teams typically have a clearly defined beginning and endpoints for their projects, which makes them suitable for empirically illustrating and elaborating the theoretical framework of collective mind in temporary business networks.

More specifically, their temporary nature is a useful attribute for defining the entry and exit boundaries for data collection as well as for conducting a comparative analysis regarding how social tensions or conflicting interests shape the maintenance of collective mind at different stages of relationship development between team members. That is, their temporal nature enables the researcher to capture the impact of relational structure on the teams' interaction processes by specifically negotiating access for teams at the early and later stages of project completions, which then facilitates the analysis of the team's collective mind through the lens of the duration of their relationships and shared experience. The initial purpose for choosing two distinct industries (i.e. pharmaceuticals and construction) was to learn from a cross-industrial analysis how different structural factors and contextual mechanisms shape the maintenance of a collective mind in vastly different social contexts. It is noteworthy to highlight that drug discovery teams were later excluded in the study because it was impossible to secure access despite much attempts to contact different pharmaceutical organizations. Hence, only design teams of construction projects participated in the study. The exclusion of the drug discovery teams does not, however, undermine the quality of the case study because this dissertation generates a rich contextual data by contrasting the

practices of three construction design teams at different RIBA stages of project completions.

As a starting point for the selection process of the design teams, the researcher explored multiple channels, e.g., scouting for potential gatekeepers through the alumni network of the University of Nottingham and, more importantly, exploring a database for the construction market data in the UK. Through the construction database (i.e., TCi, 2014), the researcher was able to obtain names of the top one hundred construction companies in the UK, and then explore the websites of the companies to extract the contact details of relevant people through whom potential research informants could be recruited. All the one hundred companies were contacted through emails, and some by phone calls, to introduce the research aim of the doctoral dissertation and to negotiate a one-to-one meeting. Additionally, five potential leads obtained through the alumni network of the University of Nottingham were also contacted by email. Of all the contacted construction companies, only six demonstrated initial interests, and the "gatekeepers" from the interested companies asked for further discussions – these include four contractors from the construction database, one client representative and one contractor company that were both connected via the network of the University of Nottingham.

For the next phase of the access negotiation (i.e. recruitment of informants), the researcher presented more details to the six gatekeepers regarding the type of data and access needed as well as categories of informants and the RIBA stages of the construction projects that would be appropriate for the research objectives. The researcher also assures the gatekeepers that data acquisition and management will adhere to the ethical guidelines of the British Educational Research Association (BERA). Additionally, the researcher presented two letters (i.e. information sheet and consent form) that had been approved by the ethical committee of the University of Nottingham to the gatekeepers, which was a way of further assuring them that their companies' data will be protected, and informants' details will be anonymised. Next, the gatekeepers had internal discussions with their respective companies to identify current projects that meet the research objectives, and the informants that can grant the type of access

required for the dissertation. In the end, the client representative provided access to two design teams, the contractor from the university's network offered access to one design team, and one of the contractors from the construction database also provided access to one design team – therefore, making a total of four construction design teams that were initially recruited. However, two issues are worthy of further elaboration.

First, despite using a theoretical sampling for the initial stage of the case selection process, the actual recruitment of informants appears to take the form of de factor snowball sampling approach (Auerbach and Silverstein, 2003). Specifically, this is because the client representative created the initial connection to his colleague, who is also a client representative on a concurrent construction project for the same client organization but working with an entirely different design team. Second, after confirming consent from four different design teams, the gatekeepers arranged for the researcher to attend a design team meeting for a proper introduction to the actual members of the team. However, before the scheduled appointment dates, the construction company for one of the teams declared bankruptcy, and the project was terminated. The fourth design team was, therefore, excluded from the data collection process, leaving the dissertation with three design teams. The three selected cases (design teams) were appropriate for the study objectives not only because they were designing buildings with different types of complexities, but also because they were at different RIBA stages when the data collection commences, which increases the variances between the case contexts and offers an opportunity for a more fruitful and robust data analysis.

Although the client organization is the same for two design teams, it is noteworthy to clarify that no other overlaps exist across the three cases. For instance, regarding team compositions, one of the design teams has eight members representing five different organizations. The second design team has twelve members representing seven organizations (i.e. six unique organizations plus the client organization from the first design team). The third team has eleven members representing six unique organizations. Across the three design teams, there are a total of thirty-one individuals, but seventeen and not eighteen unique

organizations because of the client organization that overlaps the first and second design teams. However, this does not undermine the data collection process because the design team members across the three cases were assured that the doctoral student is an independent researcher who is by no means working for the client to "spy" on their works and processes.

Furthermore, the design team members were informed of their right to withdraw if they feel uncomfortable at any point during the data collection, and they were also apprised of their right to deny the doctoral researcher attendance to specific meetings if there was sensitive information they were not willing to divulge. Finally, the use of NVivo12 to systematise the coding and initial data analysis limits a potential researcher's bias towards any specific cases because, instead of using a specific design team as an *ideal case* for comparative analysis, search queries were used to generate random text passages from the NVivo database. As would be elaborated in the subsequent chapters, the only explicit form of researcher's bias in the data collection and data analysis is related to the use of the theoretical framework as a template for structuring the early stage of data analysis (Weston *et al.*, 2001), and this aligns with the theory-laden and value-laden nature of the critical realist approach (Easton, 2010).

4.3 Data collection - Approaches and instruments

There is a variety of data collection methods that a researcher can use for case study research, and these could have either or both qualitative and quantitative evidence – e.g. archives, statistical records, interviews, questionnaires, and observations (Eisenhardt, 1989). Despite these array of methods, three particular approaches with mainly qualitative evidence seem to stand out in process research, namely, observation, interviewing, and document archives (Bizzi and Langley, 2012). The use of qualitative instead of quantitative evidence in business network research is typical for the industrial marketing and purchasing group (IMP) as well as for the progenies of actor-network theory (Halinen and Törnroos, 2005; Tidström and Hagberg-Andersson, 2012; Halinen, Törnroos and Elo, 2013).

On the one hand, this is due to the constructivist's nature of those researches. On the other hand, it is because – unlike quantitative evidence which focuses primarily on producing predictive knowledge from a surface or general data – qualitative evidence allow researchers to reflectively and reflexively analyse the deep processes and multiple layers that characterise the complex and contingent nature of the business network. Thereby, enabling researchers to develop explanatory [scientific] knowledge of different network phenomena (Harrison and Easton, 1998; Easton, 2010; Ryan *et al.*, 2012). However, despite the advantages of qualitative evidence for process research, scholars advocate that one should evaluate the strengths and weaknesses of each data collection approach to decide the most appropriate qualitative instrument to answer a research question (Bizzi and Langley, 2012). Yin (1994, p. 92) added that multiple instruments should be combined to offset the weaknesses of each approach and, more importantly, to enable the researchers to address a broad range of historical, attitudinal, and behavioural issues.

Moreover, according to realists, researchers can combine multiple qualitative approaches to reveal new aspects and dimensions that could increase the explanatory knowledge of the mechanisms and structures which are bringing events to bear (Easton, 2002, 2010; Aaboen, Dubois and Lind, 2012). Therefore, in line with the tradition of the realist process research, this dissertation uses three main qualitative instruments, namely, face to face interviews, observations, and documents analysis. By combining multiple qualitative instruments, this dissertation captures (in real-time) the evolution of different interactive behaviours of the project team members and develops a sound knowledge of their everyday practices. However, a particular qualitative approach, i.e. direct observation of meetings, enables the researcher to properly investigate the coordination practices that are being used by the project teams both during stable periods and when responding to unexpected situations.

Due to the long duration of construction projects, and to optimise the limited time available, this dissertation conducts observations of all the project teams in parallel. Furthermore, regarding data management, this dissertation uses NVivo12 as a centralised database to organize and keep track of data from all

the data sources (Yin, 1994; Ben-menahem *et al.*, 2016). Relevant data from project archives and documents (e.g. scope of work, progress charts, and variation reports) were also stored simultaneously during the period of observations. Despite their simplicity, the archives and documents provide rich information regarding the chronologies of key events in the project and are useful in tracking crucial changes over time (Bizzi and Langley, 2012). Moreover, the archives and documents provide some contextual links between events and also facilitate the identification of the social conditions that shape the unfolding actions (or inaction) of team members in different circumstances (Araujo and Easton, 2012).

Finally, in addition to the three qualitative instruments discussed above, a quantitative approach, known as necessary condition analysis (NCA), is also used in this dissertation. Unlike other quantitative models (e.g. sufficiency models like regression analysis), NCA uses a necessity logic and non-probability statistical approach in explaining causality between variables. The central tenet of NCA is in two folds. Firstly, in the absence of the necessary condition variable, the expected outcome cannot be achieved – this statement justifies the necessity of the variable. Secondly, if the condition variable is present, the outcome is not guaranteed – this statement clarifies that the condition is not sufficient to produce the outcome (Dul *et al.*, 2010). According to critical realists, necessary conditions are mechanisms with causal power to generate events and, therefore, their presence or absence in social processes are crucial in explaining and justifying causality between research variables (Mingers and Standing, 2017).

Hence, the central tenet of NCA aligns with the critical realists' view of causality, which is based on the requisite properties and characteristics of an entity rather than on event regularities or the law of constant conjunction that characterizes the sufficiency models. Therefore, in line with the critical realism approach to causality, this dissertation uses NCA to test and strengthen the qualitative findings and clarify the conditions that must be present – but not sufficient – to sustain a collective mind in temporary business networks. Because it is a unique approach which is different from the qualitative technique, this study has

dedicated a separate chapter (i.e. chapter 5) to fully discuss the data collection processes and design instrument relating to NCA.

4.3.1 The transformation model of social activities (TMSA) – A guide for collecting process/longitudinal data

The emergent and dynamic effect of boundary objects (e.g. project documents, budgets, and drawings) on the permissible actions of project team members suggests that causal relation between agency and structure is non-fixed and thereby historical (Archer, 2000b). This view necessitates a transformational model of social activities – that is, TMSA. According to the TMSA (see figure 3 below), the social structure provides humans with both cognitive and material resources for action. Therefore, the social structure tends to function as a necessary condition for any actions (Bhaskar, 1989, p. 77). A key point here is that social structure has a real and distinct existence from human agency. Though the only way to empirically identify the social structure is through humans' collective activities, nonetheless its emergence is in parallel relation with the (wo)man social becoming (Bhaskar, 1989; Mingers, 2000).

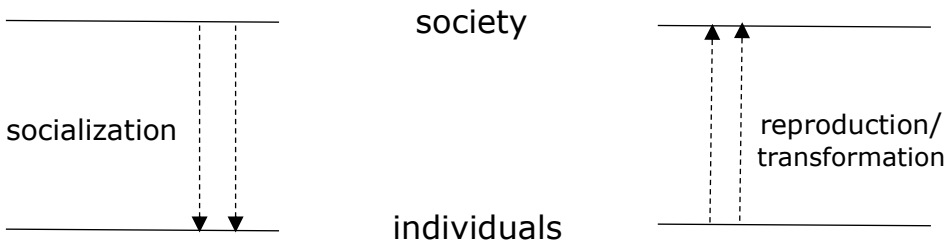


Figure 3. *The Transformation Model of Social Activity (Bhaskar, 1989, p.94)*

Since the existence of social structures is immanent in the social activities that reproduce (maintain) and transform (change) them (Archer, 1996); it follows that the enduring or self-constituting nature of the social structure is not automatic (Sayer, 1992; Mingers, 2004). Likewise, human activities or practices are only possible because of pre-existing structures which allow them to occupy certain social positions and endows them with power or susceptibility to act in certain ways – which Bhaskar regarded as a position-practice system (Bhaskar, 2009, p. 88).

Therefore, in line with TMSA, two different sets of dualities exist in the realists account of science – namely, the duality of structure and the duality of agency (Mingers, 2004), and this is the main point of difference between realism and structuration theory such as put forward by Giddens (1984). This separation of the duality of structure from the duality of agency (praxis) was tagged by Archer (1996) as analytical dualism, and this dualism considers both agency and structure as different mechanisms of causation as well as entities with different social genesis. For critical realists, the reproduction and transformation of social activities are shaped but not determined by social structure. And in the continuous exercise of their intentions, reasons, and plans, which are made possible by structure (e.g. social functions, relations, positions, roles, rules); humans tend to cause social transformation and structural elaboration (Archer, 1996; Ehret, 2013). Hence, one can regard the realist view of science as a strong philosophical foundation to examine the time dimensions of social processes. For instance, by exposing the parallel existence of structure and agency, realism allows researchers to investigate the interplay between them. More specifically, realism allows researchers *to investigate how structure at time t conditions social activities at time t+1 which (i.e. the social activities) then transforms or reproduces structure at time t+2* (Mingers, 2004, p. 412).

Accordingly, this dissertation combines observation and document analysis with interview data to capture three different time dimensions relating to the effect of relational structure on the project team member's actions over a period. Firstly, the data capture how the project team members reflexively account for their past actions and its consequences (i.e., retrospective data). Secondly, it allows the project team members to reflect on how the current state of their relationship – *e.g. perception of interest (mis)alignment with other project members* – are conditioned by past events (i.e., real-time data). Thirdly, the data collection approach allows them to reflect on their future expectation of relationship outcomes – e.g., a shift from *I-centric* to *We-centric* dispositions between members (Corsaro and Snehota, 2012; Hoholm and Olsen, 2012; Nenonen *et al.*, 2017). What this implies is that interview data covers both past and present activities or events that took place between the project teams. Hence, this robust data collection activity has generated a thick understanding of how project teams

make sense of their world, and how the perception of members regarding their interactions with each other changes over time, it also exposes the dynamic effect of social structure on the joint actions between the team members (Araujo and Easton, 2012; Corsaro and Snehota, 2012).

Moreover, it also reveals that this dissertation captures the time dimension of the construction processes as an entity that is intersubjectively decided based on the interpretations and the individual experiences of the project team members. Hence, rather than focusing exclusively on the chronology of events as indicated on the RIBA framework, the understanding of time is also based on how the project team members interpret those events as well as how they perceive the unfolding relationship with other team members. The implication of this is that RIBA stages do not exclusively determine the ascription of past, present and future to a series of events, but a meaningful understanding of the time dimension is embedded in the narratives of the project team members as they are subjectively as well as intersubjectively experienced (Aaboen, Dubois and Lind, 2012; Araujo and Easton, 2012; Halinen, Medlin and Törnroos, 2012).

Finally, by observing the time dimension from the perspective of intersubjective experience, this dissertation enables the project teams to engage in personal reflections about their shared activities with other project members. Therefore, they were able to: present a detailed chronological account of key events in the order of importance to them, express their motives for and interests in certain actions, explain their expected future outcomes of specific decisions (i.e. their intention), reflexively discuss what they have learned and are learning about specific events, and recount on how their perception of the relationship with other team members has changed or is changing over time (Makkonen, Aarikka-stenroos and Olkkonen, 2012; Ryan *et al.*, 2012; Tidström and Hagberg-Andersson, 2012).

4.4 Methods of data analysis – A combination of DREIC model and temporal bracketing strategy

As argued by Yin (1994, p. 96), data analysis involves scrutinising, categorising, combining and tabulating evidence from the obtained data to link the findings to the initial theoretical propositions or frameworks – all in the effort of identifying

justifiable answers to the research questions. However, as a result of the open-ended nature of social reality, causal explanation between research phenomena and outcomes is complex and subject to multiple interpretations. Therefore, arriving at a theoretically grounded causal explanation with the possibility of any practical applications would require a constant back and forth movement between theory (or theoretical framework) and the empirical world throughout the process of data analysis (as well as data collection) (Harrison and Easton, 1998; Brodie *et al.*, 2017; Kohli, 2017; Nenonen *et al.*, 2017).

Furthermore, as social reality continues to change in process research – which is particularly important because data collection, data analysis, and theoretical elaboration take place simultaneously – it becomes illogical to claim finality for any research outcome. Outcomes are observed and analysed as a potential starting point for further actions and processes (Bizzi and Langley, 2012). Hence, realists' explanatory theory is considered *retroductive* in nature because it commences from agents' account or description of their experiences relating to a particular event or multiple events (i.e. surface explanation). And then moves on to a deeper level explanation which involves uncovering the causal mechanisms that possibly lead to the experienced events, which (i.e. the mechanisms) then becomes the new phenomenon to be explained (Sayer, 1992; Mingers, 2000).

Therefore, realists tend to engage in multiple processes of analysis before arriving at the best possible explanation for the phenomenon under investigation (Easton, 2010). One realist data analysis tool that captures the messiness and stratification of social reality is known as DREIC model. DREIC is a five-stage data analysis process, and an acronym for Description, Retroduction, Elimination, Identification, and Correction. One of the core features of this model is that it sensitises the researcher to the fact that they need to check, re-evaluate, and update their theoretical framework and explanations as new findings arise from data (Bhaskar, 2008; Mingers, 2014). Therefore, the DREIC model suits the goal of this dissertation and is appropriate for studying the collective mind of network actors, which is an ongoing and continuous phenomenon that changes as network actors encounter new social cues that

disconfirm their previously plausible explanation and force them to renegotiate and make sense of their shared beliefs about the network environment (Weick, Sutcliffe and Obstfeld, 2005; Weick, 2009). Hence, the five stages of the DREIC model will guide the data analysis of this dissertation.

4.4.1 Description – Informants' accounts of project events

Data analysis starts by capturing and structuring the experiences of project team members while using the theoretical framework of a collective mind in temporary business networks as a tentative guide. Because project activities extend over a long period, the project team members tend to experience the same events differently. Also, the events that one team member considers important do not always overlap with, and are not even considered relevant by, other members of the team – and this complicates the description of the team's collective experience. Additionally, the contextual conditions shaping project implementations, as well as relationships between project members, tend to change considerably over time (Araujo and Easton, 2012; Corsaro and Snehota, 2012). Therefore, to account for these dynamic factors, this dissertation uses a *temporal bracketing strategy* to create a well-structured account of the team's collective experience and, more importantly, to focus the description of project implementation processes on influential activities shaping the interrelation processes and joint decision-making between the team members (Bizzi and Langley, 2012; Makkonen, Aarikka-stenroos and Olkkonen, 2012).

The temporal bracketing approach involves bracketing specific periods in time to identify and compare linkages between the periods and to explain temporality in the business network processes (Harrison and Easton, 1998; Halinen, Medlin and Törnroos, 2012). This dissertation considers three periods of data collection for the description of the project team's collective experiences. The first period is the observation data, which extends throughout the data collection process. That is, attendance of monthly and weekly meetings and analysis of project documents continues throughout the data collection period, which enables the dissertation to develop a broad contextual understanding of the linkages between "*actual*" events that took place during the entire data collection process. It also provides significant background knowledge about the construction projects and

serves as a unifying point of reference (evidence) for scrutinising and assessing the empirical data obtained from the face-to-face interviews (Mingers, 2014). Therefore, apart from being a good source for discovering unanticipated data, the observation data and project documents were also invaluable in corroborating or challenging (and therefore eliminating) explanations obtained from the empirical (interview) data – e.g. based on how the project member's experiences correspond (or not) to what actually happened.

Hence, the observation data and project documents stored on the NVivo12 database were extremely valuable for mapping out events as they occur in episodes as well as how events are interconnected. More importantly, the data and documents served as a useful template for organising, describing, augmenting, fortifying, scrutinizing, and contextualising the perception data from the interview testimonies of project team members (Tsoukas, 1989; Ben-menahem *et al.*, 2016). Moreover, to sensitize the interview data with the theoretically developed framework of a collective mind in temporary business networks, the project team members' narratives of their experiences were re-described (Tsoukas, 1989; Araujo and Easton, 2012). The re-description involves tracking the changes at the individual level perception and attempting to link those changes to how the relationship between project team members evolves. To summarise, the first stage of analysis involves *mapping* the interconnections between events/actions that occur during the implementation of each project and using the theoretical framework to *re-describe* informants' experiences of those events.

4.4.2 Retroduction – A discovery of potential causal mechanisms generating events

Retroduction is simply a process of uncovering the specific entity or social structure at the domain of the real – *be it tangible or abstract, perceivable or unperceivable* – that are causing events to happen, or causing the patterning of events in specific ways (Mingers and Standing, 2017). The retroduction process in this dissertation involves a thorough assessment of the empirical data (i.e. interview, observation and document data) to track and identify the enduring mechanisms as well as contextual conditions generating the observed patterns of events – that is, those events highlighted at the description phase of the analysis.

Moreover, the assessment of the interview data, through the lens of the observation data and theoretical framework, results in the development of two separate explanations and levels of analysis. First, an explanation regarding how each project team member's perception of certain events or actions at a specific period (e.g. t1) shapes the interrelations with their colleagues at other periods (say t2 and t3) – this involves an individual-level analysis. Second, an explanation regarding how the joint decision-making and collective actions of all the team members relating to specific events [i.e. a chain of events from t1 to t3] influence their relationship development, maintenance, or dissolution - this involves a team level analysis (Harrison and Easton, 1998; Corsaro and Snehota, 2012; Makkonen, Aarikka-stenroos and Olkkonen, 2012). The 2-stage explanations above, therefore, result from two process elements.

The first process element is the intentional (knowledgeable) actions by the project team members that are triggered, enabled, or constrained by the temporally occurring material circumstances and conditions of the projects – e.g. a significant change in the initial project budgets or a major change in weather conditions that disrupt project routines or slow down building plans. The second process element is the change in the relational structure as a result of project team members' reflective monitoring of each other's actions (Giddens, 1984; Turner, 1986; Araujo and Easton, 2012).

The 2-layered explanations and processes were achieved by utilising open and then axial coding methods to *categorise* the descriptions obtained from the first stage of the analysis (Ben-menahem *et al.*, 2016). More specifically, the categorisation resulted from the identified patterns in the reasons provided by the project team members as justifications for the following. Firstly, their justification for the events that occur. Secondly, their motivations for specific actions they undertook, and for engaging in mutual agreement with other project team members. Thirdly, the reasons they provide regarding the factors enabling the establishment of shared understanding during joint decision-making between the team members. Lastly, their justification for the level of effectiveness in the coordination of joint activities in the project team. Therefore, the 2-layered explanations enable this dissertation to establish linkages between the collective

decisions taken by the teams during project implementation, and how each team member rationalises such decisions, which then facilitates the identification of the underlying generative mechanisms causing events to be patterned the way they do.

4.4.3 Elimination & Identification– A reflexive analysis and decision on the most probable causal explanation

Two distinct activities were carried out simultaneously at this stage of the analysis – i.e. eliminating improbable explanations and identifying causal mechanisms. The identification process of the "real" causal mechanisms that most probably explain events in each team is directly linked to the categorisation process discussed above. As earlier noted, team members tend to experience the same events differently and provide competing explanations regarding why events occur. And to arrive at the most probable causal explanation, some explanations and justifications provided by the project team members were eliminated.

The elimination process of competing explanations, and the eventual identification of the real causal mechanisms, rely on the judgement of the doctoral student. However, the process was systematized by using a combination of tools such as open and axial coding on the NVivo12 database as well as evaluating the interview data through the lens of observation data and project documents, while also using the theoretical framework of collective mind to re-describe the testimonies of the project team members. And retrospectively, some explanations were also eliminated after conducting NCA analysis, which tests and confirms the "actual" necessary conditions for establishing and maintaining collective mind in temporary business networks.

4.4.4 Correction – Revisiting and modifying the theoretical model of collective mind

The correction stage of the analysis is for theory generation and modification of the theoretical framework. This stage involves the development of explanatory theory regarding the configuration of the causal mechanisms and the necessary conditions in each project team, and how the causal mechanisms and conditions were (de)activated to enable (or interrupt) heedful interrelations between team

members (Porpora, 1998; Mingers, 2004; Ryan *et al.*, 2012). As a final product of the analysis, the initial theoretical framework of collective mind is corrected and redeveloped to accommodate new empirical findings and to foster contribution to knowledge enhancement in the business network literature (Corsaro and Snehota, 2012; Mattsson, Corsaro and Ramos, 2015; Mouzas and Henneberg, 2015).

Chapter 5 – Necessary condition analysis (NCA)

The purpose of NCA in this research is to provide more depth, and potentially discover new insights or offer additional explanations to the findings from the qualitative study. One of the tenets of the necessity logic is that the absence of a necessary condition is a guarantee that the expected research outcome will not happen, and this assumption is a direct replica of the counterfactual theory of causation to which critical realists subscribe (Mingers and Standing, 2017). By treating absence as a cause, NCA logic acknowledges that the causal tendency of a social entity (or variable) is not determined by their perceptibility, an assumption that also aligns with the critical realist's idea of retroduction. More specifically, critical realists belief that causal efficacy is a property that inheres in the nature of things, not in their perceptibility, therefore the absence of things with causal power is as valuable as their presence to develop a complete and valid explanation of causality (Mingers and Standing, 2017). Critical realists also acknowledge that absence could be a necessary condition to achieve the desired outcome, and this view aligns with the objectives of this dissertation.

Hence, this dissertation considers NCA as a useful tool to answer the second research question – that is, what levels of subordinating, contributing, and representing as well as shared understanding, coordination of actions and alignment of interests, are necessary to maintain a collective mind between network actors? Moreover, this dissertation uses NCA as a systematic tool to learn more about, and better understand the degree of importance of the antecedent causal mechanisms (i.e. necessary conditions) in achieving different levels of the research outcome (i.e. collective mind). Therefore, NCA promisingly offers more rigour to the qualitative findings. By recognising how each antecedent causal mechanism functions in different situations, organisations could more appropriately and accurately commit resources to their interrelation processes as well as joint activities. In what follows, this dissertation introduces the theoretical underpinnings of NCA, discusses the methodological implications for using a necessity logic, and presents the questionnaire designed for the NCA.

5.1 Brief introduction to NCA

Necessary conditions are "causal" conditions that must be present for the desired outcome to be possible. In the absence of such necessary conditions there is guaranteed failure, i.e. the outcome will not occur (Dul *et al.*, 2010; Van der Valk *et al.*, 2016). As an example, at the post-contract stage of the construction teams investigated in this dissertation, it was a requirement that any designers that would be appointed to work on the projects must be willing to use a centralised project database – known as 4project – for sharing, reviewing, and commenting on all project drawings. Therefore, an agreement to use 4project becomes a necessary condition for the designers to get employed. Without such an agreement, no possibility of being employed. Put differently, a non-agreement regarding 4project is a bottleneck, constraint, or barrier that must be removed to initiate a business relationship between the project parties. According to a project manager (i.e. informant 22 table 1); "*a good example of that is using 4project for our drawing reviews communications. …if they [i.e. the designers] don't want to use the system, then really, we're going against something that is going to massively affect our business. We wouldn't work with them*."

However, despite its necessity, an agreement to use 4project is not a guarantee (i.e. sufficient condition) for employment because other factors might still affect the designer's employability. In a situation where multiple conditions are necessary to produce an outcome, each condition would function in isolation, and the absence of one condition cannot be compensated by the presence of another (Dul, 2016; Van der Valk *et al.*, 2016). Unlike in regression analysis, a necessary condition is not based on additive causality where multiple variables are used, and the presence of one variable (e.g. control variable) could influence the behaviour of another (Dul, 2016; Van der Valk *et al.*, 2016). Hence, necessary condition analysis can offer a new and interesting explanation to a dataset – which makes it a complementary methodology to the traditional data analytical tools (Dul, 2016).

Moreover, in line with critical realists' explanation of causality (Mingers and Standing, 2017), a necessary condition analysis could be invaluable in

demonstrating and confirming the mechanisms and structures that are operating at the domain of the actual. That is, by uncovering the necessary conditions producing an observed outcome, a realist researcher is better able to understand the events that are jointly experienced or reported by network actors at the domain of the empirical.

5.2 Methodological decisions relating to the logic of necessary conditions

Regarding the observation and measurement of the relationship between research variables (i.e. conditions and outcome variables), three types of necessary conditions exist – namely, dichotomous, discrete, and continuous, necessary conditions (Dul, 2016). The dichotomous type of necessary condition only analyses and measures whether the variables are present or absent. However, the discrete necessary condition requires a researcher to engage in a more detailed analysis by investigating different levels of both conditions and outcome variables such as low, medium, and high levels. The continuous necessary condition is considered a combination of both discreet and dichotomous types of analyses, and it involves an analysis of the relationship between variables (i.e. if the relationship is present or absent) as well as the measurement of the levels of each variable with any values ranging from 0% (lowest level) to 100% (highest level) (Dul, 2016).

As earlier stated, the focus of RQ2 is to investigate what levels of subordinating, contributing, and representing as well as shared understanding, coordination of actions and alignment of interests, are necessary to maintain a collective mind between network actors. Therefore, this dissertation considers the continuous necessary condition as the most appropriate analysis to achieve the objective of RQ2. It is, however, important to highlight that this study does not claim that these are the only six necessary conditions for developing a collective mind in temporary business networks. Such a claim is unwarranted because it is rarely possible to know all the required conditions for a targeted outcome variable (Dul *et al.*, 2010).

Moreover, from a critical realist point of view, all mechanisms exist as tendencies that only become activated in the absence of any contravening

mechanisms, or under the right circumstances and suitable conditions (Bhaskar, 2008). Implicit in this assumption, for critical realists, is the pointlessness of any scientific investigation attempting to uncover *all* mechanisms or conditions causing an outcome in a business network. Essentially, any given social event or outcome occurs in an open system and therefore impossible to be fully comprehended. The focus of the necessary condition analysis is to uncover two things. First, to uncover the ceiling lines and present the bottleneck tables indicating how the condition variables constrain the outcome. Second, to calculate the accuracy of the ceiling lines and determine the ceiling zones, scope, and the effect sizes of each of the necessary conditions.

This dissertation conducts the analysis using NCA software on R Studio package. The analysis starts by plotting a scatterplot for each of the condition variables (e.g. how shared understanding shapes the collective mind of network actors) in order to determine their individual effects on the outcome. Each scatterplot is divided into two parts by the ceiling lines. The upper left corner of the plot, that is, the empty area without observation, and the crowded lower right of the plot, which denotes the area with observations. The larger the size of an empty zone, the greater is the effect of the condition on the outcome. And if there is no empty zone, then such condition is not necessary for the outcome.

And regarding measurement accuracy of the ceiling zones, there are different types of ceiling techniques, the defaults for NCA being ceiling envelopment (CE) and ceiling regression (CR) (Dul, 2016). For the CE technique, ceiling lines appear as a continuous step from the lower left to the upper right of the scatterplot without allowing any observations above the line. Hence, the CE technique tends to produce 100% accuracy. However, CR is a straight line across the scatterplot, which makes it difficult to capture all the observed areas below the line. As a result, the CR technique can potentially produce less than 100% accuracy. This dissertation presents both the CE and CR values in the analysis table. However, the interpretation of results is from the CE technique because of its high level of accuracy. Finally, the effect size (usually denoted as "d"), which is how much each condition variable constraint the outcome, is interpreted as follows. $0 < d < 0.1$ interpreted as a ''small effect,'' $0.1 \leq d < 0.3$

interpreted as a ‘‘medium effect,’’ $0.3 \leq d < 0.5$ interpreted as a ‘‘large effect,’’ and $d \geq 0.5$ interpreted as a ‘‘very large effect’’(Dul, 2016).

5.3 Questionnaire design and data collection

Following previous studies (e.g., Westerhuis *et al.*, 2012; Van der Valk *et al.*, 2016), this dissertation uses a structured questionnaire to collect NCA data, and the data collection involves construction project actors who participated in the interview for qualitative data. Where available, the dissertation uses existing or validated scales for the scale development of most of the condition variables. However, for some of the variables, particularly the outcome variable (i.e. collective mind), no scale currently exists. Hence, new scales were developed based on a combination of assumptions from the reviewed literature and the experiences garnered while observing the decision-making processes of construction project teams. Each variable was measured using a continuous 5-point scale to avoid any neutral responses from the informants. That is, there were no neutral choices such as, *undecided* and *neither agree nor disagree*. Moreover, the continuous scale fits the continuous necessary condition approach, and it aligns the NCA data with the focus of the research question (i.e. RQ2). This dissertation takes two main steps to increase the quality of the measurements.

Firstly, after completing the first draft of the questionnaire, a pilot test was conducted with eleven MBA students and ten doctoral students who have had previous experiences or are currently working as active members of some project teams. The students were asked to provide feedback on the time they take to complete the questionnaire as well as how the questions relate to their experiences in project management, and how easy it was for them to understand the questions. Secondly, a one-hour skype meeting was held with a professor who is vastly experienced with NCA application and research design. The professor reviewed the questionnaire and offered some suggestions for improvement. The questionnaire was then revised based on the feedback from the students and the professor’s recommendations. Table 2 shows the measurement items for each of the variables, and their theoretical origins.

***Table 2**. Measurement scales of variables for the Necessary Condition Analysis*

Variables	Measurement items	Theoretical source	What changed?
Shared understanding (SU)	Our team members have similar prior experience on how to implement projects (SU1)	[consultant William] and I have very similar prior experience with implementing projects (Ko, Kirsch and King, 2005, p. 83)	This is a validated scale and used as in the original work.
	Our team members have similar ways of solving problems (SU2)	[Consultant William] and I solve problems the same way (Ko, Kirsch and King, 2005, p. 83)	This is a validated scale and used as in original work
	Our team members are always on the same page regarding which aspects of the project to prioritise (SU3)	[there's] agreement among team members regarding the aspects of work to prioritize (Aubé, Rousseau and Tremblay, 2015, p. 473)	This is a validated scale. The word "always" is added to this item to indicate the process element of shared understanding in project teams
	All our team members have a clear understanding about the requirements and goals of this project (SU4)	[there's] agreement among team members regarding the team goals to achieve (Aubé, Rousseau and Tremblay, 2015, p. 473)	This is a validated scale. The word "requirement" is added because it is a common language in construction projects.
	We always ask members to clarify the meaning of any ambiguous words (or acronyms) used when exchanging messages or information (SU5)	"If something is unclear, we ask each other questions [for clarifications]" (Bittner and Leimeister, 2014, p. 123)	This is a validated scale. The word "always" is added to this item to indicate the process element of shared understanding in project teams.
	Members of our team sometimes use unfamiliar words or phrases that are wrongly interpreted or misunderstood by other members (SU6)	People frequently use the same label for different concepts, and use different labels for the same concepts. People on a team also frequently use labels and concepts that are unfamiliar to others on the team" (Bittner and Leimeister, 2014, p. 112)	The phrase "wrongly interpreted" is added based on personal experience while observing design team members. That is, engineering concepts are sometimes misunderstood by the client and end-users.
Coordination (C)	Our team has a well-structured routine (e.g. bi-monthly meetings) to ensure our workflow is implemented smoothly and efficiently (C1)	We accomplished the task smoothly and efficiently (Lewis, 2003, p. 604) Coordination was measured by asking respondents to indicate the extent to which [they] scheduled group meetings through a standard committee that meets regularly to plan and coordinate the work within the unit. (Van de Ven, Delbecq and Koenig Jr., 1976, p. 327)	These are validated scales that were modified to suit construction projects. For instance, "bi-monthly meetings" was highlighted because it is the standard meeting schedule for design teams. The word "workflow" is used instead of "task" or "work" to acknowledge the continuous nature of coordination in construction projects.
	Our team has a very effective (formalised) process of circulating project or design related information, reviews, comments, and feedbacks (C2)	Coordination was measured by asking respondents to indicate the extent to which [they] use impersonal coordination mode through formally or informally understood policies and procedures for coordinating work within the unit (Van de Ven, Delbecq and Koenig Jr., 1976, p. 327)	This is a validated scale that has been adapted to suit construction projects. The main focus of coordination in design team is ensuring that the drawings of all the engineers align perfectly. Hence, policies and procedures have been replaced with reviews, comments, and feedbacks
Compliance (CP)	What is the level of compliance of your team's project execution practices with Client's/end-users' requirements (this also includes unexpected variations/changes in requirements)? (CP1)	We assume, as Follett (1924: 146-153) did, that mind begins with actions, which we refer to here as contributions. The contributions of any one individual begin to actualize collective mind to the degree that heedful representation and heedful subordination define those contributions. A heedful contribution enacts collective mind as it begins to converge with, supplement, assist, and become defined in relation to the imagined requirements of joint action presumed to flow from some social activity system.(Weick and Roberts, 1993, p. 365)	New scale that builds on key assumptions from Weick and Roberts (1993). In the original work, actions must subordinate to the imagined requirement of a system. In this dissertation the measurement focuses on two different requirements that actions *must comply with.* Item 1 measures the compliance of actions (practices) with regulatory requirements vis-à-vis the client requirements. Item 2 measures the compliance of actions (practices) with administrative or process requirements vis-à-vis budget, schedules, and plans.
	What is the level of compliance of your team's project execution practices with Project objectives, budget, scope, schedules, and pre-determined project outcomes? (CP2)		
	The requirements, objectives, project scope and expected outcomes were thoroughly	There are group actions that are possible only when each participant has a representation	New scale that builds on key assumptions from Weick and Roberts (1993).

Representing (R)	explained to project team members at the beginning of this project (R1)	that includes the actions of others and their relations. The respective actions converge relevantly, assist and supplement each other only when the joint situation is represented in each and when the representations are structurally similar.(Weick and Roberts, 1993, p. 363) An increase in heedful interrelating can prevent or correct these failures of comprehension in at least three ways. First, longer stretches of time can be connected, as when more know-how is brought forward from the past and is elaborated into new contributions and representations that extrapolate farther into the future. Second, comprehension can be improved if more activities are connected, such as when interrelations span earlier and later stages of task sequences. And third, comprehension can be increased if more levels of experience are connected, as when newcomers who take nothing for granted interrelate more often with old-timers who think they have seen it all. (Weick and Roberts, 1993, p. 366) Whether collective mind gets renewed during resocialization may be determined largely by the candor and narrative skills of insiders and the attentiveness of newcomers. Candid insiders who use memorable stories to describe failures as well as successes, their doubts as well as their certainties, and what works as well as what fails, help newcomers infer dispositions of heed and carelessness. (Weick and Roberts, 1993, p. 368)	Two key points define the eight measurement items. The first point is the nature of representing that enacts collective mind – i.e. *the representation of team members must be structurally similar*. Items 1 to 4 includes key phrases that capture and measure how project team ensures that their representations are similar - i.e. thoroughly explained requirements, resolving conflicting views, ensuring everyone is up to speed, fitting together different perceptions or variances in perceptions of team members. The second point relates to the scope of representation and the processes that update it. The key process elements, measured in items 5-8, is regular communication that outlines the linkages between past, present and future activities, or procedures. The process enables the team to *avoid any failure of comprehension between members*. Useful phrases in the items are - giving detailed updates, deliberating regularly, ensuring members (both new and old) are well informed about changes. Item 6 also includes the scope of representation of the team by measuring how they prepare for the influence of external stakeholders.
	Our team regularly review the project-relevant knowledge and experience of each member in order to identify and resolve conflicting views (R2)		
	Our team regularly update and circulate our reference items (e.g. project drawings, reports, project guidelines, contract instructions) to ensure everyone is "up to speed" (R3)		
	I feel like we are not paying enough attention to "fit together" the different perceptions of our team members (either with new or current members) about project tasks (R4)		
	When new members join our team, we give them a detailed update of the project (including successful and unsuccessful experiences) and inform them about plans going forward (R5)		
	Our team regularly deliberate over the potential influence of other project stakeholders on our activities (stakeholders, such as, BREEAM, building control, neighbouring buildings, safety officers, and fire officers) (R6)		
	Each member knows who (or where) to turn to whenever they are confused or need information about changes in project requirements (R7)		
	Our team members are well informed about the process of sharing and/or storing project information, documents, drawings, and reports (R8)		
Contributing (CT) plus alignment of interests (AI) equals we-centric contribution (WC)	The level of empathetic intelligence in our team (e.g. "team members always "put themselves in other member's shoes" during team discussions) (CT1)	Each contribution is important and must interrelate with the others (contributions must converge, supplement, assist, and be defined in relation to one another) (Weick and Roberts, 1993, p. 369) People can't be careful unless they take account of others and unless others do the same. Being careful is a social rather than a solitary act. To act with care, people have to envision their contributions in the context of requirements for joint action. (Weick and Roberts, 1993, p. 373) People know the locations rather than the details of common events and rely on one another to contribute missing details that cue their own retrieval.(Weick and Roberts, 1993, p. 358)	New scale that builds on key assumptions from Weick and Roberts (1993). Three key points define the four measurement items of contributing – namely, caring, mutual reliance, and mutual support. Items 1 and 2, respectively, capture and measure "caring" with the phrases; "empathetic intelligence" and "actively monitors the activities of others". Item 3 measures mutual support (assist) with the phrase "offers support to other members". Item 4 measures mutual reliance (i.e. relying on one another) with the phrase "give to and accepts suggestions".
	The level to which each member actively monitors the activities of the other team members even when it does not directly affect their work (CT2)		
	The level to which each member offers support to other members even when they did not ask for it (CT3)		
	The level to which each member gives to and accepts procedural suggestions from other team members (CT4)		
	Because of the differences in our professional backgrounds and tastes, it is mostly difficult to reach a consensus when making decisions together as a team (AI1)	The cross-boundary challenge is not just that communication is hard, but that to resolve the negative consequences by the individuals from each function they have to be willing to alter their own knowledge, but also	New scale that builds on key assumptions from the knowledge sharing literature – mainly, the work of Carlile Three key points define the six measurement items for

	Most of our team members frequently adjust their preferences to accommodate the opinions and interests of others (AI2)	be capable of influencing or transforming the knowledge used by the other function. (Carlile, 2002, p. 445) Boundary objects (Star 1989, Carlile 2002, Bechky 2003) such as drawings, prototypes (Wheelwright and Clark 1995, Schrage 1999), and "trade off" methodologies (Carlile and Lucas) have proved effective in providing a concrete means of representing different functional interests and facilitating their negotiation and transformation in product-development settings. (Carlile, 2004, p. 559)	alignment of interests – namely, cross-boundary challenge, boundary objects as a unifying reference point, and trade-off practices. Item 1 captures the challenges of multiple perspectives (i.e. *communication and consensus are hard* due to different professional backgrounds). Items 2, 3, and 4 capture mutual compromise (i.e. trade-offs) with the phrases; "accommodating the opinions and interests of others", "always respect each other's opinion", and "always find a way to compromise". Items 5 and 6 measure the role of boundary objects. On construction projects (i.e. observation data), *the shared electronic platform functions as a boundary object for tracking inconsistencies* in the schemes and plans of project members. Not having a shared platform tends to delay the identification of such inconsistencies.
	We always respect each other's opinion, for example, regarding how to respond to changes in end-users' (or client's) requirements (AI3)		
	When we encounter unforeseen situations that are not particularly in favour of everyone (or anyone) we always find a way to compromise (AI4)		
	We have tracking systems to promptly identify and address differences in the intentions, plans, or schemes of our team members before it escalate into serious problems (such as delay or workflow interruptions) (AI5)		
	Our team mostly ignore minor problems until they escalate into unexpected or unpleasant surprises (AI6)		
Collective mind (CM)	There have been no major accidents on site or any noticeable errors in the way team members implement their tasks (CM1)	Collective mind is conceptualized as a pattern of heedful interrelations of actions in a social system. ...As heedful interrelating and mindful comprehension increase, organizational errors decrease. (Weick and Roberts, 1993, p. 357) The preceding analysis also suggests that it is crucial to pay attention to mind, because accidents are not just issues of ignorance and cognition, they are issues of inattention and conduct as well. (Weick and Roberts, 1993, p. 373) A collective mind that becomes more comprehensive, comprehends more. (Weick and Roberts, 1993, p. 366) People act heedfully when they act more or less carefully, critically, consistently, purposefully, attentively, studiously, vigilantly, conscientiously, pertinaciously (Ryle, 1949: 151). (Weick and Roberts, 1993, p. 361) When interrelating breaks down, individuals represent others in the system in less detail, contributions are shaped less by anticipated responses, and the boundaries of the envisaged system are drawn more narrowly. (Weick and Roberts, 1993, p. 371) The ways people connect their activities make conduct mindful. Mindless actions ignore interrelating or accomplish it haphazardly and with indifference (Bellah et al., 1991). (Weick and Roberts, 1993, p. 374)	New scale that builds on key assumptions from Weick and Roberts (1993). Three key points define the nine measurement items of collective mind – namely, reducing the likelihood of errors and accidents, establishing consistency in behaviour and social practices, and ensuring comprehensive understanding by accounting for the different aspects of social life. Items 1 and 2 capture the level of attentiveness in the project implementation process by measuring the incidence of errors in the project tasks. Item 3 captures the level of comprehensiveness of the team's collective mind by measuring how they intentionally care for the needs and expectations of others– for instance, how they avoid major problems or contentions with the external stakeholders. Items 4, 5, 6, and 7 capture the level of consistency and predictability in the behaviours and attributes of team members. For instance, by being consistent, team members would have fewer delays or interruptions in their processes, and predictable behaviours will create an atmosphere with less unwanted surprises. Items 8 and 9 measure the level of indifference in the team member's disposition, and how comprehensively they link, integrate, or connect their activities. E.g. having the best interest of the project at heart is an indication that team members implement tasks with little or no indifference.
	There has been a considerable amount of errors in the way team members implement their tasks (CM2)		
	Our team have had no major problems or any contentious issues with other project stakeholders (e.g. BREEAM, building control, neighbouring buildings, safety officers, and fire officers) (CM3)		
	Our team had very few delays or workflow interruptions since the beginning of this project (CM4)		
	Members of our team have acted in a consistent and predictable manner throughout this project (CM5)		
	I find the actions of some members of this project very unpredictable and confusing (CM6)		
	There have been no surprises in the behaviour of our team members since the beginning of this project (CM7)		
	Our team has worked together effectively to integrate different aspects of the project (CM8)		
	I have come to realise that everyone in our team has the best interest of the project at heart (CM9)		

This dissertation combines the scales and assumptions from several relevant empirical studies to develop the measurement items associated with each of the observed variables, an approach that aligns with previous works in marketing research (e.g., Selnes and Sallis, 2003, p. 86). It is noteworthy to highlight that table 2 contains a redrafted list as the study eliminates some of the items because of a low factor loading from factor analysis. A full list of measurement items plus eliminated items, which are marked red on the questionnaire, is available in the appendix. As indicated in table 2, this dissertation measures the outcome variable (i.e. *collective mind*) with nine items which relate, primarily, to how project teams avoid errors in their workflow, and how they ensure consistency of behaviour between their members. The theoretical motivation for the measurement items was the work of Weick and Roberts (1993) who relate the maintenance and eventual increment of collective mind between flight operators with minimisation of organisation errors. For individual informant who completed the questionnaire, this dissertation calculates the scale values as the averages of the item values (Van der Valk *et al.*, 2016). While the measurement scale was a 5-point score ranging from 1 to 5, the observed minimum (i.e. lowest score across all cases) and maximum (i.e. highest score across all cases) for collective mind were 2.44 and 5, respectively – the table 3 below contains the dataset for all observed cases.

This dissertation measures *shared understanding* (a condition variable) by combining items from existing scales, which relate to dyadic and team level processes (i.e., Ko, Kirsch and King, 2005; Bittner and Leimeister, 2014; Aubé, Rousseau and Tremblay, 2015). The questions focus on how project teams ensure clarity of communication regarding project tasks, project priorities, and implementation processes. It also measures how team members avoid and resolve any misunderstanding when sharing information. This dissertation measures shared understanding with six items and uses a 5-point scale (table 2). The observed minimum and maximum scores are 2.83 and 5, respectively. This dissertation also measures *Coordination b*y using a combination of validated scales (Van de Ven, Delbecq and Koenig Jr., 1976; Lewis, 2003) that are modified to suit the research objectives. This dissertation uses a 5-point scale and measures coordination with two items which capture how project teams

utilise routines and formal processes to align overlapping project activities. The observed minimum and maximum scores resulting from the measurement are 3 and 5, respectively.

Table 3. *Dataset for NCA from all observed cases*

Informants	Collective Mind	Shared Understanding	Coordination	Representing	We-centric Contribution	Compliance
1	4.44	3.67	4.50	4.25	3.30	5.00[b]
2	4.44	4.67	5.00[b]	5.00[b]	4.40	3.50
3	4.44	4.33	4.50	4.38	3.90	4.50
4	4.56	4.00	5.00[b]	4.00	4.10	4.50
5	3.33	2.83	3.00[a]	4.00	3.40	4.00
6	4.67	1.67[a]	5.00[b]	4.50	3.80	4.00
7	4.11	4.33	4.50	4.50	4.10	4.00
8	4.67	4.00	5.00[b]	4.63	3.60	4.00
9	4.44	3.33	5.00[b]	4.13	3.70	5.00[b]
10	4.33	4.00	5.00[b]	3.88	4.00	5.00[b]
11	4.67	4.17	4.50	4.50	3.50	3.50
12	4.33	3.17	5.00[b]	4.50	3.90	5.00[b]
13	4.11	4.00	3.50	3.75	3.40	4.00
14	5.00[b]	5.00[b]	5.00[b]	5.00[b]	4.40	5.00[b]
15	4.22	4.33	4.00	4.25	4.50	4.00
16	4.56	3.83	5.00[b]	4.38	4.20	4.00
17	4.44	4.50	5.00[b]	4.38	4.60[b]	4.50
18	5.00[b]	4.17	4.50	4.88	4.40	5.00[b]
19	4.11	3.83	4.00	3.88	3.80	4.00
20	5.00[b]	4.00	5.00[b]	4.63	4.30	5.00[b]
21	4.67	4.83	5.00[b]	5.00[b]	4.50	3.50
22	4.22	4.17	5.00[b]	4.00	3.50	4.00
23	2.44	2.83	3.50	3.63	3.20	4.00
24	4.67	4.00	5.00[b]	4.75	2.90[a]	5.00[b]
25	3.89	3.50	5.00[b]	3.88	3.80	4.00
26	4.00	3.33	4.50	4.13	2.90[a]	3.50
27	3.78	3.33	3.50	3.50[a]	3.50	4.00
28	4.33	3.33	5.00[b]	4.75	3.90	4.50
29	2.00[a]	3.83	4.50	3.75	3.20	2.00[a]
30	4.44	3.00	3.50	3.75	3.00	4.00
31	3.11	3.83	5.00[b]	4.50	3.40	4.00

Note: [a] denotes empirical (observed) minimum and [b] denotes empirical (observed) maximum for each variable

It is worthy of emphasis that "subordinating", which is one of the condition variables in the original framework of a collective mind in intraorganizational settings, has been replaced with "compliance" in this dissertation. The

replacement of subordinating with compliance is as a result of the findings from observation data. Subordinating tends to imply that one network actor is controlling the other and does not reflect the actual situation between construction project team members. However, compliance is a more appropriate language as it highlights that industrial network teams work collaboratively together to align their shared activities with external rules and standards. Moreover, while subordinating may be an appropriate concept for research observations within the boundary of a specific organisation, compliance cuts across organisation boundaries; and is, therefore, more suitable for this dissertation.

The measurement for *compliance* was derived from observation data but also inspired by previous scholars who argued that collective mind could be sustained when the actions of social actors are defined by the requirements of the community they belong to (Weick and Roberts, 1993). This dissertation uses a 5-point scale to measure compliance with two items relating to the level of compliance of project teams with two types of requirements, namely, regulatory requirements (via client's requirements) and administrative requirements (via administrative processes, e.g. schedules and plans). The empirical minimum and maximum scores for compliance were 2 and 5, respectively. An important point to note here is that when defining client requirements, design consultants ensure that their design specifications comply with building codes and industry standards. Therefore, compliance with industry-level standards is measured through client requirements.

This dissertation also measures the remaining condition variables – i.e. representing, contributing, and alignment of interests – using newly developed scales. The scales for *Representing* were inspired by assumptions in the work of Weick and Roberts (1993), which focus on how the perceptions of network actors shape their expectations and their definition of shared activities. One of the main arguments from Weick and Roberts (1993) (see table 2) is that when there is a mismatch in representations, the possibility of process errors increases. Therefore, representing is a measure of how project teams align the perceptions of their members and ensure that they have a clear and comprehensive

perspective of project activities and goals. This dissertation measure representing with eight measurement items and uses a 5-point scale. The observed minimum and maximum scores for representing are 3.5 and 5, respectively.

"Contributing" and "alignment of interests" were initially regarded as two separate condition variables. However, both loaded together when factor analysis and reliability test were conducted to ascertain the validity of the measurements. The combined conditions, tagged as a *we-centric contribution* (tables 2 & 3), were measured with ten items on a 5-point scale. This condition (i.e. we-centric contribution) captures the level of inclusiveness and compromise in the project teams' planning and decision-making processes, as well as how team members respect, monitor, and support each other to ensure a smooth implementation of their shared activities. The observed minimum and maximum scores for we-centric contribution are 2.9 and 4.6, respectively.

As indicated in table 3 above, a total of 31 questionnaires were completed across the three project teams investigated – informants 1 to 8 are from Case A, 9 to 20 from Case B, and 21 to 31 from Case C. To ensure that all questions were answered, the researcher asks the informants to complete the questionnaire simultaneously with the face-to-face interviews. And even more importantly, this approach enables the researcher to properly explain to the informants whenever they need or would like to provide additional information on any measurement items in the questionnaire. While the number of responses may appear small (i.e. 31 observed cases), this is arguably acceptable considering that the primary goal of NCA is not to identify relationships between variables based on statistical probabilities – which is common practice for sufficiency models such as in regression analysis (Dul, 2016).

Moreover, because it is based on the necessity of the condition variables, theory-building and testing with NCA as well as generalisation of results can be achieved with a small number of cases (Westerhuis *et al.*, 2012). It is noteworthy to clarify that in addition to conducting reliability tests and factor analysis, the measurement instruments were validated by calculating the Cronbach Alpha for all the scales before NCA analysis (Van der Valk *et al.*, 2016). The result of the

Cronbach Alpha is as follows: collective mind (0.890), shared understanding (0.766), coordination (0.715), representing (0.775), we-centric contribution (0.815), and compliance (0.715). The relationship between the variables is then tested using NCA analytical software. The results of the analysis are presented in chapter 8.

Chapter 6 – Description of empirical data and qualitative findings

This chapter presents the actual process of qualitative data collection and analysis. Chapters 7 discusses the qualitative findings in more details, and chapter 8 focuses on the findings from the necessary condition analysis. The data collection was from three construction design teams that the doctoral researcher actively observed between March 2018 and January 2019. The main themes of the research findings are regarding how the construction project teams utilise a collection of project-specific and industry artefacts, while also making judgement calls when the situation demands, to ensure a smooth implementation of their interconnected activities. That is, the discussion of the findings relates to how the collective mind of design teams is established and maintained throughout the project implementation processes despite the unexpected occurrences and events that intermittently disrupt interrelations between the team members.

6.1 A brief overview and description of the cases

The table below is an overview of the background information regarding the three construction teams that participated in this dissertation.

Table 4. *Background information of projects and project teams*

	Case A	**Case B**	**Case C**
	Information about the construction projects		
Type of project	Institutional building	Institutional building	Commercial building
Purpose of project	offices, laboratories, workshop spaces, meeting rooms for engineering professors and students.	Science laboratories, offices, and meeting rooms for academics and postgraduate researchers.	For corporate offices, headquarters' spaces, and retail centres.
Project Budget	9 million pounds	23 million pounds	28 million pounds
Location of Project	United Kingdom	United Kingdom	United Kingdom
Duration of project	Autumn 2017 – summer 2019	January 2018 – October 2019	July 2015 – summer 2019
The stages of construction work that were observed	RIBA Stage 2 & 3 – Concept and advanced design stages. Activities include an intensive discussion with clients to jointly develop proposals on building plans, structural, mechanical, and electrical design layouts as well as to develop preliminary cost plans. Activities also include risk analysis by the design team and ongoing negotiations with the client on alternative design layout options.	RIBA Stage 4 – Technical design stage. Activities include consulting with third parties on how to address health and safety strategies, rounding up electrical and mechanical design, consulting with BREEAM to address sustainability issue, and negotiating design decisions with building control.	RIBA stage 5 – Preconstruction and construction stages. Activities include obtaining planning and building permissions, conducting specialists design works (e.g. finalising tender documents), ground preparation works, procurements and other construction activities.

Information about project ownership			
Project Client	Tertiary institution	Tertiary institution	Private organization
Project end-users	About 125 academics and researchers including, professors, lecturers, doctoral students, and laboratory technicians.	More than 300 scientists mainly biology, chemistry and pharmaceutical professors and postgraduates.	A 7-storey building for commercial companies' employees and executives as well as shopping centres.
Information about Project teams			
Project team	Design team, client team and end-user representatives.	Design team, client team, clerk of work team, building managers, contractor team, sub-contractors, and design consultants.	Design team, design consultants, contractor team, sub-contractor, commercial team, project management team, and client team.
Team composition	Project Manager, electrical engineers, mechanical engineers, Architect, cost manager, project PI, and engineering professors.	Project managers, contract manager, mechanical & electrical engineers, architect, structural engineers, consultants, acoustics, surveyors, and building services manager.	Project managers, contractor, operations director, project secretary, structural engineer, design engineer, Architect, client representatives and project developers.
Number of interviews conducted	8	13	11
Number of observation meetings attended	17	10	16
Companies represented	5 organizations	7 organizations	6 organizations

6.2 Qualitative data – Observation of meetings, face-to-face interviews, and a database of project documents

The data collection activities involve face-to-face interviews, direct observation of meetings, and data in the form of documents such as meeting minutes, project reports, and email conversations between the members of the observed teams. Additional data were collected for the necessary condition analysis (NCA) with the aid of a structured questionnaire that was designed by combining theoretical assumptions with observation data (questionnaire appended – appendix B). Data collection activities commenced with preliminary discussions with key members of each project team, that is, one project manager and one client representative (team A), one client representative (team B), and two project managers (team C).

During the preliminary discussions, the aim of this dissertation was introduced to the project teams. The discussion also covers specific project issues such as, the managerial practices that are being implemented for coordinating project activities and for establishing shared understanding and agreements (i.e. alignment of interests) between the project team members. The informants specified design team meetings (DTM), client/end-user progress meetings

(CEPM), and specialist workshops as the three managerial practices for coordinating project activities. Hence, the doctoral researcher negotiated with the informants to gain access into the meetings and workshops to observe and gain a first-hand insight into their decision making and planning processes. Two teams granted full access to all the meetings, but the third team only granted access to the CEPM. However, that was sufficient, considering that the third team constantly revise the issues from the DTM and specialist workshops during the CEPM.

The actual meeting observations started in March 2018 and were conducted concurrently across the three teams. Two main construction milestones were covered during the observation of the project team meetings, namely, pre-contract stage (involving team A) and post-contract stage (involving teams B and C). During each meeting, the doctoral researcher makes personal observation notes of activities relating to how team members communicate with each other and manager project interfaces, as well as reach agreements or resolve conflicts and coordinate each other's actions. In addition to the personal observation notes, meeting minutes and contractor's reports containing important email conversations between project members were also obtained from project coordinators and design managers.

The personal observation notes, contractors' reports and meeting minutes were immediately stored on NVivo12 software after each meeting or as soon as they were available, which then enables the doctoral researcher to organise the data properly and to accelerate data analysis by identifying coding categories as they emerge. Moreover, the project documents (i.e., observation notes, contractor's reports, and meeting minutes) also facilitated the identification of relevant members of the project teams who were actively participating in the planning and decision-making processes of each construction project. Therefore, the project documents were instrumental in delineating and specifying members of the project teams – mainly the design team and some members of the management and client teams – that were later considered for face-to-face interviews.

Table 5. *Profile of research informants*

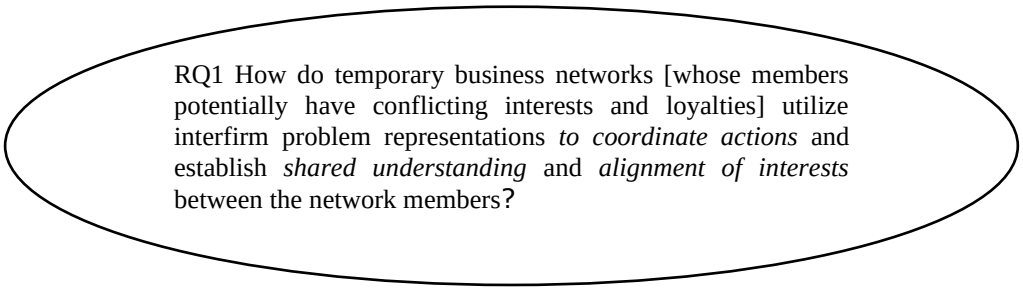
Informants	Project role	Team	Project involvement	Interview
1	Project manager	A	Pre-contract	72 minutes
2	Architect	A	Pre-contract	69 minutes
3	Cost manager	A	Pre-contract	81 minutes
4	Mechanical engineer	A	Pre-contract	80 minutes
5	Electrical engineer	A	Pre-contract	67 minutes
6	Project technologist	A	Pre-contract	26 minutes
7	Senior electrical engineer	A	Pre-contract	74 minutes
8	Client representative	A	Pre-contract	55 minutes
9	Contractor's project manager	B	Pre & post-contract	90 minutes
10	Contractor's mechanical engineer	B	Post-contract	66 minutes
11	Senior architect	B	Novated	71 minutes
12	Architect	B	Novated	
13	Client's mechanical engineer	B	Pre & post-contract	41 minutes
14	Client representative	B	Pre & post-contract	56 minutes
15		B	Pre & post-contract	36 minutes
16	Contractor's electrical engineer	B	Post-contract	78 minutes
17	Client's project manager	B	Post-contract	58 minutes
18	Client's electrical engineer	B	Pre & post-contract	49 minutes
19	Contractor's quantity surveyor	B	Post-contract	39 minutes
20	Contractor's design manager	B	Pre & post-contract	77 minutes
21	Client's quantity surveyor	B	Pre & post-contract	82 minutes
22	Contractor's project manager	C	Post-contract	85 minutes
23	Architect	C	Novated	177 minutes
24	Contractor's design consultant	C	Post-contract	35 minutes
25	Contractor's M&E design manager	C	Post-contract	39 minutes
26	Contractor's steelwork coordinator	C	Post-contract	81 minutes
27	Contractor's electrical engineer	C	Post-contract	31 minutes
28	Contractor's site project manager	C	Pre & post-contract	53 minutes
29	Contractor's quantity surveyor	C	Post-contract	65 minutes
30	Contractor's design manager	C	Post-contract	48 minutes
31	Senior quantity surveyor	C	Post-contract	60 minutes
32	Contractor's civil engineer	C	Post-contract	-

Overall, a total of forty-three meetings were observed as follows, seventeen meetings (team A), ten meetings (team B), and sixteen meetings (team C). Each observed meeting lasted between 2 and 4 hours. A total of thirty-two face-to-

face interviews were also conducted across the three teams as follows, eight, thirteen, and eleven interviews for teams A, B, and C, respectively. The interviews started in the seventh month of observations (i.e. in September 2018) after a sufficient knowledge of the teams' processes and technical languages had been acquired. The duration of each interview is between 30 minutes and 3 hours (table 5) and, except for one, the interviews were audio-recorded and transcribed verbatim. The one exception was conducted as an email interview because of the informant's busy schedule. Altogether, this dissertation compiled 646 pages of interview transcriptions, 201 pages of field notes from the observation of meetings, and more than one hundred pages of project documents (e.g. contractor's reports, meeting minutes, and architectural photos). Both the audio and text versions of the interview transcripts, as well as all the project documents and observation notes, were stored on NVivo12 to create a centralised database for a systematic coding process and data analysis.

6.3 Coding and analysing qualitative data – Open and axial coding

The qualitative data analysis in this dissertation takes a slightly different approach from the grounded theory process of data analysis, which typically starts without any preconceived or predefined theoretical assumptions by developing "In vivo" coding categories (i.e., keywords and phrases from the empirical data) (Weston *et al.*, 2001; Yearworth and White, 2013; Bernard, Wutich and Ryan, 2016). Data analysis in this dissertation builds on a critical realist research program and is therefore biased towards the predefined theoretical framework and research questions (Bhaskar, 2008; Easton, 2010; St. Pierre and Jackson, 2014). In essence, despite not constrained by them, the initial coding process is focused on the main theoretical concepts in the research questions (see highlighted concepts below).



The three concepts (i.e., shared understanding, coordination of actions, and alignment of interests) therefore represent the tentative dimensions of the coding framework for organising, grouping, categorising and describing the empirical data (Attride-Strirling, 2001; St. Pierre and Jackson, 2014). However, while reading and re-reading the interview transcripts and the project documents, the doctoral researcher derives and adds a fourth dimension, i.e. *compliance*, to the coding framework. Compliance was identified as a crucial regulatory instrument used by project teams for aligning conflicting assumptions and for ensuring that team members are working collaboratively towards their shared goals. After the four dimensions of the coding framework had been defined, an open coding process of the raw data was initiated. The purpose of the open coding was to breakdown a large amount of raw data on the personal NVivo database into manageable subcategories and themes which are relevant for the predefined coding framework (Yearworth and White, 2013; Ben-menahem *et al.*, 2016).

Nodes

Name	Files	References
Coordination	31	86
Time pressure	6	9
Planning	5	7
Deviation	17	32
Change	16	19
Routines	2	2
Compliance	17	33
Regulation	31	59
Client's Requirement	17	25
Project Objectives	3	3
Shared Understanding	21	31
Information sharing	14	18
Communication Protocol	11	15
Interests alignments	20	27
Agreement	51	84
Mutual Compromise	10	24
Trust	12	17
Relationship	8	12

***Figure 4**. Coding Framework - dimensions and subcategories of factors relating to collective mind*

More specifically, relevant text passages from observation notes, project reports, and interview transcripts (i.e., testimonies of each informant) were used to create subcategories and then coded under the associated dimensions of the coding framework. For instance, "*coordination*" (and other variations of it such as "coordinating, coordinator, and coordinate) was coded 86 times from 31 documents. One of the associated subcategories, e.g. "change" (or "changing"), was coded 19 times from 16 documents. See "references" and "files (i.e. coding sources)" in figure 4 for the number of instances in which each dimension and subcategory has been coded. Moreover, multiple keywords or search queries were used to access each dimension and subcategory, to scrutinise the NVivo database properly, and to ensure a high level of rigour in the coding process. For example, some occasions where project teams negotiate for *"shared understanding"* or resolve "*misunderstanding"* between members were accessed from the NVivo database using keywords and search queries such as "on the same page", "clarify", "clarity", "lack of clarity", "understand", "misunderstood", "comprehend", "comprehension" and "understanding".

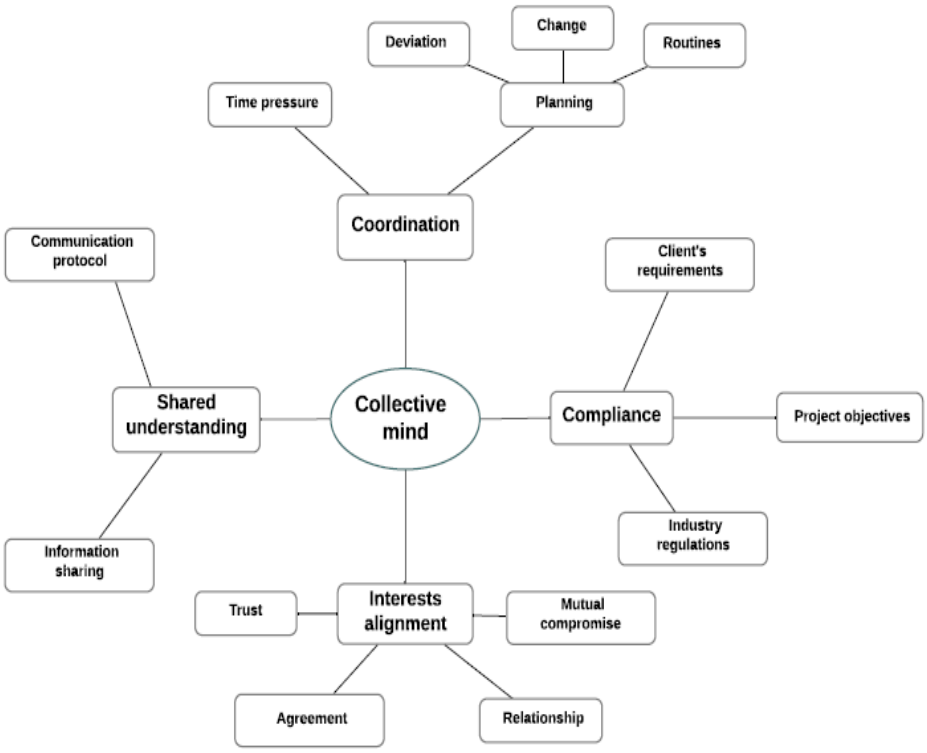


Figure 5. *A mind map of coding categories and subcategories relating to collective mind*

It is worth mentioning that the identification of subcategories and the association of each subcategory with the relevant dimension of the coding framework – as indicated in figure 5 above – is both theory and data-driven. For instance, subcategories like "trust", "mutual compromise (or give and take)", "communication protocol (or chain of communication)", "client's requirements (or employer's requirement)", "project objectives", "change", "deviation", and "time pressure" were derived directly from data. While subcategories such as "planning", "routines", "information sharing", and "relationship" were predefined from the reviewed literature and confirmed from data during coding.

The relationship between the subcategories and the dimensions of the coding framework was constantly being refined as new evidence came to light to properly reflect any findings and themes obtained from the data (Auerbach and Silverstein, 2003; Yearworth and White, 2013; Ben-menahem *et al.*, 2016). It was realised that data saturation had been reached when the analysis stopped generating any noticeably new subcategories relating to the four dimensions of the coding framework (Bigley and Roberts, 2001; Weston *et al.*, 2001; Bechky, 2006; Ben-menahem *et al.*, 2016).

Finally, throughout the analysis, the references (i.e. coded passages from the NVivo database) were read repeatedly to identify *local* themes (e.g. from interview testimonies of informants) and to more properly organise the patterns in the coded data (i.e. specific similarities and differences within and across project teams). The patterns and themes together with the dimensions of the coding framework and their associated subcategories are utilised in chapter 7 to systematically and coherently structure, present, illustrate, and interpret the findings from this dissertation (Attride-Strirling, 2001; St. Pierre and Jackson, 2014).

Chapter 7 - Findings from qualitative analysis: The four antecedent causal mechanisms of collective mind

A detailed discussion of the findings from the above coding processes and data analysis would be presented in this chapter. As visualised in figure 5, the coding of qualitative data yielded four categories of conditions that were considered as antecedent mechanisms or relational structure for explaining why events occur and how heedful interrelations (i.e. collective mind) was established and maintained between project team members. Therefore, in the following subsections, findings relating to each of the four mechanisms would be presented.

7.1 Shared understanding between project sub-teams – The role of communication structure, communication pathways, and knowledge boundaries

Empirical and observation data show that the establishment of shared understanding is shaped by the structure of communication that exists between the client, client agents, contractor team, and the design team. Each of the project teams who participated in this study has a distinct structure of communication which is driven by the contractual links or role relations between the project sub-teams. Based on findings from data analysis and direct experience from meeting observations, two different types of role relations were identified – namely, advisory, and representative roles. That is, for both the clients and the contractors the appointed [*intermediary*] agents tend to function either in advisory or representative capacities. An advisory agent's role is limited to providing professional support and guidance for the client or contractor. But representative agents take on the full responsibility of managing the project negotiation processes. As illustrated in figure 6, four typologies of communication pathways or structure are developed from the different combination of role relations between the project sub-teams. These are regarded as intermediary-led communication pathway, client-led communication pathway, mixed (Intermediary-2-Client) communication pathway, and mixed (Intermediary-2-Contractor) communication pathways in temporary business networks.

While the four structures are possible in business relationships, only the client-led and intermediary-led communication pathways were identified in the observed project teams. It is also noteworthy to highlight that Case A – which was observed at the pre-contract stage – is less prominent in the current discussion regarding shared understanding. The absence of Case A is because project negotiation is less complex and one-directional at the pre-contract stage, focusing mainly on the client. And in situations where the end-user team were involved, a lead user is appointed as an intermediary agent to facilitate information exchange between the client's design team and the project end-users.

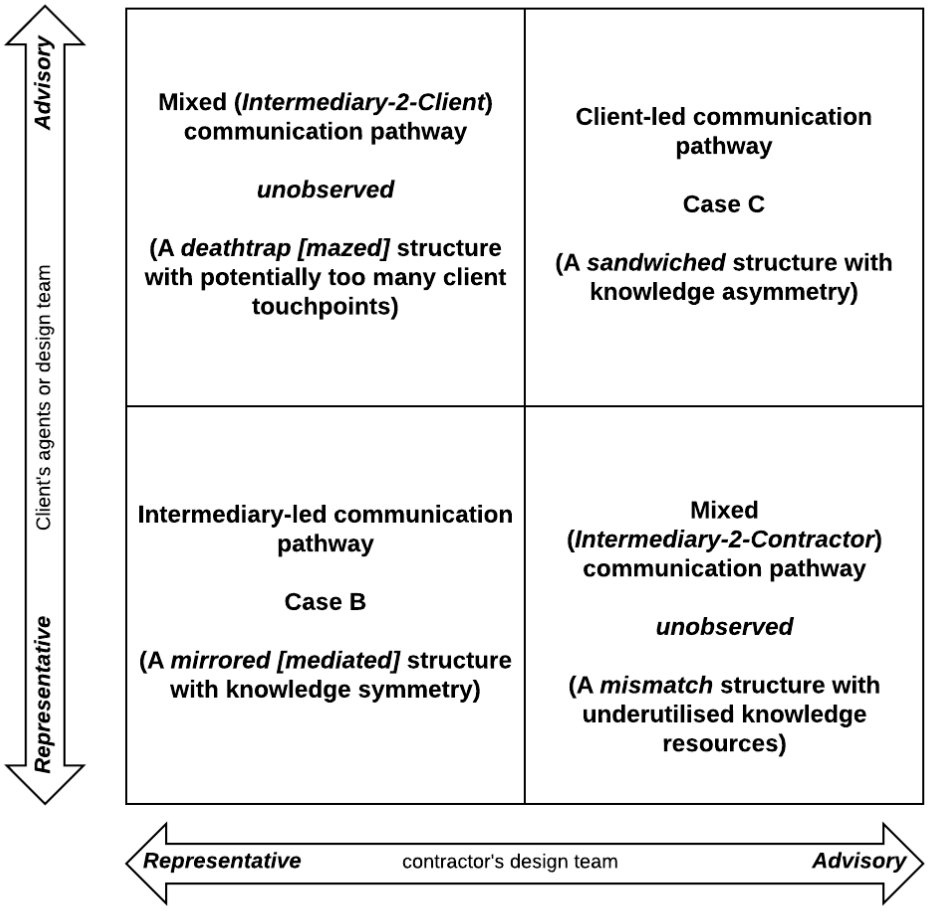


Figure 6. *A matrix of the relational structures shaping shared understanding between project partners*

In Case B, where the intermediary-led communication pathway was observed, the client agents and the contractor's design team function as representatives. That is, the client employed a dedicated design team (i.e. architect, structural, mechanical, and electrical engineers) for developing his requirements (known generally as employer's requirement). The design team also represents the client in negotiating with and monitoring the project contractor, who is responsible for constructing the building. Likewise, the contractor employed a dedicated design team who engaged directly with the client's design team for negotiating design development and modifications. Hence, in Case B, communication linkages between the project sub-teams tend to be driven by the specialization or required knowledge for each decision episode. Essentially, any communication or problem-solving situations between the client and the contractor are intermediated by the client and contractor agents with relevant skillsets to manage the situation effectively.

Evidently, with the intermediary-led communication pathway, the client has less direct engagement with the contractor. Which, in a way, reduces the potential tension that could arise as a result of the knowledge boundaries between them. That is, the responsibility for interpreting and translating the boundary objects (i.e. technical layouts or building plans) into the language that the client understands is borne by his appointed design team. Moreover, according to the client, Case B (i.e. informant 14 table 1); *"the [design] team there just gives us that surety, that sort of say, they [i.e. the contractor] are building it how we designed it, they are not cutting any corners, they are fitting the right sort of equipment, they are doing the right fittings. Just that third eye. Well we've got about four eyes now because Clerk of Works (CoW) is also there"*. In Case B, not only were the appointed design team experts in their respective fields but more importantly, they had had a history with the client on the design process, even before the contractor was appointed. Therefore, their roles as "go-between-ers" tend to facilitate the communication flow and how shared understanding is attained between the contractor and the client.

Conversely, in Case C, a client-led communication pathway was observed. In this case, no dedicated design team was employed by the client. Rather than

functioning as a client representative, the client agent's (i.e. project manager) role is limited to an advisory capacity. And regarding client-contractor negotiation, a similar structure is observed on the contractor-side. That is, the contractor's design engineers also functioned in an advisory capacity. Apparently, the specialist knowledge needed to solve unique and complex problems appeared to be taken for granted. This structure implies that the client and the contractor are *sandwiched* between their agents and engineers, respectively. Consequently, the client is constantly engaging directly with the contractor to negotiate project requirements and discuss design progress. The high frequency of direct interactions led to a recurrent tension between the client and the contractor. The client-contractor tension could also be traced to the client's limited experience on the technical details of the design layouts.

The project site manager, Case C (i.e. informant 28 table 1) alluded to this saying; "*so, the client-facing is a big challenge on this one, with it being a demanding client. Uneducated in this kind of level of construction".* The communication challenge has resulted from the complicated boundary created during the direct engagement between the two parties (Carlile, 2002, 2004). In this client-led communication pathway, the client relies on the contractor's design team for translating, interpreting, and communicating all the design outputs. Based on the experience from the meetings observed {i.e. observation data} and the testimonies of the affected research informants {i.e. interview data}, this communication approach creates avoidable distractions for the contractors' design team. In addition to their primary responsibilities – which is to develop and assemble design layouts and other building drawings – the contractor's design team also needed to create a simplified summary report for the client, which they generally referred to as "*a complete idiot guide*".

It is noteworthy to mention that neither of these two typologies of communication pathways is superior to the other. Although the intermediary-led communication pathway appeared to be more reliable, empirical data does indicate a paradox in each approach. Whereas, the intermediary-led communication pathway tends to remove the "extra" knowledge boundary associated with the client-led communication pathway – e.g. by reducing or

eliminating direct engagement with the client. The client-led communication pathway favours spontaneity in decision making due to the direct engagement with the client.

Additionally, for the intermediary-led communication pathway, some information may "get lost in translation" due to the presence of the "go-between-ers" or "gate-keepers" between the contractor and the client. The potential for information to be lost in translation contradicts the essence of the intermediary-led pathway, which is to ensure communication clarity as well as facilitate shared understanding between the project partners. One client metaphorically describes the intermediary-led communication pathway as a "Chinese whisper" – that is, a game in which information can lose its content or meaning when passed through multiple channels or people. As the client Case B (i.e. informant 14 table 1) explained further; "*…so if the end user says I want extra cupboard in that room, I could hear it as 2 cupboards, by the time it gets to the project manager it's three cupboards, gets to the contractor it's half a cupboard, and then with architect it's no cupboard, and they don't know about it. It is Chinese whispers really, it all changes*". These paradoxes then raise a question about the need to develop a hybrid approach which exploits the benefits of both types of communication pathways while minimising the highlighted challenges.

As highlighted in figure 6, two other communication pathways are possible – namely, mixed Intermediary-2-Client and mixed Intermediary-2-Contractor communication pathways. Although neither of the two mixed pathways was observed in this dissertation, their implications on the establishment of shared understanding could be conjectured.

With the mixed Intermediary-2-Client communication pathway, the contractor would tend to appoint a dedicated design team with representative roles while the client only employs agents that would function as advisors. This approach is regarded as a death-trap structure because the client would need to engage directly with multiple engineers simultaneously and, with potentially no cross-disciplinary skillsets, make sense of complex engineering drawings. Hence, during joint negotiations, communication flow between the client and the

contractor's representatives could easily escalate into serious misunderstanding as the potentially confused client struggles to manage the multiple contact points.

However, with the Intermediary-2-Contractor communication pathway, the client and the contractor's situations are reversed. That is, the client appoints a dedicated design team who would function as representatives while the contractor's design team only occupy advisory roles. Because the contractors are usually experts in construction and construction management, they are potentially in a good position at establishing a shared understanding with the client's agents or representatives. Although by limiting their roles to advisory capacity, the contractor's design team may not be fully committed to the project, and some of the skillsets possessed by the design team members may remain underutilised. Hence, this is regarded as a mismatch structure because the roles represented on the client-side may not be necessarily present or fully activated and exploited on the contractor-side. As earlier stated, arguments regarding the mixed communication pathways are conjectural, and lacking an empirical validation.

Therefore, future empirical investigations could further explore the assumptions made in this dissertation and could ascertain the actual implications of these mixed communication pathways. I.e., on the establishment and maintenance of shared understanding in business networks. Of particular importance would be to uncover situational conditions and factors motivating the choice of communication pathways.

7.1.1 Summary - How IFPR is utilized to establish shared understanding between project sub-teams?

The discussion above highlighted the process of establishing a shared understanding between construction project actors. No specific individual in a construction project possesses an encompassing knowledge or all-inclusive skillset which captures the nitty-gritty of the different design pieces that make up a building project. Essentially, a diverse range of specialist knowledge is employed to implement each piece of the design puzzle. Moreover, each specialist creates design layouts and drawings which function as representational artefacts or boundary objects to bridge the knowledge gaps and therefore

facilitate communication between the construction professionals. As discussed above, two distinct processes – i.e. intermediary-led and client-led communication pathways – are utilised for creating, transferring, and synthesising the different design elements.

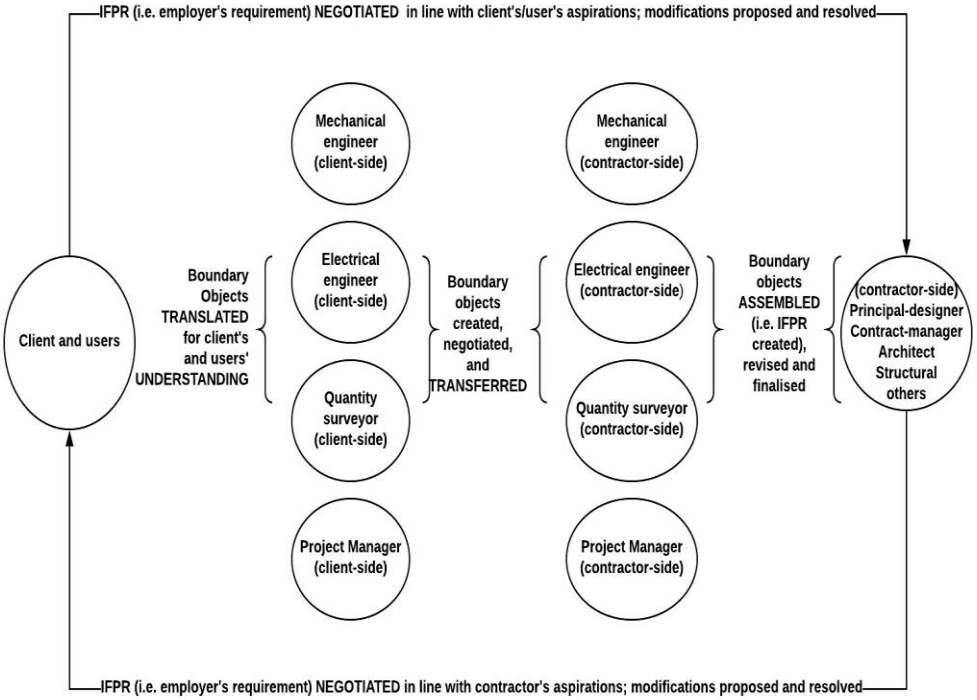


Figure 7. *Intermediary-led communication pathway for establishing shared understanding between construction project actors*

In the Intermediary-led communication pathway (figure 7), the project client appears to retain control of the design process and design narratives by appointing own dedicated engineers who are actively involved in the creation and transfer of the different design elements. Whereas, in the client-led communication pathway (figure 8), the contractor seemed to control the design processes by taking on the responsibilities of not only creating and assembling the design layouts (boundary objects) but also of translating them for the client's understanding. Evidently, during joint negotiations, the client-led communication pathway gives a contractor the positional advantage to control the design narratives, except in situations where the client is highly knowledgeable and therefore able to tease out suspicious agenda in the design. Counterintuitively, Case C adopted the client-led communication pathway in

engaging directly with a less knowledgeable client, which gives the contractor the possibility to utilise the design layouts/drawings as narrative tools to propagate own agenda during negotiations. But it also presents them with the need to dedicate more communicative resources as leverages to manage the client-contractor knowledge gap, and for ensuring shared understanding is not compromised. [*More elaboration on this in chapter 6.3 where interest (mis)alignment is discussed*].

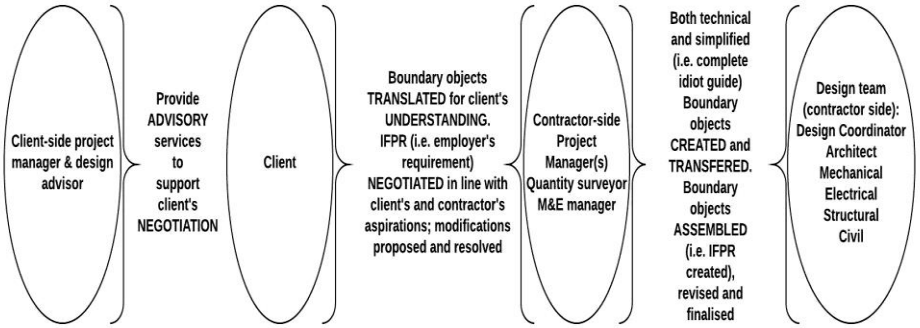


Figure 8. *Client-led communication pathway for establishing shared understanding between construction project actors*

The preceding discussion provides an empirical foundation to answer the first part of RQ 1. That is, to demonstrate how IFPR is utilised to establish a shared understanding between construction project members. As discussed in previous chapters, IFPR is a collection of localised boundary objects that are curated for a specific task or project. IFPR enables the establishment of a shared understanding between project partners through the activation of three key processes by relevant project actors. The first process is the "*visualizing"* or *picturizing* of complex designs, the second is establishing *"big picture effect"* from the portfolio or collection of boundary objects, and the third is *"managing expectations"* by calling attention to different regulatory conditions behind each design element or boundary object. The visualisation of design elements tends to break down the complexities associated with knowledge asymmetry between project partners by simplifying complex engineering processes into images that are more readily accessible by non-engineers, such as project clients.

Similarly, the collation or assembly of the different pieces of client requirements and other project layouts into a single bundle of specifications enables the project actors to see the implication of each design item [boundary object] in the bigger context of the overall project goals – which then enhances the establishment of a shared understanding between them. For instance, once a client becomes aware of the implication of each isolated decision or project requirement on the overall project goals, and also in the context of external regulatory restrictions which are made obvious by IFPR; such client tends to be more likely to adjust their expectations.

Therefore, IFPR tends to ensure a shared understanding between project partners through "expectation management" that is facilitated by the "visualisation effect" of each boundary object as well as the "big picture effect" which exposes the broader implications of isolated actions when all the project-related boundary objects are combined.

Relating to the extant literature, particularly knowledge sharing (Carlile, 2002, 2004) and shared cognition literature (Mouzas and Henneberg, 2015), this finding has implications. Both of the highlighted literatures have already spelt out the importance of using boundary objects and inter-cognitive representations to facilitate collective decision making in networks. In particular, the knowledge sharing literature has identified the different types of boundaries that could potentially exist between interdependent actors, and also proposed relevant processes for managing each type of boundary. However, the literature lacks explicit discussion regarding how role structure and communication pathways between teams could shape responsibility distribution or knowledge sharing and hence, shared understanding at each boundary. For instance, issues relating to *who should be responsible for transferring, translating and transforming boundary objects* appeared to be taken for granted or assumed to be easily taken care of by project partners (Carlile, 2004).

Moreover, it appeared that the need to assemble boundary objects or to create a localised portfolio of boundary objects for specific project tasks (i.e. IFPR) does not seem to capture scholars' attention. Attention seemed to be more directed to how the boundary objects are (co)created and shared during "social interaction"

between network actors (Mouzas and Henneberg, 2015). What the current finding suggests is that shared understanding in project teams is not only affected by the types of knowledge boundaries that exist between the team members or the processes that are implemented to alleviate boundary effect. Furthermore, rather than using social interaction as a cliché, of noteworthy importance is the role structure or communication pathways tying the teams together. Without utilising the appropriate communication pathways in project teams, role distribution relating to the creation and assembly of boundary objects becomes disorientated, and the establishment of shared understanding may become unnecessarily tedious even if relevant boundary management processes are implemented.

7.2 Coordinating interfaced activities between project sub-teams

Coordination of all the interfaced activities as well as interdependent expertise of the project actors is a very crucial practice to ensure smooth delivery of construction projects. Evidence from empirical data revealed three different systematic and interactive coordination processes that are utilised by the observed project teams. The interactive processes show how project team members simultaneously draw on a variety of representations and boundary objects (e.g. building plans, industry standards, and design layouts) when planning for and responding to different problem situations.

To proactively detect problems or to report identified problems, construction teams create and adapt their boundary objects by engaging in the following activities. (1) An electronic (software) platform is created at the beginning of the project where every team member uploads their technical drawings, sketches, schemes, or project reports. The software then generates a report indicating potential problems such as clashes between connected activities. (2) The team purposefully appoint a change management staff (e.g. a design coordinator and an architect) who possesses cross-boundary knowledge and, therefore, acts as a boundary spanner. (3) The team organises regular review meetings and specialist workshops to update on progress, as well as negotiate changes to design activities. These three interactive processes characterise how social interactions take place in construction teams and typifies how network teams ensure

collective views by proactively responding to problems that are brought to bear by unplanned or previously overlooked events (Grandori, 1997; Bigley and Roberts, 2001; Motawa *et al.*, 2007; Raineri, 2011; Okada, Simons and Sattineni, 2017).

According to the testimonies of the research informants, the three coordination processes are regular practices in the construction industry, and this raises an important question. That is, if every construction project team utilises similar practices in coordinating their activities, then why do some projects succeed while others end in unwanted events, such as disruptions, delays, and disputes. According to evidence gathered from the observed teams {i.e. observation data}, it was apparent that it is not the "what" of shared activities but the "how" and "why" that makes the difference. Therefore, the current analysis is focused on how the observed project teams conduct the three coordination activities. The "why" question would be elaborated in chapter 9.

7.2.1 The role of shared electronic platform

The first coordination process, i.e. a shared electronic platform, was absent in Case A – which is the project team at the pre-contract (or pre-tender) stage of a construction project. Consequently, project layouts were only shared via email and manually compiled by the project manager. And for influential cross-team events, such as quarterly signoff of funds by the project stakeholders, each specialist tends to translate their element of the overall design layout into a simplified report. The reports are then collated and assembled by the project manager and priced by the cost consultant before being presented to the project stakeholders for approval. The collation and, particularly, translation of the boundary objects into simplified reports [i.e. the creation of new boundary objects in the form of summary reports] is necessary to facilitate shared meaning and shared understanding with the project stakeholders (Carlile, 2002, 2004). The project manager (i.e. informant 1 table 3) puts this in context when advising the design team members during one of the review meetings by saying – "*XXX [i.e. stakeholder team] members are not engineers, don't do it [i.e. the report] more than half page … they are more interested in the progress from [RIBA] stage two to three and implications on cost plan … and we seek endorsement*"

{please note that this is a representative quotation from observation data or personal observation note – see appendix for the complete observation note}.

Because a shared electronic platform was absent, inconsistencies or clashes between overlapping design elements only became apparent during the assembly or collation process. It appeared that the process would have been more proactive, and clashes would have been captured in real-time if an electronic platform were shared by all the project sub-teams instead of the email approach. For instance, three months into the project, the architect called attention to the need for a specialist workshop purposely for comparing his drawings with the one from the mechanical, electrical, and structural engineers. As he (i.e. informant 2 table 3) asserted; "*we need another meeting … we've drawn stuffs, they've drawn stuffs … so we need to go through the drawings line by line*" {this is a representative quotation from observation data}. And when clashes were identified during the proposed workshop, the project manager realised that someone should have been appointed whose role would be to manage clashes between drawings, specifically. According to him (i.e. informant 1 table 3); "*the contract needs to provide a lead coordinator because no one feels responsible for bringing the different design pieces together*" {this is a representative quotation from observation data}. This particular experience between the project actors is an indication of the role of a shared platform as a crucial social condition for preventing clashes or major errors in teams shared activities. This role becomes even more apparent in the other two observed cases.

For both Cases B and C – that is, project teams at the post-contract stage of the construction process – a shared electronic platform was created, where design layouts were simultaneously submitted, commented on, reviewed, and transformed into construction-ready outputs. The electronic platform shapes the interaction between project participants in a considerable way. Aside from clash detection, the real-time and simultaneous access to information on the platform also facilitated time management and ensured effective coordination of activities between all the project members. As stated by one mechanical engineer Case B (i.e. informant 13 table 3); "*we've set up a tracker, so, every time we get reviewable design data through, I'll put it on a tracker give it a date and when*

we need to respond by. We didn't have that at the start, but I think it was a bit messy. It was like, ah, we've got something due tomorrow. But now that we've got this, it's very manageable."

In retrospect, when compared with the email approach as used in the pre-contract stage, one electrical engineer Case B (i.e. informant 18 table 3) mentioned that; "*I think the common portal is more effective because all the documents are in one place and everyone has access to them*." These testimonies were also corroborated by a quantity surveyor Case B (i.e. informant 21 table 3) who claimed that; "*an electronic system flags timescale better. So, you're probably less likely to miss a deadline in that sort of scenario. Whereas you are relying on the discipline of each individual team member to meet deadlines via the email exchange system.*"

A noteworthy observation between cases B and C is that while a shared platform may be more readily manageable within each project sub-team (e.g. within the contractor's team); managing a cross-team shared platform (i.e. between the contractor and the client teams) may be problematic. Evidence from data suggests that the key structural mechanisms enabling a cross-team shared platform – especially at the post-contract stage – are the willingness of the contractor to share information with the client, history of past relationships between the project actors, as well as the knowledgeability of the client. Regarding project processes, Case B's client appears to be more knowledgeable than Case C's, and this had an important implication on how each team experienced the use of the shared electronic platform.

Data shows that a less knowledgeable client may have the propensity to display some resistance even in situations where a contractor is willing to share information via an electronic platform. Such resistance may then create avoidable liability on the project and therefore result in unwanted events, such as a delay in information relay between project sub-teams, and also create some degree of difficulty in keeping an audit trail of project activities. Preventing delays in such situations would require some levels of compromise and a focus on relationship learning between the project parties. This is well captured by the M&E design manager (i.e. informant 25 table 3) of Case C who claimed that;

"*the only thing is that the viewpoint [i.e., a shared platform] which we all use, he [the client] won't use that. Which causes us a problem. Because the drawing is going onto a server and you can comment on it and it's a good system. And whether they don't know it or just don't want to use it, so, in a way that's cause us a problem. Because we have to do things the new way for the rest of the team and the old way for the client.*"

Another valuable observation, which slightly differentiates Cases B and C, is that a shared electronic platform is not a perfect system, especially if information flowing through it is not properly managed. In both Cases B and C, team members get notified through their emails whenever a document or drawing is uploaded on the shared platform. However, based on the testimonies of the informants, it appeared that the notification process was better structured in Case B. For instance, in Case B, notifications were delivered in packages, which means that when uploading documents, a project member has an option to specify how the notification is distributed and who gets notified. And in doing so, team members were more likely to get notified regarding information that is relevant to their roles and responsibilities. This approach to notification management seemed not to be the practice in Case C because members tend to get both relevant and irrelevant information, which then leads to information overload. As the electrical engineer Case C lamented (i.e. informant 27 table 3); *"We get all the information coming through viewpoint [i.e. the shared platform] … Yes, the drawings are up there for everyone to review, but also, I don't need to look into the window data and all sorts of things, it means nothing to me. But you get their notifications… Which I think that whole platform doesn't work. It's too much information for people."*

Therefore, some respondents claim to intentionally ignore most of the notifications (i.e. irrelevant information). But in doing so, overlook critical requests and information that are pertinent to their roles and possibly require immediate actions. Hence, leading to unwanted events such as delays and snags in some aspects of the design processes. Again, the electrical engineer reported; "*…always having information coming through it. So, then you start to ignore the notifications because you think I don't really need that, that, that, that. And then*

in between them ten thousand notifications you get, one of them might have been for you. So, you overlooked it." It is vital to highlight that the challenges associated with the shared platform are not only related to notification management but also emanate from some deep-seated structural mechanisms in the nature of the project team members.

Two notable structural mechanisms which became liabilities or bottlenecks to the project are: (1) the project members knowledgeability or prior experience of using a shared platform in previous projects. (2) Because the shared electronic platform is relatively new, some project members still display certain resistance to change as they are more familiar with the traditional way of communicating via face-to-face meetings and email exchange. Therefore, to restore coordination effectiveness in Case C, where information overload was evident, two key events were implemented.

Firstly, a training program was implemented, and a dedicated team of technologist was appointed to provide support on how to use the shared platform effectively – which, to some degree, contravenes the liabilities associated with the team member's inexperience. According to the Senior quantity surveyor Case C (i.e. informant 30 table 3); "*I'm sure the only issues we generally have is when subcontractors might not have an experience of viewpoint. So, we offer training but if they have issues of following or properly submitting the documents to viewpoint, they might need some assistance".* Secondly, the previously randomised process of issuing notifications via the shared platform was overhauled and reprogramed. Despite not reducing the amount of information received by project members, this provided a better structure for the notifications – and therefore, enhanced information and communication management.

The overall experience was explained by the M&E design manager (i.e. informant 25 table 3) that; "*because people were getting hundreds of notifications in a day which has nothing to do with them, to be quite honest. Because, the way it does, everybody gets notified. So, it was changed to this daily alert, so you've got one daily alert. So, what the girls in the office did, they're just on that, they listed everything that had been sent that day. When you get the daily alert now, and then you look down and you go, oh yeah, I'll have a look at*

that, I'll look at that, which is a better system." And based on observation data, the interaction processes between the project team members were noticeably enhanced as a result of the implemented events.

7.2.2 The role of boundary spanners

The boundary spanners are notable entities in cross-team communication throughout the entire construction process. They act as "general overseers" who proactively spot and address misalignments of interdependent activities – e.g. by alerting relevant members within the team. Because of their cross-boundary knowledge, they can engage in constant negotiation with different interest groups across the project sub-teams, and they tend to function in tandem with the electronic platform earlier discussed. According to one design coordinator Case C (i.e. informant 30 table 3), people tend to deviate from plans. However, it is the role of the boundary spanner; "*to sit down and bring people back in. Things don't quite go smooth, people slightly head off to the side, you have to grab them and bring them back in line. Otherwise, if somebody goes off that way, their piece of information won't tie-up with another piece of information from another one, and you've got 3 outcomes in the end.*

In construction projects, the main boundary spanners are the architects and design coordinators. However, as the project progressed from pre-contract to post-contract stage, more and more members of the project tend to act as boundary spanners. Examples of project team members who transitioned into boundary-spanning roles post-contract are; the client-side project managers and, at least in Case B, the client-side electrical and mechanical engineers. According to one electrical engineer (i.e. informant 18 table 3); "*That's the whole reason why we stay on the client side from pre-tender to post-tender, to make sure that the employer's requirements that we put forward, that was priced by the contractor, it's to make sure that is adhered to, and that's stuck to."* Data shows two main conditions that tend to affect how effectively boundary spanners can perform their roles – and this is specifically related to post-contract activities and changes.

The first condition relates to the structure and composition of the client and contractor's teams – that is, the Intermediary-led and Client-led communication

pathways presented in the previous chapter. For instance, unlike Case B, the client in Case C did not retain the structural, electrical, and mechanical engineers for post-contract continuity of the design. The immediate implication of this is the knowledge asymmetry between the client and the contractor sides which then created difficulties with information sharing in Case C. This is especially complicated because the contractor side had to engage directly with the client who possesses limited technical expertise on construction designs and processes. However, in Case B, knowledge seemed to be symmetrical because of the mirrored representation of roles on both client and contractor sides. The benefits of this were echoed by several members of the project team in Case B.

For example, the client-side mechanical engineer Case B (i.e. informant 13 table 3) mentioned that; "*in terms of working together it's quite a good team. Everyone is always in communication with each other. We are always in contact with X, who is doing the M&E [contractor side]. Constantly emailing or calling, they will send us through information before it comes through as RDD, which is for us to approve and say, happy to proceed. And then we'll sit down and have workshops, which helps to progress again with the design and resolve any outstanding issues.* And regarding how post contract changes were managed, the client-side project manager Case B (i.e. informant 17 table 3) expressed his satisfaction saying; "*there's always some changes because you don't necessarily understand exactly what the requirements are at tender stage, so there's always some post-contract change, but that has been managed really tightly between the quantity surveyor (QS) [client-side] and the contractor's QS. They are working well together to get to the bottom of additional cost, really easily."*

The second condition relates to the novation agreement between the client, contractor, and the architect. Novation is essentially a change in contractual relations which necessitates the switching of roles of design consultants – in these 2 cases, the architect – from the client to the contractor side. With a novation agreement, the technical design done post-contract would be undertaken by the same consultants who did the concept design pre-contract. As claimed by the Case A's architect (i.e. informant 2 table 3); "*If you are novated, you have far more control of things lining through. You know the details, and*

stuffs joining through, and how those junctions come together." However, the observation data gathered from Cases B and C tends to suggest that the architect's claim might not be entirely accurate, which is because of the existence of some intervening mechanisms that might be (de)activated post-tender.

One key mechanism that tends to enable a novated architect to maintain their boundary spanning role, and to have sufficient control over the design processes, is "*unrestricted communication*" by the contractor. Sometimes, the contractor might not explicitly restrict communication but may create an environment where direct communication between the architect and the client is not encouraged. For example, the contractor might not formally invite the architect or other design consultants to attend the client progress meetings regularly. For instance, when asked why the consultants were consistently absent in the client progress meeting, the Case C M&E design manager explained that (i.e. informant 25 table 3); *Because the design team works for us. And the client meeting we might have the Architect with us, or we might take them along. We had one the other week because at the moment we are discussing this ground floor reception area and we are sort of at the moment about it. So, if we need some of the professional team sitting at the meeting to get the point across, we will invite them to come to the meeting. But generally, it's usually me and the [site project manager]and the [design coordinator].*

Therefore, regarding novation, the one major difference between Cases B and C is that there is consistent and direct communication between the architect and the client in the former but not in the latter. Evidently, the ability of a novated architect to control or influence the design processes was hampered in Case C but not in B. According to Case C's architect (i.e. informant 23 table 3); "*…and again, immensely frustrated when I find that tile suppliers are starting to impact on the design of the reception area as an example. You know, I can't get my head around that because, you know, we are qualified designers. … And it's very frustrating to not be able to advise on things like this. … in the employer's requirement document, we did put the design forward and one or two items might have found their way through, but a lot has changed. And that is a difficult pill*

to swallow in some ways, because before you know it all you are doing is really drafting."

However, for Case B, where there was unrestricted communication between the architect and the client, there was a different outcome. As the architect (i.e. informant 11 table 3) satisfactorily claimed; "*I mean it's very transparent. You know, the client trusts us. We want to do a good job and deliver a project that was in accordance with their original aspirations. And the fact that we still get the opportunity to sort of talk to them and meet with them regularly, you know, there's no hidden things they miss out on. Everybody is open in their discussions and emails and people get copied in on things. It works well from a project perspective.*"

Because the study is driven by the critical realist ideologies, the inquiry was not only concerned with what happened but also what did not happen or what could have happened. Therefore, the Case B architect was asked to give an account of what could have happened if there was no consistent access to the client. And according to him (i.e. informant 11 table 3); "*I think if that was the case on this project, if we weren't allowed to attend those progress meetings, I think I'd feel frustrated as well. I think things will get missed as well, I mean, if you are not there in those client meetings where those decisions are taken, and you are not there to put your points across. Then, the client ultimately, I don't think will have, the building wouldn't be as good if you haven't got that input all the way throughout the process.*"

Even prior to appointing a contractor, Case A's client also expected a situation where there would be open and consistent access to the architect. According to him (i.e. informant 8 table 3); "*on this scheme, I don't need to keep the Architect this side. It's not that architecturally sensitive. What I would personally get annoyed at though is regardless of the novation agreement, if the contractor was so arrogant, or blocking conversation. Which doesn't help anybody."* What all these testimonies indicate is that communication restriction by the contractor represents a bottleneck or liability that must be removed in order to achieve a smooth and effective interrelation process between the project sub-teams.

7.2.3 The role of review meetings and workshops

Review meetings, such as DTM, CEPM, and specialist workshops, are mainly concerned with planning, scheduling, and process management in construction projects. During the meetings, project members conduct numerous activities, e.g., vetting, reviewing, and analysing of project documents or drawings. They also jointly deliberate on progress, carry out impact and snag assessment on change-related actions and, in some situations, settle disputes between project sub-teams (Moore and Dainty, 1999; Motawa *et al.*, 2007; Okada, Simons and Sattineni, 2017).

What seemed to be the underlying factor for a successful implementation of review meetings was active participation by all the project actors, which includes clients' and user's involvement in varying capacities. Apparently, an inclusive or democratic process is necessary because it promotes a speedy identification of change drivers. Potential consequences of change could also be jointly anticipated in advance (Burnes, 2005; Raineri, 2011). As emphasized by the informants across the three cases, review meetings facilitate the establishment of predictive knowledge between project actors. For example, a design manager Case B (i.e. informant 20 table 3) mentioned that; "*so, everyone should know what they are doing, know what everyone else's work is, and how they interface with adjacent work. And through these meetings, we discuss what's the process, what's done first."*

Observation data shows three key conditions that are relevant in order for the review meetings to result in effective change and time management between the project sub-teams. The first condition is the *regularity of attendance* of key decision-makers in the meetings. The second is the *meeting structure,* which relates to how project activities are organised for decision making during each review meeting. The third is the act of promoting a *sense of urgency* as a regular agenda in review meetings. Evidence from previous studies tends to suggest that some of the most salient events in construction projects are latent changes that only become noticeable during intensive negotiation and joint reflections (Motawa *et al.*, 2007).

Therefore, regarding the first condition, if relevant members of the team are missing *[habitually]* during the review meetings, decisions would be potentially delayed or made tentatively, and this could potentially have broader implications on the teams' further interrelation processes. Unaddressed or unmediated changes could lead to uncertainty or loss of predictive knowledge between team members. For instance, in Case A where some of the decision-makers were consistently absent during review meetings, the project manager (i.e. informant 1 table 3) reported that; "*the bi-weekly ones with the users are, I found the more difficult ones because certain team members had answers but didn't have the authority to confirm the requirements. And that's a tricky bit. When the main lead, [X] for example, was in one of those meetings he overruled decisions or confirmations already made in past meetings. But that was the tricky one, to capture what they really need in the end."*

The most obvious factor or situational mechanism preventing regularity of attendance appeared to be overcapacity and limited resources, especially for the members of the design team. Evidence from observation data indicates how different generative mechanisms were activated to restore regularity of attendance and therefore avoid unnecessary delays in decision making. For example, in Case C, *cofacilitation* between project members tends to be an effective generative mechanism in restoring regularity of attendance. According to the site project manager (i.e. informant 28 table 3); "*I think we've had regular, good attendance from them [the engineers and consultants]. Some people let you down sometimes, but you speak to them or speak to their boss to see if he can free some time off of these guys*." Without such proactive intervention from the project manager, at least in Case C, the situation could have potentially escalated into avoidable delays.

Regarding the second condition (i.e. how each review meeting is structured), two types of structures were identified across the three cases, but the difference is more pronounced between Cases B and C. For Case B, meeting arrangement is "*specialization-driven"*. The meetings are also broken into sections, which then allows the boundary spanners (i.e. the design manager and the architect) to focus on one specialist at a time. Essentially, each specialist (e.g. an electrical engineer

or an acoustician) is given a time slot with an option for other design team members to sit in, if their activities overlap. However, for Case C, meeting arrangement is "*activity-driven",* and the activities of all the specialists are randomly organised, which means that the specialists must all engage simultaneously with the boundary spanners.

The *turn-taking approach* of the specialization-driven meeting structure tends to enhance the optimisation of project and discussion time. Whereas, with the *randomised approach* of the activity-driven structure, some project members could sit in a meeting for up to three hours before it gets to an activity which relates to their roles. And this has implications on the level of attentiveness or mindfulness of team members during joint decision making, which then affects coordination effectiveness between the project members.

For instance, during review meetings {i.e. observation data}, the design coordinator or architect in Case C usually confirms that members are in support of a decision, and are willing to act accordingly, by utilising the phrase; "*are we all happy with the plan*". By saying yes or simply gesticulating by nodding their heads, team members would have collectively entered into an agreement to implement the elements of the plan which pertain to their respective roles. However, it is not uncommon that a team member is not paying attention during such a "supposed" agreement. And this typically leads to an "unnoticed" lack of shared understanding in the team, which is then reflected in how actions are subsequently implemented.

A misunderstanding ensuing from inattention was well captured in the testimony of the architect (Case C) regarding a disruptive event in the design process. As he reported (i.e. informant 23 table 3); "*…the M&E were assuming that level 2 was the structure that supported level 2. Whereas, Steelwork coordinators were defining level 2 as the services on the surface of level 2. So, they were disjointed. And as you can imagine, that caused a huge problem because they've got the building services distribution different floor by floor. And this is about guys being in the room together and not being fully engaged to what they are doing. Maybe on a mobile phone or whatever it was. Because they had a workshop dedicated to this."* Occurrences such as reported by the architect tend to confirm

that what people do is not as important as how they do it. Despite that all the observed cases were engaging in similar activities; different outcomes were realised due to the subtle variances in how the processes were implemented.

Regarding the third condition, evidence from observation data indicates that having a *sense of urgency* as a regular agenda in review meetings – e.g. through generative mechanisms such as milestone invocation – tends not only to enhance time management but also facilitates change management between project sub-teams. By constantly introducing a sense of time and urgency in cross-team conversations, a culture of proactivity would gradually develop. A proactive culture that is intentionally and actively managed by a consistent sense of urgency enables project teams to avoid time pressure as well as prevent unnecessary delay or rush in their processes.

As the client-side project manager in Case B confidently reported (i.e. informant 17 table 3); *when it comes to decisions, they [the contractor] are really good at making up, this is when we need the decision by, we then have time to go do what's required to make the decision and press on. Compared to other projects, this project doesn't feel very time pressured, and I think that's because [the contractor] is very good at looking ahead and flagging up when they need information. And we then have time for us to go and feasibly do it.* As observed in Case A, when a sense of urgency is not consistently implemented, change management becomes unnecessarily tedious and the potential for time pressure increases. This is well captured in the testimony of the Case A's mechanical engineer (i.e. informant 4 table 3) that; "*there were some of the decisions that we made that actually we didn't need to finalise them until much later. So, it was a bit kind of stop-start in that way. Which I think made things probably more pressurised than they would do normally. Because it was sort of just talking all along and then suddenly there's a deadline to achieve.*"

To put the mechanical engineer's testimony into context; the implication of a sense of urgency on change management could be demonstrated by an event that caused a slight disruption and unexpected errors in the design process of Case A. At the early stages in their design process, it was planned by the client of Case A to use generators as an alternative source of energy, and this was to ensure

flexibility of energy distribution once the building is in operation. As a result, there was a regular debate during review meetings regarding generator choices (diesel or gas or both) as well as capacity and output frequencies (50Hz or 60Hz). And after a few months into the project, an external consultant (i.e. a generator manufacturer) was also invited for professional guidance.

The goal at that stage was to recommend the generator manufacturer to the contractor as the one to supply and operate the generators during post-contract and post-commissioning, respectively. The debate went on for almost six months. In the end, power distribution and earthen schematics were designed (i.e. boundary objects were created) with a generator as the power source. However, weeks before going for tender – which essentially is the start of contract negotiation – the client and the users completely discarded the generator ideas, which then resulted in the design team discarding the schematics (i.e. boundary objects discarded). The unplanned change led to the end of the relationship with the generator manufacturer, at least regarding this particular project, and a new relationship with another power supply company was initiated. That is, there was a radical change in the business network structure of the project team (Halinen, Salmi and Havila, 1999). The design team was also required to create an entirely new set of power distribution schematics within weeks and needed to incorporate the schematics into the employer's requirement (i.e. IFPR) before inviting potential contractors.

The last-minute change has two main implications for coordination. Firstly, the limited time available for the electrical engineer to redesign the schematics created time pressure – and this led to some errors in the employer's requirement that were highlighted by the contractors during contract negotiation. As the lead electrical engineer lamented (i.e. informant 7 table 3); "*it was very close to the deadline of when we were trying to issue our information from, I think it was like a week. So, as you can see it can be frustrating because you've had a long period of time from the beginning of February right through till now and the client [snaps his finger] can just decide, that's what I want. And you're like, what!*" Secondly, the initiation of contract negotiation (i.e. tender submission) was also delayed, which then reduced the contract negotiation time by one week.

Therefore, increasing the possibility of omitting important details in the employer's requirement.

As later gathered from interview testimonies, which would be further discussed under the compliance chapter (i.e. chapter 7.4), an employer's requirement that is incomplete or contains ambiguous information tends to aggravate the already tedious contract negotiation. And it may eventually lead to serious tension between the client and the contractor during the post-contract stage. It may also cause a significant cost to the client due to the changes that would potentially be made to the contractual agreement (Okada, Simons and Sattineni, 2017).

Interestingly, for Case A, the last-minute change had a positive implication on the project because the removal of the generator options substantially reduced the project price. When reflecting on the incident, the project manager admitted there was "*a bit of luck"* because the situation could have turned out with a different outcome. Nonetheless, the experience confirms the arguments that changes do not always attract negative consequences on a project if detected and implemented at the right time (Ibbs, Wong and Kwak, 2001). Which essentially means, identifying and addressing the changes before finalising the employer's requirement or during contract negotiation, before actually signing the project contract.

7.2.4 Summary – How IFPR is utilised to coordinate actions between project sub-teams?

The table 6 below summarises the discussion regarding coordination processes that are facilitated by objectified organisational artefacts. Two key assumptions could be drawn from the analysis to provide an answer to the second part of RQ 1, that is, how IFPR is utilised to coordinate actions between project sub-teams.

Firstly, IFPR – in this case, employer's requirement, contractor proposal, and binding contract – tends to tie the pre-contract and post-contract stages of the construction project together, e.g. by functioning as the medium and outcome of interrelations between the project partners. Fundamentally, IFPR gives the project team a sense of purpose and a sense of direction at each interaction episode. That is, the employer's requirement is constantly at the centre of

discussion during contract negotiation or review meetings because it stipulates the expectation of the project client upon which a binding contract is established with the contractor. Therefore, as an underlying structure which drives communication and information flow in project teams, IFPR facilitates coordination of activities by outlining three process elements. One, the requisite knowledge and expertise for task completion. Two, roles and responsibilities of team members and, three, defining interfaces for overlapping tasks. Essentially, IFPR functions as a confluence of both administrative and expertise coordination by organising and shaping not only tasks but role distribution between the project sub-teams.

Secondly, IFPR only provides the project team with requisite resources to function but does not determine the pattern of actions. Findings show that the media [i.e. non-human agency] used to transfer boundary objects, and the potential for resistive [human] agency, tend to moderate how IFPR facilitates coordination of activities and actions between the project partners. As presented in the summary table below, interrelation processes between construction project actors tend to yield different coordination outcomes if the email approach was used to transfer boundary objects instead of a shared electronic platform. Moreover, in situations where both emails and electronic platform were simultaneously used for transferring boundary objects, such as in Cases B and C, process disruption could still be experienced as a result of the resistive agency from project partners.

As experienced in Case C, a resistive agency could be triggered by an agent (e.g. Case C client) as a "defence mechanism" to compensate for their insufficient knowledgeability regarding design processes and technicalities. Moreover, a resistive agency may also manifest as an "emancipatory mechanism" triggered to regain control from a supposedly overwhelming coordination process – e.g. Case C engineer who decided to intentionally overlook “irrelevant information” as a way to manage and cope with information overload. Irrespective of the triggers, resistive agencies tend to complicate the effectiveness of IFPR in coordinating construction processes.

Table 6. *Summary of findings regarding coordination in project teams vis-à-vis IFPR*

Coordination vis-à-vis IFPR	**Case A**	**Case B**	**Case C**
IFPR (i.e. employer's requirement, contractor's proposal, and binding contract between project partners) *functions as medium and outcome* of coordination between project partners	*Employer's requirement* (i.e. a bundle of sketches, drawings, and layouts) developed by the client and his designers *facilitates* contract negotiation and *dictates* what the contractor would implement post contract.	In line with the employer's requirement a *contractor proposal* is designed which represents the promise of what the contractor intends to deliver post contract.	In line with the employer's requirement a *contractor proposal* is designed which represents the promise of what the contractor intends to deliver post contract.
Activity alignment and coordination processes being shaped by *the channels or media* used for transferring boundary objects and complicated by *the resistive agencies* of team members	Project drawings were communicated between project partners *via email* and manually assembled by the project manager. All project actors working for the client at this stage. Due to reliance on email approach, *inconsistencies and clashes* between design elements were *identified retrospectively* when layouts were manually assembled. Project manager only realised the need to employ a lead coordinator when the design layouts of the engineers were assembled, and clashes or inconsistencies detected – *i.e. process appeared to be reactive.*	Project drawings and layouts were communicated and assembled *via electronic platform.* Notification of drawing uploaded on the electronic platform sent via emails to *relevant project partners.* In retrospect designers reflected on the email approach used at the pre-contract stage as *"messy" for deadline management.* The electronic platform was considered to facilitate *real-time identification of drawing errors* as well as a simultaneous access to project drawings by team members.	Project drawings and layouts were communicated and assembled *via electronic platform.* Notification of drawing uploaded on the electronic platform sent via emails to *all project partners.* *Client's unwillingness to use electronic platform* complicates document sharing process – e.g. by slowing down information relay and causing avoidable tension between the client and the contractor. Design members *overloaded with information* due to members getting notifications for all document uploads. Designers exercise their agency to regain control and liberate themselves from information overload by *intentionally ignoring* "irrelevant information".
IFPR being shaped by and shaping role distribution and task distribution between project partners	Two lead users appointed to bridge the knowledge gaps between the designers and the users, to translate design drawings for users, and to make decision when there's disagreements between users. . Each designer *creates a simplified summary report* of own design which is then presented to other project stakeholders by the project manager. Pre-agreed activities and drawings were occasionally overruled due to *irregular attendance at review meetings* by key decision makers.	In order to ensure design continuity, *client retained the engineers* (as boundary spanners) on the client side to monitor contractor's activities and to ensure early identification of problems or design errors. The architect was transferred to the contractor side post-contract through a novation agreement but *continues to engage directly with the client* through regular attendance at client progress/review meetings.	With the exception of the architect who transferred to the contractor-side post contract, *none of the pre-contract engineers were retained* by the client. The architect *does not engage directly with the client* as communications appeared to be restricted (i.e. the architect is not regularly invited to client progress/review meetings) The contractor's site manager *cofacilitated the designers' regular attendance at design review meetings* by negotiating directly with their respective companies.
Key events or process outcomes	*Absence of a consistent sense of urgency* in review meetings and some last-minute changes to design lead to time pressure and therefore errors in the employer's requirement (IFPR). *"Last minute" changes* to design layouts also lead to	An electronic tracker was set up post-contract *to better manage deadlines* and to facilitate team members' simultaneous access to project drawings. *Absence of any significant disruption* in workflow or interfaced project activities e.g. due to proactiveness of	*Overhauling* of notification process by the contractor as a reaction to the delay in information relay that resulted from engineers' *"intentional overlook"* of email notifications. *Process disruption* due to miscommunication between engineers as well as

	radical changes in the structure of the project team, e.g. relationship with a generator manufacturer became redundant and therefore terminated. Invitation for tender submission and contract negotiation were also slightly delayed.	project actors resulting from a consistent sense of urgency.	inattention (e.g. designers distracted by electronic gadgets) during review meetings. *Major changes* made post-contract to the employer's requirement in order to reflect budget capacity – which then triggered some resistance and conflict between team members.
Communication pathways	Intermediary-led communication pathway	Intermediary-led communication pathway	Client-led communication pathway
Stage of construction project	Pre-contract stage	Post-contract stage	Post-contract stage

The findings discussed above confirm the assumptions in the practice perspective of coordination which suggest that effective coordination requires not only administrative procedures such as routines and schedules but more importantly demands the management of knowledge interdependencies between members of an organisation (Faraj and Sproull, 2000; Faraj and Xiao, 2006; Ben-menahem *et al.*, 2016). However, the outcome contradicts the generic view of the information processing theory which assumes that the need for communication between project actors could be reduced by creating a shared electronic platform where common knowledge of interfaced activities could be made available – for example, to increase the predictability of actions between members of an organisation (Galbraith, 1974; Srikanth and Puranam, 2011).

According to the information processing view of coordination, "*to achieve coordinated actions, it is sufficient that knowledge of the interface is in [the] common ground [i.e. in the Electronic Data Interchange]*" (Srikanth and Puranam, 2011, p. 853). Whereas, as the current findings indicate, it is not sufficient to have a shared platform or even to establish common knowledge [shared understanding] between project actors by using boundary objects. Rather, effective coordination is achieved through continuous management and (re)distribution of expertise as well as constant (re)negotiation of resistive agencies by leveraging the procedures outlined in the pre-agreed IFPR as the basis for expected actions. And, in line with the sensemaking approach (e.g., Weick, Sutcliffe and Obstfeld, 2005; Seidl and Werle, 2018), the negotiation of resistive agencies also includes being open to accommodate changes as new information arises.

7.3 Aligning conflicting interests

This dissertation captures interest as the desires, intentions, plans, and aspirations of the different individuals that make up a construction project team. As a starting point in a construction project, the project teams immediately face two different but interconnected types of interest misalignments – namely, knowledge related and process related interest misalignments. Knowledge misalignment is as a result of the different professional backgrounds in the project team, which drives how each team member envisions the project. Process misalignment, however, is due to the mismatch in the project team members' understanding of how the different interfaces of the project activities should be planned and executed.

In the absence of appropriate mechanisms, interest misalignment may tend to manifest as the most formidable conundrum in the construction process. And this is because the interests and goals of members of a project team significantly influence the day-to-day decision making between them. As one quantity surveyor from Case B attested (i.e. informant 21 table 3); "*that's always one of the real difficulties on projects because everybody's got sort of own ideas and goals a little bit.*"

Hence, to better explain the implications of interest misalignment on the team's shared activities and processes, it is important to highlight the key sub-teams that make up a typical construction project. In the observed cases, there were six different sub-teams – namely, design team, project management team, client and cost-consultant team, user team, principal contractor, and stakeholder team. Except for the stakeholder team, all the sub-teams function as internal members of the design process. As would be explained in later discussions, the stakeholder team, therefore, represents a regulatory framework for the implementation process.

A key point to note is that each sub-team has own agendum and the different agenda do not always align, which creates tension when making decisions across sub-teams. Even within a sub-team, there are numerous occasions where interests do not align, which then creates a spillover effect on other sub-teams and therefore, complicates the construction process. For example, regarding the

user team in Case B, the contractor's project manager mentioned that (i.e. informant 9 table 3); "*I think more of the problem for [the lead user] is that there's more than 1 person and they don't always agree with each other. That's more of a problem. And there's been a little bit of delay in coming back with some of their answers*."

Generally, the primary interest of the user team is to have a bespoke design that is customised to the specific need of each user. The design team's ultimate goal is to ensure compliance with regulations, to design a building that is functional and aesthetically pleasing, and to ensure that different design elements are properly aligned and well-coordinated. The client's and cost consultant's focus are on budget and project completion time. The stakeholders' team is concerned with ensuring value for money by conducting objective assessments of the process and approving signoffs at critical milestones in the design – e.g. signoffs for planning application and tender submission. The project manager's goal is to liaise between all the different sub-teams to ensure that their interests are aligned while also simultaneously ensuring that the core project objectives are not compromised in the process. The principal contractor focuses on producing a building that satisfies the needs or aspirations of the client/users and also on making a meaningful profit from the project. One contract manager explained why it is important for the design elements to align with the requirements of the users by saying; "*it is pointless to build something that does not suit their [users] needs. … It would be like shooting ourselves in the foot."* {please note that this is a representative quotation from observation data or personal observation note – see appendix for the complete observation note}.

As evident from the discussion so far, aligning interests or establishing consensus between project partners is an important process in construction projects. Consequently, two questions are worthy of exploration in this analysis. First, is it possible to consistently achieve consensus between project team members throughout the construction process? Second, if the answer to the first question is a "no" then, what happens in situations where it is simply impossible to achieve consensus without causing any major disruption to the project? Evidence from observation and interview data points to *shared*

history and *existing relationship* as two crucial conditions that could shed light on the first question. It is noteworthy to highlight that having these two antecedent conditions does not automatically translate into an ideal situation where teams consistently agree on issues. Nevertheless – provided that shared history and existing relationship are based on positive experiences – observation data shows that team members are more readily attuned to engaging in mutual compromise during intense negotiations.

In particular, the presence of shared history and existing relationship in a project team tends to alleviate process-related misalignment or disagreement between team member, which is because of the potential existence of predictive knowledge that enables such teams to manage expectations more effectively. According to Case B's architect (i.e. informant 11 table 3); "*this is the third project as a team. So, that's a huge benefit in terms of coordination and working with those guys. We know them, we've worked with them before, we understand their processes, they understand ours. So, it worked well, there's no issues, there's not really been any conflict there because we are all friends and we all work well together.*" Similarly, in Case A, shared history and existing relationship positively influence the establishment of consensus across project sub-teams. The client attested to this saying (i.e. informant 8 table 3); "*I think more than anything because most or all of the consultants on this project have worked with us before. I think we are past that sort of things. So, I don't recall any disagreements at all, meaningful or disruptive to the process. What I think we've seen is strong, robust debate, resolving design questions, or engineering questions. Not disagreement.*"

The argument here is not to suggest that without a shared history or existing relationship teams could not function or engage in a consistent pattern of agreements in their processes. However, as identified in Case C, where most of the team members (client inclusive) lack a history of shared relationship; what seemed to facilitate the establishment of consensus are the willingness to learn, desire to forge a new relationship, and an adaptive behavioural disposition in unfamiliar situations. When these are the core criteria in the procurement of project (sub)contractors and are also promoted as regular agenda during cross-

team interactions, then the focus of each member of the team would gradually shift from role-specific goals to a much broader project objective.

As an example, in Case C, a series of value engineering processes were conducted post-contract, which led to major changes to what the architect had designed before the appointment of the principal contractor. That is, boundary objects (the architect's drawings) were being used by the contractor as a bargaining chip to negotiate different project outcomes. As a result of the unexpected changes, there was some level of resistance and tension in the relationship development between the contractor and the architect. As noted by the contractor's quantity surveyor (i.e. informant 31 table 3); "*but there were certain aspects that they [the architect] probably don't appreciate fully what's in the contract. So, they still design as in the initial client requirement intention regardless of what we've said we were going to build. Obviously, we have a check-in role before it gets approved, but we've had to remind the architect that they haven't designed it as it should have been.*"

By focusing on the overall benefits for the project, the architect compromised and accepted the changes, which prevented any major disruption to the process. The architect, however, reported a potential alternative outcome that could have resulted from the situation. According to him (i.e. informant 23 table 3); "*the architect may dig their heels in the sand and just say no, I'm not accepting that. But how do you move on from that. Do you go back to what you specified to the client that was four-hundred thousand pounds or whatever it was, I don't know. That's not a way of moving the project forward."*

In the example above, due to mutual compromise and relationship learning between the project parties, the architect continued to work on the project through to construction stage. However, a different outcome was observed in Case B, where there was no prior relationship or history in a specific dyadic relationship, i.e. between the principal contractor and the client's project manager. The parties in the dyadic relationship had difficulties in building trust. Moreover, the perceived lack of transparency resulted in major disputes between the parties, and this eventually led to an unplanned event. That is, the situation escalated into a sudden replacement of the client's project manager. As

recounted by the contractor's design manager (i.e. informant 20 table 3); "*I think there was a little bit of friction with [the client's project manager] earlier on, probably because they didn't know us, they didn't really trust us. There was no need for that really. I think [X] has taken over the role of project manager, and he is a lot more open and you know, sort of create a better working environment. There's definitely an improvement since [X] got involved. And you feel like you can just talk more openly with him and you don't have to be so guarded. Which is a benefit to everyone.*"

Given the experience from the three observed cases, it appears that the answer to the first question above is not entirely straightforward. Yes, there is a possibility for a multidisciplinary team to reach consensus consistently throughout the construction process. But this comes with a price of mutual compromise – which is not necessarily readily available during complex negotiations. Moreover, there is ample evidence across the project teams of situations where any engagement in mutual compromise may be to the detriment of the project. And in such situations, typically during review meetings, the project sub-teams do struggle to reach a consensus on design issues. As echoed by one architectural technologist from Case A (i.e. informant 6 table 3); "*compromise is not always the best way.*" And this could be as a result of some underlying regulations or even pragmatic reasons, e.g. the users' request for a design element may not be financially viable for the project budget. Therefore, regarding the second question posed above, findings show three different layers of structural mechanisms that are sequentially activated when consensus is impossible between the project sub-teams or within a sub-team.

Firstly, during CEPM {i.e., from observation data}, it is sometimes impossible to reach a consensus because of the lack of shared understanding that is brought to bear by the knowledge misalignment between the project sub-teams – particularly, between the design team and the user team. In those situations, boundary objects – such as building layouts and assessment reports from external experts like ecologists – are utilised as structural support mechanisms to justify the rejection of a client or user request. Essentially, the boundary objects tend to function as tiebreakers in such situations and also lessen the effect

of the knowledge misalignment on negotiation processes. As reported by the mechanical engineer, Case A (i.e. informant 4 table 3); "*sometimes a drawing is a bit easier and it's quite visual and it's quite easy for everyone to understand. So, it helps to orientate them [the users] and helps them to get an understanding what the building actually would be like. You almost lose that barrier of the language thing then. … And I think [X] was quite good at bridging that, mostly, and [Y]. I think they [the lead users] are quite good at trying to kind of translate a little bit between the two groups.*" In this example, boundary spanners complement boundary objects to facilitate cross-team negotiation processes.

Secondly, during DTMs {i.e., from observation data}, members of the design team might have difficulty agreeing on design issues. In those situations, the causal power of the client as a *mediating agent* is activated to reach a resolution. Due to the technical nature of construction projects, the activation of the client's role as a mediating agent is not effortless and could be potentially problematic. The problem is mainly because a less knowledgeable client may also rely on his appointed agents before making decisions in such situations. Observation data shows two different types of client agents, each with distinct attributes. On the one hand, a client agent may be *emphatic* and *analytical* when intervening in tough discussions between the client and the other sub-teams. On the other hand, the client agent could exhibit a relatively *neutral* or *yes-man-ly* disposition. A yes-man-ly agent may, therefore, "sit on the fence" when consulted by the client, which then dictates a different outcome when compared to the analytical and emphatic agents. For instance, in Case A, there seemed to be a positive experience in the design team regarding how conflict resolution is handled through the active participation of the client agent. The electrical engineer of Case A satisfactorily reported that (i.e. informant 7 table 3); *he [the project manager] seems pretty keen and seems switched on, giving us enough time to deal with things and will fight our corner as much as just protecting the client*." However, in Case C, the role of the client agent is less emphatic, which then results in a less satisfactory outcome. According to the contractor's quantity surveyor (i.e. informant 31 table 3); "*so, in some respects, [the client agent] don't have a great role and when they do get involved, they are led a lot by the*

client as opposed to being, impartial is not the right word but perhaps, they are not strong with the client."

Thirdly, some situations may remain unresolved despite the activation of the boundary objects and the mediating agency of the client. Such situations are then resolved through *regulatory control* mechanisms. For instance, in Cases A and B, the stakeholder group may tend to have the ultimate decision in such situations. As reported by the client representative of Case B (i.e. informant 14 table 3); "*if somebody higher power than me says, I want that building to be pink, we will then assess the cost, any implications like that, take it to XXX [the stakeholder group] and say OK look, [X] has asked to be pink, planning is going to be against it and the cost is this amount of money, this amount of delay to the program, what do XXX want to do? If XXX then say we still want to do it, then we do it. So, the architect will be told, you need to change that cladding to be pink, that's the end of it.*" This particular testimony exemplifies the power game in the negotiation process between project partners and how the process is intermediated by boundary spanners by using boundary objects as justification tools to make sense of design issues.

These three highlighted mechanisms (i.e. boundary objects, client's mediating agency, and regulatory control) may facilitate the characterisation of project (sub)teams into two distinct categories. That is, by observing the conflict resolution processes, project teams could be categorised as either *contract-driven* or *relationship-driven*. Arguably, if a project team is relationship-driven, issues are more likely to be resolved simply by activating the boundary object mechanism. Whereas, any project team that constantly requires the activation of all the three highlighted mechanisms before resolving a disagreement could be said to be a contract-driven team. In this current investigation, there is no sufficient evidence to confidently categorise any of the three observed cases as either relationship-driven or contract-driven.

However, experience across the project teams tends to suggest that a relationship-driven process might be more beneficial, for instance, in avoiding unnecessary disruptions or delays, while a contract-driven process could be catastrophic. One notable example to substantiate this claim is the testimony of

the contractor's design manage, Case B. According to him (i.e. informant 20 table 3); "*some groups of people, it could be architects, project managers, clients, contractors, can be contractually biased. So, they want to be reading, basically, reading all the clauses, you've not done this, you've not done that, you must do this you must do that. And I've been on projects like that and they are never successful.*" This testimony confirms the double-edged nature of boundary objects and IFPR – which, on the one hand, could be used as justification tool to make sense of complex design issues. But, on the other hand, could also be a major impedance if used or abused to enforce actions that are considered burdensome or less satisfactory by project counterparts.

It is noteworthy to highlight that regulatory control mechanism is double layered. The first layer is directly set-up and relates to a specific construction project, e.g. the role of the stakeholder group as a regulatory framework in Cases A and B. The second layer is not directly related to any project but designed as an overarching structure to establish universal standards across the construction industry. The structure could be a governing authority regulating electrical and mechanical installations or those ensuring proper adherence to safety measures. There are extreme situations in construction projects where heedless actions between project partners would remain unresolved even with the activation of the project-level regulatory control. Such situations are mostly related to the issues of non-compliance with industry standards and would typically require the intervention of the industry-level mechanisms. Specific examples of such situations would be presented in chapter 6.4 when discussing compliance.

7.3.1 Summary – How IFPR is utilised to align conflicting interests between project sub-teams?

In the above discussion, interest alignment has been demonstrated to be a crucial factor in ensuring process effectiveness as well as avoiding disruptions or delays in construction projects. However, during interrelations between project sub-teams, certain events (e.g. value engineering) tend to trigger or expose the political differences between the project partners. Which then create contentious issues and thereby complicate joint decision making. Similarly, knowledge asymmetry between project partners creates unwanted boundaries, e.g. language barriers and power gap, which makes global consensus impossible across the

project sub-teams. Power, in this case, relates particularly to expertise knowledge but could also include positional authority. Essentially, it is impossible for everyone on the project to get what they want in every situation because the more knowledgeable or powerful actors tend to gain a better position during negotiations. Findings show that relational conditions – such as shared history, adaptive behaviours, and willingness to learn – play a vital role in (re)aligning interests, e.g. during or after a contentious debate.

Moreover, structural conditions (e.g. boundary objects vis-à-vis IFPR) were also found to be particularly instrumental in shaping and moderating the joint interrelation processes in project teams. These highlighted roles of boundary objects have implication for the third part of RQ 1, i.e. relating to how IFPR is utilised to align conflicting interests between project partners. IFPR, as a single entity or its constituent boundary objects, is used during negotiations to align conflicting interests by leveraging its visualisation effect for orienting the project partners towards the expected project outcomes. And, provided there are knowledge brokers to translate its inaccessible components to the less knowledgeable project partners, boundary objects tend to function as justification tools to make sense of complex design issues. Consequently, boundary objects and, hence, IFPR are considered essential structural conditions in lessening the negative effect of knowledge asymmetry on joint negotiations. However, as already demonstrated, boundary object tends to exhibit a double-edged nature as it could be a major impedance to interrelation processes if used or abused to enforce actions that are considered burdensome or less satisfactory by project counterparts.

These findings provide support for and shed more light on recent research in industrial marketing regarding how a network-wide consensus is not always feasible, and how boundary objects play a vital role in shaping and rearranging power relations between network partners (Harrison *et al.*, 2018). Extant discussions on the role of boundary object in aligning conflicting interests tend to assume that network could function without a balance of power between the network actors. This is because some "powerful individuals" could utilise

boundary objects as narrative tools to gain control or strengthen their position of influence – and, therefore, shape negotiation processes to suit *I-centric* goals.

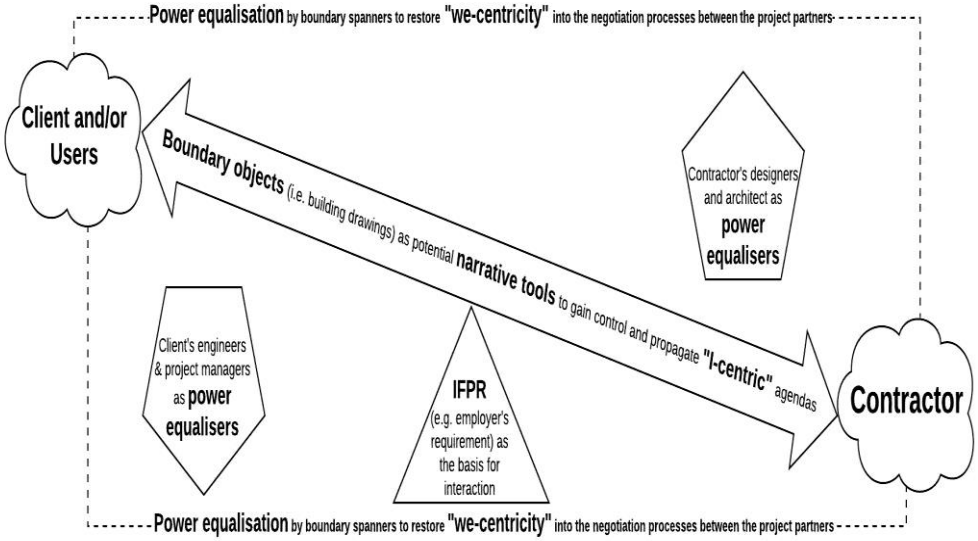


Figure 9. *Aligning conflicting interests in project teams - Towards a refined framework of collective mind*

While not disputing existing assumptions, the current findings (see figure 9 above) also point to the crucial role of boundary spanners as well as the communication pathways between network partners as the two overlooked conditions explaining the *"seesawed"* nature of network interrelation processes. That is, the processes characterised by a constant struggle between network actors to achieve relational balance while using IFPR (boundary objects) as the structural basis for actions and joint decision making. Particularly, the findings reveal the role of boundary spanners (e.g. client-side engineers) who function as "power equalisers" by exposing suspicious agenda from other project actors – thereby, injecting a sense of "power equilibrium" and "we-centricity" into the network interrelation processes. Power equalisation is important to network processes as it increases trust and mutual confidence in the joint decision making between the network actors (Galbraith, 1974). In the absence of such power equalisation, boundary objects may be abused and weaponised by the more knowledgeable experts or powerful individuals to exert "excessive control" over

other network members, and this could trigger resistive agencies. Hence, resulting in unnecessary disruption of network processes.

It is noteworthy to highlight that boundary spanners are most likely able to function as power equalisers if they are emphatic and analytical as opposed to being neutral and yes-man-ly. The ability to be either emphatic and analytical or neutral and yes-man-ly may be traced to the communication pathways in project teams as these define the scope of work of boundary spanners. Arguably, project teams utilising the Intermediary-led communication pathway (figure 7) are more likely to experience power equalisation as this essentially necessitates the boundary spanners to exercise more commitment due to their relatively broader scope of work. Whereas, in the client-led communication pathway (figure 8), the boundary spanners only occupy advisory roles and may, therefore, lack the requisite incentives to expend the resource and knowledge capacities that power equalization demands.

7.4 Compliance with project requirements and industry standards

Compliance is a crucial requirement in any construction projects and may hugely influence interrelation processes between project teams. This could range from the need to comply with site rules or a pre-defined communication protocol. And could advance to the more legal requirements such as contractor's obligation to fulfil client's needs and project objectives, or to produce a building that meets industry regulations and standards. Ensuring compliance with all relevant requirements could be a daunting task, especially because of the asymmetric nature of knowledge between the vast number of people working on a typical construction project. And this is further complicated by the potential presence of conflicting interests across the project sub-teams.

So, how do construction project teams achieve compliance while simultaneously managing all the potential bottlenecks that could complicate or disrupt project implementation processes? This question is approached by focusing on how the two distinct, but interconnected, stages of construction projects are implemented. That is, how the pre-contract stage connects with and influences the process of achieving compliance in the post-contract stage of construction projects.

Besides, some of the earlier discussions regarding shared understanding, coordination of actions, and alignment of interests would be recapped in this chapter, but in the context of compliance. And this is because the need for compliance generally spreads across all the project activities, which makes compliance the subtext of every project negotiation.

Hence, during the pre-contract stage, the client or project beneficiary employs a group of specialists – mainly an architect and, in some cases, some engineers, a cost consultant, and a project manager. One of the key goals of the specialists is to ensure that the client's needs comply with all relevant regulations and standards. Hence, the outcome of the entire process of the pre-contract stage is the development of an employer's requirement (ER). The ER contains all the design specifications and service requirements of the client/users that must be implemented by the main contractor during the post-contract stage. The ER is a comprehensive document which typifies what is theoretically tagged as IFPR in this dissertation, and it is a bundle of different design elements (i.e. boundary objects) such as building plans, office furniture layout, door schedule, lab layout, lighting schedule, floor plans, intent sketches, mechanical and electrical design services.

During contract negotiation, the client and the contractor would reach an agreement on the content of the ER document. Essentially, post-contract, the document becomes an objective reference point or a legal framework upon which mutual expectation of responsibilities and performance is formed between the project parties. The role of the ER is well captured by the testimony of the client, Case A, who reported that (i.e. informant 8 table 3); "*So, as long as we got the employer's requirement right and the contract right, it's their [the contractor's] responsibility. We want to be able to scrutinise the employer's requirement and say, you've built what we've asked for, and we are happy to take it.*"

As indicated in the client's testimony above, which is also observed across the 3 cases, what appeared to be the most salient condition for post-contract compliance is the ability of the client and her team of specialists "to get the ER right". In an ideal world, what this suggests is that all the elements in the ER are

clearly defined and mutually understood by project partners when negotiating contract proposals with the contractors. However, as empirical data indicates, there is almost always some ambiguities in the ER document, and the client's or users' requirements are sometimes not fully known pre-contract. These two factors (i.e. ambiguities and partially known client's requirements) tend to necessitate the establishment of new agreements post-contract, which sometimes create conflicts between the project partners.

For instance, in Case C, some ambiguities in the contractual agreement vis-à-vis ER, as well as miscommunication between project sub-teams, culminated in occasional difficulties in deciding who should be responsible for certain design elements. This is recounted by the contractor's senior quantity surveyor that (i.e. informant 31 table 3); "*In terms of client-contractor conflict, I guess the one going back to the atrium was, obviously the design did change part of the estimated, we believe we've been clear and outlined what the changes were but the client believed they've never been informed. Did we inform them clearly enough, were the drawings clear, did they read the CPs [contract proposals] …? But I guess more instances where we've had conflict was possibly the misunderstanding on ours and the client's side, which I guess, in some part is related to their inexperience*."

Another implication of ambiguities in the ER is that when negotiated post-contract, there is a tendency for exploitative behaviour to manifest between the negotiating parties. Depending on the structural mechanisms operating between the project partners, two potential outcomes could result from the situation. On the one hand, if the process is "contract-driven", the power dynamics could shift in favour of the contractor who could then weaponize or exploit the grey areas in the industry regulations to propagate own agenda. The electrical engineer, Case A, attested to this saying (i.e. informant 5 table 3); "*if you miss something out of it [i.e. the ER] then the contractor feels he's got a free range to put forward whatever they want, and you don't want that. Because they could put forward something that might not necessarily be a good quality design. It would probably be a cheaper design that meets the spec because there's sort of holes in the spec*." On the other hand, if the process is "relationship-driven", regulations would still

play a major role in the negotiation, and the client's original aspiration might still be rejected. However, rather than hiding behind regulations or simply saying "sorry, we can't fulfil your requirements because of certain regulations"; the contractor would tend to offer a much more efficient alternative.

Despite the potentially positive outcome in a relationship-driven negotiation of ambiguities, it is still a reactive approach which relies on the possibility that the contractor would act favourably. A more proactive approach would require the client agent to be emphatic and analytical by addressing ambiguities in the client requirements during the pre-contract stage. A noteworthy example of situations where these agencies (i.e. emphatic and analytical agencies) were activated was observed in Case A. In this particular case, the client agent noted that some of the user's specifications were non-compliant with industry regulations. The lead electrical engineer, Case A, expatiated on the event saying (i.e. informant 7 table 3); "*there's a lighting guide 5 which is for education which is written by CIBSE. … So, for their [the users'] type of spaces five-hundred lux is what that guidance recommends. So, for them to then turn around and go, we need one-thousand lux, that's double what it should be. I appreciate they might need that but what they were trying to say to me is that they need that everywhere. And that's not the case. They need that in specific locations."*

The specification illustrated above generated intense debate between the project sub-teams. However, rather than being weaponized to reject the user's specifications outrightly, the industry regulation was utilised by the electrical engineer to clarify the situation, and an alternative solution was proffered. A key observation {i.e., from observation data} in this specific situation is that, despite not understanding the industry lighting regulation, the users were better able to understand their needs once they became aware of the regulation, which then helped to resolve the tension between them and the design team. In this instance, compliance plays a central role in the establishment of a shared understanding of their joint problem and also in the alignment of conflicting interests between the project sub-teams.

The discussion so far has mainly focused on the pre-contract stage of construction projects and particularly on how the client ensures compliance with

industry regulations by avoiding unnecessary ambiguities in the employer's requirements. The process of correcting ambiguities is facilitated by the emphatic and analytical agencies of the client engineers and agents. What is left to discuss is the contractor's perspective on compliance and ambiguities, and this is important because the issue of compliance in construction projects is never one-sided but requires the project partners to reflect actively on and monitor each other's processes.

For instance, during contract negotiations, the employer's requirements were scrutinized by the potential contractors, and any ambiguities or non-compliant elements were reported as technical queries. Furthermore, changes in the client's situation usually warrant some changes to the initially agreed elements of the ER. And whenever those change requests are submitted by the client post-contract, it is the responsibility of the contractor to ensure that they are in compliant with regulations. For example, regarding a specific client change in Case B, the contractor's electrical engineer explained that (i.e. informant 16 table 3); "*the electrical contractor [client-side] has said that the client wants all the sockets to go 50mil off the floor, but they can't do that because that's against the compliance to the regs, they must be at least 450. Then, we'll go and tell them that and will make sure that don't happen. ...The regulations always take precedent. We will never install anything that didn't meet the wiring regulations because that's obviously not the approved way of installing anything."*

Likewise, the contractor might propose some changes to the initially agreed elements on the ER. For instance, to save costs for the client or to maximise profits for the contractor. Such proposals are vetted by the client agents who also conduct monthly assessments on the contractor's implementation processes to ensure compliance with the ER. Any issues identified during such monthly assessments are negotiated and resolved between the client agent, the contractor, the design team, and the client or users. However, the electrical engineer, Case A, reported an extreme situation which happened in one of his previous projects with the same client but a different contractor. The event relates to the contractor's non-compliance with regulations.

As he reported, attempts were made to resolve the situation by activating all the project-level regulatory mechanisms. But no resolutions were attainable until a decision was imposed on the contractor by an industry-level governing body. According to him (i.e. informant 5 table 3); *previously on [X] building we've had a situation where [the contractor] loaded the incoming cables into the switchboard and it's twisted. All our specs say you should have good workmanship, it should be to a certain standard of installation and we didn't feel that, that was the case. So, we then raised it with the sort of the governing body for electrical engineering called the IEC. Saying, the contractor hadn't installed it properly, it doesn't meet good workmanship, it's poor standard. And I think they did an overall review of that, we sat down with the contractor and [the client] and they agreed in the end for the contractor to change it. They took all the cables, repositioned it, so it's much more safer installation.*"

To reiterate earlier arguments, projects would typically suffer undue delays, and the relationships between the project partners could be significantly affected if the industry-level mechanisms are constantly being activated before a dispute can be resolved. Therefore, contractors in the observed cases emphasized how they intentionally and actively set up measures to avoid the occurrence of any extreme situations of non-compliance. What appeared to be the standard practice across the three cases is the novation of the architect who had developed the compliant ER at the pre-contract stage. However, data suggests that novation would only effectively prevent an extreme situation of non-compliance if every member of a construction project sees themselves as a compliance agent by working collaboratively with the architect. The contractor's steelwork coordinator, Case C, alluded to this saying (i.e. informant 26 table 3); "*generally, it's the Architect's responsibility to build the side of drawings that satisfy the client's requirements, and it's our responsibility to make sure that ours comply with the Architect's. And if ours comply with the Architect's and the Architect's with the client's then that all closes that loop.*"

Moreover, the Case C site project manager also emphasized how external compliance consultants were appointed to provide objective assessments on all the drawings and layouts that were being produced by members of the design

team. As he testified (i.e. informant 28 table 3); "*So, it's appointing all these external consultants, they don't really get involved too much. But they are there, and the drawings have all gone through them. We get then visited twice a month from the building inspector, he comes here and sees what we're doing on site. Takes photos and gives us the report of his findings. ...So, what we are building will always be compliant."*

The appointment of the external consultants is in addition to the internal review processes that are conducted by the design and project management team through a shared electronic system. This "extra step of caution" [i.e. appointing external consultants], as an intentional and proactive managerial practice, confirms scholars' recommendation that "*managers need to be aware that the process of developing inter-cognitive representations does not occur automatically but can, and arguably needs to be guided carefully to develop a shared understanding*" (Mouzas and Henneberg, 2015, p. 65). In the situation of this project, the practice provides "extra confidence" in ensuring that the project teams meet the expectation of the regulatory agencies and the city council that will approve their planning applications. The series of reporting that accompanies the internal and external assessment processes also sends positive signals to the project clients and beneficiaries. For instance, during one of the client progress meetings, the client of the Case C project said satisfactorily; "*I think it's good practice … and it lifts my spirit to see that all these [inspections and reporting] are been done."* {please note that this is a representative quotation from observation data or personal observation note – see appendix for the complete observation note}.

In the ongoing discussions, the issue of compliance has been addressed from the perspective of the actors working on construction projects. The implication of potential changes in the circumstances of the project actors on the assessment of compliance has also been discussed. Besides, the role of regulatory mechanisms such as governing bodies and compliance agencies has also been presented. What appears to be missing in this discussion is the dynamic nature of industry regulations. The fact that industry regulations are dynamic in nature and can potentially change during the implementation of a construction project is a

significant issue. Hence, relating to the issue of industry regulations, two essential points are worthy of elaboration.

Firstly, evidence from the construction industry tends to indicate that construction designs are guided by two different sets of regulations. The first set of regulations are legally binding "approved" documents for which compliance are non-negotiable. Whereas, the second set of regulations – which are commonly called best practices or standards or guidelines – are non-legally binding, and therefore a matter of choice. The implication of this distinction is that project actors can adapt the standards to suit the specific needs of the client or project beneficiaries. However, interestingly, "despite the freedom of choice", the observed project consultants still strongly encourage the clients to comply with the standards. For example, regarding compliance with the non-legally binding standards, the contractor's design consultant [Case C] offered what appeared to be a piece of cautionary advice. According to him (i.e. informant 24 table 3), "*British regs is not so much legally binding document. OK, if you want to deviate from that you could possibly do it. But let's say something happened, somebody got hurt, and you are not compliant with those regulations, you wouldn't stand a chance of explaining why you've deviated from that. Plus, it's good practice too. So, don't go off and do something that's not covered.*" The underlying motivations for such loyalty to best practice at the expense of choice may offer some interesting explanatory insights. E.g. for uncovering the generative mechanisms that tend to influence the establishment and maintenance of heedful interrelations between project actors. More discussion on the generative mechanisms in chapter 9.

Secondly, the employer's requirements are designed at the pre-contract stage (i.e. time t1) in compliance with industry regulations, and activities post-contract (i.e. time t2) are implemented as per the employer's requirement. It follows from this that any changes in regulations at the post-contract stage may significantly alter the predefined employer's requirement and the project activities that resulted from it. Essentially, what this means is that a change in regulations post-contract tends to trigger unexpected negotiations between the project partners (i.e. time t3). One particular example of such an event, which noticeably affected

Case B, is the change in the air handling unit regulation during the post-contract stage of the project. The design would have complied at the time of contract negotiation, but it was overlooked by the contractor that the regulation had been updated or changed. Consequently, the contractor was required to deviate from the terms of the initial contractual agreement to accommodate the change in regulation – and this was not contested by the client. That is, there was a top-down change in the implementation of project activities, whereby, changes in industry regulation led to changes in the employer's requirement (IFPR) and contractual terms. This then resulted in the change of project activities (boundary objects), processes, and eventually led to a refinement of the aspirations (intentions) of the project actors.

To put this in context, the change in regulation led to a series of unplanned activities. For example, the design team had to redesign their drawings to reflect the change. And the contractor had to seek for a manufacturer that can supply the required material for implementing the change. Which then lead to additional spending. In this particular situation, relationship and mutual compromise play a key role in how the project sub-teams responded to the change. For instance, the normative approach for dealing with unexpected changes in regulation is for the contractor to bear the cost associated with the change. But in Case B, the client empathises with the contractor by sharing the additional costs that were incurred as a result of the change. The situation was encapsulated by the testimony of the client's cost-consultant (i.e. informant 21 table 3). As he reported, "…*what the client had actually done is say, actually see what's happened there, and we will contribute towards that and pay fifty percent of the cost of that as a good-will gesture, in a fact. And that shows just the sort of relationship there is, because that won't happen in every project, certainly. And likewise, the contractor has tried to help out the client with issues particularly over site logistics and the likes, which is obviously very important to the client.*"

7.4.1 Summary – How IFPR is utilised by project partners to ensure compliance with industry regulations?

This chapter discusses the issue of compliance from three main perspectives namely, the perspective of the project contractors and their engineers; the

perspective of the project client and their agents; and the perspective of industry regulations and regulatory agencies. The chapter also presents the role of each actor (see figure 10) in ensuring project compliance. The study, therefore, identifies two main findings.

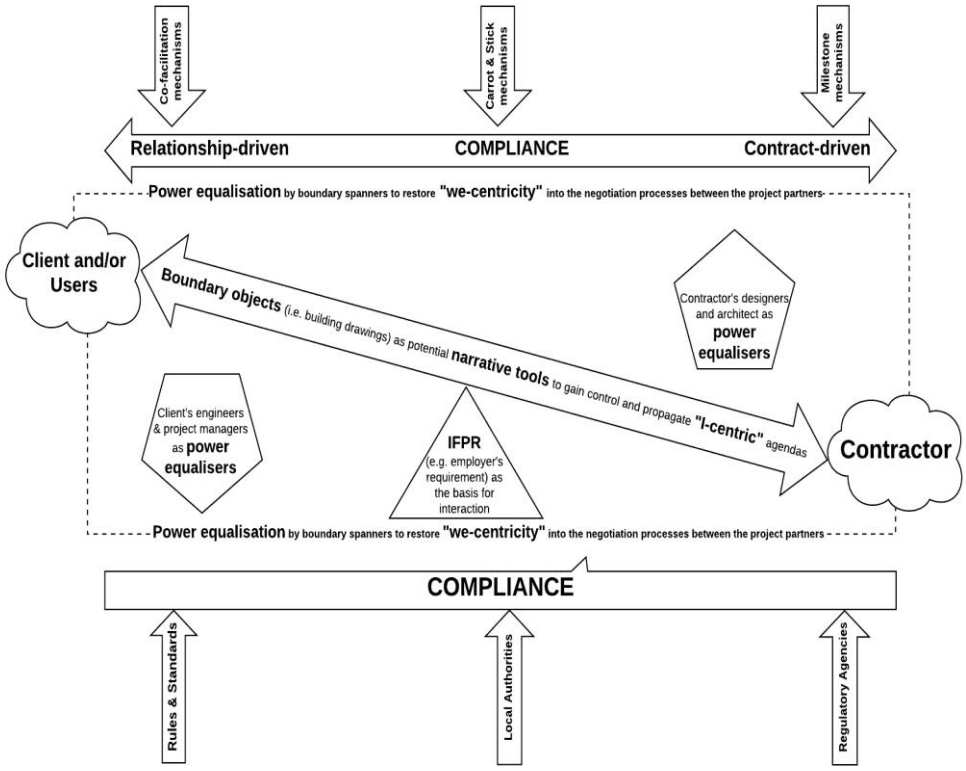


***Figure 10**. Achieving regulatory compliance in project teams - towards a refined framework of collective mind*

The first finding relates to the renewed understanding regarding the role of compliance in the interrelation processes of construction project teams. Whereas, the initial coding and data analysis pointed to compliance as the sixth antecedent causal mechanism – that is, in addition to shared understanding, coordination of actions, contributing, alignment of interests, and representing – explaining the process of establishing heedful interrelations between construction project actors. However, it could also be deduced from the above discussion that compliance can function in tandem with IFPR as an overarching mechanism in teams' processes. Essentially, compliance underlies how IFPR is utilised to establish a shared understanding, alignment of conflicting interests, and coordination of actions between project partners. The discussion, therefore, offers additional explanations to understand and answer

RQ1 – and, therefore, useful for refining the initial framework of the collective mind of network actors.

The second finding shows that changes in project processes are not championed by any particular individual in the project sub-teams but actualised at the team level through joint negotiation of compliance. Ideally, project teams tend to function effectively when every member regards themselves as compliance agents by reflectively monitoring project activities and ensuring that non-compliant actions are modified as per industry regulations. The process of achieving compliance was identified to be either relationship-driven or contract-driven, and either of the two approaches would dictate different project outcomes. As already demonstrated in earlier discussions, a contract-driven process typically leads to unnecessary conflicts and exploitative behaviours, while a relationship-driven process tends to foster shared understanding and interest alignment in project teams. Whether a project team would be relationship-driven or contract-driven is a function of three generative mechanisms, namely, cofacilitation mechanism, carrot and stick mechanisms, and milestone invocation mechanism.

These findings have two notable implications for the theory of change in networks (Fonfara, Ratajczak-Mrozek and Leszczyński, 2018). Firstly, existing understanding tends to categorise network change as either radical or incremental events that are punctuated by periods of stability (Halinen, Salmi and Havila, 1999). However, in the above discussions, network change is observed across the three project teams as a continuous process that is intricately woven into the very existence of the project processes (Brown and Eisenhardt, 1997; Burnes, 2005; Bizzi and Langley, 2012). Secondly, existing studies, particularly those taking a constructionist view, tend to assume that network changes are *only and always* caused by social [human] actors (Halinen, Salmi and Havila, 1999; Harré, 2002).

However, by taking a realist view and, therefore, observing the project teams over a period of 11 months, the efficacy of industry regulations as real and legitimate entity causing social change became evident in this dissertation. Other non-human entities, such as the electronic platforms used for sharing and

assembling boundary objects, also proved to be causally efficacious as they tend to drive noticeable changes in project processes. Moreover, as earlier discussed, industry regulations at time t1 tend to condition project actions at time t2, and when the regulation changes, the affected project actions must be changed accordingly at time t3 to ensure compliance. Thus, the implication of this multidimensional and "continuous view" of network change is that interrelations between project actors could easily become precarious and unstable, which may then make it feasibly impossible to establish predictive knowledge sustainably on joint actions.

Hence, by taking a realist process view in the investigation of change in project teams, the dissertation uncovers three underlying generative mechanisms – namely, milestone invocation mechanism (e.g. drawing a line-in-the-sand to expedite decisions from project counterparts), carrot and stick mechanisms (e.g. cost or penalty avoidance, sanction invocation, reputation and relationship protection), and cofacilitation mechanism (e.g. mutual reminding of overlooked actions and regular audit of actions). These mechanisms enable the project actors to make sense of their joint activities while effectively and proactively managing change in the face of uncertainties. Further elaboration would be provided in chapter 9 regarding the manifestation of these mechanisms in the context of the key project events they generate and the experiences of project actors emanating from those events.

7.5 Summary of chapter

Figure 11 below summarises the entire discussion in chapter 7. The qualitative analysis has attempted to address RQ 1 relating to how IFPR is utilised to establish shared understanding (part 1), alignment of conflicting interests (part 2), and coordination of actions (part 3) between project actors. The discussion uncovers different structural mechanisms that enable project actors to function and those that manifest as liabilities and therefore limiting the effectiveness of their interaction processes. A series of project events were discussed in the context of the conditions as well as the causal agencies bringing those events to bear. Findings from the study were presented and discussed in the context of existing literature to highlight the contributions of the study.

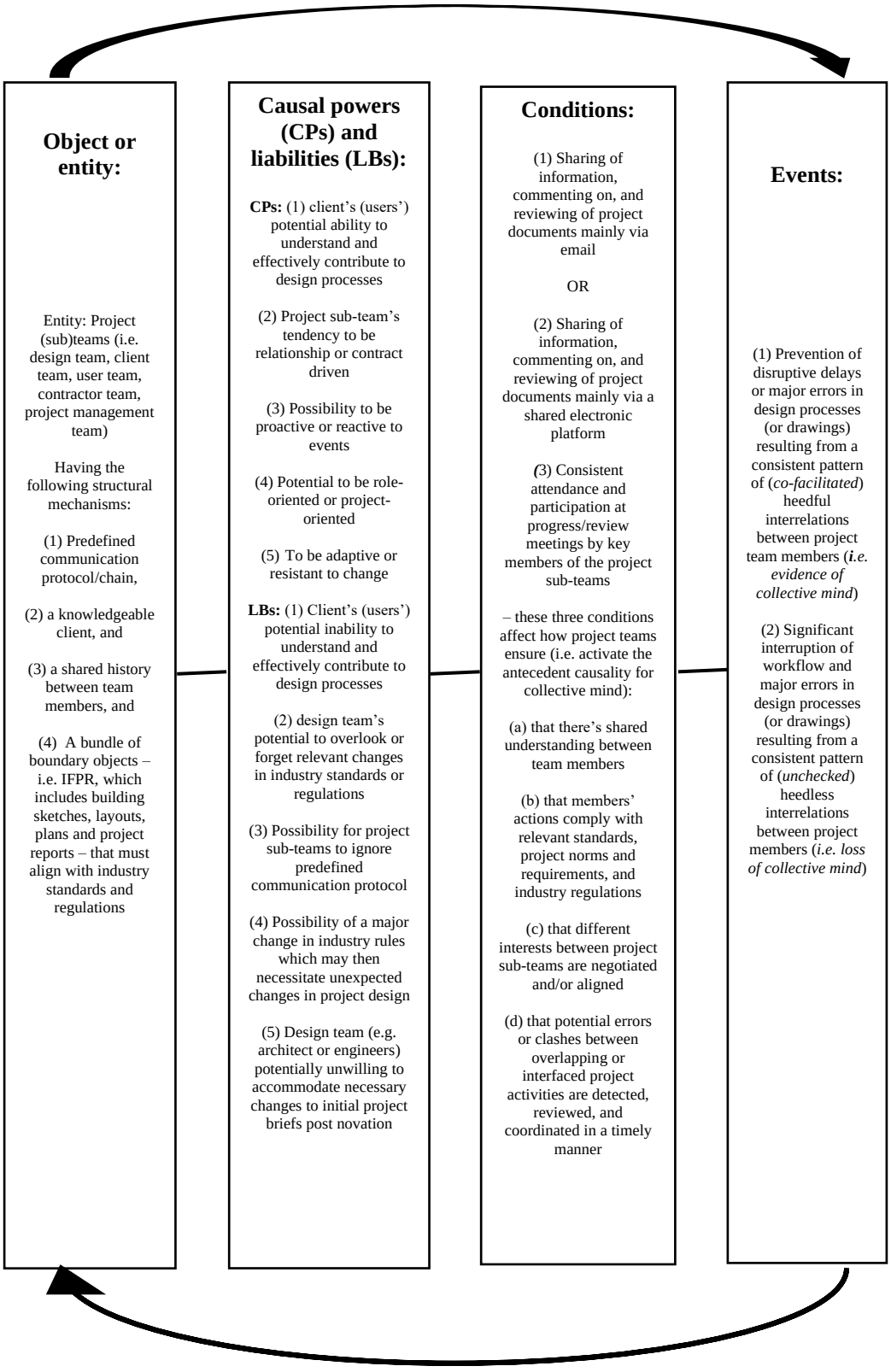


Figure 11. *A summary of the entities, structural mechanisms, conditions, and antecedent causal mechanisms for maintaining collective mind between construction project partners*

Chapter 8 – Results and findings from NCA

This chapter focuses on answering RQ 2 by presenting the findings from the necessary condition analysis. That is, this chapter aims to understand what levels of shared understanding, coordination of actions, compliance, representing, and we-centric contribution are necessary to establish and maintain a collective mind between project partners. As shown in figures 12, 13, 14, 15 & 16, there are empty spaces in the upper left corners of the scatterplots for all the condition variables investigated – which is an indication of the presence of necessary conditions (Dul *et al.*, 2010; Dul, 2016; Van der Valk *et al.*, 2016). As can be noted on each diagram, there are three different types of ceiling lines (i.e. the red, green, and yellow lines). The red line, which represents the CE technique, gives the most accurate result because there are no observed cases (i.e. the blue rings) above it. Hence, CE is used to interpret the results.

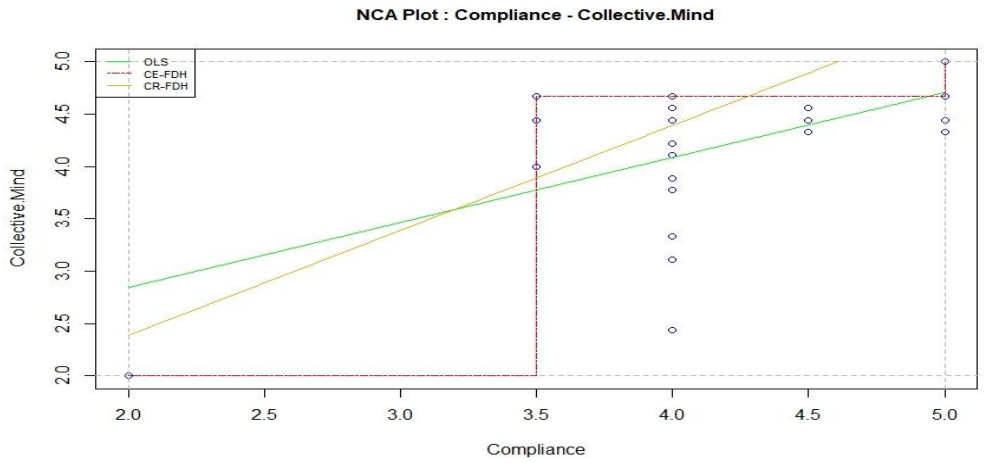


***Figure 12**. NCA – A scatter plot for compliance against collective mind*

Once all conditions were confirmed to be necessary for collective mind, further calculations were conducted with the NCA software, and the results are presented in table 7. For compliance, the size of the areas with observation (i.e. the scope, table 7) is 9.0, and the ceiling zone (i.e. the size of the areas above the ceiling line – CE) is 4.995. Hence, the effect size for compliance against the collective mind of project actors is 0.56 (i.e. ceiling zone (C) divided by scope (S), which is 4.995 divided by 9.0). Based on the dataset used in this study, the

result shows that compliance has a very large effect on collective mind (figure 12).

Table 7. *The results of the necessary condition analysis for all variables (31 observed cases)*

Condition variables	*Ceiling techniques*	*Accuracy (in%)*	*Ceiling zones (C)*	*Scope (S)*	*Effect size (d)*
Compliance	CE	100	4.995	9.0	0.56[a]
	CR	74.2	3.406	9.0	0.38[b]
Coordination	CE	100	1.395	6.0	0.23[c]
	CR	93.5	0.993	6.0	0.17[c]
Representing	CE	100	0.708	4.5	0.16[c]
	CR	87	0.588	4.5	0.13[c]
Shared Understanding	CE	100	0.769	9.99	0.08[d]
	CR	100	0.384	9.99	0.04[d]
We-centric Contribution	CE	100	0.462	5.1	0.09 [d]
	CR	100	0.231	5.1	0.05 [d]

[a] $d \geq 0.5$ interpreted as a ''very large effect.'' in accordance with Dul, (2016)
[b] $0.3 \leq d < 0.5$ interpreted as a ''large effect,'' in accordance with Dul, (2016)
[c] $0.1 \leq d < 0.3$ interpreted as a ''medium effect,'' in accordance with Dul, (2016)
[d] $0 < d < 0.1$ interpreted as a ''small effect,'' in accordance with Dul, (2016)

For coordination (figure 13), the scope is 6.0, and the ceiling zone is 1.395. Hence, the effect size for coordination against collective mind is 0.23 (i.e. 1.395 divided by 6.0). This result shows that coordination has a medium effect on collective mind.

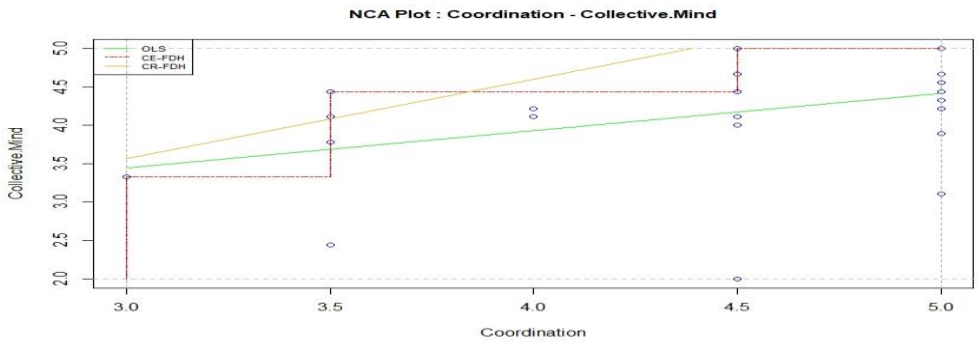


Figure 13. *NCA – A scatter plot for coordination against collective mind*

However, for representing (or representations, figure 14), the scope is 4.5, and the ceiling zone is 0.708. Hence, the effect size for representing against collective mind is 0.16 (i.e. 0.708 divided by 4.5). This result shows that representing has a medium effect on collective mind.

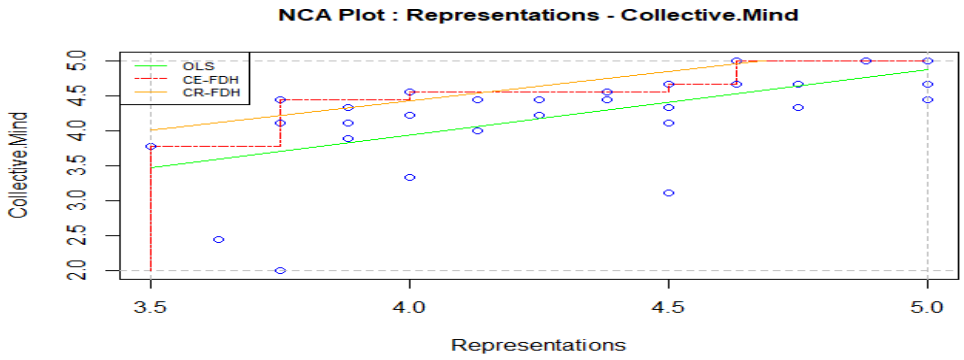


Figure 14. *NCA – A scatter plot for representations against collective mind*

Moreover, for shared understanding (figure 15), the scope is 9.99, and the ceiling zone is 0.769. Hence, the effect size for shared understanding against collective mind is 0.08 (i.e. 0.769 divided by 9.99). This result shows that shared understanding only has a small effect on collective mind.

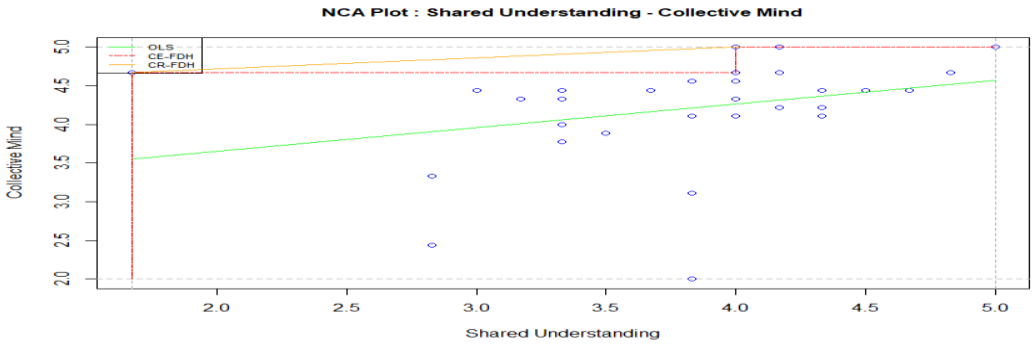


Figure 15*. NCA – A scatter plot for shared understanding against collective mind*

Lastly, for we-centric contribution (or contributions, figure 16), the scope is 5.1, and the ceiling zone is 0.462. Hence, the effect size for we-centric contribution against collective mind is 0.08 (i.e. 0.462 divided by 5.1). This result shows that we-centric contribution only has a small effect on collective mind.

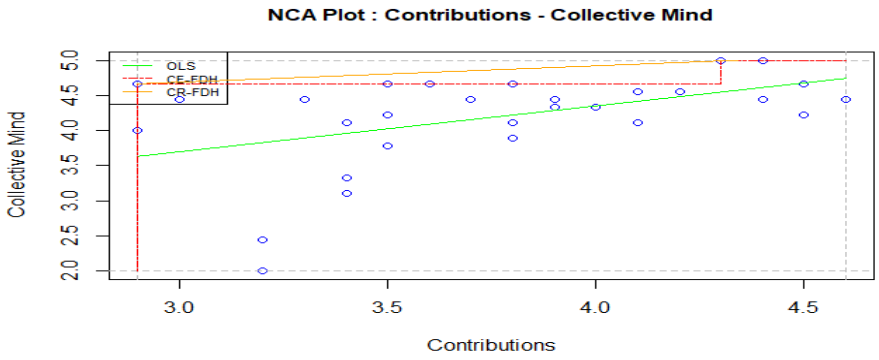


Figure 16. *NCA – A scatter plot for we-centric contribution against collective mind*

In addition to the results presented above, a further analysis was conducted to identify the minimum levels of compliance, coordination, representing, shared understanding, and we-centric contribution that are required to achieve different desired levels of collective mind. The results are presented in table 8.

Table 8. *Bottleneck table for NCA results*

Collective mind	Compliance	Coordination	Representing	Shared Understanding	We-centric Contribution
0	NN	NN	NN	NN	NN
10	50.0	NN	NN	NN	NN
20	50.0	NN	NN	NN	NN
30	50.0	NN	NN	NN	NN
40	50.0	NN	NN	NN	NN
50	50.0	25.0	NN	NN	NN
60	50.0	25.0	16.7	NN	NN
70	50.0	25.0	16.7	NN	NN
80	50.0	25.0	16.7	NN	NN
90	100.0	75.0	75.3	70.0	82.4
100	100.0	75.0	75.3	70.0	82.4

Note: the CE (i.e. ceiling envelopment) ceiling technique was used for the above bottleneck table. By using CE, 100% accuracy level is attained (i.e. no outlier cases above ceiling line is permitted). Please note that the results are in percentages and "NN" means not necessary.

The bold lines (table 8) are used to highlight three levels (i.e. low, medium, and high levels) of a collective mind that are potentially attainable. The values below 50% are considered low level, values between 50% and 70% are considered medium, while a high level of collective mind is above 70%, and up to 100%, which is the highest level attainable (Dul, 2016). A 100% level of collective mind should be an ideal target for organisations where there is zero-tolerance for errors, or where a single error could lead to disastrous effects – such as the case of aircraft careers and flight operators (Weick and Roberts, 1993).

Interestingly, for a low level of collective mind, only compliance is necessary, even for the levels as low as 10%. Counterintuitively, coordination and representations (i.e. representing) only become necessary for a medium level of collective mind, while shared understanding and we-centric contribution are only relevant when a very high level of collective mind is desired. These results have both theoretical and practical implications, as presented in the summary below.

8.1 Summary – Answering RQ2 and synthesising the qualitative and NCA findings

The primary purpose of the NCA analysis has been to answer RQ 2. That is, to identify what levels of the initially six antecedent conditions namely, subordinating, contributing, representing, shared understanding, coordination of actions, and alignment of interests, are necessary to achieve different desired levels of collective mind. However, through iterative processes of going back and forth between qualitative findings and literature review, one of the conditions (i.e. subordinating) was replaced by a new condition (i.e. compliance) that emerged from empirical data. Moreover, when factor analysis and reliability test were conducted, contributing and alignment of interests loaded together to form a single condition, which is now tagged as we-centric contribution. Therefore, the revised framework of collective mind before NCA analysis contains five antecedent conditions – namely, shared understanding, coordination of actions, representing, compliance, and we-centric contribution.

Table 9. *The degree of necessity of the antecedent conditions in relation to collective mind*

Antecedent and outcome conditions	**Levels of the antecedent conditions required for different desired levels of collective mind**			
Collective mind	Low	Medium	High	Very High
Representing	Not required	Low	Low	High
Coordination of actions	Not required	Low	Low	High
Compliance	Medium	Medium	Medium	Very High
Shared Understanding	Not required	Not required	Not required	High
We-centric Contribution	Not required	Not required	Not required	Very high

According to findings from the NCA, all the antecedent conditions have varying effects on collective mind (see table 9 above). To answer RQ2; the results of the necessary condition analysis show that a considerable amount of "shared understanding" is required for a very high level of collective mind, but no shared understanding is required for low and medium or even high levels of collective mind. Similarly, "we-centric contribution" is only relevant in situations where a very high level of collective mind is desired, and we-centric contribution must be at a very high level in such situations. The results also show that both "representing" and "coordination of actions" are not required for a low level of collective mind. Moreover, only low levels of both conditions are required for

medium and high levels of collective mind. High levels of representing and coordination of actions are only required when a very high level of collective mind is desired. However, a medium level of "compliance" is required even for low levels of collective mind. And to achieve a very high level of collective mind, there must be a correspondingly high level of compliance.

These NCA results complement the findings from the qualitative analysis and have potential implications for theory building. The results are particularly useful for resource optimisation between project teams. That is, project teams could more appropriately invest in developing the antecedent conditions depending on their relative relevance in different situations. As a starting point, the previous explanations regarding the establishment of shared understanding in teams could now be revisited and revised. Specifically, rather than sticking to either a client-led communication pathway or intermediary-led communication pathway; project teams could achieve varying degrees of shared understanding at the different stages of construction projects by alternating between both approaches.

For example, during the periods when a very high level of collective mind is desired, or when sophisticated specialist knowledge is required – such as during tender submissions, contract (re)negotiations, and design development – an intermediary-led communication pathway could be adopted to ensure that a high level of shared understanding is achieved. However, for periods involving relatively less knowledge-intensive activities – such as administrative processes like a program (re)scheduling, planning (re)applications and progress reviews – it might be sufficient for the intermediary agents to assume advisory roles through the client-led communication pathway. The client-led communication pathway is deemed appropriate for these highlighted project activities because, at that stage in the construction process, the client is not required to understand the nitty-gritty of the complex engineering elements of the project. Therefore, utilising an intermediary-led communication pathway during such stages could be considered as a disproportionate use of project resources.

Regarding coordination of actions and representing, the NCA findings may also shed light on the findings from the qualitative analysis. Particularly, issues of

coordination failure that manifested as information overload and resistive agencies could now be further explained. As the NCA results indicate, a high level of coordination is not needed unless a very high level of collective mind is desired. Therefore, it is understandably necessary for effective coordination of project activities to utilise a shared electronic platform within a project sub-team (especially within the design team). However, reviewing project drawings across project sub-teams (client inclusive) may not warrant the use of a shared electronic platform. This is, arguably, because such practice would require a sizeable project resource for monitoring, assessing, and globally agreeing on project activities.

The use of a cross-team shared electronic platform for the design development phase is, therefore, considered excessive and *over-coordinating* – which may further explain the tension between the client and the contractor in Case C. Particularly, regarding the frustration between the team members when the contractor's needs and expectations for document reviews through a cross-team shared platform was not embraced by the client. It may also clarify the challenges in Case A regarding the elongation of the design development processes due to the "unusual influence and inputs" of the end-users on design coordination – which then resulted in several design iterations, architectural redesign and, eventually, unwanted delays. Therefore, with these findings, it can be argued that the complexities of cross-team interrelations and the challenges of managing interfaced activities are not only related to the "speed of coordination" (Bigley and Roberts, 2001), or the "efficiency and effectiveness of coordination" (Grandori, 1997; Tsai, 2002) but also influenced by the "quantity or amount of coordination". This indicates that activities and actor's interdependencies towards the attainment and maintenance of a collective mind could also be *over-coordinated* or even *under-coordinated*.

The NCA results for we-centric contribution (i.e. the combination of contributing and alignment of interests) also have interesting theoretical implications, especially when interpreted within the context of the qualitative findings. As presented above, the NCA results indicate that "we-centric contribution" is not necessary for low, medium, and even high levels of a

collective mind. However, qualitative findings tend to suggest that we-centric contribution – *i.e. a mental process and attitudinal disposition which reflects that a network member is consistently and mindfully considering how own actions are affecting the actions of other network actors* – is required in any joint tasks for ensuring a smooth implementation of interfaced activities. Especially, if those joint activities are being carried out simultaneously by distributed network actors who are mostly working alone but, in a sense, constantly working together because of their interdependencies (Bruns, 2013). Arguably, in such situations, "we-centric contribution" is necessary regardless of whether a very high or low level of collective mind is desired.

Hence, one possible explanation for the NCA output is that there may be other mechanisms moderating the effects of we-centric contribution on the collective mind of network actors. For instance, in situations with low or medium levels of collective mind, the effects of we-centric contribution may have been contravened by other conditions such as coordination and compliance. As demonstrated from qualitative findings, project members occasionally exhibit actions that do not align with predefined project objectives. That is, they tend to occasionally engage in "I-centric contribution", which may then trigger a loss of collective mind due to unexpected errors or misalignment of interfaced activities. Qualitative findings indicate that such situations are corrected by the coordinating efforts of the boundary spanners who oversee the interrelation processes between the project teams, and consistently ensure that the different pieces of the design puzzle fit well together. Thus, one benefit of mindful we-centric contribution, even when a low level of collective mind is desired, is that it reduces the amount of explicit coordination required to align interfaced activities. This is because we-centric contribution foster predictive knowledge between project actors and, therefore, enables network teams to tacitly anticipate or coordinate each other's actions without the need for a boundary spanner (Srikanth and Puranam, 2011).

Relating to the alignment of interests (i.e. the second component of we-centric contribution); by exclusively focusing on the NCA results, one might be easily tempted to assume that a network-wide consensus is not necessary when low,

medium, or high levels of collective mind are desired. However, as indicated in the qualitative findings, the challenge for project teams is not whether consensus is necessary for such situations. Because when interests do not align, things generally escalate into unexpected outcomes (e.g., see Seidl and Werle, 2018). Therefore, even when a low level of collective mind is desired, the challenge for project teams lies in the interventionist process of identifying the most appropriate mechanisms for untangling the complexities of any unexpected events for which consensus is practically not achievable. This includes the use of boundary objects, such as industry regulations vis-à-vis compliance, as tiebreakers to manage the relational tensions, process disruptions, and power games that are brought about by interest misalignments. Therefore, despite confirming earlier work that (we-centric) contributing is a necessary condition for achieving a very high level of collective mind (Weick and Roberts, 1993), these NCA results should be interpreted with caution when being transposed to other business contexts.

To reiterate earlier arguments; there may be other mechanisms at work moderating the effects of the observed necessary conditions on the collective mind of network actors. And because the algorithms for NCA are typically designed to consider the effect of each antecedent condition in isolation, it would be impossible for such analysis to capture the combined effects of multiple variables on an outcome. Hence, to fully grasp the effect of the alignment of interests, we-centric contribution, shared understanding, compliance, coordination, and representing on collective mind, other analytical methods (e.g. qualitative comparative analysis - QCA) that are based on additive causality may be required (Harrison and Easton, 1998; Dul, 2016).

However, for the current dissertation, no additional analysis is considered necessary. This is because the focus of the study is not to develop a sufficiency framework, or to determine the possible configurations of antecedent conditions that could sufficiently explain collective mind. Nonetheless, current findings could open up avenues for future studies that are specifically designed for sufficiency configurations.

Chapter 9 – Correcting theory: Revisiting and summarising the causal mechanisms for collective mind

The focus of this chapter is to discuss the changes in the orientation of the doctoral researcher since the beginning of this dissertation, which is done by revisiting and re-evaluating the framework of collective mind through the lens of the research findings. More specifically, this chapter is a form of personal introspection regarding how the researcher's view of social reality has changed through the course of data collection and analysis. In doing so, the study presents a revised framework of collective mind and also provides a further discussion on the generative mechanisms that were uncovered in the dissertation.

9.1 Elaborating and contextualising the generative mechanisms for collective mind

In the following subchapters, this dissertation revisits the qualitative data presented in chapter 7 to elaborate on and further explain the generative mechanisms for developing a collective mind in temporary business networks. Revisiting empirical data after identifying the generative mechanisms causing social events aligns with the critical realist's view of retroduction (e.g., see Bhaskar, 2009). Fundamentally, for critical realists, *"the key point is in going from surface observations (empirical domain) to underlying explanatory structures (the real domain) and back again"* (Mingers, 2000, p. 1262).

9.1.1 Cofacilitation mechanism

The cofacilitation mechanism is experienced as the relational support system that exists informally within and between project sub-teams. That is, cofacilitation mechanism is activated in situations where project members feel they can freely call each other's attention to the "*blind spots*" that could potentially harm the expected outcome of the project. This tends to manifest in the form of friendly phone calls, visiting each other's offices, and even organising social gatherings such as group night outs which happened in Case B. Many project informants alluded to these informal activities as promoting a perception of cordiality, trust, and transparency. As pointed out by an electrical engineer, a socialised team with communicative freedom between project members translates into "*a good kind*

of professional working relationship where we can raise issues or offer solution for things that we feel might not be right."

In the absence of cofacilitation vis-à-vis lack of communicative freedom, heedful interrelation becomes arduous between project sub-teams. One project manager reported that "*if people couldn't feel they can come to other people to get some assistance or work together to achieve the same thing, we probably wouldn't get to the right end. And that's where problems happen because we have different people working in silos and are not really understanding what the other people in the team are doing and are not really working for a common goal, just an individual goal".* Cofacilitation, therefore, triggers a sense of "we are all pushing forward in the same direction, and we are all working together in the best interest of the project" – which then enables teams to proactively identify potential problem areas in the project before such escalate into uncontrollable situations or unwanted outcomes.

As a generative mechanism, cofacilitation tends to result in heedful interrelations between project teams when two conditions are fulfilled. First, cofacilitation results in heedful interrelations if colleagues pay attention to each other by actively considering and acting upon the suggestions of their counterparts. This was explained by an architect that "*you'd hope that we've got to that relationship with the contractor where they respect us, and if we were to point to something out like that, you know, they'd take it on board, and they'll approach the client so that the client is aware of what they want to do. So, the client can make the decision, or they listen to us and stick with the original proposal*". Second, cofacilitation also results in heedful interrelations if it is based on balanced reciprocity or perception of mutualism between the project partners. Otherwise, it could trigger a perception of "babysitting". In which case, the party who perceives themselves as doing all the "heavy lifting" might resort to a "withdrawal" or even more formalised approach – e.g. triggering the milestone or carrot & stick mechanisms to steer their counterparts in the expected direction.

In such situations (i.e. from observation data), the language of interaction – e.g. during (sub)team meetings – suddenly changes. For instance, in a cofacilitation

process where team members have a sense of balanced reciprocity, resource utilisation is optimal. And during team meetings, team members use statements like, how do we get around this, or what can we do to resolve this and move on, which is usually done through advice-giving or suggestion-analysis in a brainstorming session. Such statements could then change to a "we-them" language game where people start using statements like; do you really need my help with that, or we can only shout at him so much (i.e. withdrawal, which manifests as unwillingness to share opinion). Members could also use statements like, it is not our risk, it is their risk. That is, rather than engaging in cofacilitation, members start to be self-focused. And rather than jointly solving any anticipated problems, project teams would resort to finger-pointing to fish out the team members to be responsible for eventual penalties or costs.

What all these do is underutilizing the resources within the team, and potentially slowing down workflow which tends to exacerbate the situation. For example, drawings and building layouts might contain wrong calculations or might be missing required dimensions when people are suddenly under pressure to produce results. Moreover, when available resources are not properly utilized – e.g. when there is a perceived lack of collective support or when people are not transparent about their role related challenges – people tend to play catch-up to recover lost time, which then breaks down the pre-defined feedback system or communication chains. This is well captured in a design manager's testimony that "*We have had some issues with the glazing contractor producing information on time. But what that has created is, he's done his drawings, but they've not been signed off by our architect. But then we've had to send it through RDD for the client's comments. And there's a potential that the client could comment on those drawings, but he's already started on site because he hasn't allowed for that window, a window of time to have the client's comments come back before he commences on site.*"

9.1.2 Milestone mechanism

The milestone mechanism relates to how the key stages in the construction process – e.g. planning application, tender submission, and quarterly stakeholder reviews – function as "real" structural elements for steering and motivating

actions. One key issue that this seems to regulate is the different perception of time between the project sub-teams. On the side of the end-users, one problem is *indecision*. The indecision is, however, unintentional. It is only a consequence of their long process of deliberation and double-checking with their colleagues in "the hope of making sure they get things right". The downside of this is that it slows down the design process for the design team who, on the one hand, must produce designs that satisfy the specific users' needs. And, on the other hand, needs to simultaneously produce a convincing progress report for the other project stakeholders. For instance, to (1) secure budget approval, and (2) secure the required permission for progressing to the next stages of the project.

Therefore, while the end-users think they have all the time in the world to produce "accurate specifications and requirement" – and hence, appear to be micro-focused on their own specific needs – the design team and, interestingly, client team, are more concerned with the macro challenges of the project. That is, the macro challenges concerning not only the specific requirements of a particular laboratory or workshop but other aspects of the project that are either directly or indirectly affected by the end-users (*in)*decision. Hence, by regularly activating the milestone mechanisms, e.g. during the bi-monthly meetings, the design teams were gradually creating a converged perception of time across the project sub-teams. They were then able to obtain the desired decisions from the user team. As implied by a project manager, if the milestone mechanisms are not activated, "…*it goes on forever. They [end-users] are not committed to something, but you as a design team need a certain decision, you need to force them, you need to make a decision now, if you can't make it, either we need to work on an assumption or you are risking to delay the project.*"

9.1.3 Carrot and stick mechanisms

The carrot and stick mechanisms are experienced as the most formalised of the three mechanisms and may not be activated throughout a construction process. For example, the carrot and stick mechanisms may not be activated on projects where the first two mechanisms generate desired results. For instance, when mindful dispositions and mutual considerations are consistently exhibited within and between the project sub-teams.

The *carrot* relates to how the perception of benefits (either individual or team focused) drives actions. However, the *stick* is the opposite, and it is the personal disposition to avoid sanction or systemic enforcement of sanction to stimulate the desired behaviour. The effects of carrot and stick mechanisms manifest in sub-teams' interactions in many ways. In the observed cases, *relationship* and *reputation protection* seemed to be the two anticipated benefits which operate simultaneously with *cost-avoidance* and *sanction processes* in shaping how actions are interrelated between the project sub-teams. For example, it is not uncommon for a contractor to motivate the project team to implement design activities according to best practice or industry standards. However, rather than using the (contract-driven) language of compliance, the language is primarily about potential benefits (i.e. relationship-driven) that could be derived from the joint decision. E.g. to get good ratings from regulatory authorities, or as a form of insurance to instil confidence in the client, and to show that they are getting the best service or value for their money. (please note that these are findings from the observation data)

Interestingly, even when driven by self-interest – such as reputation protection – an expected benefit tends to foster and drive collective project goals. And may, therefore, have the power to enhance heedful interrelations between the project sub-teams, especially at the camps of the design and contractor sub-teams. A case in point is the testimony of an Architect who claimed that *"…for us the difficulty is that we have a number of stakeholders; we have the original client, we have the contractor, but we also have the local authority, and the wider stakeholders, that we have committed to deliver them a certain building [i.e. we have a reputation to protect]. So, if there's a decision that we think is going to be to the detriment of the building, we have a duty of care to say, I don't think this is the right thing."*

The cost-avoidance mechanism also functions similarly to reputation protection or relationship protection mechanisms. And rather than being a control mechanism, evidence from the observed cases suggest that this is primarily based on the intrinsic motivation of each project member. The effect of cost-avoidance mechanisms was captured in the flow of communication and

interaction between the project sub-teams. For example, in an intermediary-led communication pathway, the actions of the architect and engineers are expected to go through the project manager before getting to the client and then to the end-users. Likewise, instructions from the end-users are expected to go through user's lead, client, and project manager before reaching the engineers or the architect.

Despite potentially having a shared history and, hence, a good relationship with the end-users, design team members generally stick to the communication pathways. The main reasons for such actions are to maintain the integrity of their contractual links [i.e. people generally talk to who pays their bills] and to prevent avoidable losses or costs. A mechanical engineer [contractor side] explained that *"...But don't get me wrong, we do interact, we do talk, and discuss things with them [i.e. client & end-users] but, ultimately, they can't instruct me verbally to do something, they got to go through the main contractor. Then, he will then, in turn, pass it on to myself. Because we are not covered, if we do something that's instructed by the [client & end-users] and nobody else is aware of it then we could struggle to recoup any costs because we have not followed the chain [of communication]."*

It is vital to emphasize that, despite activating all the highlighted mechanisms, things could still go wrong as a result of the endless possibility of reasons. And in such situations, which is potentially after all the dialogue-based mechanisms (i.e. cofacilitation and milestone mechanisms) fail to generate desired actions, a control mechanism [i.e. sanction invocation] may then be triggered to restore order across the project sub-teams.

Across all the three project sub-teams, only one instance of sanction invocation was observed. And this was justified by a project manager in Case C saying, *"Really, steel frame is one where, in term of the program, the time planned, they massively overrun. ... you've given them every opportunity to try and come to the table with some ideas how they can mitigate against their delay. If they can't, then we have to get a little bit more contractual by sending them a letter saying we believe you are going to overrun by this, whatever it might be, here is a notice of a non-completion by a certain date, or whatever it is. That then spurs them into thinking this is serious."*

However, even in such extreme situations, relationship protection may still contravene the need to invoke sanction – especially, if the faulted sub-team member was the client. This was emphasized by the contractor-side quantity surveyor of Case B that; *"Yes, we've not had to drag the contract out. And to be honest, with the client of this sort of nature you will obviously try not to because they do give us a lot of work and the last thing you want to do is to get into contractual arguments."* Therefore, in such extreme situations, the ability to reach a mutual compromise might be the deciding factor for success or failure of the project team, or what drives project outcomes.

9.1.4 Summary – Linking the real, actual, and empirical domains of reality

The table 10 below is a summary of how some of the events experienced by the project teams were linked to the identified generative mechanisms causing the events to happen the way they do. The table will hopefully provide more clarity and further contextualise the above explanations regarding the three generative mechanisms. For the sake of clarity, the carrot and stick mechanisms were presented in the table as cost-penalty avoidance, relationship or reputation protection, and sanction invocation.

Table 10. *Domain of the real, actual, and empirical – evidence from data relating to the causal explanations for collective mind within business networks*

Generative Mechanism (i.e. domain of the "real")	**Structural mechanisms or events** (i.e. domain of the "actual")	**Experiences of project teams** (i.e. domain of the "empirical")
Cofacilitation	The architect struggles with conflicting loyalties as he tries to align his interest, with the client's and contractor's interests.	*"But there were certain aspects that they probably don't appreciate fully what's in the contract. So, they still design as in the initial client requirement intention regardless of what we've said we were going to build. So, we need to, obviously we have a check-in role before it gets approved, but we've had to remind the architect that they haven't designed it as it should have been"* (Informant 31)
	Cross-coordination between project sub-teams to avoid delays	*"if it was on a program that said [the client-side project manager] needs to do something on a certain day, and it's a massive long program, it might not be in the forefront of your mind, but if it's important to [the contractor-side QS], that, that was done on that day, he'll pick up the phone, pre-warn that I'm going to need some actions out of you tomorrow, that's why I push, no worries, everyone is aware."* (Informant 17)
		"you can't just let one guy design steel frame and accept that it's right. You know,

	Cross-coordination between project sub-teams to avoid process errors	*there must be checks on his calculations to make sure you're not making mistakes on something and everything comes down."* (Informant 22)
Milestone invocation	Cross-coordination between project sub-teams to avoid delays	*"you've got a program in the background, the program outline for example, when you need to have the final decision in place, when the design needs to be frozen, because then it triggers the tender and everything. And the closer you get to that date the stronger you need to be and tell them [the users] now that's your final date to make your final demand or final decision. Because if you don't do it, it goes on forever. They are not committed to something but you as a design team need a certain decision you need to force them, you need to make a decision now, if you can't make it, either we need to work on an assumption or you are risking to delay the project."*(Informant 1)
	Cross-coordination between project sub-teams as a control mechanism and a reaction to indecision of some project counterpart.	*"At some point early next year we have to draw a line in the sand for the changes"* (Contract Manager, Case B, from observation note, see appendix E).
		"Then there's a line in the sand at each RIBA stage where we then cost the scheme. And at that point we need all the information on day one, to be able to have two full weeks for measuring the quotations et cetera. ...that's key for us as a part of the communication that we need to see what has changed. Otherwise, we can't manage the cost." (Informant 3)
Cost-penalty avoidance (i.e. a stick mechanism)	Alerting project counterparts of the need to comply with project requirements	*"...I will flag it to the contractor and say, you know, we've deviated here from the original concept design, this isn't what the client wants, they wouldn't like that. And I will flag it directly to the contractor, I couldn't flag that to the client because that would, I'd be in bridge of contract then because, as I said, we are contracted with the main contractor, they are our client for this stage"* (Informant 12)
	Strictly following and complying with the pre-define communication protocol	*"But don't get me wrong, we do interact, we do talk, and discuss things with them [client & end-users] but ultimately, they can't instruct me verbally to do something, they got to go through the main contractor. Then he will then in turn pass it on to myself. Because we are not covered, if we do something that's instructed by the [client & end-users] and nobody else is aware of it then we could struggle to recoup any costs because we have not followed the chain [of communication]."* (Informant 10)
	Process disruption due to a lack of trust, shared understanding and transparency between the client project manager and the contractor's team.	*"And if you try to put a contractor in a difficult position he will fight back. And, what goes around comes around. You know, it might be earlier on in the project, contractor might have a problem, and the client might be, oh no it's your problem, you solve it. And be quite arduous on the contractor. But then later on in the project, the table probably would be turned, they*

		normally are, and they'll end up paying the price." (Informant 20)
Sanction invocation (i.e. a stick mechanism)	Cross-coordination between project sub-teams as a control mechanism and a reaction to non-compliant with predefined plans	*"Really, steel frame is one where in term of the program, the time planned, they massively overrun. … you've given them every opportunity to try and come to the table with some ideas how they can mitigate against their delay. If they can't then we have to get a little bit more contractual by sending them a letter saying we believe you are going to overrun by this, whatever it might be, here is a notice of a non-completion by certain date, or whatever it is. That then spurs them into thinking this is serious" (*Informant 22)
Reputation or relationship protection (i.e. a carrot mechanism)	Mutual compromise, mutual respect, and unwavering commitment to client's satisfaction.	*"Yes, we've not had to drag the contract out. And to be honest, with the client of this sort of nature you will obviously try not to because they do give us a lot of work and the last thing you want to do is to get into contractual arguments."* (Informant 19)
	Alerting project counterparts of the need to comply with project requirements	*"…for us the difficulty is that we have a number of stakeholders; we have the original client, we have the contractor, but we also have the local authority, and the wider stakeholders, that we have committed to deliver them a certain building. So, if there's a decision that we think is going to be to the detriment of the building, we have a duty of care to say, I don't think this is the right thing."* (Informant 23)
	Addressing cross-team disagreement and non-compliance with the pre-defined communication protocol	*"And that route there [i.e. direct communication between design team and users] is dangerous from a project perspective. Because, these guys [users] want everything, these guys want 20 sockets on a desk. So, it's very easy for these guys to say, well, they want 20 sockets on a desk, so, they'll [M&E] draw 20 sockets on that desk. This group [the client] might say, you only need 5. Then these guys [M&E] are going to then redraw it all. And then that relationship there [between M&E and user] then starts to get a bit strained, because they say they want 20 sockets and now you want to give me 5."* (Informant 2)
	Strictly following and complying with industry regulations, and outrightly rejecting non-compliance design requests.	*"We get audited by the NIC and the ECA who are the electrical associations. To be given that accreditation, they will come out to site and review jobs on site, review our processes in the office to make sure we are NIC, ECA approved. Because that looks good for the company if you are approved by those companies. So, if we didn't work to those wiring regs, you then lose your accreditation which is obviously not good."* (Informant 16)

9.2 Revisiting initial framework for collective mind

At the start of this study, an extensive review of coordination, knowledge sharing, and structuration literature culminated in the development of an elegant but simplified theoretical framework of collective mind (i.e. figure 2). The central thesis of the framework was based on the assumption that the process of sustaining a collective mind in temporary business networks was held together by two polarised mechanisms – namely, We-centric, and I-centric attitudinal dispositions. Intervening between the two mechanisms is IFPR; which is a structural template for defining expected behaviour, establishing shared understanding, and aligning conflicting interests between project team members. Therefore, IFPR functions as a coordination mechanism for assessing and adjudicating actions that deviate from pre-planned programs. Resulting from the framework are three key assumptions which guided the early stage of data collection.

Assumption one: due to relationship development between the team members, it was expected that *we-centricity* would tend to promote and sustain collective mind when individual project member acts as a team representative by prioritising project goals over personal gains – which will then facilitate the establishment of predictive knowledge and, hence, coordination effectiveness between the team members.

Assumption two: it was expected that individual project member might exploit the relationship that has been built with other team members to exhibit *I-centric* tendencies or opportunistic behaviour. Opportunistic behaviour or I-centric disposition is regarded as being mindful of individual interests and goals at the expense of collective objectives. Which essentially implies that individual with I-centric dispositions is mindless of and inattentive to the team's collective goals. Therefore, opportunistic behaviour was expected to eventually lead to a loss of collective mind as individual goals override collective objectives, and coordination becomes practically impossible to sustain.

Assumption three: project team members were expected to utilise the content of the *IFPR* when confronting any team members that are suspected of I-centric dispositions. Hence, the *confrontation* was expected to be utilised as a feedback

loop and a coordination mechanism for restoring the team's collective mind. As a feedback loop, the confrontation was regarded as a medium for cross-team learning. Moreover, through joint deliberation by team members, an action that was initially considered I-centric could be re-evaluated as we-centric. For instance, if it was jointly realised that the confronted team member has acted with a future-directed intention which may provide benefits that outweigh the pre-planned actions or acceptable rules of engagement.

9.2.1 A journey of self-introspection: What has changed?

Looking back, now that data has been analysed, and findings presented, the theoretical framework of collective mind appeared to be more *human-centric* than initially thought. For instance, despite acknowledging the role of IFPR as an objectified system that shapes the establishment of shared understanding and alignment of interests in a business network, it was assumed at the early stage of the study that the main driver of interrelation processes are the project actors. That is, the focus then was mainly on the human's role in reproducing social structure by *contextualising and adapting industry regulations* to project needs. E.g., through inter-subjective interrelations and confrontation between project members. In a way, causal autonomy was implicitly granted only to humans in the earlier version of the framework of collective mind.

However, having conducted a deep search into different methodological approaches and identifying critical realism as the most logical philosophical position for the study, and then re-reviewing the literature through the lens of critical realism, the researcher's orientation seemed to have shifted. It became clear later in the study that the research goal should not be limited to identifying patterns and processes in business networks. And in the spirit of critical realism, the research goals have gradually shifted to uncovering the structure behind network processes. E.g., rather than limiting the analysis to specific confrontation episodes between project actors, the research focus has shifted to the *relational structures* and *communication pathways* enabling or constraining the observed pattern of interactions (see figure 7). Moreover, after reflecting on critical realists' methodological approaches, it became clear that a proper investigation of collective mind would require uncovering the antecedent causal

mechanisms behind the pattern of heedful interrelations that Weick and Roberts (1993) postulated. For critical realists, necessity can be equated with causality (Sayer, 1992; Easton, 2002; Mingers and Standing, 2017). Hence, the identification of the antecedent necessary conditions for collective mind increases the robustness of the research analysis.

By focusing on the *realness* of social structure as stipulated by critical realism, the flipside of the coin for network processes was uncovered and became more prominent during data collection and analysis. This has enabled the study to move beyond the *human-centric* domain of research knowledge (Sayer, 1992; Mingers and Standing, 2017).

Therefore, the most noticeable change in the study – and the doctoral researcher's view of social reality – has been that *the role of rules was underplayed in the theoretical framework* as something that can always be adapted, provided there are justifiable reasons to do so. However, it was realised during data collection that industry regulations tend to condition project processes considerably, so much that project teams always use the phrase "it is what it is" when referring to industry regulations. Which then became the "ah-ah!" moment for the researcher to further question the validity or completeness of the human-centric causal autonomy advocated by the human exemptionalist view of the world (Murdoch, 2001; Harré, 2002). Besides, what the data shows is that even when there is freedom for adaptation, social actors are still cautious in their willingness to adapt their industry regulations. And the need to constantly abide by and comply with industry regulations tends to trigger mindful consideration of project implementation processes – which then leads to a sustained pattern of heedful interrelations between the project actors.

In line with the critical realist's view, this study applied a longitudinal approach to data collection, which then enabled the researcher to capture temporality in the project processes. In particular, two main milestones of construction processes were observed – namely, pre-contract and post-contract stages. Among other things, the longitudinal process enabled the researcher to uncover two different sets of causalities. (1) The dynamic nature of industry regulations which then causally affect the project implementation activities. (2) The

relationship development and shared history between project sub-teams which shape interrelations over time. These two causalities could be demonstrated with a particular incident in Case B.

That is, at the pre-contract stage, the client requirements were designed in compliance with the version of the industry regulations at that point in time (*i.e. time t1*). And when the contractor took over at the post-contract stage, project implementation processes were carried out as per the client requirements (*i.e. time t2*). However, at a later stage in the process, there was a change in one of the industry regulations which then required the contractor to revise all their previously implemented activities to remain compliant with the updated regulation (*i.e. time t3*). This led to additional costs on the project which [*normatively*] should be the contractor's liability. This example demonstrates the causal efficacy of industry regulations over the activity of project teams.

The client's reaction to the contractor's situation exemplifies agentic causality. As a piece of background knowledge, the Case B client is very knowledgeable and has had numerous projects with the same contractor in the past. And regarding the event presented above, the contractor made a judgemental mistake by not identifying the changes in the industry regulations much earlier in the design process. An important attribute captured from the event was that *the client was more forgiving than expected*. Despite identifying the contractor's errors of overlooking the changes in industry regulations, the client supported the contractor by paying a portion of the additional costs. A close observation of the contractor-client relationship revealed that the client's behaviour was driven by the contractor's past generosities. Hence, the client's reaction was based on a sense of moral obligation to maintain what has now become a *gentleman's agreement* with the contractor. That is, both parties have developed a principle of reciprocity or what could be regarded as *"you scratch my back and I'll scratch yours"*.

These two specific sets of causal explanations correspond with the transformation model of social activity (TMSA) (Bhaskar, 1989) and the realists' view of analytical dualism (Archer, 1996). More generally, by using the realist' methodology of retroduction (Bhaskar, 2009; Mingers and Standing,

2017), influential events that were jointly experienced by project teams were traced back to the mechanisms generating those events (table 9). In the spirit of critical realism, events have been viewed in the current study as social occurrences or activities that were jointly experienced by the team members. This view is reflected in the three generative mechanisms uncovered in the study – namely, cofacilitation mechanism, carrot and stick mechanisms, and milestone mechanism.

The logic followed for identifying the generative mechanisms is as follows. (1) Through temporal bracketing methodology, events – *e.g. disruption, process errors, delays, and noticeable disagreements between project team members* – that were jointly experienced at different project stages were documented. (2) During the face-to-face interviews, project team members were asked to rationalise the events by explaining the reasons for the joint decisions made by the team. (3) The justifications provided by the project team members were analysed *[using NVivo12]* and structured through the lens of the observation notes and the theoretical framework. This is to identify the most probable antecedent causal mechanism enabling the observed events. (4) NCA was conducted to improve confidence in the identified causal mechanisms. (5) By iteratively reflecting upon the reviewed literature, as well as qualitative findings and the outputs of the NCA analysis; the mechanisms that generated the observed processes were abstracted from the research results.

9.2.2 Summary of changes to the framework of collective mind

By integrating findings from the qualitative and NCA analysis, this dissertation makes four crucial modifications to the theoretical framework of collective mind in temporary business networks. The first modification to the initial framework (i.e. figure 2) is the removal of the Time 1, Time 2, and Time 3, which is necessary because the time stages tend to suggest that the activation of the antecedent conditions of collective mind for making sense of emerging events is sequential. However, as this dissertation already demonstrates, change management is continuous and iterative in project implementation because events happen simultaneously, which means the network actors negotiate for and activate the necessary conditions in the flow of time, rather than in phases (or

stages). This renewed understanding and representation of time as "flowing" corresponds with the assumptions in the interorganizational sensemaking literature, which suggest that a view of time as something that happens in phases or stages does not align with the process-oriented ontology that characterises sensemaking activities in network interactions (Medlin and Törnroos, 2014). It, therefore, becomes redundant to indicate any specific time stages on the revised framework of collective mind (i.e. figure 17).

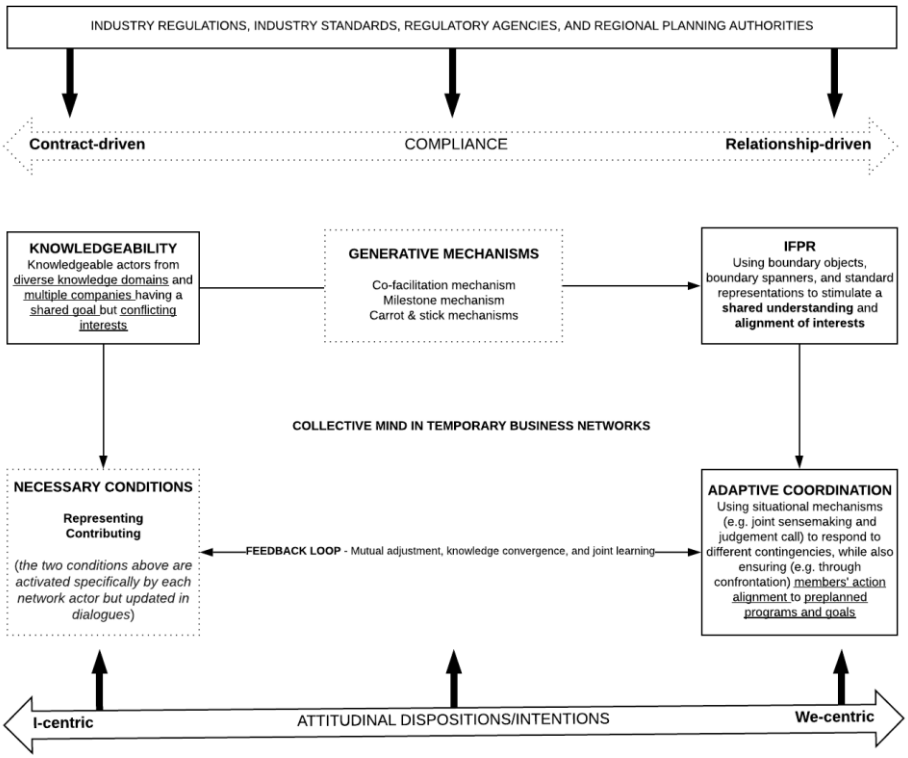


Figure 17. *The revised framework of collective mind in temporary business networks*

The second modification is the introduction of the necessary conditions into the revised framework (see figure 17). The initial framework of collective mind suggests that network actors engage in adaptive coordination activities to respond to contingencies while utilising any new knowledge or learning experience from the coordination practices (e.g. confrontation) to update their knowledgeability. However, findings from the NCA enable this dissertation to review and update the assumption. Particularly, the NCA results draw attention to the possibility that the overall knowledgeability is not necessarily what the network actors are updating, but their specific "*contributing"* and

"*representing"* activities to the shared goal of the ongoing project. Hence, the role of knowledgeability vis-à-vis professional knowledge is to function as a benchmark for negotiating with and persuading their colleagues as well as defending their actions when confronted by other network actors.

The third modification is the introduction of the generative mechanisms from the qualitative findings into the revised framework. The mechanisms are positioned between knowledgeability and IFPR (figure 17) to demonstrate that the creation and collection of the different boundary objects (i.e. the components of IFPR) are not only guided by the professional backgrounds of the network actors but also the generative mechanisms that are activated when they jointly deliberate on how to synergize their potentially conflicting views and understanding of the project. As presented in earlier discussions, the outcome of joint deliberation and sensemaking between the project partners depends on which generative mechanisms are activated when creating the IFPR.

Lastly, compliance has also been added from the qualitative findings into the revised framework to highlight its distinct role as a structural and linguistic resource used by project actors to embed and inject the industry regulations into the ongoing conversations and sensemaking of their shared tasks. Particularly, compliance functions as a vital linguistic resource used by project partners to activate either a relationship orientation or a contractual orientation when assembling the different components of the IFPR. Moreover, due to its prominent role in the creation of IFPR, one could regard compliance as a medium for activating the performative role of industry regulations during joint sensemaking between network actors. In other words, *industry regulations speak through the language of compliance* and manifest materially or symbolically within the content of the IFPR.

Moreover, as demonstrated in earlier discussions, industry regulations are dynamic, and any changes in regulations tend to necessitate a modification of the IFPR. Therefore, one can regard IFPR as a structural mechanism which functions as a provisional or tentative future making artefact by enabling and facilitating the collective imagination as well as sensemaking of network actors towards their shared goals that are wrapped in unstable realities. Consequently,

when they encounter an unexpected event, *IFPR is typically a "go-to" sensemaking resource* through which network actors trace their steps back into their shared – but newly created – history to understand what has been happening between them. In a nutshell, network actors rely on the IFPR for going back in time to make more sense of the presence and, therefore, correcting or modifying their imagined future, intelligently.

Considering the above changes and updates, the doctoral researcher can confidently argue that the new findings and results from this study have embellished the theoretical framework of collective mind (figure 17). However, despite the highlighted updates, the researcher does not claim or pretend that this is the actual or only representation of reality. It is believed that the research outcome is driven by the specific literature that underpinned this study and, more importantly, the events that occur and the mechanisms that were (de)activated during the time of the data collection and analysis. Hence, by using the revised framework as a starting point, future work is encouraged to search for new and interesting aspects of social reality that can improve the understanding of collective mind beyond what this dissertation proposes.

In summary, an attempt has been made in this chapter to revisit and revise the theoretical framework of collective mind. The preceding subchapters also contain a reflection on how critical realism has influenced the doctoral researcher's journey. Moreover, the previous subchapters also demonstrate the effects of the three generative mechanisms on joint project activities and processes. Therefore, the conclusions of the study, as well as managerial and theoretical implications, will be discussed in the next chapter. The study ends with some recommendations for further research.

10 Discussions and contributions

This doctoral dissertation investigated the process of forming a collective mind in temporary business networks by drawing robust empirical evidence from the interrelation processes between construction professionals. The sole purpose of the study has been to contribute to the conversation regarding how network actors develop collective cognition and shared understanding to facilitate the implementation of their shared objectives (Weick and Roberts, 1993; Mattsson, Corsaro and Ramos, 2015). Network actors typically have different understanding and somewhat conflicting interests about their shared tasks, which then creates coordination challenges and knowledge boundaries that complicate joint decision making.

Based on current knowledge in industrial marketing literature, the effectiveness of joint decision, as well as the maintenance of collective mind, requires the use of (inter)organisation artefacts and (cross)boundary objects to synthesize the different cognitive views of network actors (Carlile, 2002, 2004; Araujo and Kjellberg, 2015; Mouzas and Henneberg, 2015). Moreover, findings from the construction industry indicate that social tension between network actors is more pronounced, and tends to create more boundary problems, when different boundary objects are assembled. Hence, rather than focusing on the effect of each isolated boundary object, the research effort in this dissertation has been to understand how a portfolio or a collection of boundary objects shapes and conditions joint decision making between network partners. To this end, the concept of IFPR has been introduced in the dissertation to shed more light on the discussion regarding the role of boundary objects in network processes – particularly, in establishing shared understanding, coordinating inter-actions, and converging (or aligning) conflicting views between network actors.

In the construction industry, an example of IFPR is the employer's requirement, which is a portfolio of different project drawings (boundary objects); such as, building layouts, building plans and intent sketches. Project teams develop the employer's requirement by collating different drawings (boundary objects) from each member of the team. Each engineer's drawing, which is an objectified

representation of their perception of the team's shared activity, is constantly brought to test during the team's review.

By focusing on how the project teams jointly develop and subsequently utilize employer's requirement to coordinate each other's activities, the current dissertation has been able to provide additional clarifications on the amalgamation of individual perceptions into shared cognition in network processes (Mouzas and Henneberg, 2015). This is because the employer's requirement creates a big picture effect by exposing each engineer to any potential misalignments or inconsistencies between their isolated drawings and the overall project objectives or outcome. And such inconsistencies are essential triggers used by project teams as the basis for re-evaluating project activities and goals, as well as reaffirming that shared understanding is sustained between the project members.

As evident from the construction industry, the re-evaluation of project activities, which characterises the collation of boundary objects, is sometimes contentious. The contention is primarily because of the knowledge asymmetry between the project partners, which tends to create language barriers and power gaps during joint negotiations. Power gaps and language barriers potentially generate unwanted interactions which then negatively affect the maintenance of heedful interrelations (i.e. collective mind) between the project partners. For instance, a supposedly less knowledgeable project actor may exhibit resistive agencies when they feel oppressed or perceive that they are being manipulated by the more knowledgeable actors – which then creates unwanted tensions, disruptions, and delays on the overall project implementation processes. The restoration of shared cognition and collective mind in such situations usually requires the intervention of some designated project members who function as boundary spanners – e.g., by engaging in knowledge brokerage as well as fostering power equalisation between the disputing members of the project team.

Because of its central role in the development of the employer’s requirement, industry regulation may also be activated as a tiebreaker to resolve disputes between project partners and also to challenge any non-compliant behaviours. Evidently, the role of knowledge brokers is immanent in the use of boundary

objects for dispute resolutions (Carlile, 2004; Harrison *et al.*, 2018). Notwithstanding, findings in the current study suggest that teams are more likely to effectively integrate individual's (potentially limited) perception into shared cognition or collective mind when every team member functions actively as a compliance agent, instead of restricting the responsibility of knowledge brokerage to a few designated members of the team.

However, due to the dynamic nature of project processes and the complexities of some project tasks, varying levels of participation may be required from project members to manage different situational contingencies effectively. For instance, when a necessary condition analysis was conducted on the project data, the results showed that alignment of interest, shared understanding, and even coordination of actions are not needed for situations requiring low levels of collective mind. Therefore, encouraging network-wide participation in such situations may not necessarily translate into improved team performance.

10.1 Theoretical contributions

This dissertation makes three contributions to the marketing literature in the context of temporary business networks.

10.1.1 Contribution 1 – A theoretical reorientation regarding the links between cognition, action, and network outcomes.

The dissertation contributes to the shared cognition and knowledge sharing literature by expounding the linkages between individual cognition, shared actions, and network outcomes – an area that has remained under-researched and poorly understood by industrial marketing scholars (Mattsson, Corsaro and Ramos, 2015; Mouzas and Henneberg, 2015). The study moved beyond the extant discussions on shared cognition – *in which researchers have been mainly preoccupied with the interplay between cognition and action* – by demonstrating and explaining how a collective mind is formed as an outcome of network interactions. The dissertation challenged and expanded previous individualist assumptions which mainly assume that cognition (e.g. perception) shapes actions, without having much consideration for the reciprocal or reverse process

of how collective actions shape the individual perception of joint tasks (Weick and Roberts, 1993; Mattsson, Corsaro and Ramos, 2015).

Moreover, by exclusively focusing on the intentions, actions, or perceptions of individual network members as the only unit of analysis, little can be reliably said about the evolution of network views (Corsaro and Snehota, 2012). As demonstrated in the research findings, the heart of theorising that could convincingly generate more practical insights is the tasks and activities that are jointly performed by network actors. Hence, through the retroductive methodology prescribed by the realist account of causality, the generative mechanisms motivating joint actions and moderating shared views between construction professionals were uncovered in this dissertation.

Besides, by taking a process view of network interactions, and deviating from concepts like network pictures which tend to project a static image of network processes (Mouzas, Henneberg and Naudé, 2008); it became clear that cognition does not always precede actions. Evidence from the study shows several occasions where collective actions (re)produce and (re)shape the perception of individual members of a network – especially when the network tensions created by power game and resistive agencies are being confronted with appropriate interventionist processes. It has also been shown in this study how the interplay between cognition, action, and outcome are moderated or influenced primarily by the structural linkages tying the network actors together. One specific structural link identified in this dissertation is the communication pathway that is permitted by the type of contractual relationships between the construction project partners.

Evidently, when activated during joint decision making, external rules (e.g. industry regulations) and internal structures (e.g. IFPR and boundary objects) also shape individual understanding, knowledgeability, and perception of shared tasks. Hence, rather than taking sides between the psychological (individual cognition or knowledgeability) and the social (conflict resolution); the empirical discussion in this dissertation has demonstrated how the interplay between cognition and joint actions results in heedful or heedless interrelations in different social contexts. Moreover, the study highlighted how power play,

resistive actions, boundary objects, and intervention processes between network actors create and reconstitute network interactions.

Relating to boundary objects, earlier conception and characterisation of its role in network interactions have mainly focused on the network position of actors as the source of power and influence (Harrison *et al.*, 2018). However, this dissertation also accounts for expertise knowledge as a crucial source of power as it gives privilege to the more knowledgeable actors to potentially take advantage of other network members by utilising boundary objects as narrative tools to propagate *I-centric* (or self-focused) agenda. Hence, by emphasising expertise knowledge as another key source of power in network interactions, the current study is better positioned at explaining how power balance could be negotiated between network partners. For instance, when a less knowledgeable client employs a consultant to represent them in negotiating with a project contractor as opposed to having direct contact with the contractor – which tends to create unwanted difficulties in the information flow between the network partners. Therefore, by bringing actors' knowledgeability to the fore, this dissertation is more equipped and better able to discuss the effects of communication arrangements on the development of shared cognition between network partners.

Arguably, as highlighted in the ongoing discussions, the shift in theoretical orientation is important because it may inspire and also enable academics to develop a more useful prescription for managerial choices in different social situations. For instance, the dissertation re-emphasizes the value of interventionist actors (i.e. boundary spanners) and also promotes interventionism as a network practice that could productively influence or even reshape individual cognition or perception. As the research findings suggest, the project teams with interventionist culture are more likely to experience a high level of heedful interrelations as well as low level of social tensions. This is because such networks exhibit communicative freedom and cofacilitate joint tasks by proactively identifying or resolving any problem-laden activities before they escalate into disruptive events.

Therefore, relating to shared cognition and knowledge sharing between network actors, as well as sense-making in business networks, the main contribution of the dissertation has been to demonstrate the combined roles of boundary objects and boundary spanners as regulatory frameworks which moderate power relations during intense negotiations between network partners. The study also shows how collective actions can generate individual perception just as much as individual perception influences actions (Araujo and Kjellberg, 2015). However, one notable observation in the dissertation is that the effectiveness of the reciprocal interplay between cognition and collective action – *e.g. to generate a desired network outcome, such as collective mind* – hinges not only on boundary objects and boundary spanners but, more importantly, on the type of communication pathways tying the network actors together. Therefore, the study concludes that the combined effects of boundary objects and boundary spanners are more likely to produce a sustained level of collective mind if a suitable communication pathway is implemented between the network partners.

10.1.2 Contribution 2 – A revised framework of collective mind and the use of IFPR to demonstrate the performative power of industry regulation

The second contribution of the study relates to the refinement of the framework of collective mind and the use of IFPR to demonstrate the performative power of industry regulation in the joint sensemaking and change management process between network actors. By updating the framework of collective mind and highlighting the distinct causal power of industry regulation, albeit through human agency vis-à-vis negotiation of compliance, this dissertation illuminates the ongoing debates in the sensemaking literature – and thereby, contributes to the theory of change in networks (Fonfara, Ratajczak-Mrozek and Leszczyński, 2018).

As highlighted by prominent scholars in the sensemaking literature (e.g., Weick, Sutcliffe and Obstfeld, 2005), the academic debate has mostly favoured agentic causality with less attention to the institutional order that is facilitating, enabling, and structuring the social exploration of network actors. Consequently, while there is a plethora of agent-oriented language – e.g. "enact", "generate", "create", and "imagine" – in the contemporary debates relating to the sensemaking of network actors, the literature is impoverished of institution-

oriented phrases, such as “comply with” or “become aware of” (Weick, Sutcliffe and Obstfeld, 2005, p. 417). The side-taking approach, characterised by the exaggeration of agentic (human) causality at the expense of the distinct causal efficacy of social structure, is also evident in the constructionists dominated debate in the theory of change in business networks (Halinen, Salmi and Havila, 1999; Harré, 2002; Corsaro and Snehota, 2012). However, from a realist perspective, the more reliable and balanced approach to understanding organization processes or change management is by positioning human causal agency and activities within the broader context of the regulatory forces structuring those activities. The view taken in this dissertation is to regard structural artefacts, e.g. industry regulations, not only as “ representational tools” in the hand of the powerful human agents but entities with distinct performative power that objectively conditions and shapes sensemaking activities, especially in interfirm environments where conflicting views exist.

It should be noted that this dissertation is not in any way against the agentic causality advocated by the constructionist view of the world, but has attempted to offer structural causality as the other side of the same coin that provides a complementary explanation to the causal power of human agency. Besides, this dissertation has responded to the need for uniting and integrating the structural and agentic causality (e.g., see Gephart, Topal and Zhang, 2010) by highlighting the role of IFPR as a sensemaking resource that network actors activate during negotiation both for making sense of localised ambiguities in their shared tasks, and for reproducing and sustaining wider regulatory requirements. More specifically, this dissertation offers a practical example of the role of institutional arrangements and structures vis-à-vis plans and IFPR in legitimising or enabling prospective sensemaking between interdependent actors – e.g. by showing how industry regulations are evoked in joint conversation to instil confidence and engender shared meaning about future intentions and plans.

An important observation in this dissertation is that IFPR structures and facilitates the enactment of the unknown future by legitimising plans while also reducing the potential for unnecessary confrontations or disagreements that tend to interrupt sensemaking processes in diverse teams. The development of IFPR

and the use of a regulatory language (e.g. compliance) to legitimize its content and, therefore, achieve temporary agreements and shared understanding between construction professionals also exemplifies the process of (re)producing and sustaining institutions through sensemaking practices. Furthermore, by focusing on structures as complementary entities to agentic causality, this dissertation has been able to highlight the distinct role of regulatory forces – specifically, compliance – as both structural and linguistic resource used by project actors to embed and inject the industry regulations into the ongoing conversations and sensemaking of their shared tasks. More specifically, compliance has been shown to function as a vital linguistic resource used by project partners to activate either a relationship orientation or a contractual orientation when assembling the different components of the IFPR. Therefore, due to its prominent role in the creation of IFPR, one could regard compliance as a medium for activating the performative role of industry regulations during joint sensemaking between network actors. In other words, industry regulations speak through the language of compliance and manifest materially or symbolically within the content of the IFPR.

Moreover, industry regulations are dynamic, and any changes in regulations tend to necessitate a modification of the IFPR, which may then lead to a radical change in both network structure and processes. Therefore, one can regard IFPR as a structural mechanism which functions as a provisional or tentative future making artefact by enabling and facilitating the collective imagination as well as sensemaking of network actors towards their shared goals that are wrapped in unstable realities. Consequently, when they encounter an unexpected event, IFPR is typically a "go-to" sensemaking resource through which network actors trace their steps back into their shared – but newly created – history to understand what has been happening between them. In a nutshell, network actors rely on the IFPR for going back in time to make more sense of the presence and, therefore, correcting or modifying their imagined future, intelligently. Project teams react to a change in IFPR vis-a-vis industry regulation by revisiting a previously executed task, which may necessitate a radical change in the network processes and structure (Halinen, Salmi and Havila, 1999).

Arguably, by explicating the dual nature of regulations as both representational tools and as social entities with performative power, this study has illuminated and added more institution-oriented language to the understanding of the collaborative practices that characterise interorganizational sensemaking processes. Moreover, highlighting the performative power and dynamic nature of regulations has an essential implication in further exploring and understanding the evolution as well as interruption of the relationship between network actors. For instance, empirical evidence in this dissertation shows that construction professionals with a longstanding relationship (e.g. Case B's contractor and client) tend to enact the historical and relational elements of their interactions through mutual compromise to alleviate the process tension, ambiguities, and complexities that result from any change in regulations. And, in doing so, the professionals do not only avoid unnecessary interruption in their sensemaking process but, more importantly, demonstrate and further strengthen their relational ties.

The project actors in the above illustration take a reactive or "good faith" approach by engaging in mutual compromise and deciding to share the financial burdens that resulted from the unexpected change in regulations. The incident illustrated above could be regarded as the potential for interorganizational sensemaking to be emergent rather than a deliberate outcome of social interactions that are activated when network actors encounter an unexpected change in regulations. As exemplified in recent research (e.g., Konlechner *et al.*, 2019), there is also a possibility for interorganizational sensemaking to be based on planned and deliberate effort towards change management. However, both emergent and deliberate approaches are driven by different mechanisms. In this dissertation, gesturing of goodwill that is motivated by a longstanding relationship between network actors was identified as a crucial factor in restoring stability in situations where interorganizational sensemaking is emergent. But what remains unknown is what happens when the relationship between interacting partners is not mature enough to foster mutual compromise and good-will gestures? Exploring such a question may further expose how the dynamic nature of regulations could interfere with the relationship development and change management between network actors.

Finally, acknowledging the dual nature of regulations could sensitise researchers to its role as a potential avenue for observing the relational strength of network partners in situations where interorganizational sensemaking emerges when responding to unplanned events. Such research effort could also clarify to professionals any potential mismatch between the perceptual and actual strength of relationship with their counterparts. For instance, a relational outcome where affected network actors are not able to secure support from their counterparts to compensate for the financial burdens incurred from a change in regulations could offer them the opportunity to become aware of and better understand the strength of the network relationship.

10.1.3 Contribution 3 – Confirming and extending the foundational work of Weick and Roberts (1993) on collective mind

The third contribution of this dissertation is that it enriches and adds new insights to the foundational work on collective mind (Weick and Roberts, 1993) in two valuable ways. Firstly, the study identifies and confirms the bottleneck conditions that could potentially constrain the maintenance of collective mind between network actors. Specifically, in addition to two antecedent conditions from the original framework, this dissertation identified three more conditions shaping the formation of a collective mind in the business network context. Secondly, the study shows the relative importance of each antecedent condition in different situations and highlighted their implications on the activities of construction professionals.

Based on findings from the NCA, this dissertation confirms and supports the initial assumptions regarding contributing and representing as crucial mechanisms to sustain a collective mind, not only in intraorganizational relationships but also in interorganizational contexts. However, in interorganizational settings, rather than subordinating – which was the third condition in the work of Weick and Roberts (1993) – compliance was found and confirmed as a more suitable conceptual language or necessary condition that captures the process of forming a collective mind between network actors. Consequently, this dissertation has been able to advance the discussion across organization boundaries and teased out the different types of tensions that network actors have to deal with in their interrelation processes. Moreover, this

dissertation offers a comprehensive explanation of how the dialogue-based conditions, i.e. coordination and shared understanding, can have implications for interorganizational sensemaking.

Particularly, regarding shared understanding, the four typologies of communication pathways developed in the dissertation have implications on how network actors can organize their decision-making structure to foster deference to expertise – rather than a deference to authority – and appropriately respond to new cues in their sensemaking processes. Whereas, deferring decisions to authority creates less heedful interrelations between network actors because in such situations people with more dominant positions are more likely to tune out interpretations that do not confirm their biases (Weick, 2010). Scholars have shown that deference to expertise promotes heedful interrelations and reduces the potential for confirmation bias by enabling network actors to dynamically adjust their interconnectivity and the structure of their network when responding to emerging cues (Weick, 2009).

Hence, the dissertation contributes to these assumptions by showing how an intermediary-led communication pathway allows more room for construction specialists to take the leading position in negotiation for complex engineering requirements while a client-led communication pathway tends to limit the experts to advisory capacity – which then creates unwanted tension and knowledge asymmetry between the network actors. Furthermore, in project teams who subscribed to a structure that reflects deference to authority, i.e. client-led communication pathway, the contractor and the client engage more frequently in conflict and disagreements as a result of the ambiguities in their communication and information relay practices.

However, rather than explicitly prioritizing one approach over the other, what this dissertation has done is to highlight specific situations when deference to expertise and deference to authority are most appropriate and, therefore, necessitates the use of an intermediary-led communication pathway and a client-led communication pathway, respectively. More specifically, this dissertation argues that network actors should alternate between both approaches depending on the complexities of specific activities. For instance, routine-based activities

and administrative tasks (such as monthly progress review and program scheduling) tend to require less specialist input, and deferring decisions to expertise (i.e. using an intermediary-led communication pathway) in such situation may distract the network actors from the more knowledge-intensive tasks. Likewise, deferring decisions to authorities when activities require a sophisticated intellectual input (e.g. during tender submission and design development) may create unwanted burden and increase the potential for misinterpretation of cues, which may be detrimental to the sensemaking process.

This dissertation, therefore, argues that academics and professionals alike can benefit from the use of communication strategies as another productive lens to observe and design the structure of decision making that is appropriate for sensemaking process in a network environment. As findings from this study show, avoidable symptoms in the sensemaking process, such as confusions, frustrations, resistive agencies, information overload, frequent conflicts, and an ongoing process interruption, tend to manifest when network actors use an inappropriate communication pathway to respond to emerging cues – and such process outcomes are indicative of a poorly developed communication strategy.

10.2 Managerial implications

Based on empirical findings from data analysis as well as theoretical discussions, this dissertation offers three suggestions that could improve managerial practices and network interaction processes. The first two suggestions relate to practices that must be avoided, namely, communication restrictions and excessive coordination practices. The last suggestion relates to a specific practice that needs improvement – that is, risk management regarding unanticipated changes in industry regulations. The three suggestions are presented below.

10.2.1 Managerial suggestion 1 – Avoiding communication restriction to promote a perception of transparency

Findings from this dissertation show that even when not directly intended, communication restriction could limit collaborative effort and diminish any perception of honesty between project partners. With regards to openness in communication, one of the obvious factors shaping the client's perception is the

quality of the monthly review meetings. Clients are particularly interested in having direct communication with both the contractor's management team as well as the contractor's design team. The clients start to develop a perception of communication restriction when the contractor's engineers or consultants are not regularly attending the progress meetings. Which then creates a culture in which the client becomes suspicious of the contractor's intention. For example, such client might think that the contractor is holding back or filtering crucial information to benefit their interest – which would ultimately affect relationship development as well as how much the client would be willing to actively support the contractor when unexpected events happen.

Similarly, without openly or formally inviting their engineers to participate regularly in the client progress meetings, the contractors risk creating a "Chinese wall" between their team and the client team. Understandably, resource limitation and time constraints might prevent the engineers from consistently participating in the client progress meetings. Nonetheless, an open invitation could make a meaningful difference in how the engineers would perceive the level of communicative freedom that is permitted by the contractor. As already demonstrated in the research findings, communicative freedom between project teams tends to create a work environment where colleagues feel they can freely call each other's attention to the "blind spots" that could potentially harm the expected outcome of the project. Therefore, this dissertation suggests that project teams could bridge the two sides of the Chinese wall that separates the contractor and the client sides by encouraging or promoting open communication through regular attendance and participation in review meetings.

10.2.2 Managerial suggestion 2 – Avoiding over-coordination to improve process efficiency and resource management

It has been shown in this dissertation how coordination processes can become excessive, if not managed appropriately. Excessive coordination practices usually generate negative effects, such as information overload, and unnecessary time pressure or disagreements between the project partners. The two main activities contributing to excessive coordination are (1) shared electronic platform, and (2) the length or duration of design team meetings. Observations in this study suggest that the use of a shared electronic platform is mainly

beneficial when used within a project sub-team – *e.g. the design team* – for specialised activities such as design development. However, problems do arise when such platforms become the medium for sharing information and reviewing documents with the client. The challenge with extending the capacity of the platform across project teams is that the client might not be familiar with its usage – which then affects information relay between the contractor and the client teams. Therefore, unless in situations involving a highly knowledgeable client, extending the usage of the electronic platform beyond the boundary of the design team may unnecessarily overstretch the already limited project resources. Particularly, project time and budget may suffer.

And regarding the length of design review meetings, observation in this study shows that people's attention to vital details usually deteriorates with time. In an attempt to ensure that project activities are well-coordinated and properly aligned, a design team coordinator may be tempted to engage simultaneously with all the engineers during a design meeting. Unfortunately, such practice typically extends the length of the meeting beyond the attention span of the engineers, some of whom could sit in a meeting for up to three hours before discussing an activity which relates to their roles. An alternative and potentially more productive approach is for the design coordinators to break the meeting into sections and assign a time slot to each engineer. This turn-taking approach may, however, limit the extent of social interactions between the engineers. Therefore, to maintain a sufficient level of team interactions, a global meeting involving all the engineers might be organised tri-annually, every three months, or as deemed necessary by the team members.

To verify its benefits, the turn-taking approach was proposed by the doctoral researcher to one of the investigated project teams, and the proposal led to the restructuring of the design team meetings. After its adoption, the turn-taking meeting structure was consistently used by the team until August 2019 when the last design team meeting for the project was held. In January 2020, the design coordinator and the architect were both contacted for feedback on how the change affected the meeting processes. According to the architect, the turn-taking approach significantly improved the communication processes, and the

design team meetings became more focused and shorter. Evidently, by adopting a turn-taking meeting structure, project teams could more efficiently manage their most valued resource: TIME.

10.2.3 Managerial suggestion 3 – Improving change management culture through risk-sharing

Managing external changes, such as changes in industry regulations, can be a daunting task for construction professionals, which is because such changes may be unanticipated and usually place an unnecessary burden on the project budget. With regards to the dynamic nature of industry regulations, risk-sharing proved to be a more proactive and effective approach for change management than risk transfer. By planning how to share any potential risks associated with changes in regulations, project teams may reduce some of the disputes which tend to happen after signing contractual agreements. The current practice in the construction industry has heavily focused on client's or users' change request as the primary culprit when explaining why unexpected changes and, therefore, disputes happen in projects (Okada, Simons and Sattineni, 2017). This way of thinking is, arguably, a reflection of the extant notions on social (network) change, which tend to regard social actors as the only mechanisms of change while reducing changes in network structure, such as rules and regulations, to "critical events" (Halinen, Salmi and Havila, 1999; Harré, 2002).

This dissertation argues that much can be learned, both in theory and practice, by placing industry regulations at the centre of network change, or in this case, changes in project activities. Because in doing so, project actors and managers can take a proactive approach on how to address changes in regulations rather than a reactive approach as the "critical events" notion tends to suggest. Essentially, the argument in this dissertation is that during the development of employers' requirement (IFPR) and the contract negotiations that follow from it, there should be a distinct space or allowance for negotiating unexpected changes in regulations. As an example, the project contractors and their clients can make a pre-emptive decision during contract negotiation to share responsibilities and costs in the events of an unexpected change in regulations.

10.3 Limitations and suggestions for future research

The process of forming a collective mind in temporary business networks has been investigated in this dissertation, and a theoretical framework was developed based on empirical findings from three construction project teams. As presented above, the study offers new insights regarding how network actors make sense of their joint tasks while dealing with both internal and external changes affecting their network processes. Despite the theoretical and managerial contributions, the study has some limitations that could be addressed in future research. The primary limitation relates to the research design. The original intention of the study was to capture variances in the experience of network teams and to compare how a collective mind is actualised in two different industrial contexts – namely, construction and pharmaceutical industries. However, the research design was later revised because every effort to secure access to pharmaceutical projects was unsuccessful – which then deprived the study of the possibility to conduct a cross-industrial analysis.

Compared to the construction project teams, the project partners in the pharmaceutical industry operate under a different set of regulatory structures, which may affect the functioning of the generative mechanisms during social interactions. Moreover, despite their high level of interdependencies, specialists that are jointly working on pharmaceutical projects, such as drug discovery teams, always operate in isolation (Ben-menahem *et al.*, 2016). The absence of frequent physical interactions in such teams may generate different types of challenges relating to communication pathways and knowledge sharing protocols. Therefore, by using the framework developed in this dissertation as a starting point, future investigation of collective mind in such business contexts could offer a far-reaching benefit for theory development.

The second limitation of the dissertation relates to the necessary condition analysis (NCA). Because of the exploratory nature of the research, the only theoretical inference for developing the measurement scale for the collective mind of network actors was obtained from the foundational work of Weick and Roberts (1993). In hindsight, this could be considered as a limitation, especially because Weick and Roberts mainly focused on error avoidance as the basis for

capturing collective mind. However, evidence from the qualitative data in this study suggests that collective mind could also be linked to resource appropriation and optimisation. Therefore, future research could further explore how resource management between interacting partners affects their collective mind. Future investigations could also consider measuring any potential reverse effect of collective mind on interfirm resources.

Another limitation relating to NCA is the size of the dataset used for the analysis. Because the analysis was based on a small number of completed questionnaires, the identified relationships between the antecedent conditions and collective mind could be considered as experimental outcomes requiring further verifications. Moreover, as common with any NCA study, the relationship between each antecedent condition and collective mind was measured in isolation, which is because NCA software and algorithms are not designed to measure the combined effects of multiple variables on an outcome (Dul, 2016).

Therefore, future research could further clarify the links between the antecedent conditions and collective mind by utilising methodological tools – *e.g., qualitative comparative analysis (QCA)* – that are based on additive causality (Harrison and Easton, 1998; Dul, 2016). It has been shown in the qualitative findings how joint decision making and negotiations between project actors are constantly being influenced by the need to comply with industry regulations. In view of this, one potential question for future research would be to investigate how compliance moderates the effects of the antecedent conditions on the collective mind of network actors. Another avenue for future research is regarding how to overcome the challenges associated with operationalising and measuring qualitative data as well as the complexities of creating different configurations of condition variables. Recent research has shown that such challenges could be managed by using a template approach, such as the Generic Membership Evaluation Template (GMET). Research evidence (e.g., see Tóth, Henneberg and Naudé, 2017) tends to suggest that GMET could offer reliable guidance for improving transparency in the operationalization and measuring of qualitative data, especially relating to how a researcher can assign fuzzy set values to condition variables.

Lastly, this study developed four typologies of communication pathways that are shaping the establishment of shared understanding between interacting network partners. However, only two of the communication pathways (i.e. client-led and intermediary-led communication pathways) were associated with the investigated project teams. The remaining two communication pathways namely, intermediary-2-client and intermediary-2-contractor, were not empirically verified. Therefore, future research could explore these unverified communication approaches to better understand the network situations they are suitable for and to identify the types of challenges associated with their adoption. Future study could also investigate which of the two (unverified) communication pathways is more effective in creating an interactive environment that fosters knowledge integration and power equalization across network boundaries (Galbraith, 1974; Carlile, 2002; Mouzas and Henneberg, 2015; Harrison *et al.*, 2018).

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Appendix A – A guide for collecting observation data

Nos	Interview Questions	Theoretical Outcomes	Main Research questions
1	Why was the meeting organized?	Personal reflections and comparison of meetings	
2	How is this meeting different from the last one?		
3	Am I learning anything new in this meeting that could help me during my next interviews?		
4	What is the structure of communication between meeting attendees?	Shared understanding (or absent of shared understanding)	**RQ 1** How do temporary business networks utilize interfirm problem representations to coordinate actions and establish shared understanding and alignment of interests between the network actors?
5	How the team members receive, share and review information and new ideas?		
6	What tools are set in place to guide future actions?		
7	Was a particular person dominating conversation or people engage in dialogue?	Convergence of interests (or absent of convergence of interests)	
8	How do the team members make decisions – were decisions made jointly or made by someone and shared with the rest? Why is that?		
9	How teams motivate each other to follow a particular course of action?		
10	Is this a routine meeting or as a response to an unexpected occurrence?	Actions and activities were properly coordinated (or people were having difficulties in coordinating each other's actions)	

Interview protocol

Greetings and appreciation –
Thank you for agreeing to participate in this interview.

Explain the goal of the interview –
The main goal of this interview is to understand your personal experience of working in this design team. There are no right or wrong answers. I don't have any preferable answers.

Explain the structure of the interview –
The interview has 2 parts and it might take up to 90 minutes. The first part will take about 70 minutes and we will discuss different issues regarding collaborative practices of the design team. For the second part, I will give you a questionnaire to complete – this is also based on collaboration in design and project teams. The questionnaire will take about 15minutes to complete. The last 5 minutes will be to summarise and conclude our discussion.
Kindly let me know if you would like to take a break in between.

Permission to use a tape recorder –
Is it OK with you if I tape-record the interview conversation? This is important because it will enable me to concentrate on our conversation and also give me an opportunity to go over your answers later. I promise to store the recording in a secure place and your comments will remain confidential.

Any questions? If none then let's crack on with it!
(Switch on tape recorder).

Background information

1. For the record, what is your name and what is your role in this project?
2. How well have you been involved in this project, for example, in decision making, attending meetings and so on?

Main interview questions (Part 1) (60 - 70minutes)

1. Can you tell me about your experience when the design team met for the first time to discuss about this project? Or the first time you met the team members?
2. How has your experience evolved since you joined the team?
3. Have you noticed any changes in the way you work together in the team, for example changes in the pattern of decision making, or anything else?
4. Looking back to how far the team has come on this project, would you say the journey has been *a smooth sail*? Could you explain why?

5. Let's talk about planning, how important is planning for your team? And what happens when members do not stick to plans?
6. Is it possible for you to make changes to project plans without first informing the other project team members? If yes, how are changes usually reported to the team?
7. Does the project team have a time limit for how long a team member can wait to report changes made to an agreed plan? What do you think are the implications if changes to agreed plans are not communicated properly to the rest of the team?
8. Could you give an example of a situation when you made changes to an agreed plan and explain how the rest of the team responded to your actions?
9. So far since the start of the project, can you think of any particular incident that really surprised you (personally) or events that interrupted workflow between team members?
10. Could you explain why the incident happened and how the project team worked together to respond to it?
11. If the incident happened again, would you do anything differently? Could you explain why?
12. Now let's talk about how your role has evolved in the design team – Which other team member(s) do you regularly interact with in order to fulfil your work on this project?
13. How do you expect your work with them to develop as you continue working together on this project?
14. What happens when team members have different perceptions or ideas about a design task? Does your team have any tools or reference points to make sure different perceptions of members blend together nicely?
15. Could you draw a sketch of how your role is connected to the role of other members of this project?
16. Would you consider the way the design team work together as collaborative? For example, do you feel any "*sense of togetherness*" in the ways team members implement their tasks? Could you elaborate on this?
17. What do you think enables you to work collaboratively in this team? Can you give examples of different ways people collaborate in your team?
18. How does collaboration affect workflow between team members on this project? Do you think the project would have progressed the way it does without collaboration between team members?
19. Now let's talk about industry rules, project guidelines, contract specifications and changes in client's requirements – How do these affect decision making and workflow in your team?
20. What are the possible implications of non-compliance with rules or client requirements?
21. How does the team deal with complex design issues when there are no industry guidelines on what to do?
22. Now let's talk about the different professional backgrounds in the design team; how does that affect clarity of communication between team members or clarity of communication with the client?
23. How does your team ensure everyone is on the same page when making decisions about project or design tasks?

24. What are the possible effects on workflow when team members are **not** on the same page regarding how to perform their tasks?
25. What happens when specific requirements of this project are in conflict with the accepted modes of operations in the companies which team members work for?
26. Have you worked with any member of the design team on other projects? And do you think that has any bearing on how you work together on this current project?
27. Let's talk about coordination, what are the ways the design team ensure that different aspects of this project fit together nicely?
28. How do you manage information sharing and circulate updates between team members?
29. What is your opinion about the regular team meetings and the other special meetings the team organises (e.g. DTM, client/end-user meetings and stakeholder meeting as well as occasional workshops)?
30. Finally, let's talk about workload and time pressure, what is your experience in this project regarding workload, deadlines, and program schedules?
31. What is the typical reaction of the team if members do not meet up with deadlines?
32. Does the design team have any practices which take unanticipated events into accounts, for example, when deciding task deadlines? Could you explain how that works?
33. Since the beginning of this project, has there been any noticeable changes in your team's routines or project agenda? For example, changes in the number of times you organise DTM? If yes, why was the change implemented?
34. Do you think time pressure has any bearing on workflow between team members? In what ways?

Part 2 (Completing questionnaire) (15minutes)

Now let's carry on to the second part of the interview – I will hand over the questionnaire to the informant.

Kindly complete this questionnaire now. And please answer all questions. Please let me know if any of the questions is unclear.

Concluding remarks (5minutes)

After confirming that all questions have been answered – Do you have anything else you would like to say? Something that was not covered in the interview or questionnaire?

Thank you very much for your time today!

NCA questionnaire for RQ2

Questionnaire on collaborative practices in project teams

Please answer all questions based on your experience in this current project and with the current project team. There are 8 different topics to be completed.

Kindly indicate your answer to each question by entering "X" into the appropriate box. There are no right or wrong answers. No desirable or undesirable answers. Your expert opinion will be most appreciated, and data will be managed with confidentiality.

Please answer all questions.

Topic 1. Collective mind

To what extent do you agree with the following statements regarding implementation of activities in this project?						
No	**Statements**	Completely Disagree (1)	(2)	(3)	(4)	Completely Agree (5)
1	Our team had very few delays or workflow interruptions since the beginning of this project					
2	Our team has worked together effectively to integrate different aspects of the project					
3	Members of our team have acted in a consistent and predictable manner throughout this project					
4	There have been no surprises in the behaviour of our team members since the beginning of this project					
5	There have been no major accidents on site or any noticeable errors in the way team members implement their tasks					
6	I have come to realise that everyone in our team has the best interest of the project at heart					

7	Our team have had no major problems or any contentious issues with other project stakeholders (e.g. BREEAM, building control, neighbouring buildings, safety officers, and fire officers)					
8	I find the actions of some members of this project very unpredictable and confusing					
9	There has been a considerable amount of errors in the way team members implement their tasks.					

Topic 2. Representing

How different perceptions of your team members about project tasks were negotiated – to what extent do you agree with the following statements?

No	Statements	Completely Disagree (1)	(2)	(3)	(4)	Completely Agree (5)
1	The requirements, objectives, project scope and expected outcomes were thoroughly explained to project team members at the beginning of this project					
2	Our team regularly review the project-relevant knowledge and experience of each member in order to identify and resolve conflicting views					
3	Our team regularly update and circulate our reference items (e.g. project drawings, reports, project guidelines, contract instructions) to ensure everyone is “up to speed”					
4	Our team regularly deliberate over the potential influence of other project stakeholders on our activities (stakeholders, such as, BREEAM, building control, neighbouring buildings, safety officers, and fire officers).					
5	Each member knows who (or where) to turn to whenever they are confused or need information about changes in project requirements					
6	When new members join our team, we give them a detailed update of the project (including successful and					

	unsuccessful experiences) and inform them about plans going forward					
7	I feel like we are not paying enough attention to "fit together" the different perceptions of our team members (either with new or current members) about project tasks.					

Topic 3. Compliance – – items marked red were eliminated from NCA because of a low factor loading from factor analysis

What is the level of compliance of your team's project execution practices with the following?						
No	**Statements**	Almost no Compliance (1)	(2)	(3)	(4)	Almost 100% Compliance (5)
1	Client's/end-users' requirements (this also includes unexpected variations/changes in requirements)					
2	Project objectives, budget, scope, schedules, and pre-determined project outcomes					
3	Industry rules & regulations, guidelines of regulating agencies (e.g. CCS - Considerate Constructors Scheme, DDA – Disability Discrimination Act, or EA – Equality Act					
4	Successful practices from past projects or past experiences of members					
5	Professional judgement or personal intuition of members					
6	Suggestions from engineers in your social network – (that is, engineers who are not directly involved in this project)					

Topic 4. Contributing - items marked red were deleted because of a low factor loading from factor analysis

How the actions of each member of your team reflect their attentiveness to the needs and expectations of others?						
No	**Statements**	Far below my expectation (1)	(2)	(3)	(4)	Far above my expectation (5)
1	The level of empathetic intelligence in our team (e.g. "team members always "put themselves in other					

	member's shoes" during team discussions).					
2	The level to which each member actively monitors the activities of the other team members even when it does not directly affect their work.					
3	The level to which each member offers support to other members even when they did not ask for it.					
4	The level to which each member gives to and accepts procedural suggestions from other team members.					
5	The level to which team members support the design coordinator (project manager) in coordinating overlapping project activities in order to minimise the need for changes or rework					
6	The level to which members actively participate (e.g. during DTM) when discussing issues that **do not** directly affect their role.					

Topic 5. Shared understanding – item 5 (marked blue) loaded with representing from factor analysis

Regarding how clarity of communication is established between your team members, to what extent do you agree with the following statements?						
No	**Statements**	Completely Disagree (1)	(2)	(3)	(4)	Completely Agree (5)
1	We always ask members to clarify the meaning of any ambiguous words (or acronyms) used when exchanging messages or information					
2	Our team members are always on the same page regarding which aspects of the project to prioritise					
3	All our team members have a clear understanding about the requirements and goals of this project					
4	Our team members have similar prior experience on how to implement projects					

5	Our team members are well informed about the process of sharing and/or storing project information, documents, drawings, and reports.					
6	Our team members have similar ways of solving problems					
7	Members of our team sometimes use unfamiliar words or phrases that are wrongly interpreted or misunderstood by other members					

Topic 6. Alignment of interests – items marked red were eliminated from NCA because of a low factor loading from factor analysis

How the differences in your professional backgrounds and preferences are affecting the way you work together – to what extent do you agree with the following statements?						
No	**Statements**	Completely Disagree (1)	(2)	(3)	(4)	Completely Agree (5)
1	Because of the differences in our professional backgrounds and tastes, it is mostly difficult to reach a consensus when making decisions together as a team.					
2	Most of our team members frequently adjust their preferences to accommodate the opinions and interests of others					
3	We always respect each other's opinion, for example, regarding how to respond to changes in end-users' (or client's) requirements					
4	When we encounter unforeseen situations that are not particularly in favour of everyone (or anyone) we always find a way to compromise					
5	We have tracking systems to promptly identify and address differences in the intentions, plans, or schemes of our team members before it escalate into serious problems (such as delay or workflow interruptions)					
6	Our team always motivate each other to see unexpected or unplanned events as opportunity to learn new things					

7	Our team mostly ignore minor problems until they escalate into unexpected or unpleasant surprises					
8	When something unexpected happens, our first line of actions is to investigate who (or what) is at fault and apportion blames accordingly					

Topic 7a. Coordination – items marked red were eliminated from NCA because of a low factor loading from factor analysis

Regarding how your team continuously adjust their activities for different aspects of the project to fit together nicely – to what extent do you agree or disagree with the following statements						
No	**Statements**	Completely Disagree (1)	(2)	(3)	(4)	Completely Agree (5)
1	Our team has a well-structured routine (e.g. bi-monthly meetings) to ensure our workflow is implemented smoothly and efficiently					
2	Our team has a very effective (formalised) process of circulating project or design related information, reviews, comments and feedbacks					
3	When we notice inconsistencies in workflow or encounter unfamiliar (or complex) situations we promptly organise an impromptu workshop to address the issue					
4	Our team members sometimes wait too long before making notifications for changes made to agreed plan or project requirements					
5	The client/end-users sometimes wait too long before providing important information needed for design tasks					
6	Crucial information from the clients/end-users are not always circulated on time within the design team					
7	Our team's process for issuing design reports, reviewing and					

	updating design drawings is unnecessarily bureaucratic					

Topic 7b. Coordination modes used in different situations (***not included in NCA*** because it was originally meant to provide contextual information for the coordination practices of the project teams.

The extent to which each of the following coordination methods was used to coordinate activities in different situations						
No	**Situation 1 – when project activities are progressing as planned:**	Never (1)	(2)	(3)	(4)	Always (5)
1	The use of routinized face-to-face meetings (e.g. regular DTM) to communicate updates					
2	The use of project database to electronically communicate progress and share drawings & layouts					
3	The use of impromptu meetings (e.g. special workshops or conferences) to communicate progress and share new updates or negotiate changes to overlapping activities					
4	The use of telephone or email messages to communicate and report changes made to pre-agreed plans					
Situation 2 – when members encounter unexpected problems or when the team encounters difficult situations that could affect program schedule						
1	The use of routinized face-to-face meetings (e.g. regular DTM) to report the problems					
2	The use of project database to electronically communicate the challenges faced by members as well as share project drawings and layouts					
3	The use of impromptu meetings (e.g. special workshops or conferences) to ensure the problem bottoms-out and then to negotiate potential way forward					

4	The use of telephone or email messages to report and resolve the problem with relevant team members					

Topic 8. Time pressure **(*Not included in NCA* -** because of a very low loading of the factor analysis and Cronbach Alpha**)**

How high is the level to which your team was under pressure to complete tasks with non-negotiable deadlines?						
No	**Statements**	Very low (1)	(2)	(3)	(4)	Very high (5)
1	To what extent was your team under external pressure (e.g. from client) to meet certain deadlines?					
2	To what extent was your team required to do too much work within limited time?					
3	To what degree has your team underestimated the time required to complete a design task?					
4	To what extent was your (or other team members') request for deadline extension not granted?					
5	To what extent does your team intentionally include buffer time in schedules to allow for (1) high complexity activities, (2) unforeseen events and (3) the transition period between different phases of the project?					
6	To what extend has time pressure negatively affected workflow in your team? (e.g. team members feeling overwhelmed, withdrawn, and unproductive)					
7	To what extent has time pressure motivated a positive reinforcement in your team? (e.g. team members jointly tackle the situation head-on and manage to finish within available time)					

Thank you for your time and attention!!!

Appendix D – A sample summary of observation notes, Case A

DTM – Case A 29th May 2018 (1:30pm – 3:30pm)

Purpose of the meeting – general updates (summary of where we are)

Meeting attended by the architect, technologists, mechanical engineer, project manager, and the client representative.

The client representative started the meeting by saying he was not in a good mood today because of an incident that happened in his previous meeting. He then decided he might only stay in the DTM for 30minutes before joining his boss for another meeting. The design team members agreed and went through the seven main decision agenda sequentially. However, other items were added to the agenda towards the end of the meeting.

Decision episode 1: A design workshop needed

Without talking to anyone in particular, the architect started by requesting another meeting so that the different drawings from the structural and mechanical engineers could be compared with his drawings. He then faced the project manager as if he wanted him to act promptly, and he said, "we need another meeting … we've drawn stuffs, they've drawn stuffs … so we need to go through the drawings line by line". The project manager responded by making a note on his diary and promised to email the design team later to negotiate the most appropriate date for the "coordination meeting". After the architect and the mechanical engineer agreed with his proposal, the project manager indicated that they should move to the next item on the agenda.

Decision episode 2: Updates on design work

The architect presented updates of architectural design relating to RIBA stage three, but the mechanical engineer apologised that she has not finished the mechanical design update and promised to finalise tomorrow. While explaining his updated design, the architect mentioned that he used the design strategy of X building as a template for designing the current project. The project manager, who seemed to be satisfied with the architect's decision, responded by saying, "that's all we need for this week". The project manager then promised the

architect and the rest of the meeting attendees that he would go through the datasheet later. As the discussion suggests, most of the updates were already sent to the client representative via email, but he has not had the time to read them. The project manager then suggested that the client representative reads them during "this week" to avoid falling behind the project schedule, and he responded by nodding his head in agreement.

The project manager continued by indicating that the design team needs more information from the end-users before completing the RIBA stage three, and he suggested that a separate meeting (i.e. user's meeting) should be organised for that purpose as soon as possible. According to the project manager, the end-user's specification for facilities (i.e. desk spaces) needs further clarification because the request is more than what the available building space can accommodate. However, despite that the end-users power requirement (I presume) does not exactly match the M&E (i.e. mechanical and electrical) professional expectations, it could still be reasonably achieved in the design. According to the mechanical engineer, "power we can cope with but data (referring to infrastructure for internet connections) is over specified". She (i.e. the mechanical engineer) made the statement to further emphasize the importance of organizing a separate meeting with the users so as to "bottom out" the confusion in their specifications. The project manager noted this down and promised to set up a meeting with the user team for next week.

Decision episode 3: Clarity of presentation and communication of changes

On the matter of clarity of presentation of changes, the project manager would like to know how changes made on the design from RIBA stage two to three could be presented to the project stakeholders. The mechanical engineer responded by assuring the project manager that all changes made in the design layout should be easy to identify because "colour codes" were used to indicate them in the updated drawings. She then placed the new drawings on the table for everyone to see and she pointed to the colour codes. The project manager and the client representative were both satisfied (and the client representative, in particular, smiled when looking at the colour codes). The project manager pointed to a space on the drawing and indicated that he suspects that the users

might want a cleaning room in that space because they ("the users") have something similar in their current facility. However, the client representative was not entirely sure if that would be the case as he responded that, "we all thought we were doing the right thing in W (i.e. the name of another building), but we didn't notice ...". The client representative made the statement as a piece of cautionary advice for the design team, indicating that they should not decide on hunches, but should ask directly from the users to confirm what they actually want. The project manager then responded that he would clarify the issue in the next users' meeting.

Decision episode 4: Overlapping roles – confirming episode 1

The project manager called attention again to the first item on today's agenda by asking the architect and the mechanical engineer to have a review this week to make sure their layouts are aligned. He explained that the designers need to sort out any differences in their drawings, and they should send the final layouts to the cost consultant by Monday (4th June) for proper cost planning. I think the project manager wanted the designers to act fast so that the designs could be properly aligned and priced before the next users' meeting but was unable to confirm this assumption because he left in a hurry after the meeting. After the engineer and the architect agreed with his suggestions, the project manager presented the next item on the agenda, i.e. a building demolition. The building demolition is required because another building is currently on the piece of land to be used for the new project.

Decision episode 5: Demolition and investigations

Regarding demolition work and "investigations", the project manager mentioned that they've got a quote for different items already and stated that X (missed the name) has got a good idea of what needs to be done because he was there during RIBA stages one and two. The project manager promised to ask XYZ (one of the companies working on the demolition) for updates and the client representative added that "they've (i.e. XYZ) had long enough time now … they must be close". As if to assure the client representative of progress, the project manager mentioned that he expected that it would be about 2.5 weeks to

complete demolition by the date of the next ABC (i.e. the quarterly stakeholder meeting). The project manager then brought out a list.

Decision episode 6: Contracts and contractors

While going through the list, the project manager mentioned that the contract notice for the building is issued already and "the return" should be towards the end of June. He added that "we need a meeting within two weeks for evaluation". Following this, the project manager asked the client representative if it was time to start talking with contractors. The client representative did not give a straight answer, he only mentioned that HHH (i.e. a familiar contractor company to the design team) and some other contractors know about the project already. However, he stated emphatically that, "what we need to know is if we need a tender for the ABC (i.e. stakeholders) aside ABC report". He continued that this needs to be known before the next ABC meeting coming up on the 22nd of June. This question then opened up the discussion about the next item on the agenda, i.e. the upcoming ABC meeting.

Decision episode 7: ABC meeting

Regarding ABC sign off and planning permission, the client representative claimed that planning could not be submitted until ABC granted permission. He, however, stated that the permission is crucial for the project continuity. According to him, "we want to submit for planning to maintain the program … it's gonna be key that we get permission for planning". And regarding his expectation of what to present at ABC, the client representative told the architect that he would need to prepare a 3D design similar to the one "you" presented during competition stage (the "you" is possibly the architect himself or someone else from his company). The client representative, however, advised that the content should not be a repetition of the competition stage. As he asserted, "no repetition … we try to contextualise". He added that everything has to be concise because the presentation will only last for 15 to 20 minutes. And to avoid conflicting stories the client representative added – "we work through the whole narrative before the ABC … if nothing positive we simply say situation awaiting decision or decision pending". By positive, the client representative was

referring to changes promised but have not been implemented since the last ABC that was held on 12th March. The client representative ended by saying that their narrative should be consistent with X building (another building of the client), but something new should be taken along to ABC.

Section 106

The team moved on to discuss a document called section 106. It appears that the document has something to do with economic development issues. However, from the client representative's description, the document appears to be a standard document issued by the city. It appears that this document needed to be obtained before the next ABC. The project manager promised to liaise with the design team members and get this sorted.

Decision episode 8: Random ideas

Next, the technologist started showing a simulation on his computer, and he was surrounded by the architect, mechanical engineer, and the project manager. I could not see what he was showing but, as it appeared, he was explaining changes he has made on the drawing since the last meeting. Then he mentioned that windows need to be fire-rated, but the mechanical engineer interrupted that a "mono-draught module" is needed to be done first. The technologist then added that "it's more following the same principle as X building". Pointing to the computer screen, the client representative asked if "we" (the client organization) could have a normal high door, and the technologist confirmed that it is designed with a normal high door in mind. The client representative then advised that the layout should be improved to make it more convincing for the ABC (i.e. the stakeholders). The technologist then asked, "screen, doors, windows etc … we just keep the X building? And the client representative confirmed by simply saying … Yes! (An observation for interview question – why the X building is used extensively as a template for the new design.) During the presentation of the technologist, the client representative left the meeting, but the design team members continued.

While continuing the conversation, the project manager instructed the architect and the mechanical engineer by saying, "try to get the structure done next week.

Provide outlines for both of your sections, where we started, where we are now. … and for the generators, explain the pros and cons, and recommend one". Then, he mentioned that someone named "Q" is no more on the project and is being replaced by another person named "Y". After this, the architect suggested that there should be more information on the ABC report about sustainability issues. According to the architect, "maybe we should develop a little more specific … the last time it was not properly developed". His suggestion was noted, but nothing further was said about any line of actions to be taken. Then the project manager, who seemed to be referring to an earlier discussion, mentioned that the mechanical engineer should do the outlines regarding the boreholes so that the cost consultant could put it into the costing.

Decision episode 9: Roof plan

Then the team moved on to discuss roof plans. The plan was initially issued by the architect, but the mechanical engineer mentioned that she had rearranged it to make it look more appropriate. Though the architect did not object her decision, she continued by saying that "even the current plan could be changed later."

Decision episode 10: Ventilation strategy

The architect then suggested, while focusing on the mechanical engineer, that an update is required on the ventilation strategy. The mechanical engineer responded that she had some strategies in place, and she would send them over to the architect later. She, however, mentioned one specific strategy that seemed to align with the client's requirement but was not convinced if that is the way to go. According to her, "we did it (the ventilation strategy) for X building but, to be honest, I'm not sure if it's worth it … but the client wants it".

Decision episode 11: A mini design workshop

Following their discussion about the ventilation strategies, the architect and the mechanical engineer started a seemingly long conversation comparing their drawings and focusing on specific aspects where their designs overlap. The side by side comparison seemed to reveal some discrepancies. Some aspects of the

drawings were completed by a structural engineer (not in attendance today), but the mechanical engineer promised that she'd inform him (i.e. the structural engineer) when she gets back to the office to contact the architect. She added that the structural engineer might even visit the architect at his office. Seeing the struggle between the architect and the mechanical engineer, the project manager realized the project team could have employed a lead design or design coordinator to manage overlaps between the specialists. He then added (as a supposed justification) that "the contract needs to provide a lead coordinator because no one feels responsible for bringing the different design pieces together".

Rounding up

The mechanical engineer mentioned that someone named "K" was going on paternity leave. The architect and the technologist responded, with a somewhat disappointing look, that they'd like to speak with him before he leaves. But when the mechanical engineer mentioned his replacement, "M", they both seemed relaxed. The technologist, referring to M, said he was happy with that choice because he had worked with her in past projects. The architect added that "she's good!!" The architect then suggested that the end-user meeting should be held as soon as next Tuesday (5th June). The project manager responded that he would send them (the end-users) both the architect's and the mechanical engineer's updated layouts (i.e. the one containing the changes). The architect then informed the project manager that he received some confirmation regarding end-user requirements via email from "J" (there are more than one "Js" in the end-user team, but the architect did not clarify which). The architect continued that he would like the confirmation to be done in a more formalized way because, as he (the architect) added, "that's a massive change and would require remodelling of the design". The project manager suggested that they could bring up the issue in the next users meeting.

The project manager ended the meeting, and everyone said their goodbyes.

Appendix E – A sample summary of observation notes, Case B

CEPM Case B 30th November 2018. (10:30am to 1pm)

Meeting attendees: The client representative, contract manager, senior architect, project manager (contractor-side), junior architect, quantity surveyor (client-side), lead user, senor mechanical engineer (client-side), electrical engineer (client-side), junior mechanical engineer (client-side), mechanical engineer (contractor-side), project manager (client-side), electrical engineer (contractor-side), and quantity surveyor (contractor-side).

Before starting the meeting officially, the teams were all engaging in a physical demonstration of furniture arrangement for the new building. There were lots of laughter as they move the meeting room desks and chairs around to demonstrate how mobility would look like in the new design. The lead character in the desk arrangement was the project manager (contractor-side), and he did the physical demonstration in response to the concern of the lead user and the client representative. Both the client representative and the lead user were concerned that there would not be enough space in the office room as currently depicted on the design layout. However, at the end of the demonstration, the lead users and client representative were both convinced that there would be enough space for the office rooms. After the demonstration, the client representative left the meeting room.

In the first few minutes in the meeting, the team members were discussing in pairs. However, the project manager (client-side) broke-up the private discussions by officially kicking off the meeting. He started by explaining that the client representative would re-join the meeting later because he stepped out briefly to finalise discussion with members of the first meeting conducted earlier today. He (the project manager) also mentioned that there would be changes in the style of distributing meeting minutes. He continued by highlighting that everyone is now expected to bring their own printed minutes as opposed to how it used to be in past meetings; when the minutes were printed by the contractor, and hard copies circulated during meetings. He added that, based on experience

from the past meetings, those minutes always ended up on the table after the CEPMs, which is a waste of papers.

The contract manager then initiated the discussion about a “bridge-link”. He mentioned that the design needs to be tweaked in a way that facilitates future augmentation. He also mentioned that the "build rating" came back, and it is over the excellent threshold. According to him, the design manager had circulated the update about the rating yesterday. And some meeting attendees responded by nodding their heads, which suggests that they had seen the message. According to the previous meeting minutes: The quantity surveyor (client-side) was expected to confirm who should be responsible for procuring some specified client equipment. The quantity surveyor reported today that he would confirm later after having a conversation with the lead user, the client representative, and the client project manager. And the contractor seemed satisfied with that. Next in the meeting minute, it was indicated that some new RDDs (reviewable design data) had been sent to the project manager (client-side) so that he could comment on them. He responded today that he had not commented on any RDD in the last four days. He, however, mentioned that if there was any RDD that needed urgent response, the person affected by the RDD should let him know – according to him, “to know which to prioritise”.

Also, from the previous minute, it was indicated that the client needed to confirm when the M&E company must submit “G59” application. Today, the contract manager mentioned that he did not know what G59 meant, and the mechanical engineer (client-side) explained to him. After clarifying the meaning of G59, the contract manager moved to the next topic on the meeting minute and informed the senior architect that the furniture installations would start in March 2019. When the architect started to explain that a new door had been added to a particular drawing (a sample of the drawing was glued to the wall in the meeting room), the project manager (contractor-side) stood up and went to the door to point to the specific area where he thought the new door would be positioned, and the architect confirmed he was right.

Next, the contract manager mentioned that he would like to have a “sit down” with the client to discuss change requests before or right after Christmas. The

project manager (client-side) mentioned that he would set it up with the client representative. However, the contract manager responded that he would also like X (another client manager) to be in that meeting to ensure that all decisions are made right there and then. The contract manager alluded that some of the changes were already discussed internally with the project manager (contractor-side) and that the purpose of the meeting was to get confirmations and instructions from the client. The contract manager added that the meeting would facilitate progress on drawings, notes, and sketches.

Moving on from the topic; the project manager (contractor-side) informed the team that the building control would be invited very soon for a site assessment. The project manager (client-side) asked what the name of the building control was, and project manager (contractor-side) responded that the name was "JayPee" * (name changed for anonymity).

Next, the mechanical engineer (contractor-side) presented the progress made so far on M&E services. He mentioned that not all comments had been incorporated into the drawings. He said coordination is progressing as expected but emphasized that some variations from the client needed further clarifications. He also highlighted that new variations are still coming in, "some even came in yesterday", he added. The mechanical engineer continued that he is aware of the change requests, but they are in "bits and pieces, and need to be collected together through the official channel."

Regarding some installations already carried out by the mechanical engineer and his team, the contract manager mentioned that they should ensure that these align with end-users' requirements and needs. The contract manager offered a piece of cautionary advice to the mechanical engineer that, "it is pointless to build something that does not suit their needs … it would be like shooting ourselves in the foot". In support of the contract manager's advice, and to assure the project manager of design consistencies, the junior architect also added that she would double-check with the subcontractors to make sure that their drawings align with hers.

The project manager (contractor-side) then mentioned that the toing and froing regarding changes and variations are frustrating, especially changes that came in after being initially approved by the client agents – i.e. the client-side mechanical engineer, electrical engineer, project manager, and quantity surveyor. The mechanical engineer (client-side) responded to the project manager's frustration that, rather than going through the official protocol of having the changes come through the client agents, the M&E (contractor-side) could handle those changes directly to reduce bureaucracy around the process and to smooth things out. Despite appreciating the mechanical engineer's recommendation, the contract manager responded that at some point early next year; "we have to draw a line in the sand" for the changes. Moreover, regarding progress with implementation, the mechanical engineer (contractor-side) mentioned that he hopes the building materials would arrive onsite within two weeks.

As the mechanical engineer was finishing his comments, the client representative walked in and joined in on the conversation. However, the team had to go over the discussions about changes again for the client representative to confirm officially and to approve those changes. One specific change that the mechanical engineer (contractor-side) and the electrical engineer (contractor-side) were particularly interested in was regarding the office furniture. They also touched on the issues of wheelchair access in office spaces. The client-representative responded to all their questions with firm answers. But regarding a question about wall requirement in the office space, he was not firm in his answer. He simply said, "I don't think so" when the project manager (contractor-side) asked him if there would be a wall in a specific area of the office. And regarding the cost implications of those change requests, the client representative asked the quantity surveyor (client-side) to advise, and he did. Next, the senior architect reported to the client that there was a "walk-around" onsite, particularly, to assess some overlapping infrastructure between the new build and J building (J building is one of the client's buildings in close proximity to the new building). The client representative confirmed that he was aware of the walk around, and that ended the topic.

Going on with access management, the senior architect displayed some drawings on the screen in the meeting room for a visual demonstration. During the presentation, the project manager (contractor-side) interrupted the architect and said, “there is storage everywhere” – indicating that he did not expect that much storage in the area. The architect responded to him that someone in the client team “was not happy” with it as well, but the client representative replied that the person “has no say on this”. The quantity surveyor (client-side) also interrupted the presentation, informing the architect and the project manager (contractor-side) that the client also needs “shelving drawings”. He added that the client wanted the contractor to supply and install the shelves. The project manager noted down the information and then turned to the client representatives and asked him to give the specification of the shelves. The client representative was not entirely sure, so the project manager suggested that he should give some ideas about “the ones you like even if it is just some photos”. The client representative simply grinned in reply.

Regarding taps – the senor architect displayed a kitchenette on the screen to demonstrate four potential options that the client could choose from. He then asked if the client representative wanted both hot and cold water to be controlled by one knob. The project manager (contractor-side) mentioned that the choice of a tap system would have implications on cupboard space, and details were explored by the team. The project manager (client-side) mentioned that the tap system was already discussed between the client representative, the mechanical engineer (client-side) and himself, but further deliberation was done collectively by the team. The client representative asked for an option of separate cold water with a filter. However, the electrical engineer (client-side) responded that this would have a considerable effect on cupboard space. The client representative replied that he was not driven by space on this one – “space doesn’t matter”, he added. The client representative went on to explain how the tap system currently works in the client’s existing buildings.

Regarding dishwasher space, the client representative would not like to confirm that yet, but the project manager (contractor-side) responded that, at least, he should confirm if he wanted a power-point and water supply connection in the

space. “Because it is a pain to do it retrospectively” – the project manager added for emphasis. The project manager concluded that once the client representative makes a choice and approves the kitchenette as designed by the senor architect, then it would be sent to “our kitchen guys”. Two processes noted here – first, the architect presents design options and explains the pros and cons of each option. The client assesses the options and makes a choice by approving one design. Second, the architect presents design options and explains the pro and cons of each, the client chooses one and makes a recommendation that it should be tweaked. The architect updates the selected design to reflect the client’s recommendation, sends it back to the client for approval, the client approves, and then this is sent out to the relevant subcontractor. However, if the client is still not happy with the updated drawing, it would be sent back for further updates, and this would continue going back and forth until an approval is made by the client or until the contractor “draws a line in the sand” at a point where a decision has to be made.

Regarding the overall progress of the program, the contract manager admitted that the contractor was a week behind. He argued that this was due to the delay in the delivery of stones. He forecasted that this should be sorted by 15th January, but also pointed out that it might be delayed till the end of January. He explained how the installation of the stones was done in the Q project (i.e. a previous building his company did for the client). Next, regarding curtain walling, the contract manager envisaged some delays that might result from wind interruptions. He then assured the client representative that plans were already in place to mitigate against those delays. He added that most of the site activities had started ahead of program time to beat potential delays except for one activity that is starting in the new year. And according to him, even that one activity is on the program.

The mechanical engineer (client-side) expressed his surprise about the contractor not following the RDD protocol for the plant room louvre. He was expecting the contractor to make an RDD for the plant room louvre and send it to him for comments before procurement was done. The project manager (contractor-side) responded by defending the contractor’s actions, which the mechanical engineer

did not fully agree to. And regarding the rainscreen, the contract manager mentioned that this had been installed, and confidently said to the client representative that, “it looks crisp and sharp”. He suggested to the client representative to go have a look at the rainscreen after today’s meeting.

Both the contract manager and the project manager (contractor-side) reported that the installation of the ductwork had been carried out. The project manager also added that a quality check had been carried out by the Clerk of Works as well as mechanical and electrical engineers (client-side). According to him, both Clerk of Works and the engineers were happy with the insulations. His statement was confirmed by the mechanical engineer, who also attended the meeting. Next, the quantity surveyor (client-side) informed the team that he already had a discussion with the quantity surveyor (contractor-side) about valuation. He reported the details of his discussion with the contractor-side quantity surveyor to the team. The team deliberated over the valuation, and the client representative asked some questions to clarify issues and to ensure that he had a proper understanding of the current state of the budget and cash flow – all questions were answered by the client-side quantity surveyor.

Moreover, regarding variation, the quantity surveyor (client-side) mentioned that there were two change orders; one is outstanding, and one had been commented on. He assured the client representative that all variations were up to date. Next, regarding health and safety, the project manager (contractor-side) mentioned that VFK** (name changed) had come for a site visit and made comments. He reported that comments had been implemented and feedback to VFK for their record. Also, regarding security, it was stated on the contractor’s report that no incidents had been reported. But the project manager verbally informed the team that some incidents took place after the contractor’s report was prepared. He mentioned that someone broke into an unauthorised site area, and the client’s security stepped in. The city police were also called, and they told the intruders “not to do it again”. Everybody laughed at the resolution of the police. The client representative then said, sarcastically, “that will work”. The issue of security was the last item on the contractor’s report, so the contract manager asked if anyone had questions.

The project manager (client-side) asked if the contractor had any corporate plans in place to mitigate the potential effects of Brexit on logistics. The contract manager acknowledged the importance of the question and admitted that a lot of materials were coming in from Europe. But he responded that due to "so much uncertainty about where things would go (post-Brexit), it is difficult to make a plan". He, however, assured that all furniture deliveries were due in early March. So, he was happy that the furniture would already be delivered before the official Brexit date. The project manager (contractor-side) then said jokingly that; "I plan not to be in the country on that day."

The project manager (client-side) asked another question on behalf of the lead user, and the question was directed to the mechanical and electrical engineers (client-side). The question is regarding "super clean water". The mechanical and electrical engineers responded that the lead user had a picture of the existing system that he presented to them, but not clear yet what "he's after". The mechanical engineer also added that this needs to be further discussed with the lead user to finalise the requirements.

Next, the mechanical engineer (client-side) asked a question about mechanical services. Both the contract manager and the project manager (contractor-side) responded to the question, and the mechanical engineer (contractor-side) also offered some explanations. The mechanical engineer (client-side) mentioned that there is a requirement for "cold room" in the original contract, but this was not shown in J's proposal and drawings for lighting and cooling unit. He added that the proposal does not align with what was in the mechanical and electrical requirements. He also mentioned that he had raised comments about this in one of the RDDs. The electrical engineer (contractor-side) apologized about this because, according to him, J had responded to the RDD, but he (the electrical engineer) had not circulated it. He, however, assured the team that this would be circulated asap.

The mechanical engineer (client-side) also raised a concern that he was not sure if the drawings for the ventilation, boiler, and compressor system were in compliance with standards. The project manager (contractor-side) responded to him why the design was done the way it was. The mechanical engineer then

called the attention of the project manager (contractor-side) to a hole in a specific wall that was not shown on any of the drawings. The project manager (contractor-side) said he was not aware of this but would take that on board when revising the drawings.

At the end of the meeting, the contract manager mentioned that he would circulate an invite later for an end of year lunch he is organising. The lunch was expected to take place on the day of the next meeting scheduled for 20th December.

Appendix F – A sample summary of observation notes, Case C

CEPM Case C 22nd June 2018 (10am – 1pm)

Meeting attendees – Contractor's project manager, contractor's operations director, client project manager, the client, client representative, client agent, client assistant, and contractor's senior quantity surveyor.

Purpose of the meeting: a routine progress meeting.

Right at the beginning of the meeting, the client assistant mentioned that he sent feedback to the contractor's site manager on some of the drawings that were earlier forwarded to the client team. He thought the drawings were good but was concerned about – what seems to be – an additional floor in the drawing. Since the site manager was not in the building (away for his 25th wedding anniversary), the contractor's project manager stood up to address the client assistant's concern. The project manager used a photo on the wall of the meeting room – i.e. a photo of how the building would look like once completed – to visualise his explanations. The project manager explained that what looked like an additional floor was, in fact, a part of the elevation. He also emphasised that nothing had changed as there was no extra floor added. The client assistant then admitted that he had misread the drawing.

As the meeting continued, the client came in and introduced himself, and I introduced myself to him. He jokingly told me – "Samuel! You probably haven't met a nutcase like me before, but I'm a rich nutcase". Everyone laughed. The contractor's operations director explained further to the client that I am doing my PhD on collaborative work in teams. So, with regards to collaboration, the client responded that he was so far pleased with the work of the contractor's team. Then, he suggested that the team should stick to the agenda as the meeting proceeds.

They went through the minutes of the previous meeting and mostly agreed with the actions taken so far. One main issue that was first discussed was the car charge [which also connects with a discussion I observed at a previously held DTM]. The client insisted that he wanted twelve charging points, and these should be inside the building where the car park is located. He mentioned that

he has been talking to an agent about it because he wanted this to be done with the future of cars in mind – that is, the expectation that cars will soon be mostly hybrid. So, he would like a feasible solution to meet those future demands. Then the contractor's project manager presented the contractor's report and indicated that the succession of events had slightly changed from what was agreed upon four weeks ago but stressed that the changes did not affect the completion date. By completion, he seemed to be referring to specific events that were meant to be completed on 30th August. And without first responding to the changes in the contractor's report, the client expressed his satisfaction that a member of the senior management attended the meeting today. He jokingly said this in acknowledgement of the operation director's presence in the meeting. He then responded to the project manager that he was happy the changes in the sequence of events had no negative effect on the completion date.

The client raised another issue relating to bracing – he would like to know how the design team plan to get the bracing done without having an impact on the window. The project manager explained the plans of the design team to the client, and he seemed satisfied as he moved on to ask about decking – which the project manager also explained. The operations director was, at this point, taking notes. The client seemed to be also satisfied with the explanation about decking because he gave a positive remark after the project manager's explanation – "OK, well done!" he remarked, satisfactorily.

The client then narrated a story of his experience in a UK city, "Y city". He talked about a particular building at Y, that the design was horrible, and would not like this current building to be like that. He said this when the project manager was explaining how the acoustic work would be done. The client expressed his concern that "I wouldn't want to have sound problems in the rooms". He continued that he had a serious struggle communicating with people in a meeting room at Y city. He added that the problem in the meeting was related to bad acoustics. The project manager then mentioned that they could use some "flat panels" with the acoustics as that is expected to produce good outcomes. The client then proceeded to talk about façade consulting. He asked if the design team had met any façade consultant. The client assistant responded that the

design team were in contact with one person in a consultancy firm. The client then responded, “so he is looking for our interests there?", his assistant said, yes!

The project manager moved on to the next item on the agenda, which relates to the blockwork. The client did not seem to understand what that was about as he asked the project manager to clarify. The project manager explained by pointing to the ongoing construction work – which was visible from the window of the meeting room where we were all seating. After the project manager’s explanation, the client responded, “Yeah! OK, got you!”. He then asked to know who was responsible for doing the blockwork, but his assistant responded that they didn't know yet, as that had not been decided.

Outside what was initially expected, or at least planned for in the project agenda, the project manager stressed in a satisfactory tone that “we’ve lost no dates due to accident, health and safety issues or even weather”. He even added that there had not been any visit from the enforcing authorities. The client interrupted that he was surprised that the enforcing authorities had not visited the site – he thought it was not good. But the project manager responded that “it’s actually good because we get nervous when they are here”. But, as it appears, to keep the client’s mind at rest, the project manager showed him all the reporting and assessments (e.g. quality check, and health and safety reports) that had been conducted to ensure compliance with the requirements of the enforcing authorities. The client responded that he was satisfied with the amount of reporting conducted by the contractor team. He thinks “it’s good practice … and it lifts my spirit to see that all these are been done”.

The project manager, supported by the operations director, went on to explain that they had had an onsite visit from considerate construction scheme, but the report of the rating had not been received. He also explained to the client what the rating from the considerate construction scheme meant and assured him that “we are expecting a good outcome because the examiner gave us good feedback onsite”. The client project manager then asked the contractor’s project manager what score they were looking for when the rating is out. The project manager and the operations director responded simultaneously as if it had been previously agreed upon, that they were expecting a thirty-eight rating. And the operations

director added that this would be a very good rating because it is thirty-eight of fifty.

Then the next agenda was regarding the financing of the project, which was expected to have been sorted out by the client. However, the client explained the challenges he had been facing with lawyers and banks in getting loan cleared. According to him, the bank was requesting some documents and warranties, which he thinks were unnecessary. He also thinks the process should normally take three months but has now dragged for up to ten months. He added that he was frustrated last week, and after expressing his frustration and disappointment to the bank, "they came to their senses and sent the needed documents to me for signing". So, he gave his assurance regarding finances that everything was in proper order.

Then the client assistant asked about a particular lift in the building, which he was concerned about. He thought the dimensions of that particular lift (which was meant for disabled people) was different from the others and was concerned that this might make it look different. He added that – "we are trying to make the lifts look the same, will they?" The project manager responded that on the outside, all the lifts would look the same. The difference in dimension of the disabled lifts (needed extra height) will not be visible from outside, he added.

Another problem identified was regarding the ceiling height. After much deliberation how this could be sorted, no feasible solution was reached. The client was surprised that the problem with the ceiling height was just coming up at this stage of the project – "it looks serious!" he added. The project manager responded that the architect (not in attendance) was working on potential solutions for the ceiling. (I plan to ask further clarifications on this issue during interviews with the architect). However, during my post-meeting chat with the client project manager, he told me that this ceiling problem could have been avoided if an extensive project BREEAM was done at the beginning of the project (i.e. during the planning stage). His assertion suggests he was apportioning blame to the architect or the design team, but I did not probe further on this.

The client assistant then raised an issue that was unclear to him in the reports. He said he saw in one of the reports that they (not sure who "they" were) are going to use cranes to pick things up from the third floor, but "quite confused about this". The project manager explained how that works and the client assistant seemed satisfied with the explanation.

The client project manager then asked how the project objectives would be measured in the end. The operations director responded that some of the objectives are straight forward and mentioned completion time and budget as examples. But he continued that the issue of collaborative working is quite subjective – "it's more of the feel", he remarked.

That seemed to be the end of the agenda as the operations director thanked the project manager for a good report and presentation of progress. The contractor's quantity surveyor then mentioned that some of the documents and drawings would need to be shared on Dropbox. The client was confused and asked – "what is a Dropbox?" The quantity surveyor replied that it is an online storage space for data and document sharing, and the client said, OK. The client then went on to talk about the importance of security control in the building. He thinks security men must be in the building in addition to any control systems that are included in the design. The client assistant responded to him jokingly that "you'll pay for it", and the client replied, "don't I know". Everybody laughed.

Finally, while discussing with the client project manager after the meeting, I realised that a break in collective intelligence does not necessarily have to be about unreported modifications to agreed plans; it could also be related to a change in project members without properly inducting the new members into their roles. The client project manager mentioned how new members would usually defend themselves, for example, when asked to clarify certain aspects of the project relating to their roles. According to him, some new members would claim that they were not on the project when those events happened. He added that they would want to shift the blame to the person that was previously responsible for the role who, in most cases, is also from their company.