Shared and Fragmented Understandings in Interorganisational IT Project Teams: An Interpretive Case Study

Abstract

Shared understanding is essential in interorganisational projects to integrate the divergent knowledge of individual team members and support collaborative knowledge building. This can nevertheless be a challenging undertaking in interorganisational projects as team members must continuously negotiate differences in their organisational and professional backgrounds during project work. In this paper, we explore how interorganisational IT project teams deal with sources of 'fragmentation' in their understanding, explicating the theoretical and practical implications that these have for project management. Our study is needed to explore the increasingly complex and emergent nature of interorganisational project management today where neither goals nor the means of attainment are known with precision at a project's launch. We analyse interpretive case study findings from an 8-month IT project involving diverse organisations from industry, academia, and healthcare. Based on our findings, we develop a framework which highlights the relationship between three sources of fragmentation of understanding (*interpersonal*, *technical*, and *contextual*) across key project activities. We contribute towards project management literature by revealing how these sources of fragmentation might be overcome through framing project activities (the *problem*, *method*, and *solution formulation*) differently. While fragmentation may characterise any, or all, of these key activities, it is not without remedy.

Keywords: Interorganisational projects; shared understanding; fragmentation; knowledge integration; systems development.

1. Introduction

Modern organisations are under increasing pressure to develop new products and services for increasingly varied and volatile markets. To help achieve this goal, interorganisational project teams are formed temporarily to leverage the diverse knowledge, skills, and problem-solving approaches of team members from different organisational and professional backgrounds (Jones & Lichtenstein, 2008; Stjerne, Söderlund, & Minbaeva, 2019). Literature suggests that shared understanding is central to the effective functioning of these interorganisational project teams and provides the foundation of collaborative knowledge building (Lehtinen & Aaltonen, 2020; Jones and Lichtenstein, 2008). Shared understanding is said to emerge when team members "concur on the value of properties, the interpretation of concepts, and the mental models of cause and effect with respect to an object of understanding" (Bittner & Leimeister, 2014, pg. 115). Prior research on knowledge management has considered the need for collective sensemaking in projects, and the integration of various knowledge bases across different functions and organisations. However, empirical research on interorganisational project teams and shared understanding is still emerging (Lehtinen and Aaltonen, 2020). There is a recognition among scholars that new theoretical frameworks are needed to explore the unique characteristics of shared understanding in distributed team environments, particularly in relation to the contextual issues associated with different organisational structures and cultures (Jones and Lichtenstein, 2008; Ratcheva, 2009; Yu and Petter, 2014).

Shared understanding in interorganisational project teams cannot be assumed given the diverse interests, values, and perspectives of team members (S. Daniel, Agarwal, & Stewart, 2013; Kotlarsky & Oshri, 2005; Lehtinen & Aaltonen, 2020). For instance, interorganisational project teams are characterised by fluid team boundaries, temporary membership, and cross-functionality which can hinder their performance unless properly addressed (Jones &

Lichtenstein, 2008; Lehtinen & Aaltonen, 2020; Stjerne et al., 2019). Collaboration can also be hampered by the entanglement of practices in the interorganisational environment, and uncertainty owing to the lack of shared context between team members. The challenge is heightened by a lack of shared history between dispersed team members, and interpersonal differences emerging from their diverse organisational backgrounds (Adenfelt, 2010; Ratcheva, 2009; Sarker & Sahay, 2004; Wiewiora, Trigunarsyah, Murphy, & Coffey, 2013). Despite the high level of dependency between interorganisational project team members, individuals may propose very different solutions to the problem at hand which can lead to conflict (Stjerne et al., 2019).

In this paper, we explore sources of 'fragmentation' in interorganisational team members' understanding based on underlying differences between diverse social groups involved in decision-making processes (Buchanan, 1992; Conklin, 2005; Head, 2008; Rittel & Webber, 1973). Fragmentation in understandings can arise where individuals' perspectives and intentions are dispersed rather than unified (Conklin, 2005). This is a particular challenge in situations involving stakeholders with different roles, interests, and values such as interorganisational project teams (Adenfelt, 2010; Garrety et al., 2004; Ruuska & Vartiainen, 2005). Research on fragmentation challenges the 'rational-technical approach' to decision-making which assumed "impossibly high levels of goal-clarity, coordination and performance information", and ignored the likelihood of divergent political judgements among diverse stakeholder groups (Alford & Head, 2017, pg. 399). Fragmentation also provides a counterexample to situations where the decision-maker has all the information required for understanding particular problems (as epitomized by the rational-technical approach) and designing solutions which can be judged objectively as right or wrong (Alford & Head, 2017).

Our appreciation of such challenges appears to be fundamental to effective knowledge integration in interorganisational projects. But despite its potential for explaining sources of project complications, fragmentation has received limited attention as a theoretical lens in interorganisational project management literature to date. Further research is therefore required to explore how shared understanding is reached in interorganisational project teams through overcoming sources of fragmentation during decision-making (Bakker, 2010; Jones & Lichtenstein, 2008; Lundin & Söderholm, 1995). Our knowledge of fragmentation in this context could help address sources of project failure going forward, revealing the challenges faced by diverse team members when completing non-routine and non-repetitive tasks within the project's constrained timeframe (Bakker, 2010; Bechky, 2006; Jones & Lichtenstein, 2008; Lundin & Söderholm, 1995).

Consequently, in this paper, we aim to investigate the following research question: *What factors shape team members' understanding in interorganisational projects?* In investigating this question, we present empirical evidence from the interpretive case study of an 8-month interorganisational Information Technology (IT) project involving partners from industry, academia, and healthcare. IT projects provide a suitable context for investigating shared and fragmented understanding given the highly knowledge-intensive and ill-structured nature of systems development (Choudhury & Sabherwal, 2003; Kirsch, Sambamurthy, Ko, & Purvis, 2002; Wiener et al., 2016). IT projects require team members to combine diverse sources of knowledge during the design, development, and implementation of both physical and abstract deliverables such as user interface designs, software prototypes, system interfaces, test scripts, and models of enterprise IT architecture. Interorganisational IT project are also unique in that they typically involve emergent technologies, user groups that span multiple contexts, and non-routine tasks which team members may have limited prior experience of managing.

We make several contributions of interest to academics and practitioners. We firstly develop a novel theoretical framework to describe and explain *interpersonal*, *technical*, and *contextual* sources of fragmentation in interorganisational IT project teams' understanding and their co-existence within a single setting. While fragmentation is a well-established concept in the fields of planning and design, its use in project management literature is nascent. We then reveal how fragmentation in understandings can characterise any, or all, of the follow project activities: the *problem*, *method*, and *solution formulation*. Based on this, we extend literature by highlighting the implications that this has for knowledge integration in interorganisational project teams, breaking open the unique challenges inherent.

The paper is structured as follows: Section 2 provides the theoretical underpinning of our paper by reviewing relevant literature on shared and fragmented understanding in interorganisational project teams. Section 3 describes the research design of our interpretive case study which centred on an interorganisational project involving a university research centre, three industry partners, and a public hospital. Section 4 then presents the analytical vignette of a design specification meeting in this interorganisational project to offer an in-depth description of the data collected. Section 5 presents our analysis of findings using the theoretical lens, with a focus on *interpersonal*, *contextual*, and *technical* fragmentation sources in the interorganisational project team. Section 6 discusses the theoretical and practical implications from our study while Section 7 brings the paper to a conclusion.

2. Theoretical Development

2.1. Shared Understanding in Interorganisational Projects

Shared understanding refers to a state when team members have a common interpretation of the tasks to be completed, the approaches required to complete these tasks, as well as their

intended outcomes and deliverables (Bittner & Leimeister, 2014; Robert Jr, Dennis, & Ahuja, 2008; Windeler et al., 2015). The concept of shared understanding has received increased attention in recent years, particularly within the context of distributed teams where research suggests shared understanding is essential for the promotion of effective and meaningful communication (Hummel, Rosenkranz, & Holten, 2016; Windeler et al., 2015). Shared understanding has been shown to contribute positively towards teams performance by enabling project team members to resolve differences in interpretations and perspectives (Adenfelt, 2010; Hinds & Mortensen, 2005; Reich, Gemino, & Sauer, 2014; Robert Jr et al., 2008). Ratcheva et al. (2009) find that the performance of diverse project teams is enhanced by sharing knowledge across three boundaries: project action (professional communities and companies of the team members involved), project knowledge (context which the project outcomes are targeted), and project social (utilising networks to understand the interpretive mechanisms of professions). Shared understanding can also help team members utilise their knowledge resources more effectively by guiding the exchange of knowledge, specifically in terms of what knowledge to exchange and when to exchange it (Robert Jr et al., 2008; Windeler et al., 2015). Jones and Lichtenstein (2008) find that a shared understanding of knowledge content, roles, and role behaviours can help improve knowledge sharing and coordination in interorganisational project teams. This in turn supports interorganisational team members when designing solutions to identified problems and allows them to anticipate challenges. Shared understanding is also important for developing solutions that satisfies the needs of different stakeholder groups (Lehtinen & Aaltonen, 2020; Windeler, Maruping, Robert, & Riemenschneider, 2015) and preventing unintended consequences in the process such as late changes to requirements, rework, delays, and wasted resources (Weeger & Ott-Schwenk, 2017). Lehtinen & Aaltonen (2020) empirically show how a shared understanding of both

organisational structures and values is key to facilitating timely organisation and genuine cooperation in interorganisational project teams.

However, previous literature also asserts that shared understanding is often very difficult to achieve within interorganisational project teams due to the lack of a shared context and shared history between dispersed team members (Chudoba, Wynn, Lu, & Watson-Manheim, 2005; Hinds & Mortensen, 2005). Adenfelt (2010) discuss how the different 'thought worlds' of team members from different organisations and professions can impede the creation of a shared purpose and requires an appreciation of the organisational context in which they are embedded. The divergent nature of interorganisational team members' perspectives can in turn create contention around the problem formulation and solution design (Windeler et al., 2015). Issues of shared understanding are confounded as interorganisational project teams are often not able to benefit from frequent face-to-face communication and must instead rely on technology mediated communication (Hinds & Mortensen, 2005; Windeler et al., 2015). However, Ratcheva (2009) finds that epistemological differences in diverse project team members' knowledge may be more potent than geographical boundaries alone. This further impedes knowledge sharing and the emergence of trust in the interorganisational project team (Bakker, 2010; Jones and Lichtenstein, 2008). More research is still needed to empirically explore the emergence of understanding in diverse project teams and the steps along this complex journey (Ratcheva, 2009).

Building on the work of Farrell and Hooker (2013) and Lundin and Söderholm (1995), we refine our focus to look at how understanding emerges across three key decision-making activities which are critical to a project: *problem formulation*, *method formulation*, and *solution formulation*.

Problem Formulation centres on decisions around the problem to be solved in the field and shapes the activities that will be pursued to frame this problem and develop a narrative about it (Bakker, 2010; Lundin & Söderholm, 1995; Humphreys and Jones, 2006). Jones and Lichtenstein (2008) assert that interorganisational projects can respond to problems which cannot be addressed through an organisation's everyday operations, allowing the creation of new objectives that respond to disruptive changes. Similarly, Garrety et al. (2004) note that IT projects benefit from expertise drawn from diverse sources when developing and leveraging new technologies that address complex organisational problems.

Method Formulation focuses on deciding the 'modus operandi' of how the team will address the given problem. For example, team members may decide to follow an agile approach to project management which promotes ongoing team interactions over large bodies of structured documentation. Lundin and Söderholm (1995) suggest that such decisions around the method are influenced by individuals' tacit knowledge, dispositions, and experience around previous approaches that they have employed. Methods and habits inherited from diverse organisational origins are likely to require adaptation by interorganisational team members. This means that methods will need to be agreed upon prior to the achievement of substantive progress as such choices are likely to have an impact on project performance later (Lu et al, 2019)

Solution Formulation then focuses on deciding the solution that will be developed to address the aforementioned problem. For instance, prototyping can be used to create iterations of a system which stakeholders then provide feedback on. Conklin (2005) finds that this process can also contribute to higher levels of shared understanding around potential problems, as the problem-space is refined through the formulation of potential solutions. This is consistent with Humphreys' (1989) concept of representation levels where the narratives describing problems are refined by the inclusion of constraints bearing on their characterisation.

2.2. Fragmentation in Understanding

Fragmentation in understandings emerge from seemingly irreconcilable social differences between groups involved in decision-making processes, where the technical and contextual information needed to arrive at a solution is incomplete and always changing (Alford & Head, 2017; Conklin, 2005; Farrell & Hooker, 2013). Buchanan (1992) states that such situations necessitate political trade-offs among social groups to negotiate their different interests, values, and perspectives, particularly when there is no definitive knowledge source which would allow the team to objectively judge a problem or solution as right or wrong.

Prior literature has explored project contexts where solutions are very difficult, if not impossible, to determine (Bakhshi, Ireland, & Gorod, 2016; Ireland, Rapaport, & Omarova, 2012). Bark, Kragt, and Robson (2016) discuss interdisciplinary project team work where diverse professions must navigate considerable complexity and uncertainty to create an agreed solution for managing and evaluating research projects. To overcome these issues, Bark et al. (2016) suggest the need for 'synthesisers' who foster communication and learning across organisational and professional domains. Wied, Koch-Ørvad, Welo, and Oehmen (2020) speaks to the complexity of exploratory projects where, despite broad recognition of the problem, a lack of consensus exists around its management and solution. The authors call for further research in this area given the increasingly emergent nature of project management today where neither goals nor the means of attainment might be known at a project's launch.

A number of scholars have considered overarching sources of fragmentation in project team's understanding such as project complexity (Bakhshi et al., 2016; Wied et al., 2020). Building on their systematic review of literature, Bakhshi et al. (2016, pg. 1203) define complex projects as intricate arrangements of interrelated tasks that "change and evolve constantly with an effect on the project objectives". Addressing fragmentations in understanding is therefore

crucial given the presence of numerous autonomous yet connected parts. Indeed, Bjorvatn and Wald (2018) show a direct link between project complexity and delays and overspending which they assert can only be addressed by team-level shared understanding. Qureshi and Kang (2015) call for more attention to be directed towards issues of complexity (i.e. variety and interdependencies) within a project to reduce the probability of project failure.

As research on fragmentation in project management is still emerging, considerable gaps remain (Bakhshi et al., 2016; Wied et al., 2020). To begin with, research is needed to explore the impact of fragmentation on knowledge integration in temporary organisations, and the impact on project management activities going forward (Bakhshi et al., 2016; Bark et al., 2016; P. A. Daniel & Daniel, 2018). The indeterminacy of problem, approach, and solution formulation calls into question traditional project management approaches which assume that the goals and means of a project are known in advance (Bakhshi et al., 2016; Lenfle, 2014; Wied et al., 2020). Interorganisational project teams in particular, face unique challenges when exploring uncertain business contexts and resolving the differing objectives of numerous stakeholder groups (Lehtinen & Aaltonen, 2020; Stjerne et al., 2019). This requires interorganisational project teams to continuously share ideas, resolve conflict, and coordinate resources to deal with high levels of 'socio-technical confusion' (Adenfelt, 2010; Hsu et al., 2014; Sawyer, Guinan, & Cooprider, 2010; Xia & Lee, 2005).

Consequently, there have been calls for more attention to be directed towards fragmentation in order to break down its features into smaller more manageable parts (Alford & Head, 2017; Noordegraaf et al., 2019). Building on the works of Head (2008) and Conklin (2005), we develop a conceptual framework for exploring how fragmentation in understandings can emanate from one or more of the following sources: (1) *interpersonal sources* concerning team members' values, interests, and perspectives; (2) *technical sources* related to the tasks

necessary to develop new project artefacts and deliverables; and (3) *contextual sources* related to the organisational environment (see Figure 1).

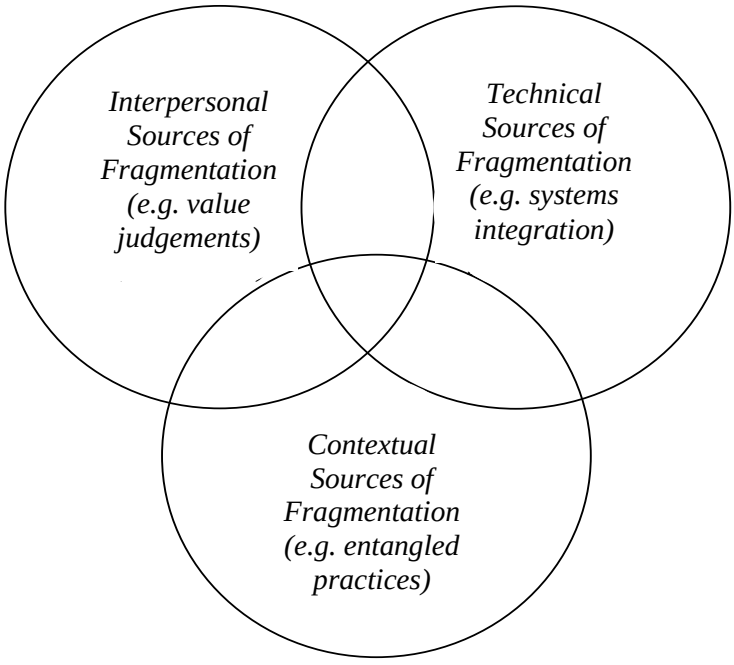

Figure 1: Sources of Fragmentation in Understanding

2.2.1. Interpersonal Sources of Fragmentation

Interorganisational projects involve the social construction of knowledge as diverse professionals from different backgrounds must continuously interact in order to share and integrate the knowledge required for goal achievement (Lehtinen & Aaltonen, 2020; Stjerne et al., 2019). For instance, IT projects teams must collaboratively build new understandings around the development of a system in order to arrive at an appropriate solution within a constrained timeframe (Lee, Park, & Lee, 2015; Luna-Reyes, Zhang, Gil-García, & Cresswell, 2005; Sawyer et al., 2010). Levina (2005) explores how the process of sense-making and negotiation can be impeded by disagreements between team members from different

organisational and disciplinary backgrounds who come to the project with different values, interests, and perspectives. Interpersonal sources of fragmentation are particularly prevalent in instances where there are high levels of both sense-making and sense-breaking in group decision-making processes (Giuliani, 2016), with no guarantee of shared understanding.

Prior literature suggests that fragmentation can arise in interorganisational projects team due to social differences in value systems, interests, and perspectives (Barki & Hartwick, 2001; Luna-Reyes et al., 2005; Robey, Smith, & Vijayasarathy, 1993). Addressing these interpersonal sources of fragmentation requires the continuous sharing and negotiation knowledge to challenge the underlying assumptions of others within the group (Noordegraaf et al., 2019; Weber & Khademian, 2008). Geraldi & Söderlund (2018, pg. 56) have highlighted interpersonal aspects of project management as a key area of research, focusing on "complex networks with interesting cases and opportunities for learning".

2.2.2. Technical Sources of Fragmentation

Interorganisational projects are characterised by technical-related sources of fragmentation which concern the numerous task factors that are both within and outside the control of the project team (Qureshi & Kang, 2015; Schmidt, Lyytinen, & Mark Keil, 2001; Xia & Lee, 2005). For instance, in interorganisational IT projects, developers are frequently tasked with integrating emergent technologies with the more archaic legacy systems present in the IT architecture of organisations. Xia and Lee (2005) outline technical complexity as an inherent dimension of IT projects and operationalise measures including: complexity of communication, diversity of IT platforms, scope of effort, systems integration effort, and installation ease.

Sammon & Adam (2010) discuss the technical challenges faced when integrating an enterprise-wide Enterprise Resource Planning package with existing legacy systems in an

established organisation. Their findings further point to measures of technical complexity that are specific to IT projects, including decisions around the choice of design techniques and development methodologies. An IT project may be further complicated by the integration of immature technologies, IT platforms which have not been used in previous projects, or incompatible methodologies (Wallace, Keil, & Rai, 2004; Xia & Lee, 2005). Swanson and Ramiller (2004) discuss how fads and fashions in the IT sector can place pressure on IT professionals to "jump on the bandwagon" and implement emerging technologies, despite uncertainties around the underlying business case. Literature has called for further research on the operational challenges of systems development (Hassan and Mathiassen, 2018).

2.2.3. Contextual Sources of Fragmentation

Context related sources of fragmentation arise from the complex interconnections between practices across different organisations, where changes in one practice reverberate through other practices (Adenfelt, 2010; Bakker, 2010; Ratcheva, 2009). Interorganisational projects are often characterised by indeterminacy due to the ill-structured boundaries within and across organisational contexts (Jones & Lichtenstein, 2008). Fragmentation in understanding can also arise in contexts characterised by high-levels of socio-technical change, affecting how individuals perform actions and engage in problem-solving within the confines of underlying organisational structures (Newell, 1993; Newell & Simon, 1972; Rittel & Webber, 1973). For instance, Johannesson and Perjons (2017) discuss the entanglement of contexts within learning content management systems by mapping the interconnections between practices such as teaching and learning, student evaluation, and staff recruitment. They assert that IT project teams must seek to understand the relationship between these contexts in order to build effective

IT solutions, particularly in situations where seemingly simple questions as “who is the client?” is difficult to answer.

Some scholars have criticised highly analytical approaches to planning and design, contending that a focus on rationality in decision making does not capture the inherent fragmentation of real-life organisational contexts which are rife with fragmented understandings and contentious value judgements (Adenfelt, 2010; Buchanan, 1992; Coyne, 2005; Geraldi & Söderlund, 2018; Rittel & Webber, 1973). Instead, Ratcheva (2009) and Jones and Lichtenstein (2008) call for more research on how diverse groups engage in dialogue to understand complex project contexts during planning activities. Geraldi & Söderlund (2018) also prioritise contextual aspects of project management as an area of future research in order to better understand the relationships between the different organisations, teams, and individuals involved in undertaking a project.

Building on the review of literature presented above, we seek to investigate how three sources of fragmentation in understandings – interpersonal, technical and contextual – occur across three key stages of interorganisational projects – problem, method and solution formulation.

3. Research Design

An interpretive case study (Walsham, 2006) was chosen to explore our research question: *What factors shape team members’ understanding in interorganisational projects?* Single case studies offer a recognised and rigorous approach for theorising in academic research (Eisenhardt, 1989; Yin, 2017). Single case studies have previously been used to explore knowledge sharing between individual and groups, as well as the surrounding contexts in which these interactions occur (Adenfelt, 2010). They are particularly appropriate where the case is deemed extreme, revelatory, or unique to the phenomenon of interest (Seidel et al., 2013).

Consequently, we adopted a purposeful sampling (Patton, 1990) to select the unique case of an IT project involving team members from different public and private organisations who faced considerable challenges in reaching a shared understanding. This sampling approach was based on three criteria of complexity (cf. Bakhshi et al., 2016): (i) *Diversity*: Team members came from diverse multi-disciplinary and organisational backgrounds which created differences between their interests, values, and perspectives, (ii) *Emergence*: All projects were without precedent in their respective organisations and few exemplars were available to guide how tasks should be conducted, and (iii) *Connectivity*: the project involved numerous interconnected and related practices, and ill-structured organisational boundaries. We view complexity varying by degree (Alford & Head, 2017) and chose to follow the 'common usage' of the term (cf. Klir, 1985). This builds on Suchman's (2007, pg. 19) assertions that the complexity "*of situations is a distinction that inheres not in situations but in our characterizations of them; that is, all situations are complex under some views and simple under others… situations are not quantities of pre-existing properties dealt with more or less fully*".

Our unit of analysis was the field of practice (i.e. the interorganisational project) which is defined as the situated, temporal, and dynamic nexus of action in the social world where individuals, groups, and subgroups, and technological objects continuously interact (Nicolini, 2012; Schatzki, 1997). The unit of observation was team interactions, the micro-level foundation of understanding (Bittner & Leimeister, 2014).

3.1. Case Description

Our interpretive case study focused on an 8-month (May 2015 to January 2016) healthcare IT project involving organisations from industry and academia, including a university research

centre (*R&D Inc.*), a multinational technology company (*Insight Inc.*), a local start-up (*Potential Inc.*), and a national public hospital (*District Health)*. The names of each organisation have been disguised and bear no relationship to similarly named organisations that might exist in the real world. *R&D Inc.* is a research institution with a centre located in a national university which offers research, development, and innovation capabilities to domestic and international companies. *Insight Inc.* is a multinational technology firm that delivers hardware products (e.g. cloud IT infrastructure), software products (e.g. data analytics solutions), and consulting services across a range of industry sectors including finance and healthcare. *Potential Inc.* is a local start-up focused on the remote monitoring of patients' wellbeing through IT. The clinicians involved in project were based in a national hospital, *District Health*, one of the largest in its country in terms of population coverage which employs over 3,000 full-time staff. In addition, the project had five wider stakeholders who while not directly responsible for project work, were involved in overseeing its completion. This included three senior managers in *Insight Inc.*, as well as a director and innovation lead in *Insurance Inc.*, a national provider of medical insurance who offer products and services to both individual and corporate market sectors. Insurance Inc. contributed cash and benefit-in-kind to support the funding application but were not directly involved in the completion of project work. The project was seen as an opportunity for each organisation to enhance their operations and strategically license any intellectual property generated during the project. The private organisations (Insight Inc., Potential Inc., and Insurance Inc.) would seek to exploit commercial opportunities in new marketplaces, while the public organisations (R&D Inc. and District Health) would aim to develop new expertise and systems for use on future research projects.

The project consisted of 12 core team members across the four organisations and two main knowledge sharing communities: A clinical researcher, research nurse, and clinical lead from

the national public hospital were tasked with providing medical knowledge, coordinating the research study and end user training, and setting directions for the scope of clinical work. A principal investigator (PI), project manager, full-time developer, part-time developer, funded investigator, and analyst from the university research centre were then tasked with setting directions for the scope of IS work, coordinating deliverables, integration testing, requirements gathering and workshop coordination. Finally, a data architect in the large global technology company, programmer and founder of the local start-up were responsible for the data analytics work package, and non-functional requirements, respectively. Figure 2 presents a project diagram illustrating the interorganisational interactions in the network that were investigated by the authors.

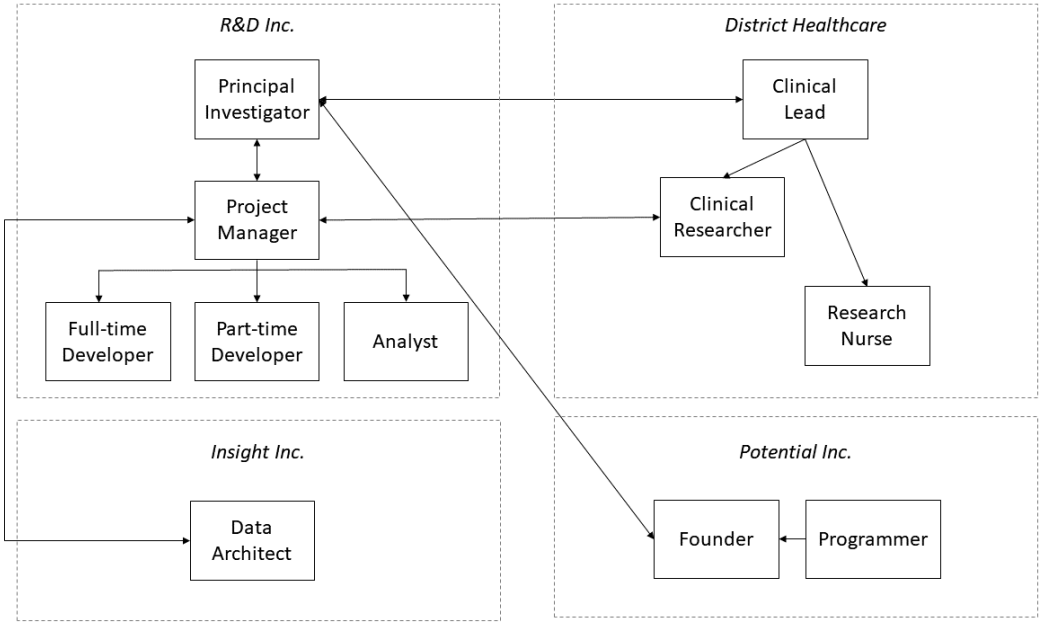

Figure 2: Project Network Diagram

The IT project consisted of five phases depicted in Figure 3. The allocated budget was €365,000 over a period of 24 months; however, the project team was tasked with completing all phases of systems development during the first eight months, a constrained timeframe for delivering

the complex system that was proposed. The lack of shared history between team members as well as the uncertain nature of the project offered unique conditions for investigating our research question. The project was to have two primary outputs; firstly, a new healthcare IT platform to enable the remote monitoring of patients' (pregnant women) wellbeing across different settings such as the patient's home, hospital clinic, and GP clinic. This platform consisted of an Electronic Medical Record (EMR), medical devices and an application for recording patient's vital signs. Secondly, a research study was to be conducted involving patients, using the deployed platform to record symptoms, and vital signs readings. Stakeholders evaluated the project as a success, with the platform going live on time and on budget for the conduction of the research study. This platform is still in clinical use at the time of writing, with follow-on projects planned to commercialise the platform. For the purposes of our case study research, we will focus our attention on the eight months of systems development: the period from May 2015 to January 2016.

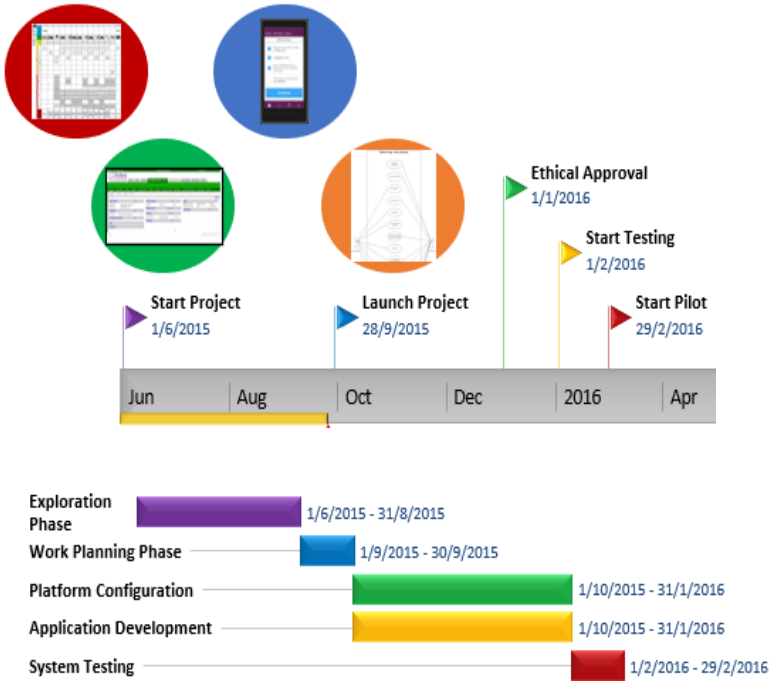

Figure 3: Project Phases

As team members were dispersed across different organisations, they interacted through a mix of face-to-face and online interactions. For instance, the team engaged in online interactions (using email, teleconferencing, and a knowledge management system) to collaboratively define the project scope, explore different approaches, and transfer disciplinary knowledge. The project team had no previous experience of working in the healthcare IT domain and did not have a shared history of working together as a team. Scheduled face-to-face meetings were organized, including a series of workshops to formulate the project vision and to elicit requirements for the platform. From a project scope viewpoint, the situation was further complicated by a pre-existing set of project documents from the funding application process which the team needed to consider during their deliberations. This acted as a constraint for the team as it was deficient in some crucial respects, having been written many months previously.

3.2. Data Gathering and Analysis

The lead author was a full-time member of the interorganisational team for a period of eight months, and he had direct access to the live project environment. To increase robustness of findings, data was collected and triangulated from three different sources: direct participant observations, interviews, and project documents. Participant observations were collected across different locations and events, such as co-design workshops, team meetings, as well as informal conversations. Observations were recorded in field notes across more than 40 events, typically lasting between two and eight hours (e.g., project team meetings, and day-long workshops). During these events and the resulting conversations, the lead author documented instances where team members did not reach a shared understanding and some of the contributing sources. This data was complemented by twelve semi-structured interviews with the interorganisational team, with each interview lasting between 60 and 90 minutes. Interviewees

were selected based on their direct involvement in undertaking project work and their role in delivering assigned work packages in the project plan. Interviews followed the thematic outline listed below:

- Understanding of the interviewee's project role, organisational approach, and the proposed vision for the project.
- Perceptions of complexity and uncertainty in the project proposal and plan.
- The impact of interests and values on team members' ability to reach a shared understanding of the healthcare IT solution.
- Impressions of how others understood their project role, organisational approach, and the proposed vision for the project.
- Evaluation of actions to promote of understanding by team leaders within the interorganisational project team.

Finally, project documents and emails were used to unearth further insights. Documents included project plans, periodic reports, related diagrams such as the work breakdown structure, and formal minutes from meetings between members of the project team. Email conversations centred on project-level communication between members of project team and the researcher, as well as internal and external stakeholders.

Data was analysed by the lead author using two primary techniques: coding and vignettes. Coding (as per Miles & Huberman, 1994; Strauss & Corbin, 1990) was used to analyse transcribed interview notes and to organize findings into common themes based on the constructs of the theoretical framework. For instance, the lead author adopted a directed approach to content analysis in which the theoretical framework guided the initial codes of interest. The lead author then read the transcript a second time and highlighted text which was

representative of predetermined codes. This analysis formed the basis of discussions on the research question.

Our categorization of 'fragmentation' in the project team was based on an interpretive analysis and coding of the three constituent subcomponents of the theoretical framework: *interpersonal*, *technical*, and *contextual* sources of fragmentation. Firstly, *interpersonal fragmentation* was coded as the emergence of misunderstanding between the interorganisational team members' values, interests, and perspectives, creating contention during group decision-making. For instance, the project vision was neither wholly technical nor wholly clinical, and therefore demanded shared meaning among all team members. Secondly, *technical fragmentation* was coded where the interorganisational team faced difficulties in understanding the tasks necessary to develop the cloud-based healthcare IT platform that would monitor the wellbeing of patients across a range of settings. For instance, the developers faced considerable challenges when planning tasks related to the integration of novel components such as wireless vital signs monitor as it required the team to follow complex protocols which had no previous experience of. Thirdly, *contextual fragmentation* was coded where the project team encountered events which were without precedent in respective organisations, impeding a shared understanding. For instance, the healthcare IT context represented a bourgeoning area of research where few exemplars were available to guide how the project should be conducted across organisations.

Building on Cooren (2004) and Persson's (2010) respective works, understanding was analysed through the interpretive coding of interactional patterns between team members as well as the perception of individual team members through interviews. Data analysis of the interview transcripts, participatory observation, and project documents focused on how team members constructed, amended, and added 'blocks' of knowledge and information during team

interactions in order to contribute towards understandings in the group (cf. Cooren, 2004). Occurrences of fragmentations were coded when understanding broke down during team interactions, and team members were misaligned in their understanding of project tasks. Our coding of empirical data from interviews, participatory observations, and project documents pointed to instances where team members faced difficulties in recognising gaps in their understanding during systems development.

Lastly, the authors coded three project activities central to understanding - as outlined in section 2.1 (problem, method, and solution formulation). *Problem formulation* coded decisions that discussed the project vision, or technical and clinical needs of the project. *Method formulation* coded decisions which centred on the approaches that would be used for finalising tasks related to the systems development methodology (e.g., requirements gathering) or research study (e.g., ethical approval). *Solution formulation* coded decisions that discussed the systems prototype and the finalisation of its requirements.

Vignettes (Miles & Huberman, 1994) were then used by the researcher to organise, reflect on, and learn from participant observation data. Ten vignettes were created across the eight-months of systems development, which interviewees indicated as representing key moments in the 'everyday life' of the project. The ten vignettes were designed as mini cases from within the case study based on temporal and spatial subdivisions (c.f. Eisenhardt, 1989; Miles & Huberman, 1994). Vignettes were then selected to provide "a focused description of a series of events taken to be representative, typical, or emblematic in the case" (Miles and Huberman, 1994, pg. 81) and offer a rich description of the phenomena of interest to our study.

3.3. Vignette of a Design Meeting

We now describe a key vignette from the case when social, technical, and contextual sources of fragmentation came to the fore and challenges of shared understanding became apparent. Examples from this vignette are used to focus a discussion of our findings in Section 4 relative to the theoretical framework presented in Section 2. This particular vignette is based on data collected during a design specification meeting that took place during the project. It provides a rich account of how fragmentations in understanding impacted interactions between team members in the case. The design specification meeting was scheduled by the project manager during the fourth month of the project in order to provide an update on work carried out around the development of the Electronic Medical Record (EMR) prototype but also to reconnect the technologists in R&D Inc., and the clinicians from District Health. Intergroup communication had gradually receded and in the weeks prior to this design specification meeting, interactions between the two groups had all but ceased. The meeting took place between the hours of 16.00 and 17.45 and was attended by the project manager, clinical researcher, analyst, and part-time developer. The meeting centred on the EMR prototype, an open source solution which had been customized for the purposes of the research study. Based on the requirements specified by clinicians during previous meetings and workshops, some features of the EMR had been removed and others modified or added. For instance, the developer had built a Maternity Vitals Assessment form to be used by the clinicians for recording the vital signs of participants in the research study. With deadlines looming, the project manager was now keen to finalize the design specification in line with the project plan.

The vignette is a narrative of the exchanges between the team members in attendance. While the PI and clinical lead were unable to attend due to other commitments, their views still shaped

the interactions among those present. The narrative has been reconstructed from the lead author's observation notes and project documentation.

To begin the meeting, the analyst demonstrated the changes that had been implemented in the EMR since the team had last met. The team sat around the analyst's computer to discuss the changes.

- **Analyst:** '*Our work on the 'Maternity Vitals Assessment' prototype form was completed based on the use case requirements. I'll just bring up the form now'*. [Analyst moves mouse across the PC screen and clicks on an option]
- **Developer:** '*Ok so here on the Maternity Vitals Assessment form, the mandatory fields are the 'Date' and 'Category' field. The 'Category' field is used for categorizing why the assessment has been undertaken and it has four options: 'Routine', 'Post-Op', 'Orthostatic', and 'Unstable'.'*
- **Clinical researcher:** '*The title 'Category' here doesn't make sense for the research study. Could you change the title to 'Location'?'*
- **Project manager:** '*Ok I understand. But I thought the Location would be specified when you're recording details of the participant visit rather than results of the actual assessment? I'd prefer if we could avoid making any unnecessary changes.*'
- **Clinical researcher:** '*The clinical lead would like to see it here. Also, the 'Pulse', 'Cuff size', and 'Position' fields aren't needed. Otherwise its ok.'*

These changes were not anticipated by the other team members and contradicted previous discussions on how readings of the vitals were to be recorded. Once the analyst's demo was concluded and any changes to the requirements were noted, the project manager broached the subject of signing-off on changes.

- **Project manager:** '*So are we happy with these discussed changes to the EMR? We would hope to close out requirements today as the deadline is approaching.'*
- **Clinical researcher:** *'Yes in general it's fine. The list of Symptoms you showed me are ok, but the clinical lead wants to add 'Birth interval of >10 years' and 'Maternity Age > 40' to the Risk Factors list. They would be of interest to the research study'.*
- **Project manager:** *'Ok these factors weren't mentioned before. Do you require any other items to be added to this list?'*
- **Clinical researcher:** '*No I think that's it. The additional risk factors came up during my recent conversations with the clinical lead. She hadn't discussed them with me before either.'*

The clinical researcher did not seem to remember the previously agreed list of symptoms and risk factors, and the analyst had to display both lists to remind her.

- **Project manager:** '*So is there anything else that we need to change?*
- **Clinical researcher:** '*Is it possible to automatically calculate the gestational age of each participant? I think this is a priority and should be included before any work is finalized.'*
- **Project manager:** '*We ruled this requirement out of scope at one of the recent workshops.*'
- **Clinical researcher:** '*I think the requirement needs to be ruled back in scope as it will ensure that the gestational age entered is correct. The calculation is currently done manually in the hospital but automating it in the system would help reduce the risk of error. There are smartphone apps that have a gestational age calculator. Can you not take this code and use it?*'

- **Project manager:** '*It's not that straightforward! As I said the requirement was deemed to be out of scope so ruling it back in at this stage will put a lot of pressure on the project timeline. Also, we had previously agreed that values from the paper-based maternity chart should be transcribed verbatim into the EMR.'*
- **Clinical researcher:** '*It's likely that a midwife will be entering data for the research study and if there's an error with the gestational age figure, the clinical lead will ask me why it's inaccurate. This will be avoided if the calculation is automated.'*
- **Project manager:** *'We didn't know that a midwife would be involved. We'll have to extend the deadline to allow enough time to develop this new feature. This impacts on the start date of the research study.'*

The clinical researcher's request came as a shock to the other team members as their understanding was that the requirement to calculate the gestational age had been ruled out of scope during an earlier workshop. However, the clinical researcher expected that the team would provide flexibility to allow the list of requirements to continue to evolve. She was surprised that the technologists in R&D Inc. did not have the flexibility to meet her request and that her request would have an impact on the project timeline. The atmosphere of the meeting became contentious with both sides failing to reach agreement on how to proceed. At one point the clinical researcher expressed frustration with the discussions.

- **Clinical researcher:** '*Fine, just get rid of the automated gestational age calculator. I'll calculate it manually.*'
- **Project manager:** '*Hold on, we can explore if it might be possible to reach a compromise. Are there any alternatives to the automated calculation?*'

- **Clinical researcher:** '*Well it would help if there was a field for entering the expected delivery date, but an automated calculator would be better.*'
- **Project manager:** '*We want to close out requirements now. If this had been highlighted earlier, we could have included the feature, but we only have a few weeks before the deliverable is due.*'
- **Clinical researcher:** '*But it's important for us that an accurate gestational age figure appears for each participant record.*'

Despite the other team members' effort to communicate the difficulty they would face in implementing this requirement within the available time, the clinical researcher asserted that the requirement was essential. The clinical researcher was eager to end the meeting and to return to obligations in the hospital and she moved towards the door to leave. Before leaving, the team did agree that it would be useful to organize a further meeting in order to run through the EMR's features again and to reach a consensus. However, a few days later, the clinical lead emailed the PI and the other team members to say that the requirement to develop a gestational age calculator must be in-scope and that no further discussion was required. The team was then mandated by the PI to implement the requested feature.

4. Analysis of Findings

4.1. Interpersonal Sources of Fragmentation

In the months prior to the design specification meeting, team members from R&D Inc., District Health, Potential Inc., and Insight Inc. had scheduled meetings with the aim of exploring differences between team members' understanding of the *problem formulation*. To facilitate these discussions, technologists in R&D Inc. created prototypes of the healthcare IT platform

and used human-centred design tools for exploring the needs of participants in the research study (McCarthy et al., 2020). These collaborative meeting had been fruitful, helping team members from each organisation to understand stakeholders' different perspectives on the project. The project manager noted that "*everything I did was based on the (design thinking) ethos… Sometimes people can't tell you what they want until you show them. The quickest way is to show something that looks concrete and then we can have concrete discussion, instead of something abstract"*.

Shared understanding of a *method formulation* did not necessarily follow, however. Technologists in R&D Inc. believed that the conflict which arose during the design specification meeting had emerged in part due to clinicians' varying interest in the project over preceding months. For example, during the design specification meeting, the clinical researcher appeared to have forgotten the list of previously agreed data points and requested new or changed requirements which contradicted prior discussions. One developer noted: "*(the clinical researcher) didn't write (notes). Once it looks right in her head, she's happy but she doesn't remember everything. We (technologists) have to write it down as we need to know what we're building*". The clinical researcher valued hospital work over project work, which in turn impacted her engagement: "*if [consideration of] the patient is taken out, there is less of a rush to have to do work, as you are no longer focused on this person and their condition"*.

Differences in values contributed to more difficulties around the *solution formulation*. Tension between the value placed on project concerns in R&D and Insight Inc., and clinicians' value on tasks in District Health constrained the team's ability to finalise the prototype. For instance, these differences became evident during the design specification meeting when the clinical researcher quickly left to attend to matters in the hospital even though there were outstanding project issues to be resolved. One developer noted these differences: "*They*

(Clinicians) were too absorbed in the everyday reality of the hospital... We have more of an appreciation of how things should be in an IT project, they only pay attention when something breaks." The clinical researcher also acknowledged her lack of familiarity with project management and the challenges posed: "*Clinical work is different to project work. [Technologists] always think in terms of projects. It is a [change for me] to think in terms of projects"*.

Interestingly, these difficulties were not limited to the relationships between R&D Inc. and their clinical colleagues. Insight Inc. and Potential Inc. also noted that the clinicians had a different perception of timeliness when it came to deliverables. While Insight Inc.'s approach was rigorous, they felt that the clinicians tended to value their patients as more important and contributed to the project on an irregular basis. The clinical researcher's work commitments in District Health often dictated the agenda of several key stages in the project, delaying the finalisation of Insight Inc.'s deliverables. As stated by one developer: "*Clinicians understand patients not projects… Clinicians have no curiosity to see (the prototype). They're not focused, and it is not a priority*". Equally, team members from Potential Inc. invoked commitments to their organisational clients as reasons for the delayed delivery of project work. Potential Inc. were regularly under time pressure and created tensions with R&D Inc. on a regular basis. In the middle of the team, R&D Inc. tried to address all the issues and harmonise the delivery of the work packages as best they could, but the overall schedule of the project and the emergence of understanding were affected by the different rhythms at which the organisations would partake in the activities.

4.2. Technical Sources of Fragmentation

In order to align team members' efforts early on, R&D Inc. had created a project plan that detailed specific task allocations across the project timeline. Planning workshops were organized to facilitate collaborative discussions around the clinical and technical tasks necessary to address the *problem formulation*. The project manager indicated that project planning was crucial to aligning organisational efforts around the problem: "*it's PM 101 – start with a manifesto, certain things we have to sign up to. We're all one team. We all have to deliver what we're being asked on time as others are dependent*". Team members indicated that the project plan and related documents helped make the problem more structured, well-defined, and enabled the team to better understand the path forward.

Despite this, issues around the *method formulation* arose later on from gaps in the PI's initial work plan. Prior to the assembly of the project team, the PI and industry partners (in particular Insight Inc.) agreed the technological architecture that would be used in the healthcare IT platform. Upon project commencement, the project manager's first task was to then validate this technical blueprint and work programme. It transpired that the technologies which had been agreed upon would ultimately not work together, triggering negotiations between R&D Inc., Insight Inc., Potential Inc. and District Health. While R&D Inc. were used to running research projects where the objectives and means can change during the course of the project, industry partners regarded the work plan as set in stone, while clinicians in District Health faced difficulties in understanding the issue.

The situation was also complicated by the integration of novel technologies – here mobile computing and wireless protocols. None of the organisations involved had the foresight necessary to envisage rapid evolutions in the underlying technology stack which placed considerable strain on the project and project manager. The PI had no other choice but to update

the Statement of Work (SOW) accordingly and renegotiate with the partners one by one, seeking formal signatures from all relevant authorities in the process. The following quote from an email sent by an industry partner illustrates the intricate negotiations required at this stage: "*The revised SOW moved away from the use of certain technology and expertise for the delivery of the core technical platform, requiring us to focus on and agree other activities. Accommodating these changes required a significant financial and time investment as well as requiring the team to reposition the project with the executives we had secured support from initially*". While this lengthy process was taking place, the project manager had been tasked with re-organising the project's execution path based on new parameters that were still changing. While the renegotiations had impacted all aspect of the project, the project manager sought to hide some of these disruptions from the rest of the team in order to progress work.

As evident in the team meeting described in section 3.3, R&D Inc. adopted a formalized approach to *solution formulation,* requiring ample documentation and sign off before a set deadline. One analyst stated: "*interactions were usually structured to derive requirements. We would be showing (clinicians) a prototype that we had been working on to get feedback, and we'd then move on with the finalization (of requirements)"*. Clinicians in District Health did not share this understanding and rejected the formalised approach, instead favouring a flexible approach to tasks which could accommodate ongoing changes to requirements. The clinical researcher believed that technologists did not always acknowledge the importance of some requirements for the hospital (such as the gestational age calculator) which led to disagreements in the project: "*Certain things are important to clinicians which techies may not understand such as [the] gestational age [calculator]… [technologists] had a different perception of the requirement."* Similarly, the industry partners found it hard to accept changes that occurred in the technological stack as the solution came into sharper focus.

4.3. Contextual Sources of Fragmentation

The project context centred around the monitoring of patients' wellbeing across multiple settings to detect the onset of hypertensive disorders. The context was initially seen as routine and prior to the design specification meeting, team members were quickly able to agree clinical aspects of the *problem formulation*. It later emerged that there were differences in how the context was formulated across organisations. On the clinical side, the clinical lead was viewed as an authoritative source for articulating the clinical aspects of the problem. The clinical lead noted that: "*I'm the lead clinician and I would provide senior clinical input… I tend to have a much more senior role in the projects that I'm involved in."* In contrast, the R&D Inc. adopted a decentralized team configuration in order to formulate aspects of the problem. Due to resource and timeline constraints, the technologists asserted that they could not afford to wait on a centralized figure to make decisions. As stated by the data architect: "*[technologists] wielded extreme power… in the choice of technology and what could be completed within the time scale*". This was illustrated by the decision to renegotiate the SOW even though the project had already started. Insight Inc. believed that these changes were imperative to project success and sought to impose the new SOW on all partners.

Frictions between the centralized approach of clinicians in District Health and the decentralized approach of technologists in R&D Inc. contributed to contextual difficulties around finding a *method formulation* that worked. Technologists criticised the clinicians' formal hierarchy for constraining their ability to move forward quickly, as the clinical researcher often did not make decisions without referring them to the clinical lead. The analyst noted "*I think (the clinical researcher) felt insecure sometimes when she interacted with us (the technologists) and I think part of that stems from the clinician's hierarchical relationship. It is a very top-down (hierarchy) and what the senior clinician says, goes."*. The clinical researcher

also acknowledged this hierarchy: "*Hierarchy depends on the organisation you're working in.… It felt strange for me to talk to everyone equally*". Frictions also occurred with the industry partners as the regular briefings and teams meetings they demanded turned out to be very difficult to organise at times. This was due to the geographical dispersion of the team as well as the constrained availability of senior team members whose diaries were constantly full.

Contextual differences within the team also impeded the *solution formulation*. Despite the importance of clinical expertise for formulating the solution, clinicians from District Health did not see the need to take ownership of project deliverables (e.g. the EMR prototype). For instance, the project manager had hoped that all team members would work together and share ownership of deliverables; however, team members perceived that ownership of the approach and the solution resided solely with R&D Inc. and Insight Inc. The project manager observed that "*the deliverables weren't owned by everyone, [technologists] nearly owned all of them.… we weren't just responsible for delivering them, we were responsible for the quality of them.*". This lack of understanding across contexts was also seen in clinicians' lack of motivation to direct their own time towards some project deliverables.

5. Discussion

This section discusses theoretical and practical contributions in relation to our research question: *What factors shape team members' understanding in interorganisational projects?*

Firstly, we reveal three sources of fragmentation in understanding among interorganisational projects team members: *interpersonal* (e.g., differences in values, interests, and perspectives), *technical* (e.g., changes in tasks and the technological architecture), and *contextual* (e.g., lack of clarity around organisational boundaries, and fundamental differences in work cultures). The novelty of our findings lies in the combination of interpersonal, technical and contextual

sources of fragmentation, seeing beyond their separate emergence to highlight how each can co-exist within the same setting. While prior studies have tended to examine interpersonal, technical, and contextual sources as isolated properties of knowledge integration in interorganisational projects, we contribute novel insights into the dynamic interplay between these sources of shared and fragmented understandings.

In the case study, this co-existence appeared during vignettes where fragmentation was not limited to one source but rather, emerged from two or more sources. During the design specification meeting, fragmentations in understanding primarily centred on both interpersonal sources related to competing interests (project vs. organisational work), and contextual sources related to unfamiliar decision-making hierarchies across different organisations. Technical sources also contributed towards fragmentation in the IT project due to difficulties in formulating the required system architecture. We first find that interorganisational IT project environments can be subject to interpersonal fragmentation in the form of differing values, interests, and perspectives over time which in turn shapes understandings around a method and solution formulation (Stjerne et al., 2019). For instance, the inconsistent levels of project interest among clinicians in District Health made it increasingly difficult for the technologists to develop a shared understanding of requirements and finalise project work. Our empirical findings also suggest that interpersonal sources combined with a lack of shared context between team members to create further difficulties during collaboration. In this case study, contextual fragmentation owing to structural complexity within different organisational environments (Bakker, 2010; Jones & Lichtenstein, 2008; Lundin & Söderholm, 1995; Stjerne et al., 2019) created difficulties e.g., top-down hierarchies in District Health vs. bottom-up hierarchies in R&D Inc. and Insight Inc. We also find that technical fragmentation owing to changing tasks and uncertainties in relation to the technological architecture can also shape shared

understanding between diverse stakeholder groups (Choudhury & Sabherwal, 2003; Kirsch et al., 2002; Lehtinen & Aaltonen, 2020; Stjerne et al., 2019). Technologists in R&D Inc. valued a structure approach to project planning whereas clinicians prioritised flexibility, which limited shared understanding. Industry partners expected a rigid definition of technical components and were surprised to see some decisions about the technology stack overturned after the project had started. Based on these findings we take steps towards answering the call of Ratcheva (2009) and Lehtinen & Aaltonen (2020) for more empirical research into the social, project-level, and organisational factors which affect knowledge integration and coordination in interorganisational projects.

Our second contribution is to explore understandings across three key project activities: *problem formulation*, *method formulation*, and *solution formulation* (cf. Farrell and Hooker, 2013; Lundin and Söderholm, 1995). Case study findings suggest that while the team were quickly able to reach a shared understanding during problem formulation, engaging interorganisational team members in the method formulation and ensuring ownership of the solution was subject to higher degrees of fragmentation. As summarised by the project manager in the case study: "*The problem was not difficult, what was difficult was trying to get people to work together*". Prior research has primarily focused on fragmentation inherent in the problem to be addressed (Bakhshi et al., 2016; Ireland et al., 2012; Wied et al., 2020). Our findings offer a complementary perspective to this existing body of project management literature, challenging the assumption that fragmentation is contingent on the problem-space. We instead highlight how different sources of fragmentation (*interpersonal*, *technical*, *contextual*) in understanding can affect project management activities differently (*problem*, *method*, or *solution formulation*). Our findings also show that issues within these different categories of

activities can combine with each other and multiply, making it seemingly impossible to keep the project on track at times.

Table 1: Summary of Case Study Findings on Shared Understanding

	Interpersonal Fragmentation	**Technical Fragmentation**	**Contextual Fragmentation**
Problem Formulation	Vision building workshops allowed team members to explore differences in their perspectives and helped support shared understanding of the problem formulation by encouraging dialogue.	Project plans, task allocations, and statements of work aligned team members' efforts and supported shared understanding of the problem formulation by visualising new processes.	The clarity of existing organisational structures for decision-making initially supported shared understanding of the problem formulation by creating role delineations.
Method Formulation	Some members' varying interest in project work, and their prioritisation of organisational work negatively impacted shared understanding of the method formulation by decreasing task engagement.	Required changes in the technology architecture and conflict during the renegotiation of tasks negatively impacted shared understanding of the method formulation by creating a gap in expectations.	Tensions between centralised and decentralised team structures negatively impacted shared understanding of the method formulation by duplicating communication channels.
Solution Formulation	Low levels of value placed on prototype engagement among some team members negatively impacted shared understanding of the solution formulation by impeding feedback loops.	Incompatible approaches to requirements gathering and managing the project scope negatively impacted shared understanding of the solution formulation by ignoring task repercussions.	Power asymmetries and the lack of shared ownership between team members negatively impacted shared understanding of the solution formulation by abdicating responsibilities.

Table 1 presents a summary of case study findings on the relationship between *interpersonal*, *technical*, and *contextual* sources of fragmentation and the *problem*, *method*, and *solution*

formulation. We include examples from our in-depth case study in each cell of the table to showcase the relationship between dimensions.

We further suggest that the application of our findings will be affected by the project context being investigated, and sub-characteristics such as project size, task, and strategic importance (Wied et al., 2020; Wiener, Mähring, Remus, & Saunders, 2016). For instance, project size will influence the problem, method, and solution formulation differently, as greater contextual fragmentation may be experienced in larger projects with more interconnected constituent practices (Bakhshi et al., 2016). Similarly, technical fragmentation may be greater for non-routine tasks where the goals, means, and capabilities available are more difficult to determine upfront (Wied et al., 2020). In contrast, projects involving routine tasks may be characterised by higher certainty as team members can rely on pre-determined approaches for goal achievement (Lundin & Söderholm, 1995). The changing nature of technological architecture in the case study illustrates this point. Strategic importance can affect the problem, method, and solution formulation further as the vested interest of different stakeholders can create considerable interpersonal fragmentation during decision-making due to their significance (Lehtinen & Aaltonen, 2020). Our case study focuses on a non-routine, temporary context of interorganisational IT development which literature has characterised as a highly knowledge-intensive and ill-structured practice, involving abstract deliverables (e.g. prototypes), novel technologies and tasks (Choudhury & Sabherwal, 2003; Kirsch, Sambamurthy, Ko, & Purvis, 2002; Wiener et al., 2016). We suggest that case study findings will also be relevant to complex projects in other domains such as exploratory projects involving interdisciplinary teams (Wied et al., 2020), and IT outsourcing projects involving client and service organisations.

Lastly, we suggest that our research has important practical implications for project management in interorganisational environments. We assert that fragmentation in

interorganisational projects is emergent and cannot be anticipated prima fascia. Our focus on the volatile aspects of technical decisions, interpersonal disagreements, and contextual inconsistencies may present an extreme case of fragmentation of understanding, but we contend that project managers should assume a project is characterised by similar fragmentation until proven otherwise. This can create unique challenges for shared understanding in practice. For instance, while structured, linear project management approaches might be appropriate for a routine practice, it is likely to be ineffective in a practice involving high levels of fragmentation (Bakhshi et al., 2016; Lenfle, 2014; Wied et al., 2020). It does not necessarily follow that a project is always straightforward once the problem is understood, or that "the skill of the professional is better expressed in the actual framing of the problem to be addressed" (Coyne 2005, pg. 6). As evident from our case study findings, the problem faced by an interorganisational project team may be relatively routine, yet fragmentation associated with the method formulation and solution formulation can still be rife due to stakeholders' diverse vested interests, as well as trust and communication issues when team members interact across organisational and professional boundaries (Jones & Lichtenstein, 2008; Ratcheva, 2009). We assert that interorganisational projects demand proactive responses from project managers to clarify sources of fragmentation among the team. From a practical perspective, this means that decision-making in interorganisational projects rests on the ability of project managers to foster argumentative mechanisms that clarify sources of team fragmentation as they occur.

6. Conclusion

In this paper, we reveal how the co-existence of *interpersonal*, *technical*, and *contextual* sources of fragmentation in understanding can impede the creation of clear and agreed solutions in interorganisational projects. While prior literature has explored interpersonal, technical, and

contextual sources of fragmentation in isolation, we provide new insights into the relationships between these sources and the cumulative challenge they pose to shared understanding within a single setting. This has important theoretical implications for interorganisational projects, particularly given the importance of shared understanding to collaborative knowledge building. Our findings further suggest that fragmentation is not necessarily hinged on the *problem formulation* but can equally manifest in the project activities of *method formulation*, or the *solution formulation*. This suggests that the development of shared understanding requires a three-pronged approach that addresses fragmentation across all three key project activities simultaneously. In terms of practical implications, we argue that interventions aimed at addressing fragmentation within one project activity such as the problem formulation may be ineffective when undertaken in isolation. Instead we propose that project managers must create targeted interventions which equally address team members' understandings of the problem, method and solution formulation in combination.

There are nevertheless some limitations associated with our study which future research may seek to address. Firstly, it is not possible to make claims of causality or generalisability based on findings from our interpretive case study. We instead aimed to provide a rich understanding of the contextual and localised factors at play within the case study through qualitative data (cf. Geraldi and Söderlund, 2018). Future research could seek to develop hypotheses based on the findings presented in our study using quantitative techniques to explain the relationship between sources of fragmentation in understanding. We also advocate that further research is needed to investigate the relationship between 'fragmentation' and success in complex project environments such as interorganisational teams. Failure to address interpersonal, technical, and contextual sources of fragmentation in understanding can provide another source of explanation for the under-performance of interorganisational project teams, beyond more technocratic

explanations e.g. KPI metrics. The management of fragmentation in interorganisational projects also merits further research to study the effect of team leadership styles on shared understanding. We therefore advocate a deeper exploration of the sources of fragmentation and their impact on managing interorganisational projects going forward to help project teams avoid the risk of failure. If our findings suggest that fragmentation may be unavoidable in many projects, they also suggest that fragmentation is not without remedy and can be addressed through the efforts of project managers and interorganisational stakeholders.

References

Adenfelt, M. (2010). Exploring the performance of transnational projects: Shared knowledge, coordination and communication. *International Journal of Project Management, 28*(6), 529-538.

Alford, J., & Head, B. W. (2017). Wicked and less wicked problems: A typology and a contingency framework. *Policy and Society*.

Bakhshi, J., Ireland, V., & Gorod, A. (2016). Clarifying the project complexity construct: Past, present and future. *International Journal of Project Management, 34*(7), 1199-1213.

Bakker, R. M. (2010). Taking stock of temporary organizational forms: A systematic review and research agenda. *International Journal of Management Reviews, 12*(4), 466-486.

Bark, R. H., Kragt, M. E., & Robson, B. J. (2016). Evaluating an interdisciplinary research project: Lessons learned for organisations, researchers and funders. *International Journal of Project Management, 34*(8), 1449-1459.

Barki, H., & Hartwick, J. (2001). Interpersonal conflict and its management in information system development. *MIS quarterly*, 195-228.

Bechky, B. A. (2006). Gaffers, gofers, and grips: Role-based coordination in temporary organizations. *Organization science, 17*(1), 3-21.

Bittner, E. A. C., & Leimeister, J. M. (2014). Creating shared understanding in heterogeneous work groups: Why it matters and how to achieve it. *Journal of management information systems, 31*(1), 111-144.

Bjorvatn, T., & Wald, A. (2018). Project complexity and team-level absorptive capacity as drivers of project management performance. *International Journal of Project Management, 36*(6), 876-888.

Buchanan, R. (1992). Wicked problems in design thinking. *Design issues, 8*(2), 5-21.

Choudhury, V., & Sabherwal, R. (2003). Portfolios of control in outsourced software development projects. *Information systems research, 14*(3), 291-314.

Chudoba, K. M., Wynn, E., Lu, M., & Watson-Manheim, M. B. (2005). How virtual are we? Measuring virtuality and understanding its impact in a global organization. *Information Systems Journal, 15*(4), 279-306.

Conklin, J. (2005). *Dialogue mapping: Building shared understanding of wicked problems*. West Sussex, UK: Wiley.

Cooren, F. (2004). The communicative achievement of collective minding: Analysis of board meeting excerpts. *Management Communication Quarterly*, 17(4), pp. 517-551.

Coyne, R. (2005). Wicked problems revisited. *Design studies, 26*(1), 5-17.

Daniel, P. A., & Daniel, C. (2018). Complexity, uncertainty and mental models: From a paradigm of regulation to a paradigm of emergence in project management. *International Journal of Project Management, 36*(1), 184-197.

Daniel, S., Agarwal, R., & Stewart, K. J. (2013). The effects of diversity in global, distributed collectives: A study of open source project success. *Information systems research, 24*(2), 312-333.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review, 14*(4), 532-550.

Farrell, R., & Hooker, C. (2013). Design, science and wicked problems. *Design studies, 34*(6), 681-705.

Garrety, K., Robertson, P. L., & Badham, R. (2004). Integrating communities of practice in technology development projects. *International Journal of Project Management, 22*(5), 351-358.

Geraldi, J., & Söderlund, J. (2018). Project studies: What it is, where it is going. *International Journal of Project Management, 36*(1), 55-70.

Giuliani, M. (2016). Sensemaking, sensegiving and sensebreaking: The case of intellectual capital measurements. *Journal of Intellectual Capital, 17*(2), 218-237.

He, J., Butler, B. S., & King, W. R. (2007). Team cognition: Development and evolution in software project teams. *Journal of management information systems, 24*(2), 261-292.

Head, B. W. (2008). Wicked problems in public policy. *Public Policy, 3*(2), 101.

Hinds, P. J., & Mortensen, M. (2005). Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication. *Organization science, 16*(3), 290-307.

Hsu, J. S.-C., Chu, T.-H., Lin, T.-C., & Lo, C.-F. (2014). Coping knowledge boundaries between information system and business disciplines: An intellectual capital perspective. *Information & Management, 51*(2), 283-295.

Hummel, M., Rosenkranz, C., & Holten, R. (2016). *The Role of Shared Understanding in Distributed Scrum Development: an Empirical Analysis.* Paper presented at the European Conference on Information Systems.

Humphreys, P., & Jones, G. (2006). The evolution of group decision support systems to enable collaborative authoring of outcomes. *World Futures*, 62(3), 193-222.

Ireland, V., Rapaport, B., & Omarova, A. (2012). Addressing wicked problems in a range of project types. *Procedia Computer Science, 12*, 49-55.

Johannesson, P., & Perjons, E. (2017). Untangling the Web of Practices: Designing Information Systems in Context. *Systems, Signs & Actions, 10*.

Jones, C., & Lichtenstein, B. B. (2008). Temporary inter-organizational projects. In *The Oxford handbook of inter-organizational relations*.

Kirsch, L. J., Sambamurthy, V., Ko, D.-G., & Purvis, R. L. (2002). Controlling information systems development projects: The view from the client. *Management science, 48*(4), 484-498.

Klir, G. J. (1985). Complexity: Some general observations. *Systems Research and Behavioral Science, 2*(2), 131-140.

Kotlarsky, J., & Oshri, I. (2005). Social ties, knowledge sharing and successful collaboration in globally distributed system development projects. *European Journal of Information Systems, 14*(1), 37-48.

Lee, J., Park, J.-G., & Lee, S. (2015). Raising team social capital with knowledge and communication in information systems development projects. *International Journal of Project Management, 33*(4), 797-807.

Lehtinen, J., & Aaltonen, K. (2020). Organizing external stakeholder engagement in inter-organizational projects: Opening the black box. *International Journal of Project Management, 38*(2), 85-98.

Lenfle, S. (2014). Toward a genealogy of project management: Sidewinder and the management of exploratory projects. *International Journal of Project Management, 32*(6), 921-931.

Levina, N. (2005). Collaborating on multiparty ISD projects: A collective reflection-in-action view. *Information systems research, 16*(2), 109-130.

Lu, P., Cai, X., Wei, Z., Song, Y., & Wu, J. (2019). Quality management practices and inter-organizational project performance: Moderating effect of governance mechanisms. *International Journal of Project Management*, 37(6), 855-869.

Luna-Reyes, L. F., Zhang, J., Gil-García, J. R., & Cresswell, A. M. (2005). Information systems development as emergent socio-technical change: a practice approach. *European Journal of Information Systems, 14*(1), 93-105.

Lundin, R. A., & Söderholm, A. (1995). A theory of the temporary organization. *Scandinavian Journal of management, 11*(4), 437-455.

McCarthy, S., O'Raghallaigh, P., Woodworth, S., Lim, Y. Y., Kenny, L. C., & Adam, F. (2020). Embedding the Pillars of Quality in Health Information Technology Solutions Using "Integrated Patient Journey Mapping"(IPJM): Case Study. *JMIR human factors, 7*(3), e17416.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: A sourcebook*. Beverly Hills: Sage.

Newell, A. (1993). *Reasoning, problem solving, and decision processes: The problem space as a fundamental category*: MIT Press.

Newell, A., & Simon, H. A. (1972). *Human problem solving* (Vol. 104): Prentice-Hall Englewood Cliffs, NJ.

Nicolini, D. (2012). *Practice theory, work, and organization: An introduction*: Oxford university press.

Noordegraaf, M., Douglas, S., Geuijen, K., & Van Der Steen, M. (2019). Weaknesses of wickedness: a critical perspective on wickedness theory. *Policy and Society, 38*(2), 278-297.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Thousand Oaks, CA: SAGE Publications, inc.

Persson, J. S. (2010). *Managing distributed software projects* (PhD thesis. Aalborg University.

Qureshi, S. M., & Kang, C. (2015). Analysing the organizational factors of project complexity using structural equation modelling. *International Journal of Project Management, 33*(1), 165-176.

Ramesh, B., Mohan, K., & Cao, L. (2012). Ambidexterity in agile distributed development: an empirical investigation. *Information systems research, 23*(2), 323-339.

Ratcheva, V. (2009). Integrating diverse knowledge through boundary spanning processes–The case of multidisciplinary project teams. *International Journal of Project Management, 27*(3), 206-215.

Reich, B. H., Gemino, A., & Sauer, C. (2014). How knowledge management impacts performance in projects: An empirical study. *International Journal of Project Management, 32*(4), 590-602.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences, 4*(2), 155-169.

Robert Jr, L. P., Dennis, A. R., & Ahuja, M. K. (2008). Social capital and knowledge integration in digitally enabled teams. *Information systems research*, *19*(3), 314-334.

Robey, D., Smith, L. A., & Vijayasarathy, L. R. (1993). Perceptions of conflict and success in information systems development projects. *Journal of management information systems*, *10*(1), 123-140.

Ruuska, I., & Vartiainen, M. (2005). Characteristics of knowledge sharing communities in project organizations. *International Journal of Project Management*, *23*(5), 374-379.

Sammon, D., & Adam, F. (2010). Project preparedness and the emergence of implementation problems in ERP projects. *Information & Management*, *47*(1), 1-8.

Sarker, S., & Sahay, S. (2004). Implications of space and time for distributed work: an interpretive study of US–Norwegian systems development teams. *European Journal of Information Systems*, *13*(1), 3-20.

Sawyer, S., Guinan, P. J., & Cooprider, J. (2010). Social interactions of information systems development teams: a performance perspective. *Information Systems Journal*, *20*(1), 81-107.

Schatzki, T. R. (1997). Practices and actions a Wittgensteinian critique of Bourdieu and Giddens. *Philosophy of the social sciences*, *27*(3), 283-308.

Schmidt, R., Lyytinen, K., & Mark Keil, P. C. (2001). Identifying software project risks: An international Delphi study. *Journal of management information systems*, *17*(4), 5-36.

Seidel, S., Recker, J., & Vom Brocke, J. (2013). Sensemaking and sustainable practicing: functional affordances of information systems in green transformations. *MIS quarterly*, 1275-1299.

Stjerne, I. S., Söderlund, J., & Minbaeva, D. (2019). Crossing times: Temporal boundary-spanning practices in interorganizational projects. *International Journal of Project Management, 37*(2), 347-365.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research* (Vol. 15): Newbury Park, CA: Sage.

Suchman, L. (2007). *Human-machine reconfigurations: Plans and situated actions*: Cambridge University Press.

Swanson, E. B., & Ramiller, N. C. (2004). Innovating mindfully with information technology. *MIS quarterly*, 553-583.

Tan, M. (1994). Establishing mutual understanding in systems design: An empirical study. *Journal of management information systems, 10*(4), 159-182.

Wallace, L., Keil, M., & Rai, A. (2004). How software project risk affects project performance: An investigation of the dimensions of risk and an exploratory model. *Decision Sciences, 35*(2), 289-321.

Walsham, G. (2006). Doing interpretive research. *European journal of information systems*, *15*(3), 320-330.

Weber, E. P., & Khademian, A. M. (2008). Wicked problems, knowledge challenges, and collaborative capacity builders in network settings. *Public administration review, 68*(2), 334-349.

Weeger, A., & Ott-Schwenk, A. (2017). *What Teams Need to Be Clear about-an Activity Theoretical Perspective on Shared Understanding in Health IS Implementation.* Paper presented at the Wirtschafts Informatik.

Wied, M., Koch-Ørvad, N., Welo, T., & Oehmen, J. (2020). Managing exploratory projects: A repertoire of approaches and their shared underpinnings. *International Journal of Project Management, 38*(2), 75-84.

Wiener, M., Mähring, M., Remus, U., & Saunders, C. (2016). Control configuration and control enactment in information systems projects: Review and expanded theoretical framework. *MIS quarterly, 40*(3), 741-774.

Wiewiora, A., Trigunarsyah, B., Murphy, G., & Coffey, V. (2013). Organizational culture and willingness to share knowledge: A competing values perspective in Australian context. *International Journal of Project Management, 31*(8), 1163-1174.

Windeler, J. B., Maruping, L. M., Robert, L. P., & Riemenschneider, C. K. (2015). E-profiles, conflict, and shared understanding in distributed teams. *Journal of the Association for Information Systems, 16*(7), 608.

Xia, W., & Lee, G. (2005). Complexity of information systems development projects: conceptualization and measurement development. *Journal of management information systems, 22*(1), 45-83.

Yin, R. K. (2017). *Case study research: Design and methods*. Thousand Oaks, CA, US: Sage publications.

Yu, X., & Petter, S. (2014). Understanding agile software development practices using shared mental models theory. *Information and software technology, 56*(8), pp. 911-921.