

**An Investigation of Social and Economic Aspects of
Structural Embeddedness in an ICT Research
Network Based in the European Union**

By

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QQI

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My husband, children, parents, parents in-law, siblings and friends give me the inspiration to learn and enjoy life, long may it continue!

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

– *T. S. Eliot, Little Gidding the last of T. S. Eliot's Four Quartets*

ABSTRACT

The objective of this research is to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. This research adopts a case study approach examining an EU funded research network, called AquaSmart¹ (Aquaculture Smart and Open Data Analytics as a Service). It is a high-tech² information communication technology (ICT) network funded by the EU Horizon 2020 research programme over the period 2016-2018. AquaSmart is using ICT to improve its data utilization and operations. The collaborative European funded research and development landscape has changed in recent years. Funding competitiveness and compulsory public private partnership (PPP) has significantly altered the dynamics of research networks, how they operate, collaborate, and acquire new knowledge and products. The emergence of the academic entrepreneur has also changed the focus of educational institutions to that of quasi-businesses (Etzkowitz, 2003; Perkmann *et al.*, 2013; Bolzani *et al.*, 2014). Consequently, there is an emerging gap between research and market adoption, and university-industry relations and commercialization (Maughan *et al.*, 2013; Perkmann *et al.*, 2013; Bozeman *et al.*, 2013). Thus, these, research networks provide a rich setting to analyse structural embeddedness.

Structural embeddedness refers to the nature of relationships, links and nodes within a network, specifically their structure, configuration and quality. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). Central to this research are the theories of Granovetter (1973), Burt (2009), Coleman (1988) and Bourdieu (2011), who present dyadic arguments for structural and relational embeddedness. Thus, there is an opportunity to investigate the core research network within a research project to further our understanding of the social and economic aspects of structural embeddedness. An initial paper (Paper 1) presented in this series presented a conceptualisation of structural network embeddedness. A methodological design paper (Paper 2) and an initial findings paper (Paper 3) followed. The final paper (Paper 4) in

¹ <http://www.AquaSmartdata.eu>

² <https://www.een-ireland.ie/eei/assets/documents/uploaded/general/ICT%20Fact%20sheet.pdf>

the paper series details the full research findings through the phases of description, analysis and synthesis offering insights for this context.

The research presents significant findings divided into three major themes; Structural Embeddedness Composition; Economic Aspects and Social Aspects. The significance of the findings are presented within the thesis and briefly stated here. The identification of a positive role for weak ties and structural holes in the AquaSmart network. It is evident that diversity of the industry focus initially created tensions in the AquaSmart network but also contributed significantly to the network output. The results show that the depth of interpersonal relationships and cultivation of friendships had a positive impact on research output and network satisfaction. Competition in the network configuration had a negative impact on research output. Industry jargon and trust during network incubation illustrated a lag in network cohesion and increased network tensions. Openness and trust were explicitly boosted at events where network individuals had an opportunity for informal dinners, breaks and exercise. The challenges encountered in the network were impacted by the quality and configuration of inter-relationships. The effect of network formation and prior relationships was significant. Trust within the network emerged as both an enabler and a barrier.

The research contributes to theory in three ways, it provides rich qualitative insights and guidelines in relation to structural embeddedness and network member roles in research networks. It provides evidence to highlight the challenges encountered by the network in relation to language and jargon. It suggests measures toward resolution of language ambiguity. The research gives insight to Competitive nodes within the network and proposes actions to recognise and manage the challenges of EU Open Data Policy.

The contribution to practice highlights the importance of network formation with guidelines for network structure, configuration and composition, assessment of implementation challenges post grant award, and longitudinal nature of research networks. It also provides recommendations for intra-network challenges in relation to open data, competition, friendships and competency enhancement.

The limitations of study include resource constraints, timeframes for scheduling data collection, opportunity for generalising findings and the use of a single network as the research dataset.

This study presents recommendations for future studies to include monitoring research impact beyond the formal network funding period, exploration of network reuse (appropriability) and network hopping. Additionally, it suggests future work to consider research policy for research networks, friendships and personal relationships in research networks and research entrepreneurs.

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Glossary of Terms

Actors	individuals or organizational units between which social relations form.
Appropriability	one type of tie (e.g., friendship) is appropriated for a different purpose (e.g., economic transaction).
Centrality	the extent to which an actor occupies a central position in a network by having many ties to other actors (i.e., degree centrality), by being able to reach many other actors (i.e., closeness centrality), by connecting other actors who have no direct connections (i.e., betweenness centrality), or having connections to centrally located actors (i.e., eigenvector centrality).
Centralization	the extent to which a network is centralized around one or a few actors.
Clique	a group of actors in which everyone has a direct tie to everyone else, and there is no external actor to whom all group members have a tie. Closure—when all members of the network have easy access to monitoring and information leading to norms of reciprocity and trust. Often measured by density.
Connectivity	minimum number of actors or ties that must be removed to disconnect the network.
Core-periphery	extent to which the network is structured such that core members connect to everyone and periphery members connect only to core members and not to other members of the periphery.
Cutpoint	an actor whose removal from the network results in subsets of actors between whom there is no connection.
Density	the number of ties in a network divided by the maximum number of ties that are possible. The more actors there are in a network, the greater the likelihood that density will be low.
Dyad	two actors connected by a tie.
Ego	the focal actor in a social network as distinct from alters to whom ego is connected.
Egocentric network	the social network surrounding ego, including the ties among ego's direct ties.
EC	European Commission, is an institution of the European Union, responsible for proposing legislation, implementing decisions, upholding the EU treaties and managing the day-to-day business of the EU.
EU	European Union, a political and economic union of 28 member states that are located primarily in Europe.

Homophily	the tendency for actors to form connections with and share the opinions and behaviors of others who are similar in terms of demography (e.g., gender, ethnicity, educational attainment) or any other attribute (e.g., personality, values).
Multiplexity	the extent to which two actors are connected by more than one type of relationship (such as being friends, as well as being workmates).
Reciprocity	a friendship relationship is said to be reciprocated if actor A is friends with actor B and actor B is friends with actor A; otherwise, the relationship is considered unreciprocated or asymmetric.
Small-worldedness	extent to which network is structured such that actors are clustered into small clumps with a few connections among clumps that result in a short average distance among actors.
Social capital	at the individual level, social capital consists of benefits or potential benefits that accrue to an actor as a result of social network connections. At the communal level, social capital consists of civic spirit, community trust, and adherence to beneficial norms.
Social structure	the configuration of interactions among actors in a social network.
Sociogram	a diagram in which actors are depicted as points, and ties among actors are represented as lines.
Strength of tie	a “combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie” (Granovetter, 1973). Strong ties are frequent, long-lasting, and affect-laden whereas weak ties are “infrequent and distant”.
Structural hole	a gap in the social network between two actors that can be spanned or is spanned by another actor (Burt, 1992).
Whole network	a network that incorporates a complete set of actors and all the ties among the actors (as distinct from an egocentric network).

SECTION ONE

INTRODUCTION & DBA RESEARCH

OVERVIEW

1.0 Overview

This research adopts a case study approach examining an EU funded research network, called AquaSmart³ (Aquaculture Smart and Open Data Analytics as a Service), a high-tech⁴ information communication technology (ICT) network funded by the EU Horizon 2020 research programme over the period 2016-2018. AquaSmart is using ICT to improve its data utilization and operations. High-tech organisations provide a rich context for the study, given their heavy reliance on network ties that stem from, and are embedded within, social relationships (Larson and Starr, 1993). The high-tech sector of the economy uses the most advanced technology available, it is often seen as having the most potential for future growth and this perception has led to high investment in high-tech sectors of the economy. The European Commission places a large emphasis on its H2020 research programme to foster innovation and competitiveness in Europe through excellence in ICT research and development. The choice of a high-tech context for this case study builds upon recent research on research networks in high-technology industries (Perkmann *et al.*, 2013; Perkmann and Schildt, 2015; Perkmann *et al.*, 2015; Scherngell and Barber, 2011; Scherngell and Lata, 2013; Wanzenböck *et al.*, 2015; Hite, 2005).

In Europe, the Aquaculture industry accounts for about 20 per cent of fish production and directly employs some 80,000 people. It is the fastest growing animal food-producing sector in the world. Global forecast on production is set to increase from 45 million tons in 2014 to 85 million by 2030. The European Commission has repeatedly called for prompt research action to stimulate large numbers of aquaculture businesses with ICT innovations. Aquaculture is identified as a key focal point of the EU's Blue Growth Strategy⁵. Furthermore, investment of €1.13 billion has been allocated to aquaculture research through the European Maritime and Fisheries Fund⁶ (EMFF) and other cross-cutting topics in H2020 during 2018 and 2019 include €170 million⁷ funding. Aquaculture is the fastest growing animal food producing sector in the world. Global forecast on production is set to increase from 45 million tons in 2014 to 85 million by 2030.

³ <http://www.AquaSmartdata.eu>

⁴ <https://www.een-ireland.ie/eei/assets/documents/uploaded/general/ICT%20Fact%20sheet.pdf>

⁵ http://ec.europa.eu/maritimeaffairs/policy/blue_growth

⁶ https://ec.europa.eu/fisheries/cfp/aquaculture/funding_en

⁷ <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/dt-bg-04-2018-2019.html>

The AquaSmart consortium comprises of 7 partners from 5 member states and 1 associated country. The consortium is coordinated by TSSG (Ireland), a department within Waterford Institute of Technology, who are an internationally recognized centre of excellence for ICT research and innovation. The AquaSmart network includes a diverse mix of researchers, fish farmers and ICT experts. This study provides rich insights to the operations of this networks and the complexities encountered within this context in relation to merging economics, society and technology.

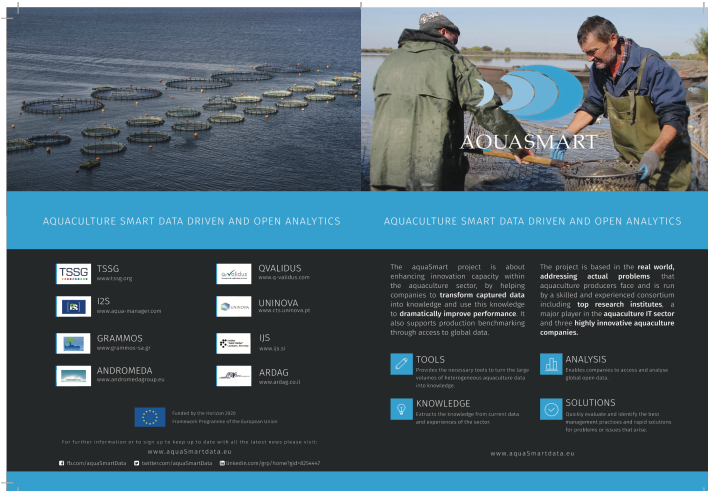


Figure 1:AquaSmart Context

Over the past few decades, there has been an explosion of interest in network research across the physical and social sciences. Network theory has yielded explanations and increased understanding for social phenomena in a variety of disciplines (Borgatti *et al.*, 2009; Moreno and Jennings, 1934). For example Granovetter (1973) claimed that when Boston claimed to absorb two neighbouring towns it was the collective action of one town generated by its more diffuse network structure that blocked the action. Furthermore, the literature has presented evidence that indicates higher order dynamic capabilities, competencies and new service offerings as a result of network alliances (Agarwal and Selen, 2009; 2011; Gulati, 1995; 1998).

This study investigates structural embeddedness in the AquaSmart network within an information communication technology research context where the network includes eight different network nodes. The setting is within the complex collaborative European funded research and development landscape which has changed substantially in recent years. Funding competitiveness, public private partnerships (PPP), open data policies and more poignant multi-disciplinary research means that networks of people involved in EU

funded research are fundamentally different in recent years. How these networks operate, collaborate, and acquire new knowledge and products contributes to society. Traditional and academic entrepreneurs are working together to refine the role of educational institutions to meet market needs (Etzkowitz, 2003; Perkmann *et al.*, 2013; Bolzani *et al.*, 2014). Structural embeddedness refers to the nature of relationships, links and nodes within a network, specifically their structure, configuration and quality. Research networks provide a rich setting to analyse structural embeddedness. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). Network theory literature claims that networks are essential to innovative clusters such as Silicon Valley (Fleming and Frenken, 2007) and innovation in high tech industries (Owen-Smith and Powell, 2004). Granovetter (1985) concept of embeddedness is what differentiates network theory from economic theory.

The literature highlights the role of inter-personal relationships as significant. However, the governance model inadequately addresses the complexity of research networks formed in response to funding opportunities. Research networks face two important and competing challenges, protecting data confidentiality while maximizing data accessibility (Perkmann and Schildt, 2015; Mehlman *et al.*, 2010; Melese *et al.*, 2009). In recent research output evaluations the focus of attention is moving from output to impact which is a significant change in the area of practice (Bozeman and Melkers, 2013). This emphasis on impact is different to the traditional norms of academic behaviour where often the value of research was peer recognition within the closed research community in the form of publications and conferences. Regular liaison between academia and industry opens up the potential for the exploration of new joint research norms and behaviours.

Highly competitive markets and the dynamic nature of technology-driven solutions have embedded open innovation as a success mechanism for organisations to foster growth and economic reward (Enkel *et al.*, 2009; Chesbrough, 2003; Perkmann and Walsh, 2007). By its nature, European funded research brings together a number of organisations toward a model of open innovation. It is clear from extant studies, that research networks can provide a rich contextual setting in which to analyse network embeddedness (Lichtenthaler and Lichtenthaler, 2009; Stuart *et al.*, 2007; Rawlings and McFarland,

2011). There is an increasing volume of research in this area focusing on the nature of relationships between universities and industry and emerging challenges in the area of open science, heterogeneous objectives and commercial sensitivity (David, 2004; Perkmann *et al.*, 2013; Bozeman and Gaughan, 2007). Converging partners collaborate even though they continue to pursue individual sets of beliefs, objectives and norms, with the literature highlighting the distinctions between academic and commercial motivations influencing societal and economic impacts (Melese *et al.*, 2009; Mehlman *et al.*, 2010).

The research has developed a set of practical recommendations for network formation, incubation and operations, cognisant of the role structural embeddedness plays within a research network. Following the practical recommendations, implications for future research are presented and a number of conclusions developed. This study provides strong evidence to demonstrate the impact configuration and quality of inter-organisational relationships has on network operations. Furthermore, it illustrates the importance of network formation and the frustrations and challenges encountered. It is clear from the study that the depth of the relationships within the network contributed significantly to the positive collaboration, mutual respect and successful evaluation of the research. The study provides empirical evidence of social and economic aspects of structural embeddedness and highlights the barriers and enablers encountered within the AquaSmart network.

2.0 Rationale and Motivation for the Study

This research investigates the core research network to further our understanding of the social and economic aspects of structural embeddedness. The study adopts a novel approach to research in this context using a qualitative approach as the structure of networks is predominantly examined using quantitative methods (Herz *et al.*, 2014). The rationale for the research emerged from the literature and the author's own professional experience of managing EU funded research projects. The author contends that unravelling the complexity of EU research networks positively impacts the economic output of research networks.

Whilst working as a project coordinator in Ericsson in the 1990's I was involved in production support and maintenance of base stations and mobile networks. Included in

our troubleshooting operations was a root cause analysis process where system errors and faults were analysed until the cause of the issue was discovered and process improvement identified to reduce the risk of reoccurrence. This triggered my ambition to delve deeper into questioning approaches and justification for action and behaviour. This approach was critical to how I approached lessons learned in all aspects of my software engineering practice over the coming years. Subsequently, I moved into academia and have worked predominantly in European funded ICT research and saw the opportunity for investigating the research networks that partake in the research as the sum of the whole being stronger than the individual parts. EU funded collaborative research has its challenges and sometimes profound achievements; the motivation grew from initial interest in the open source software community to an exploration into structural embeddedness of research networks.

The European Union funds research and innovation through a number of work programmes. The focus of this research lies in information communication technology (ICT) as supported by the Digital Agenda Europe 2020 Strategy⁸. The motivation to investigate the structure and relationships within an EU funded research network emerged from practical involvement in research networks and collaborative research within this funding framework. The complexity of inter-organisational activities is not particularly transparent in the management of research. The difficulties are often camouflaged by the necessity to succeed to warrant funding payments. The value of engagement in collaborative research is difficult to measure and capture within the specified project duration with little or no time dedicated to post-project reviews.

I am a keen life-long learner and whilst working in industry I completed a Masters Business Studies (level 9) in Knowledge Management from Waterford Institute of Technology, to optimise cross-Atlantic collaboration in a multi-national organisation. Additionally, since I work in an academic environment I recognised the need to improve my own academic writing skills and I was motivated to pursue a Level 10 qualification. Thus, I embarked upon this DBA journey with enthusiasm, keen to enhance my own critical reflection skills and improve the standard of my research practice. The first DBA

⁸ <https://ec.europa.eu/digital-agenda/en/our-goals/pillar-v-research-and-innovation>

workshop provided the necessary support to refine my research idea and proposal. From a practitioner’s perspective, I had rationale and motivation to further understand the composition of European research networks. Previously, my research had encountered learning networks, communities of practice and knowledge sharing (Brown and Duguid, 2001; Wenger *et al.*, 2011; Wenger, 2010; Jewson, 2007). Thus, I wanted to extend my understanding of structural composition and network challenges in a more complex inter-organisation environment.

3.0 Conceptual Framework

The conceptual framework is a key mechanism to develop ideas that feed into the research process. The conceptual framework helps to structure the research question and objectives to deliverable a viable concept and approach, which converts to an implementable research plan. The identification of a clear and focussed research objective and question(s) are critical to effective research and form the precursor for the research implementation. Post implementation it is useful to return to the conceptual framework to map the results and suggest direction for future research.

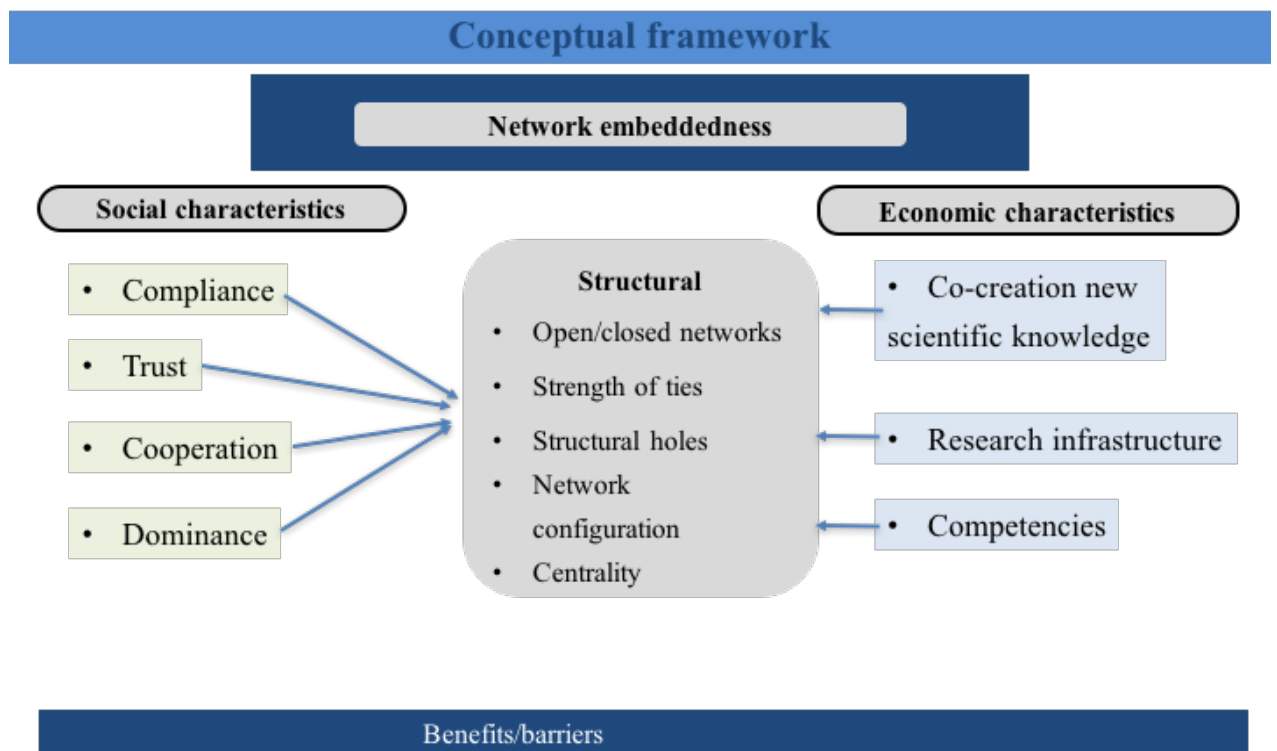


Figure 2: Interim Conceptual framework

This research framework is informed by evidence gathered from the literature that acts as a lens for this study. Figure 2 presents the conceptual framework to illustrate the research objective and shows the connectivity of the presented research themes and avenues for inquiry. It is relevant to discuss the term embeddedness to illustrate the understanding of the core principals of this study. In Krippner *et al.* (2004) they discuss the concept of embeddedness and present a number of arguments in defence of its widespread use in research.

Granovetter (1985)'s work in relation to markets and social structures is relevant for research networks, particularly in relation to productivity and innovation. He ascertains that the flow and quality of information, reward and punishment and trust within a network are important. Furthermore, he provides evidence to illustrate that these factors impact hiring, price, productivity and innovation. Granovetter (1985) recommends that embeddedness be further investigated as behaviour and institutions are so consumed by ongoing social relations. The connectedness between economic and social activities, as illustrated in the conceptual framework is also adopted by other authors (Burt, 2009; Baker *et al.*, 1992; Krippner and Alvarez, 2007). Furthermore, Granovetter (1985) states that embeddedness is an umbrella term that is ubiquitous and is not measurable. The conceptual framework based on the literature places network embeddedness as central to the study, and focuses on the analysis of structural embeddedness within a research network taking into consideration social characteristics as illustrated on left of the diagram and economic aspects on right. Following on, the author presents the research questions and approach to address the research objective.

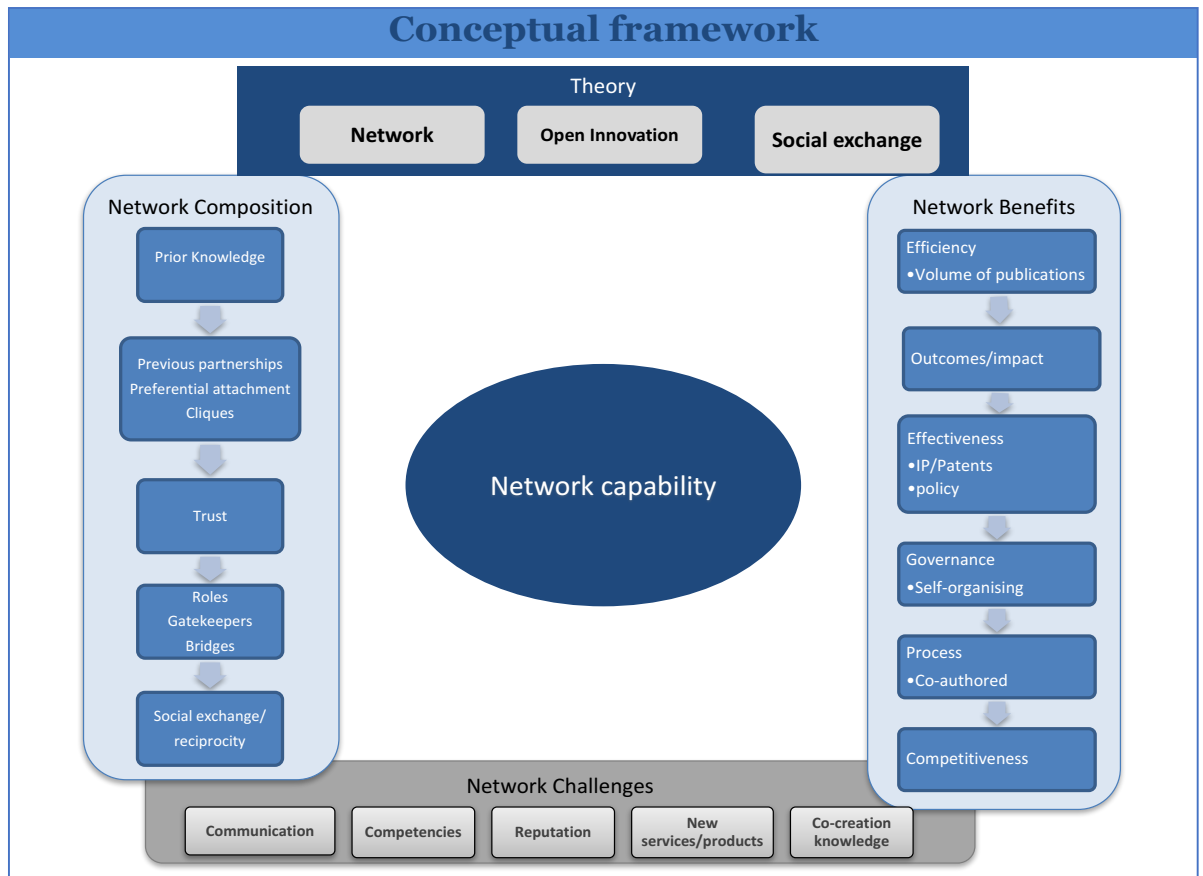


Figure 3: Final Conceptual Framework

4.0 Research Objective and Research Questions

During the initial phase of the research many avenues were examined, as there are so many nuances at play with interpersonal relationships in research networks. This phase was critical to establish the problem, domains of relevance and possible implications for theory and practice. Subsequent refinement of the research objective presented the formally stated research objective for this study:

“to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union”

The research tackles the overarching research objective and address the following questions that have arisen from a review of the structural embeddedness literature and the practical experience of the researcher. To address this research objective, several research questions are outlined below.

- RQ1 How are research networks structurally embedded?
- RQ2 How is structural embeddedness interconnected with social and economic characteristics?
- RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

This research can help to inform European or national funding initiatives that initiate and fund research networks while also providing justification (economic and social) for network actors to engage in research networks. In addition, it can support or negate theory in relation to the network theory (e.g. weak ties, structural holes). The rationale for the research question and research objective emerged from the author's previous practice experience managing EU funded research projects and previous research experience. The author contends that unravelling the complexity of EU research networks could impact co-creation output in the form of process or product. Recently, the author has engaged in some exploratory secondary research in open source communities, communication networks, collaborative working environments, open standards, interoperability and open innovation which has informed the research and provided much contextual knowledge (Power and Dooly, 2014; Doyle *et al.*, 2015; Dooly *et al.*, 2014; Dooly *et al.*, 2015).

The philosophical underpinning of the adopted methodology is based on an interpretivist epistemology and a constructivist ontology given the context of the study; highlighting the need for an inductive study to investigate the research problem. A deep understanding of network embeddedness is critical to explore this domain in this context beyond the existing predominantly quantitative studies available. Adopting an epistemological intermediary approach is considered appropriate for this study.

This study examines theory in relation to structural dimensions (Burt, 2009; Granovetter, 1973; Kim, 2014; AlKuaik *et al.*, 2016). In addition to the theoretical aspects the rationale for the research objective and research questions emerged from the author's previous practical experience managing EU funded research projects and previous research experience. The author contends that unravelling the complexity of EU research networks informs research management to enhance economic output such as co-creation

knowledge in the form of process or product and provides insights that can contribute to effective network formation.

RQ1 How are research networks structurally embedded?

The literature suggests that network configuration is a significant influencing factor within research networks and network capability (Granovetter, 1973; Granovetter, 1985). Specifically, structural holes and how advantage or disadvantage is perceived by the network actors in relation to how much they are embedded in the network and whether access to knowledge differs (Burt, 2009; Moran, 2005; Uzzi, 1997). Specifically, dimensions within the position of the actors in a research network can be significant in relation to centrality, stability, power and legacy relationships (Gulati and Gargiulo, 1999; Burt, 2009; Cook and Emerson, 1978; Cook and Whitmeyer, 1992).

Furthermore, evidence points to embeddedness within open and closed networks and new knowledge creation and cooperation between network partners (Gulati, 1995). Commercialization, generating intellectual property (invention disclosures and patenting) and the creation of spinout companies or the licensing of inventions are common output from research network collaboration (Agarwal and Selen, 2009; Bolzani *et al.*, 2014; Rothaermel *et al.*, 2007). Evidence indicates that the value chain within service organizations increasingly creates new service offerings that are the result of collaborative arrangements operating on a value network level. Furthermore, Agarwal and Selen (2009) suggest this leads to the notion of “elevated service offerings,” and coin it “service innovation”, implying new or enhanced service offerings that can only be eventuated as a result of partnering, and one that could not be delivered on individual organizational merits. This points to increased justification for inclusion and continued participation in research networks, however, the optimal structure and configuration of these networks are not evident (Geisler, 2003; Kirschner *et al.*, 2004; Stuart *et al.*, 2007). This study will discover how the network nodes within the network interact and how the network is configured, thus its contribution is linking the narrative story with the network which builds upon the qualitative contribution. This context is novel for studies on structural embeddedness and will provide contextual insights. Practically, the study will equip researchers to define and pursue structural embeddedness in their network strategy.

RQ2 How is structural embeddedness interconnected with social and economic characteristics?

Granovetter (1985), Krippner *et al.* (2004); Krippner and Alvarez (2007) previously identified the social characteristics under investigation in this study, namely, compliance, dominance, cooperation and trust. Investigating structural embeddedness in the network includes the interactions of the network nodes. These social characteristics provide a frame around which to compartmentalise these interactions. While the theory discusses the economic characteristics, this study has used economic characteristics specific to this context; new knowledge, such as new products, services or spin-outs, research infrastructure or new competencies or skills. Finding solutions to the research question resides in further understanding of the contextual players and their actions. The *a priori* network formation, network literature and open innovation evidence provides a basis upon which to investigate these phenomena in more detail. These social interactions from prior networks play a significant role in relation to the social characteristics and can impact future network configuration. In addition, the economic aspects impact the structural embeddedness in relation to success or failure to achieve desired research output. Within institutionally funded research there is increased emphasis on research and market adoption, university-industry relations and commercialization, but with little qualitative inquiry in this domain (Bozeman *et al.*, 2013; Maughan *et al.*, 2013; Perkmann *et al.*, 2013). Furthermore, the emergence of ‘open data’ initiatives has initialised new challenges in relation to industry and academic partnerships in relation to leaking data to competitors and demotivating academics highlighting the concepts of dominance, cooperation, compliance and trust (Perkmann and Schildt, 2015). These new challenges add complexity to the already diverse research networks. Previous studies focussed on measuring specific aspects without gaining a holistic picture of a full network and not within a research network context, hence the potential contribution of this study in relation to depth and understanding.

RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

The literature reveals that trust (Uzzi, 1997; Granovetter, 1985; Larson and Starr, 1993), power (Gulati and Singh, 1998), co-operation (Coleman, 1988; Burt, 2009) and governance (Rowley, 1997; Rowley *et al.*, 2000; Oliver, 1991) are key enablers and barriers to structural embeddedness. Collaboration strives toward mutual benefit where self-interest is unsatisfied in isolation. Trust is a significant factor with regard to collaborative relationships due to the nature of reciprocity, shared responsibilities, shared accountability and power and authority (Aryee *et al.*, 2002; Blau, 1964). It is essential to consider the body of literature from learning networks, collaboration and communities of practice (Brown and Duguid, 2001; Jewson, 2007; van Amersfoort *et al.*; Wenger *et al.*, 2011; Wenger, 2010). Furthermore, the network connections are considered as a critical factor in relation to embeddedness particularly joint problem-solving and information sharing initiatives which remains under-explored. (Durkheim, 2014; Granovetter, 1973; Granovetter, 1985; Hansen, 1999; Uzzi, 1997; McGrath and O'Toole, 2014). Larson and Starr (1993) identify high-tech organisations as being reliant on network ties that stem from relational embeddedness. This study will contribute to the practitioner's toolbox in relation to defining a network strategy taking into consideration the results in relation to enablers and barriers of structural embeddedness. The contribution to practice is the focus of this research question, there is some slight overlap with RQ2 in relation to the concepts that form the enabler and barrier aspects, however, this research question accentuates the steps from theoretical to practical to emphasis the contribution to the practitioners.

5.0 Research Implementation (Design and Method)

The aim of this section is to outline the adopted research process, focussing on the methodology, data collection and data analysis. The research strategy is how one intends to go about answering the research question (Saunders and Lewis, 2012). To choose the most appropriate research strategy Yin (1994) recommends the assessment of three key criteria; the type of research questions, the level of control over behavioural events and the focus of the study in contemporary versus historical events The rationale for strategy selection and its operationalisation pertinent to the current study is presented in Section 2 Paper 2.

The research process is divided into five phases (Figure 3), however the approach is not sequential. The research design is a recursive process based on the worldview that

findings are constructed and subjective. Consolidated with qualitative data collection mechanisms the interpretation of the research phenomena is considered critical and the research design addresses the challenges therein. The research is exploratory; the data collection strategy is multi-modal and includes a single case study, qualitative semi-structured interviews and documentation analysis. The data analysis strategy focuses on iterative research analysis cycles using state of the art software and research processes. Finally, the dissemination phase reached out to the research community periodically during the research process and added to the quality of the research process.

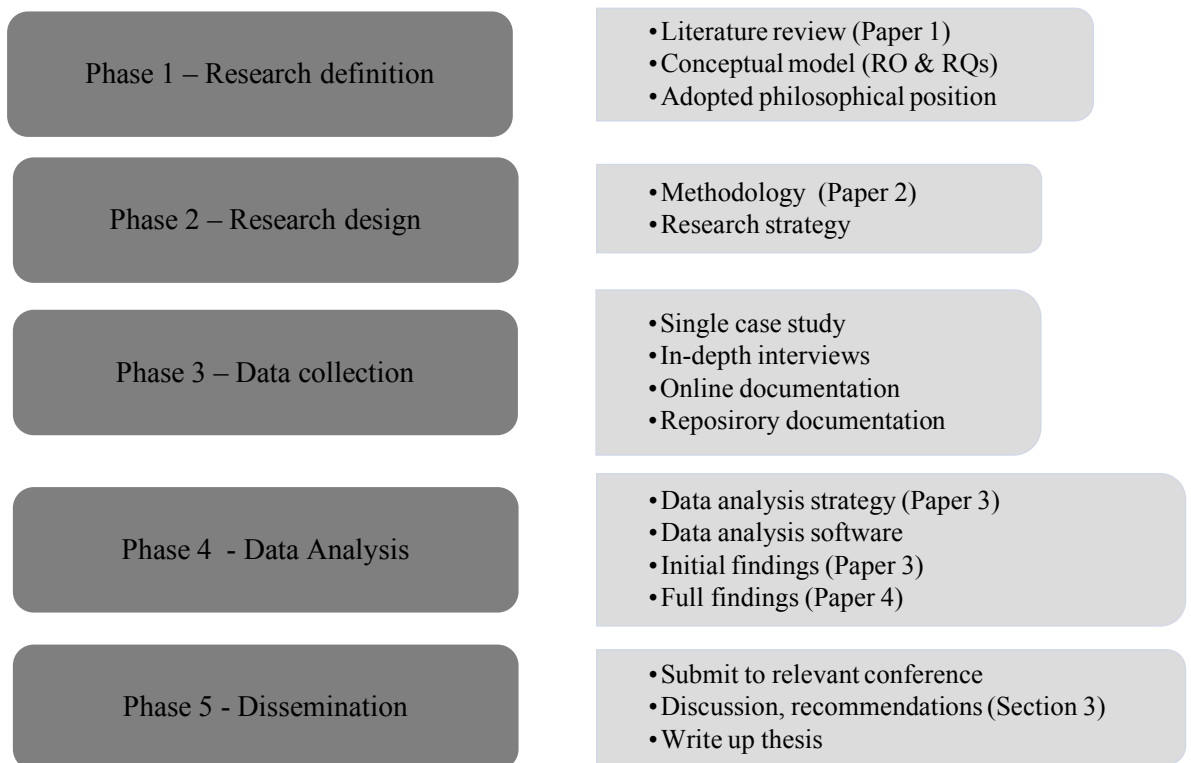


Figure 4: Summary of the overall research process

The study adopts an interpretivist frame and is not looking for a cause and effect type explanation that would be more characteristic of positivist research paradigms. Instead it aims to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The natural construction of the interaction within the network is core to the conceptual framework and is best understood in its natural environment rather than through experimentation or action of the researcher. Furthermore, Yin (1994) highlights the richness of interpretivist research where the

research process includes deciding on what to further explore and drawing conclusions that are supported by evidence. However, this process is not chaotic, researchers use previous literature to formulate the research problem and to identify concepts that may be important (Eisenhardt, 1989). These concepts are represented in this study and the capture of additional concepts and understanding is facilitated through a structured approach to data collection and analysis.

The philosophical positioning of this research study is relevant to understand the impact these arguments have on choosing the appropriate method for conducting the research. The adopted philosophical assumptions of the researcher have a direct impact on operational research design and method. Building upon the work of Burrell and Morgan (1979), Kilduff *et al.* (2011) present a new wave of research assumptions contextualized in modern society along with the emergence of technical transfer, disparate philosophical groups within organisations and open innovation. This is particularly relevant in this research as it is conceivable that the research networks comprise of disparate philosophical groups. To date much of the empirical evidence presented in relation to European funded research networks is quantitative, while providing excellent insights, adopting a qualitative approach has opportunity to provide deeper insights through the narrative of the active research network participants (Scherngell and Barber, 2011; Scherngell and Lata, 2013; Wanzenböck *et al.*, 2015). Further justification rests heavily on the ability of qualitative data to offer insight into complex social processes that quantitative data cannot easily reveal. For example, Greenwood and Suddaby (2006) studied how a known instance of institutional change at the centre of the accountancy domain occurred (i.e., promotion of change by elite firms within the accounting profession). They justified their approach in terms of extending institutional theory and the ability of qualitative data to explicate the complex social processes involved, difficult to establish using quantitative methods. In relation to research networks, the author is cognisant of the existence of the concepts of cooperation, dominance, trust and compliance as illustrated in the initial conceptual framework Figure 2, which are more appropriately addressed through qualitative inquiry. It is argued that qualitative methods introduce bias and are subjective. However, a high level of rigor and structure was adopted to minimize this bias and conduct qualitative research in this context. Inductive

inquiry is a mode of discovery that sets about the tracking down of patterns and consistencies in raw data (Mintzberg, 1979) which meets the criteria for this study.

The data collection phase was seven months in duration between July 2017 and January 2018. This included formal requests for participation, scheduling, preparation of the participant guide, conducting the semi-structured interviews, documentation analysis and reflective writing. The initial research design adopted an iterative approach for data analysis and was guided by Tracy (2013) and Miles and Huberman (1994). However, upon implementation, the model developed by Braun and Clarke (2006) employed as a more comprehensive guide. To identify convergence of themes and patterns across interviews, the data and literature was iteratively examined with initial codes or themes developed based on a pattern between the data and the conceptual framework in line with literature and a priori themes (Hite, 2005; McGrath and O'Toole, 2014; Miles and Huberman, 1994; Yin, 2003).

The Braun and Clarke (2006) inductive research model that was adopted for data analysis illustrates the iterative approach between the recursive link back to the relevant theories and concepts. A single case study approach is presented as a suitable method to investigate this phenomena in its natural context, as it allows for the subjective and contextual experiences of the participants supported by in-depth interviewing and documentation analysis. Data is analysed using both manual and NVivo approaches and the findings are presented in Section 2, Papers 3 and 4 followed by the discussion in Section 3. The case study approach is an appropriate method where the research aim is to explore, in-depth complex issues in their real-life context (Crowe *et al.*, 2011). To complete the ambition for a comprehensive network perspective this study conducted interviews with all network nodes in the EU research network. Coverage of all network nodes to gain insights from each member of the network rather than dilute the investigation to a portion of the network, is considered a crucial research design choice. In addition, use of archival data is common in this domain and a documentation analysis was conducted for this study (Greer and Lei 2012; Geisler, 2003, Kirschner *et al.*, 2004; Perkmann and Schildt, 2015).

6.0 Contribution to Practice and Contribution to Theory

The results from this research contributes directly to theory in two ways, firstly, by providing rich insights in structural embeddedness. For example, the division between the type of network member; technical and business oriented. The research highlights tensions between ICT organisations and the fish farmers. Particularly, the research gave details of anxiety in relation to sharing information and how this was resolved. The structure of the network illustrated how one network member provided a bridge between ICT and aquaculture. Furthermore, a unique ‘motivator’ role was identified within the network and insights illustrate the positive affect this node had in relation to problem resolution and work ethics.

Secondly, structural embeddedness has not previously been investigated in this context, a European Union research network and it provides novel contextual insights. The aquaculture industry has unique challenges that were identified in relation to the accuracy of the data (fish feed, fish deaths, counting juvenile fish). The research describes the difficulties encountered by the aquaculture industry in adopting ICT solutions and the complexities of sharing data with other network members. These insights and their tentative solutions provide a detailed picture of the network operations. Furthermore, the research details the approach taken to create a new company using the research output, knowledge and services. This unravelling of the complexities of EU research networks has aided understanding to illustrate the results of co-creation of new services. These insights in relation to the formation of the new company, the role of the academic entrepreneur and the prioritisation given to new services are key to contributing to theory in relation to structural embeddedness. It is evident that these rich and novel insights provide a deeper understanding of the research topic and its context not achievable through quantitative methods. Elements such as anxiety and entrepreneurship are difficult to measure.

The contribution to practice equips future research network members with the knowhow to pursue an optimised network strategy, cognisant of social and economic aspects. In addition, the research management function now has insights to enablers and barriers of structural embeddedness which supports their operations. For research networks a mix of weak and strong ties is recommended, however sufficient incubation is required to

enhance socialisation. Prior relationships are common within research networks but structural holes and weak ties are also common. It was clear from the results that the open data policy recommended by the EC has conflicting priorities with competitiveness and that intra-network competition and the fear of sharing production data needs to be addressed and mechanisms employed to mitigate risk and alleviate tensions. The research provides insights that highlights the role of the academic entrepreneur and their position in the network to push the boundaries of the ICT solution to meet the current and visionary needs of the aquaculture industry. It was clear that the role of academics within the network is akin to quasi-business in relation to the impact of research at an economic level and an extension of their competencies and service provision capabilities. Practitioners also obtained insights to the difficulties of different funding instruments to attract academic partners that are focussed solely on new knowledge and not concerned with research implementation. There was evidence that this potentially creates a barrier to cooperation and collaboration. These aspects of the network dynamics were evident through the examples that the network members described facilitated by the exploratory nature of the research and the flexibility to explain the nuances within the network in detail.

From a policy perspective, funding agencies can further understand the structural embeddedness of research networks and the complexities therein. The study findings indicate that the differentiation between partner types and funding creates a tension in the network toward inequality between partners. Furthermore, this leads to the occurrence of closed shop networks relying on prior relationships and positioning with the higher-level network that is the EC. Figure 5 outlines a summary of the case and its findings discussed further in Section 3.

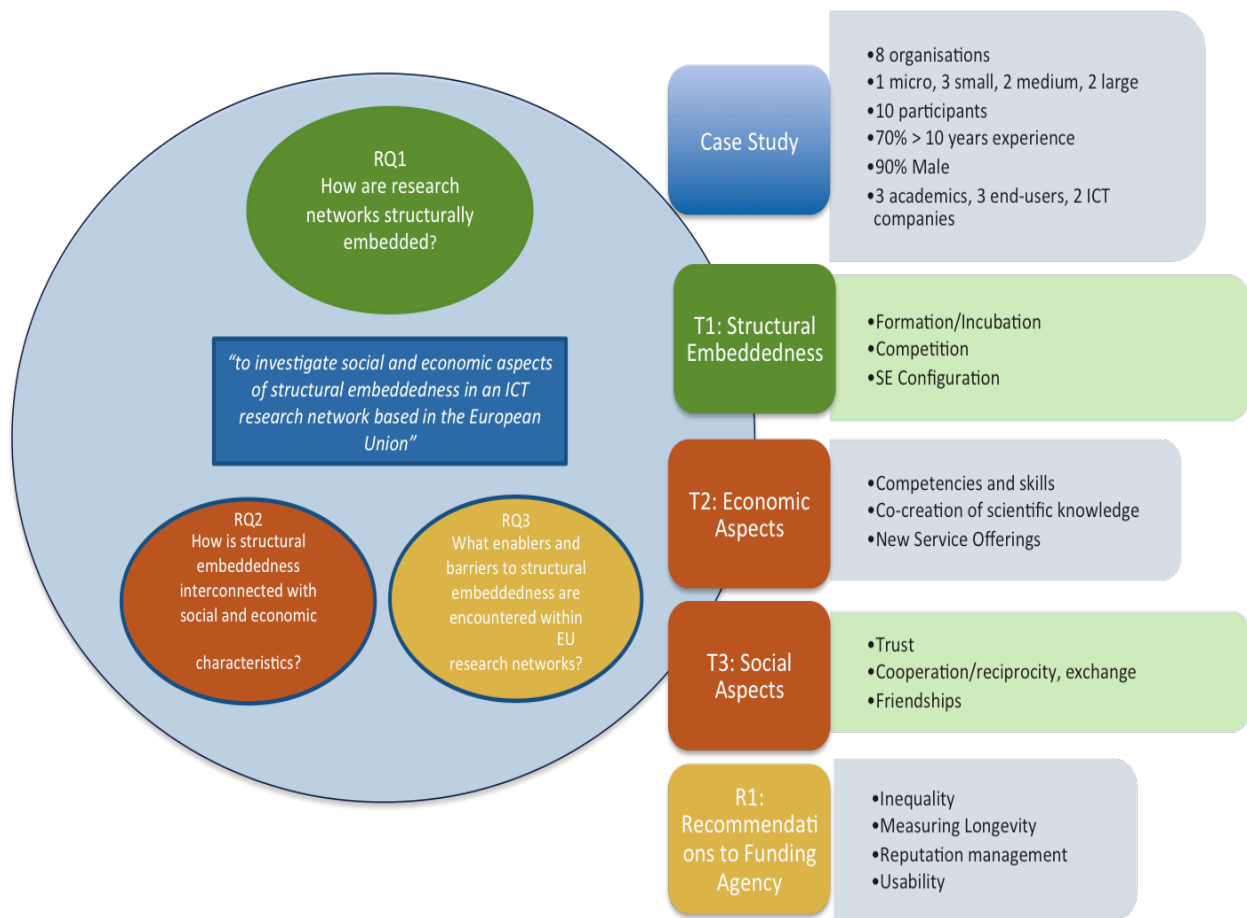


Figure 5: Summary of Research Questions and Key Findings

7.0 Thesis Structure

The structure of this DBA thesis is divided into four sections. Section 1 includes the introductory chapter, summarising the motivation, research objectives, implementation process, contribution, dissemination and high level overview. Section 2 encompasses the research paper series, this include four main chapters of the research, the conceptual development and literature review, the research methodology, followed by the initial and full-scale results. Section 3 presents the discussion of the findings, recommendations and conclusion. Following on, Section 4 present the researchers reflective journey, presented through extracts from my reflective log.

7.1 Section 1 – Introduction

This section presents the overview of the research, the background, incubation and conceptual framework. It contextualises the research implementation within the literature domain, network theory and the EC research landscape. Furthermore, it illustrates the challenges and complexity of research collaboration through a practitioner’s perspective leading the reader to further understanding of the operations of research networks, pitfalls and opportunities. The overall research objective and research questions are presented along with details of the research design and implementation.

7.2 Publications

Given my professional background in research I had set out an assertive dissemination strategy to gain the benefits of peer critique and feedback. Thus, I submitted a number of research papers to relevant conferences, detailed below. The conferences were scheduled during the research implementation phase of the study and provided an excellent mechanism for peer review and reflection around decision-making and milestones. The decision to publish during the research process did include additional effort at times in relation to submitting expressions of interest, abstracts, posters and papers that were not all accepted but provided invaluable feedback in relation to academic writing style and research direction and contribution. Furthermore, my presentation to relevant audiences triggered questions and required familiarity with the research domain that reaffirmed my own understanding of the research context, theoretical and practical implications. It also highlighted the need to review the conceptual model and the need for clarity in aligning the research questions with the theory and the data collection mechanism.

- UFHRD 2015 University Forum for Human Resource Development ‘Role of Social Media in Open Source Software Communities’ Presented 5th June 2015, UCC, Cork, Ireland
- Tech Transfer Conference, 2015, ‘Academic Entrepreneurs’ Presented 30th Oct 2015, DIT, Dublin, Ireland
- IAM, 2017, Irish Academy Management, ‘Exploring Structural Embeddedness in EU Funded Research Networks’, Presented 1st September 2017, Queen’s University, Belfast

- WIT Research Day, 2017, Poster entitled ‘An Investigation of Structural Embeddedness in EU Funded Research Networks’, WIT, Waterford, Ireland
- SPACE Network Conference, 2018, ‘Network Embeddedness in European Aquaculture networks’, 26th April 2018, Denmark
- Enterprise Ireland, H2020 Info Day, Presented 14th June 2018, ‘Partnering in H2020’, Dublin, Ireland
- IAM 2018, Irish Academy Management , ‘Exploring the configuration and management of an EU funded research network’ Pending 3-5th September 2018 UCC, Cork, Ireland

Submitted but not accepted

- OpenSym 23-25th Aug, 2017, Galway, Ireland, ‘An exploration of the impact of network embeddedness in EU funded research networks on the acquisition of new resources
- University-Industry Interaction Conference 20-22nd June 2018, London, UK, ‘Exploring the composition and nature of EU funded research networks’.
- 2018 Babson College Entrepreneurship Research Conference (BCERC), 6-9th June, 2018, Waterford, Ireland, ‘An exploration of network embeddedness in EU funded research networks toward academic entrepreneurship’.

7.3 Section 2 – Paper Series

Section 2 is compiled through the presentation of the four papers, which encompassed the bulk of the research content. The structured DBA follows a strict internal and external examination process per paper that requires a formal presentation review and upon approval the papers have been included in this thesis unchanged. These papers include the conceptualisation, literature review, research design and methodology and findings. To facilitate understanding of connectivity each paper is prefaced with a linking narrative which aims to detail deviations from original positions, articulation of justification for changes to initial approaches and inclusion of relevant feedback from formal examination.

Paper 1: An investigation of network embeddedness of EU funded research networks toward the acquisition of new resources: Conceptual Paper

The conceptual paper provides detail on the research objective, rationale, literature in relation to network theory, social exchange theory, social capital, collaboration, open innovation and resource acquisition. In addition, it provides the philosophical underpinnings of the study, presents the initial conceptual framework, the research design and possible practitioner implications.

Paper 2: An investigation of social and economic aspects of structural embeddedness in an ICT research network based in the European Union: Methodology

The methodology paper details the adopted research approach and associated justification. It presents the research design, chosen methodology, data collection instruments, data analysis approach. The formal research objective and details research questions are presented in line with the relevant literature. The adopted inductive, qualitative approach is described illustrating its suitability in pursuit of the research objective. The case study context is provided which further details the suitability of the adopted methodology. Whilst a structured qualitative approach is adopted the robustness of the approach is adhered to enhance reliability and validity from an inductive perspective rather than provide a repeatable exhibit. A detailed data collection strategy and case study protocol are identified, along with identified supportive software. The ethical considerations are presented in line with the formal ethical process application. Following on targeted dissemination opportunities were identified to assist the process of peer-reviewed feedback and on-going publication strategy.

Paper 3: An investigation of social and economic aspects of structural embeddedness in an ICT research network based in the European Union: Design and Initial Findings

The research design and initial findings paper details the research implementation, data collection and analysis. This includes a profile description of the adopted single case

study, the scheduling and operationalization of interviewing network members, documentation review and adopted data analysis technique. The paper describes the cyclical process of interviewing, transcribing, analysing, reflecting and alignment of research questions to the theory. The emerging thematic clusters and initial findings are presented and the conceptual model updated to reflect the research process. Consideration for the remaining research implementation and interpretation phases are described with an update on the dissemination of results to the wider research community.

Paper 4: An investigation of social and economic aspects of structural embeddedness in an ICT research network based in the European Union: Research Findings

The research findings paper extended the findings presented in Paper 3 to include the full research implementation, data collection and data analysis. It presents a summary of the key findings from the full research study, aligned to the research questions and overall research objective. It groups the findings to illustrate patterns and areas of interest from both a practitioner and theoretical perspective. It uses the case study profile as an instrument to further detail the type of network members and their responses in relation to the research questions. It details and links the primary data collection and secondary data collection. Paper 4 presents in detail the model adopted for the data analysis phase and the results from each phase of implementing the data analysis model. Transparency in relation to codification and hierarchical thematic clustering is provided. The paper illustrates the full DBA journey in diagrammatic format using the adopted visual software as a mechanism to support reflection of the analysis phase toward identification of contribution and its significance.

7.4 Section 3 – Discussion, Conclusion and Recommendations

This section provides synthesis, interpretation and analysis of the research results and findings. It looks at the key insights from the research in addition to the refinement of the conceptualised framework based on these findings and interaction with the reviewed literature. It makes recommendations to both practitioners and funding agencies on optimising research networks and adds to the existing body of knowledge by providing

insight into the elements, influences, enablers and barriers that can inform the stakeholders investing in and participating in EU funded research networks.

7.5 Section 4 - Reflective Journey

A reflective journey of development; take a plane, take a train, run slow, walk fast, where are we going to, where have we been, from which tree did our roots emerge? Reflection and life-long cyclical learning stems from our own philosophical stance. It affects our professional approach, how we do our jobs and the impact we have on the people around us whether we inspire them, or help them to insulate themselves to surmount difficulties or flourish in their own learning and knowledge journey. When I started my DBA journey in 2014, I had already completed the research supervisory module through continuous professional development. This module had introduced me to Moon (2006) and Hatton and Smith (1995) and I had become more reflective in my professional approach. Thus, the requirement introduced in our very first workshop for the DBA that we would keep a reflective journal was welcomed and was maintained over the course of the study, both challenging and rewarding at times. Each researcher and practitioner has their own mechanism for reflective writing my method was to write as often as possible, online in excel and searchable, and I would start each entry by reading the previous five entries. Adopting a scientific, structured approach to self-assessment, and an initial skills and competency audit (recommended in our workshop 1 by Felicity Kelleher and Denis Harrington) revealed my competencies, skills and knowledge at the start of this process so that upon completion a comparative analysis could detect changes, improvements to practice and knowledge. This systematic approach is not suited to all types of people and learning styles but it reflects the environment I am accustomed to coming from a professional background in software quality and thus I deemed it appropriate. My reflective log was an essential tool for me to evaluate, interpret and remind me of how I justified my decision-making. In addition, it assisted my milestone tracking and motivation for completion. I also used an excel spreadsheet to track progress for my DBA for each workshop assignment and mini-milestones within the paper series. In addition, I used a database for my literature review throughout the DBA process so that I could use meta data (abstract, key findings/results, method used) for quick reference of papers I had referenced or read that were or were not relevant. This was a critical tool that also tied in

closely with my reflective log to provide supportive background for the assertions I made. Furthermore, I attended the reflective practice in education module as part of continuous professional development during the DBA process, this further equipped me to adopt mechanisms and ideas that I previously may not have accessed.

I think that reflective practice is essential in a professional work environment and a very useful tool however, I would still find the practice difficult at times, it can be invasive as it forces justification for action taken and possible interventions or alternative approaches for future. We need to be cognisant of the depth to which we attribute our actions and relate these to our adopted philosophy, epistemology and ontology. Our beliefs and values don't always match the reality of our workplace environment and resources and attitudes can obstruct our approach and of course what we say and what we do (espoused theory) (Argyris and Schon, 1974). My recent knowledge journey (DBA) has opened a Johari window of self-assessment (Luft and Ingham, 1961). The wide literature available in this domain supports this recognition of difficulties to conduct regular reflective practice and how complex a self-analysis in relation to defensive mechanism identification or even collision within an organisation to cover up mistakes (Freud, 1992; Bolton, 2010; Gibbs, 1988). The reflective journey section of the thesis is presented as a narrative of sample extracts from my reflective log illustrating this knowledge journey, which included much profound learning, bridge construction and black holes.

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SECTION TWO

RESEARCH PAPER SERIES

Preface to Paper 1 – Conceptual Paper

Following the DBA structured workshops, the development of Paper 1, Conceptual Paper commenced in December 2015 and was presented to the examiner panel at the Doctoral Colloquium in WIT in April 2016. The examination panel included; Prof. Alan Wilson, University of Strathclyde, UK, and Dr. Thomas O’Toole, Head of School of Business, WIT.

The conceptual paper provides details on the research objective, rationale and related literature. In addition, it provides the philosophical underpinnings of the study, and presents the initial conceptual framework, proposed research design and possible practitioner implications.

The rationale for the research emerged from the author’s previous practical experience managing EU funded research projects and previous research experience. This research is particularly relevant to practice within networks funded by the European Commission where the emphasis has increased in public private partnerships⁹ and alliances in strengthening market potential. Thus, the formally stated research objective for Paper 1:

“to investigate network embeddedness of EU funded research networks toward the acquisition of new resources”.

The author contends that unravelling the complexity of EU research networks could impact co-creation output in the form of process or product. EU funded research networks comprise of diverse individuals and organisations collaborating toward economic and social change driven by new inventions, innovation and new knowledge. In recent years, I have engaged in exploratory secondary research in open source communities, communication networks, collaborative working environments, open standards, interoperability and open innovation which has informed the research and provided much contextual knowledge however, it does not form the core literature

⁹ <https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020>

domain of this research. (Power and Dooly, 2014; Doyle *et al.*, 2015; Dooly *et al.*, 2014; Dooly *et al.*, 2015).

The philosophical underpinning of the adopted methodology is based on an interpretivist epistemology and a constructivist ontology given the context of the study; highlighting the need for an inductive study to investigate the research problem. A deep understanding of network embeddedness is critical to explore this domain in this context beyond the existing predominantly quantitative studies available. Adopting an epistemological intermediary approach is considered appropriate for this study.

Paper 1 presents the literature review of the research domain, the theoretical foundations for the aims and objectives of the thesis, in the context of professional practice. I had witnessed changes in the collaborative European funded research and development landscape in recent years. Funding competitiveness and compulsory public private partnership (PPP) has significantly altered the dynamics of research networks, how they operate, collaborate, and acquire new knowledge and products. The literature supported what I had noticed in my work, for example, the emergence of the academic entrepreneur and the focus of educational institutions to that of quasi-businesses (Etzkowitz, 2003; Perkmann *et al.*, 2013; Bolzani *et al.*, 2014). I believe that research networks provide a rich setting to analyse network embeddedness; formation, culture, motivation, inter-relationships and absorptive capacity¹⁰ (Lichtenthaler and Lichtenthaler, 2009; Stuart *et al.*, 2007; Rawlings and McFarland, 2011).

Paper 1 outlines the main concepts that formed the conceptual framework such as network embeddedness. Network embeddedness refers to the nature of relationships, links and nodes within a network, specifically their structure, configuration and quality. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). During this period, I explored several theory bases; network and social network theory, social exchange theory, social capital, collaboration, open innovation and resource

¹⁰ ‘the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends’

acquisition. I envisaged an opportunity to investigate the core research network within a research project to further our understanding of the internal workings of the network and how network actors acquire resources. By its nature, European funded research brings together a number of organisations toward a model of open innovation. There is an increasing volume of research in this area focusing on the nature of relationships between universities and industry and emerging challenges in open science, heterogeneous objectives and commercial sensitivity (David, 2004; Perkmann *et al.*, 2013; Bozeman and Gaughan, 2007).

Converging partners collaborate even though they continue to pursue individual sets of beliefs, objectives and norms, with the literature highlighting the distinctions between academic and commercial motivations influencing societal and economic impacts (Melese *et al.*, 2009; Mehlman *et al.*, 2010). Paper 1 explores network capability, a firm's ability to develop and utilise inter-organisational relationships to gain access to various resources held by others. Network capability development poses significant challenges and opportunities such as driving competitive advantage, resource constraints and recognising network capability as a resource of the firm (McGrath and O'Toole, 2013; Walter, Auer, & Ritter, 2006). The proposed research explores actor activity, individual characteristics and network properties toward network capability in research networks cognisant of the cultural and innovation dimensions examined in McGrath and O'Toole (2014). These concepts were explored further during the DBA process and as the focus of the research was refined over the course of the paper series it is evident that not all concepts described in Paper 1 were within scope when the research questions were refined in subsequent papers. It was useful in Paper 1 to assess the literature across all research questions. I adopted this approach throughout the research, eventually linking the interview guide and findings to the literature.

The conceptual model and its potential impact is proposed in Paper 1, and the planned research design summarised. The conceptual model structures the contextual environment, research objective and research questions to provide a setting that defines the scope of the planned research. EU research networks bring together stakeholders aiming for research and innovation beyond state of the art, the complexity of the motivations, competencies, cultures, and working ethics should not be underestimated.

Whilst the conceptual paper presents an approach, the details of the approach was delivered in Paper 2 Methodology. The initial conceptual framework presented in Paper 1 focussed on the main components of an ICT research project; excellence, implementation and impact. It aimed to explore network capability through an input, process, output modelling while considering the research objectives and questions.

The feedback from the external examiners indicated that whilst the network itself was a core theme to the study it was not clear what theories were relevant. Additionally, the scope of the research questions was too wide and not adequately focussed for the boundaries of the DBA programme. Following on from addressing the feedback from the examiners, and reading the extant literature, further iterations of the conceptual framework emerged. The conceptual framework went through many iterations from Paper 1 to Paper 4 and reflecting on the value of the conceptual framework it is relevant to pertinent to envisage how it might evolve beyond this thesis.

At this stage of my doctoral studies I was still developing my research skills and the workshop on Qualitative Data Analysis had yet to come so I relied heavily on methodology books and publications, some recommended from Workshop 3. Workshop 3, Research Design and Developing Research Ideas provided adequate signposts to the pertinent authors and areas for investigation. Also at this stage, our supervisors had been allocated but the student-supervisor relationship was in its early stages. Therefore, I needed to go back and refer to papers on developing research ideas, proposals and research methodology articles (Mantzoukas, 2008; Leshem and Trafford, 2007; Sandberg and Alvesson, 2011; Horn and Brem, 2013). It was also useful to read about ethics, codes and guidelines for management research (Bell and Bryman, 2007). Additionally, Eisenhardt and Graebner (2007) and Qu and Dumay (2011) provided essential information on evaluating a method to facilitate the research questions and objective.

Paper 1 also describes the research design phase, albeit in the planning stages; a case study approach which suits the exploratory nature of the study to provide insights to our understanding of inter-organisational collaboration of research networks. There has been much evidence to support the credibility and validity of qualitative research (Eisenhardt and Graebner, 2007; Yin, 1989; Yin, 1994) and this proposed research would follow the

international standards for mitigating the shortcomings of qualitative research. Feedback from the external examiners questioned the use of qualitative approach given the seminal work that was predominately quantitative. This meant that I had to further justify the inductive approach. In addition, the examiners questioned the level of inquiry, as a result the level of enquiry was amended to focus on the network itself not the individual, thus alleviating the foreseen problem of possibly assessing the impact of individual relationship on society.

Paper 1 presents the planned methodological approach as a 3-phased approach, involving a small pilot with principal investigators to verify the approach and the challenges of research networks participation in collaborative research in relation to resource acquisition. Subsequently, an initial data collection phase was presented, given the nature and context of the study accessing the open EUPRO database was planned. This phase of data collection will validate the approach and feed directly into the development of the semi-structured interviews planned for phase 3. Use of archival data is common in this domain (Kirschner *et al.*, 2004; Greer and Lei, 2012; Geisler, 2003; Perkmann and Schildt, 2015). The type of data collected includes actor characteristics, relational and network effects, geographical dispersion/proximity, prior acquaintance, thematic proximity, and an audit report of resources before and after the project. Paper 1 presents a planned evaluation of tools; Pajek, a social network analysis tool and NVivo to analyze the unstructured data. Paper 1 presents the planned ethical considerations, central to the conduct of legitimate research in line with international standards in relation to ethics.

Following on, Paper 1 outlines expected contribution to practice and to theory. These potential contributions were envisaged early in the research journey but it was important that Paper 1, linked the theory, research questions and possible contributions toward attaining the overall research objective. The proposed contribution in Paper 1 included the extension of existing theory or support/criticism of existing theory and the practical evidence to enhance management of research networks.

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Paper 1

CONCEPTUAL PAPER

**An Investigation Of Network Embeddedness Of EU
Funded Research Networks Toward The Acquisition
Of New Resources**

Abstract

The collaborative European funded research and development landscape has changed in recent years. Funding competitiveness and compulsory public private partnership (PPP) has significantly altered the dynamics of research networks, how they operate, collaborate, and acquire new knowledge and products. The emergence of the academic entrepreneur has also changed the focus of educational institutions to that of quasi-businesses (Etzkowitz, 2003; Perkmann *et al.*, 2013; Bolzani *et al.*, 2014). Consequently, there is an emerging gap between research and market adoption, university-industry relations and commercialization (Maughan *et al.*, 2013; Perkmann *et al.*, 2013; Bozeman *et al.*, 2013). Research networks provide a rich setting to analyse network embeddedness; formation, culture, motivation, inter-relationships and absorptive capacity ¹¹ (Lichtenthaler and Lichtenthaler, 2009; Stuart *et al.*, 2007; Rawlings and McFarland, 2011). Network embeddedness refers to the nature of relationships, links and nodes within a network, specifically their structure, configuration and quality. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000).

Thus, this research investigates the core research network within a research project to further our understanding of the internal workings of the network and how network actors acquire resources. An examination of knowledge creation and knowledge circulation has the potential to uncover new impact measurement types, particularly feasible through inductive research. Similarly, an examination of the embeddedness within networks (for example, competitiveness, data confidentiality) could provide valuable insights to research management. In addition, how networks converge toward common goals while simultaneously driving their own strategy may inform policy makers. Network analysis can provide a suitable approach to detecting patterns of behaviour within a network. This conceptual paper presents an approach, however, the details of such an approach will be delivered within the subsequent paper on methodology. Thus, this research has significant

¹¹ ‘the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends’

potential to contribute to practice, theory, and policy formulation, specifically in relation to network embeddedness.

1.0 Introduction

Collaboration between industry and academia, driven by institutional funding and research strategies has been widespread throughout the decades at national, European and global levels. However, the literature suggests that some changes have occurred within these inter-personal relationships, their composition and motivations. The funding programmes are usually subject to review¹² and use explicit measurement indicators such as efficiency, effectiveness, coherence, relevance and EU added value. However, currently the governance model pays little attention to the evolution and maturity of research networks formed in response to funding opportunities. Research networks face two important and competing challenges, protecting data confidentiality while maximizing data accessibility to potential (Perkmann and Schildt, 2015; Mehlman *et al.*, 2010; Melese *et al.*, 2009). Driven by changes to institutional funding mechanisms, universities are increasingly aware of the value of their intellectual property and are keen to ensure protective formal mechanisms are in place when academics collaborate with industry to the degree that they are being referred to as quasi-firms (Etzkowitz, 2003; Perkmann *et al.*, 2013). This aspect of the value of collaboration to actors within a research network is interesting and in recent cases the focus of attention is moving from output to impact which is a significant change in the area of practice (Bozeman and Melkers, 2013). This emphasis on impact is different to the traditional norms of academic behaviour where often the value of research was peer recognition within the closed research community in the form of publications and conferences. Regular liaison between academia and industry opens up the potential for the exploration of new joint research norms and behaviours. In addition, this resonates with evidence from the business to business network research domain, specifically relational marketing (Grönroos, 1994) and has potential for investigation in a different domain such as information communication technology (ICT).

¹² https://ec.europa.eu/research/evaluations/index_en.cfm

Highly competitive markets and the dynamic nature of technology-driven solutions have embedded open innovation as a success mechanism for organisations to foster growth and economic reward (Enkel *et al.*, 2009; Chesbrough, 2003; Perkmann and Walsh, 2007). Following on, there is a need to understand the relationships within these complex networks; specifically how research collaboration can facilitate resource acquisition in areas such as knowledge, competencies and infrastructure. A study of this nature provides an opportunity to unveil activities and behaviours that contribute to research collaboration and value creation. Indeed stemming from Etzkowitz (2003) description of university status changing to a quasi-business it may be considered relevant at this stage to consider inter-organisational relationships of this nature as business networks. Furthermore, there is evidence leveraging network theory to support the development of innovation through networks which is akin to the European Commission objectives in the Digital Agenda (Snehota and Hakansson, 1995).

The Europe Union funds research and innovation through a number of work programmes. The focus of this research lies in the area of information communication technology (ICT) as supported by the Digital Agenda Europe 2020 Strategy¹³. This paper's motivation emerged from practical involvement in research networks and collaborative research within this funding framework. The complexity of inter-organisational activities is not particularly transparent in the management of research. The difficulties are often camouflaged by the necessity to succeed to warrant funding payments. The value of engagement in collaborative research is difficult to measure and capture within the specified project duration with little or no time dedicated to post-project reviews.

It is clear from extant studies, that research networks can provide a rich contextual setting in which to analyse network embeddedness (Lichtenthaler and Lichtenthaler, 2009; Stuart *et al.*, 2007; Rawlings and McFarland, 2011). By its nature, European funded research brings together a number of organisations toward a model of open innovation. There is an increasing volume of research in this area focusing on the nature of relationships between universities and industry and emerging challenges in the area of open science, heterogeneous objectives and commercial sensitivity (David, 2004; Perkmann *et al.*,

¹³ <https://ec.europa.eu/digital-agenda/en/our-goals/pillar-v-research-and-innovation>

2013; Bozeman and Gaughan, 2007). Converging partners collaborate even though they continue to pursue individual sets of beliefs, objectives and norms, with the literature highlighting the distinctions between academic and commercial motivations influencing societal and economic impacts (Melese *et al.*, 2009; Mehlman *et al.*, 2010). This research is particularly relevant to practice within networks funded by the European Commission where the emphasis has increased in public private partnerships¹⁴ and alliances in strengthening market potential. This paper outlines a justification for further research in this area exploring the structural and relational embeddedness of research networks, the composition of nodes within these networks and the depth of network ties.. Thus, the formally stated research objective for this study is:

“to investigate network embeddedness of EU funded research networks toward the acquisition of new resources”

In order to address this research objective, a number of research questions are outlined in Section 6 - The Conceptual Framework. This research can help to inform European or national funding initiatives that initiate and fund research networks while also providing justification for network actors to engage. In addition, it can support or negate theory in relation to the strength of network ties, the effect of structural holes in research networks and self-interest and individualism.

2.0 Network theory and inter-personal relationships

Research in network theory is related to graph theory and looks at asymmetric relations between discrete objects. The first proof of network theory is the Seven Bridges of Königsberg (Newman *et al.*, 2006). Problems can be represented as a graph, and network theory provides a set of techniques for analysing graphs. In social science, network theory consists of actors (nodes) and their relations (ties) between these actors (Wasserman and Faust, 1994; Fleming and Frenken, 2007). Nodes may be individuals, groups, organizations, or societies. Wellman and Berkowitz (1988) argue that network analysis is merely a tool that facilitates the study of social structures that can detect patterns of behaviour. Network theory is well established since its inception around 1800, the

¹⁴ <https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020>

associated empirical evidence from network theory is prolific. Furthermore, the recognition of network theory within social science has led to an increase in research of social network theory and social exchange theory.

Network theory literature claims that networks are essential to innovative clusters such as Silicon valley (Fleming and Frenken, 2007) and innovation in high tech industries (Owen-Smith and Powell, 2004). Network theory has many supporting examples including the diffusion of technology and innovation (Coleman *et al.*, 1966; Strang and Macy, 2001). Granovetter (1985) in his work on how behaviour and institutions are affected by social relations argues that Williamson (1979) does not sufficiently consider personal relationships during economic transactions (the network effects). This critique illustrates how the transaction cost economics (TCE) theory explicitly excludes an individual's behaviour, actions or the exchange of a commodity whereas Granovetter (1985) argues that economic action is embedded in structures of social relations. It is also worth noting that Granovetter (1973) illustrates the significance of the network effect of early innovators as opposed to first adopters. For this study, research network theory is considered highly relevant; the actors (nodes) involved are academic researchers, innovators, policy administrators and industrial organisations working collaboratively toward research innovation. Network analysis focuses on these relationships and explains the attitudes and behaviours of these actors and organisational members. It is clear from the increase in the emergence of formal and informal inter-organisational cooperation such as public private partnerships, joint ventures and contractual partnerships that collaborative networks are a critical organisational activity. In addition, with communication and information exchange facilitated by Internet trends such as micro-blogging and the additional complexity involved in follower and following type activities, there is sufficient evidence to suggest on-going research interest in this domain.

Specifically research in social network theory has expanded significantly over the last decade and a succinct account of the emerging arguments and topics is included in the book *"The Development of Social Network Analysis"* (Freeman, 2011). Conceptual models emerging from network theory explain how social networks operate. These include; self-interest, whereby the objective is to maximize personal gain, preferences and desires (Homans, 1964); social capital, which is the collective value of social

networks (Bourdieu and Wacquant, 1992; Putnam, 1993; Portes, 2000), collective action such as the building of public parks and bridges (Marwell and Oliver, 1993; Monge *et al.*, 1998) and, social exchange and dependency (Bienenstock and Bonacich, 1997).

Research in relation to networks working together on tasks, sharing responsibility and creating new knowledge through the sharing of resources spans a number of inter-related research domains; network theory, social network theory, social exchange theory, social capital theory. (Nahapiet and Ghoshal, 1998; Burt, 2009; Granovetter, 1973; Granovetter, 1985; Bourdieu, 2011; Putnam, 1995; Coleman, 1988). Emerson (1976) asserts that social exchange theory examines the exchange (productive exchange) of all relevant ties in the appropriate networks whereas network theory examines the nature of all links without assessing relevance in advance. Of interest to this research study is the role of networks relating to the network embeddedness, reuse of networks, the development of social capital and network value analysis (Granovetter, 1973; Coleman, 1988; Burt, 2009; Wenger *et al.*, 2011; Blau, 1964; Putnam, 1995). In line with the literature the author acknowledges the significance of weak ties in relation to opportunity and the role reputation plays in relation to the re-use of networks from one purpose to another.

It is useful to examine inter-organisational networks in research environments through a network lens, particularly the linkages between nodes (actors) and their relationships and associated activities. For the purpose of this study, social capital can be considered both the structure of the relationship networks and the resources that can be accessed through these relationships. It is the link between relationship and resource that is of particular interest to the study. Furthermore, Granovetter (1992) two dimensional inquiry (structural and relational) embeddedness illustrates that the source of competitive advantage can be linked to the history and configuration of interactions., demonstrating essential reputational aspects. This concept of embeddedness is what differentiates network theory from economic theory.

Network, and particularly social network theory, is not without its critics. Mejiás (2005) describes networked individualism as discriminative of the space between the nodes arguing that interests need to become non-nodal. This notion of nodes within a network unable to communicate outside of individual nodes is more challenging within network

theory in social science than physical science (Borgatti *et al.*, 2009; Vandenberghe, 2002). This will be addressed in the research method and design phase of this study. Given the temporal and spatial diversities of networks, it is feasible to test this argument but its relevance is less significant for this piece of research given its objective and context in research networks. This research plans to explore the actors (and their relationships) involved in collaborating to research and explore elements of the societal impact (e.g. network properties and differences in impact). Figure 1 depicts a simplified network (nodes and ties); this will be detailed further in the research methods phase.

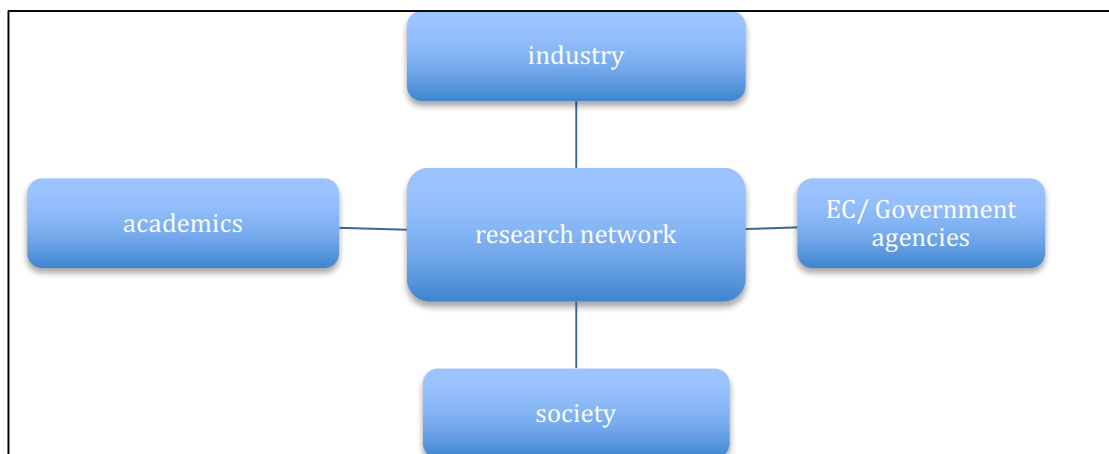


Figure 1: Initial network nodes

Particularly of interest is network capability, a firm's ability to develop and utilise inter-organisational relationships to gain access to various resources held by others. Network capability development poses significant challenges and opportunities such as driving competitive advantage, resource constraints and recognising network capability as a resource of the firm (McGrath and O'Toole, 2013; Walter, Auer, & Ritter, 2006). The proposed research explores actor activity, individual characteristics and network properties toward network capability in research networks cognisant of the cultural and innovation dimensions examined in McGrath and O'Toole (2014).

Furthermore, the process of acquiring resources such as financial, physical, human, and intangible capital from others is commonly acknowledged to be a vital entrepreneurial task (Shane, 2003; Starr and MacMillan, 1990). It is generally accepted that in order for firms to gain or sustain competitive advantage, research and development (R&D) activities are crucial to their products and services. Therefore, one can start to visualize

the storyboard in relation to network capability, research management and network theory, in line with the evidence presented.

To date, much resource acquisition research has focused on two fronts by which entrepreneurs attempt to cope with the above-noted challenges: relying on social ties and signalling quality. The social tie approach emphasizes the facilitative role played by an entrepreneur's direct or indirect connections to potential capital providers (Hall and Hofer, 1993; Steier and Greenwood, 2000; 1995). This approach has been criticized, however, for failing to satisfactorily explain the processes by which entrepreneurs leverage their existing relationships to secure additional capital (Baron and Markman, 2003; Martens *et al.*, 2007). Given the current emphasis on converting basic research to applied and commercial success, this further accentuates the importance of network embeddedness in research networks. Within the context of this study the acquisition of resources by network actors is not clearly evident in the literature as opposed to traditional perspectives of measuring research output and impact (Bozeman and Melkers, 2013; Perkmann *et al.*, 2013). In agreement with Bozeman and Melkers (2013), it is clear that there is a gap in the literature on emergent output and the author concurs with Bozeman and Melkers that further research in the area is needed.

3.0 Network capability and embeddedness

As discussed network capability forms a core component in the analysis of a firm's ability to develop and utilise inter-organisational relationships to gain access to various resources held by others. The author postulates that there is opportunity to utilise this concept as central to the research plan to explore the relationships between the network actors in given research projects and map the growth or decline of network capability. As claimed by Roediger-Schluga and Barber (2008) this network capability is enhanced by network hubs and it is intended that this type of analysis will be done on the collated dataset. In addition, embedded in the analysis will be the literature on structural holes and how advantage or disadvantage is perceived by the network actors in relation to how much they are embedded in the network and whether access to knowledge differs (Burt, 2009). Granovetter's embeddedness and strength of weak ties will be used to support this network theory approach.

Commercialisation, generating intellectual property (invention disclosures and patenting), and the creation of spinout companies or the licensing of inventions, are common outputs from research network collaboration (Agarwal and Selen, 2009; Bolzani *et al.*, 2014; Rothaermel *et al.*, 2007). These tangible outputs are clear benefits and motivating factors to participating network actors. However, there are possibly less tangible but equally beneficial factors such as enlargement and enrichment of the research network itself. Particularly, the value chain and possibly the supply chain within service organizations increasingly create new service offerings that are the result of collaborative arrangements operating on a value network level. Furthermore, Agarwal and Selen (2009, p. 432) suggest this leads to the notion of “*elevated service offerings*,” and describe it as “*service innovation*”, implying new or enhanced service offerings that can only be eventuated as a result of strategic alliances, and one that could not be delivered on individual organizational merits. This points to increased justification for inclusion and continued participation in research networks (Kirschner *et al.*, 2004; Stuart *et al.*, 2007; Geisler, 2003).

The emergence of the academic entrepreneur, a dual identity, coupled with an increased level of academic engagement facilitated by institutional financial support has put further emphasis on the role of universities in the economy and called for policy interventions (Perkmann *et al.*, 2013; Jain *et al.*, 2009).

4.0 Link between network theory and value concepts

Finding solutions to the research problem(s) resides in further understanding of the contextual players and their actions. So far the paper has described how growth, competitiveness and sustainability of organisations are evolving to include wider nodes in their core strategy. The network theory and open innovation research and research management literature provides a basis upon which to investigate this phenomena in more detail.

In relation to network theory the ties between the nodes are significant, this can be applied to research networks where the nodes are composed of actors from university, industry and institutional organisations as illustrated in Figure 1. Network ties have different benefits where they are distinguished as weak or strong, often historically established they can detect patterns of behaviour and explain attitudes (Granovetter, 1973). Following

on, Granovetter's work on embeddedness proposes pre-existing social ties are related to economic exchange in markets and is relevant to research network formation studies. In addition, Granovetter attains that the strength of weak ties is particularly important as strong ties often regurgitate the same knowledge whereas links with weak ties provides opportunity for new knowledge, ideas and innovation particularly relevant in a research context. A summary of the related literature is presented in Table 1 which links with the concepts in the conceptual framework.

Network capability Resource acquisition Value networks (RQ1)	Research management theory academic/industry liaison (RQ2 & RQ3)	Network and social network theory (RQ1 & RQ3)
Agarwal and Selen (2009); Agarwal and Prasad (2012)	Bozeman and Melkers (2013)	Wasserman and Faust (1994)
Wenger <i>et al.</i> (2011)	Bozeman and Gaughan (2007)	Fleming and Frenken (2007)
McGrath and O'Toole (2014)	Perkmann <i>et al.</i> (2013)	Wellman and Berkowitz (1988)
Walter <i>et al.</i> (2006)	Perkmann and Schildt (2015)	Granovetter (1973); Granovetter (1985; 1992)
Hall and Hofer (1993)	Maughan <i>et al.</i> (2013)	Williamson (1979; 1998; 1981)
Steier and Greenwood (2000; 1995)	David (2004)	Coleman <i>et al.</i> (1966)
Baron and Markman (2003)	Bolzani <i>et al.</i> (2014)	Strang and Macy (2001)
Martens <i>et al.</i> (2007)	Etzkowitz (2003)	Freeman (2011)
Roediger-Schluga and Barber (2008)	Jain <i>et al.</i> (2009)	Homans (1964)
Bolzani <i>et al.</i> (2014)	Owens (2012)	Bourdieu and Wacquant (1992); Bourdieu (2011)
Rothaermel <i>et al.</i> (2007)	Roediger-Schluga and Barber (2006)	Putnam (1993)
Kirschner <i>et al.</i> (2004)		Portes (2000)
Stuart <i>et al.</i> (2007)		Marwell and Oliver (1993)
Geisler (2003)		Monge <i>et al.</i> (1998)
van Amersfoort <i>et al.</i> (2012)		Bienenstock and Bonacich (1992; 1997)
Trompenaars and Hampden- Turner (1998)		Burt (2009)
Hofstede and Bond (1984)		Blau (1964)

Network capability Resource acquisition Value networks (RQ1)	Research management theory academic/industry liaison (RQ2 & RQ3)	Network and social network theory (RQ1 & RQ3)
Steenkamp and Geyskens (2012)		Emerson (1976)
Perkmann and Schildt (2015)		Mejias (2005)
Mehlman <i>et al.</i> (2010)		Borgatti <i>et al.</i> (2009)
Melese <i>et al.</i> (2009)		Vandenberghe (2002)
Rawlings and McFarland (2011)		

Table 1: Summary of related literature

5.0 Challenges in networks and resource acquisition

In Table 2 the author presents three supporting theoretical models adaptable for further consideration of the research problem domain. The proposed research will decipher the feasibility to leverage existing classifications and determine their suitability for inclusion in the planned research. Particularly, it is evident that all three models suggest a positive effect on resource acquisition (value propositions) within organisations in relation to innovation, learning and social capital. Within the context of EU research networks, it is feasible to assume that culture may be an influencing factor, the EU comprises of twenty-eight member states each with its own unique identification and cultural norms. Agarwal and Selen (2009) argue that partnering and collaboration are essential for dynamic capability building. In their evidence in the telecommunications domain they contend that organisational relationship capital (ORC), which is made up of three sub-constructs: relational capital, employee capital, and prior relationship provide the ingredients for inter-organisational teams to operate in a plug and play mode. Moreover, they highlight trust, respect and reciprocity as important elements of relational capital that feed into the prior relationship trust and interaction concept. They postulate that this has a positive effect on organization learning, innovation, supply chain efficiency and performance. Following on, Trompenaars and Hampden-Turner (1998) seven dimensions of culture explores business relationships focused on collaboration and partnering between related organisations highlighting that internationalization calls for cognizance of cultural differences and norms. It is clear from their evidence presented that implementation of process across cultures is not easily portable without considering the delivery format.

Given the proposed setting of the current research, cognizance of cultural differences across EU member states should not be excluded and the possible inter-relational dynamics. Hofstede and Bond (1984) five cultural dimensions used widely in business and marketing studies has an exponential level of related evidence and has been criticized as being non-exhaustive. However, for these study concepts such as how collectivism influences innovativeness and power distance are particularly relevant to the research objective and questions and are along with the aforementioned models provide useful tools to inform the development of the research instruments. The planned methodology paper will address the feasibility of adopting the concepts relevant to these models in this research through a pilot.

Agarwal and Selen (2009)	Trompenaars and Hampden-Turner (1998)	Hofstede and Bond (1984)
Relational capital	Universalism versus particularism.	Individualism– collectivism
Employee capital	Individualism versus communitarianism.	Uncertainty avoidance
Prior relationship	Specific versus diffuse.	Power distance
	Neutral versus emotional.	Masculinity– femininity
	Achievement versus ascription.	Long-term orientation
	Sequential time versus synchronous time.	
	Internal direction versus outer direction.	

Table 2: Models on implications of culture in business and management

Resource acquisition is the acquisition of something tangible, which can be interpreted to include value to an organization or network. Adoption of the value creation matrix approach presented by Wenger *et al.* (2011) and presented in Figure 2 can facilitate a structured approach to exploring the activity path of the research network.

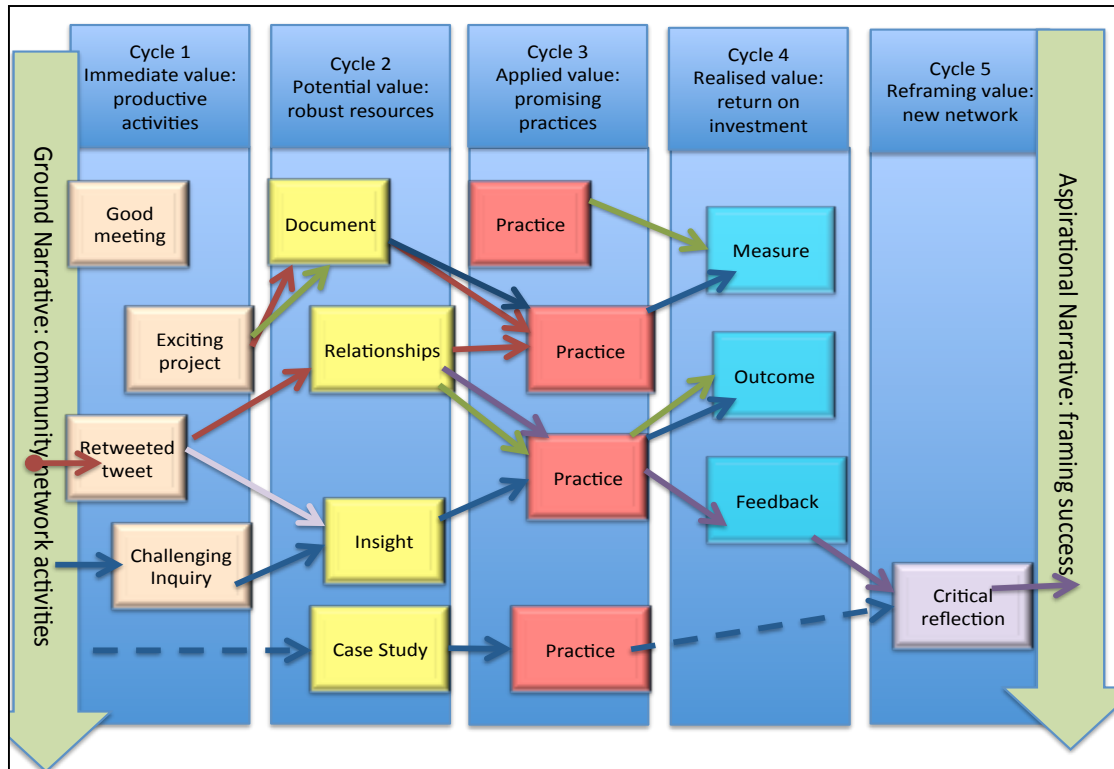


Figure 2: Wenger's Value Creation Matrix

6.0 Proposed Conceptual Framework

A conceptual framework is presented to frame the research objective and illustrate the connectivity of the presented research themes and avenues for inquiry. Subsequently the author presents the research questions and approach to address the research objective in the following sections of this paper.

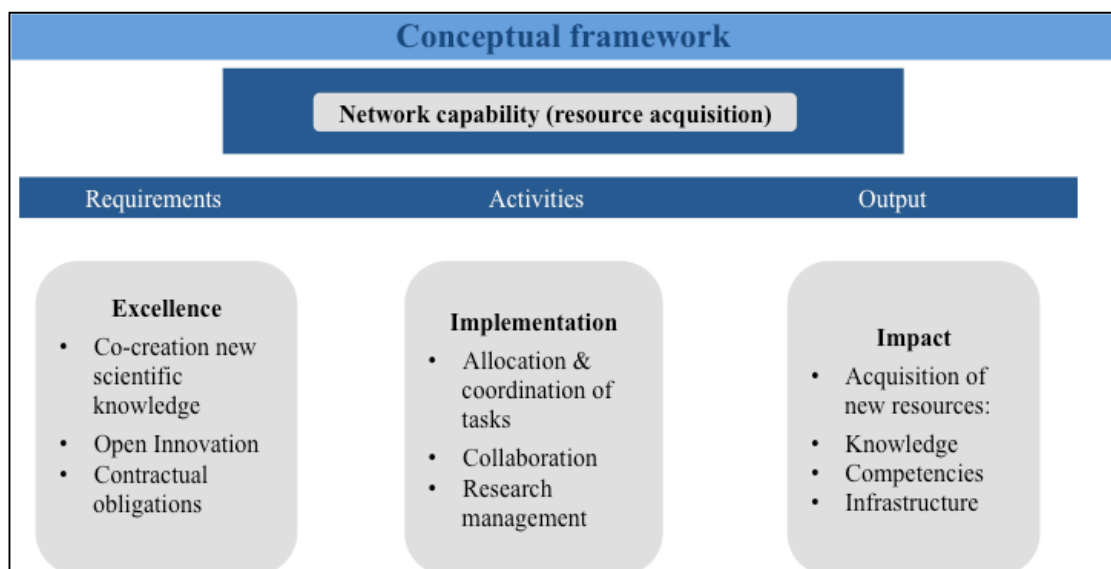


Figure 3: Initial conceptual framework

The conceptual framework helps to present the concept and approach, which forms the basis for the proposed research plan presented in section 7 of this paper. The context of the proposed research has been presented in the previous section, the research is positioned within an EU research context, both the literature and practice elements and needs consideration in tandem with the research objective and questions presented below.

Research objective:

“to investigate network embeddedness of EU funded research networks toward the acquisition of new resources”

The conceptual framework illustrates network embeddedness as central to the study, the analysis of the network within this context focuses on three pillars of activity;

- excellence; what is the focus of the study,
- implementation; how is this realised and
- impact; why is it relevant.

These three pillars are reflected in the essence of the literature review as illustrated in Table 1 and are reflected in the research questions. Thus, a further representation of the conceptual framework is presented in Figure 4 and linked to the research questions.

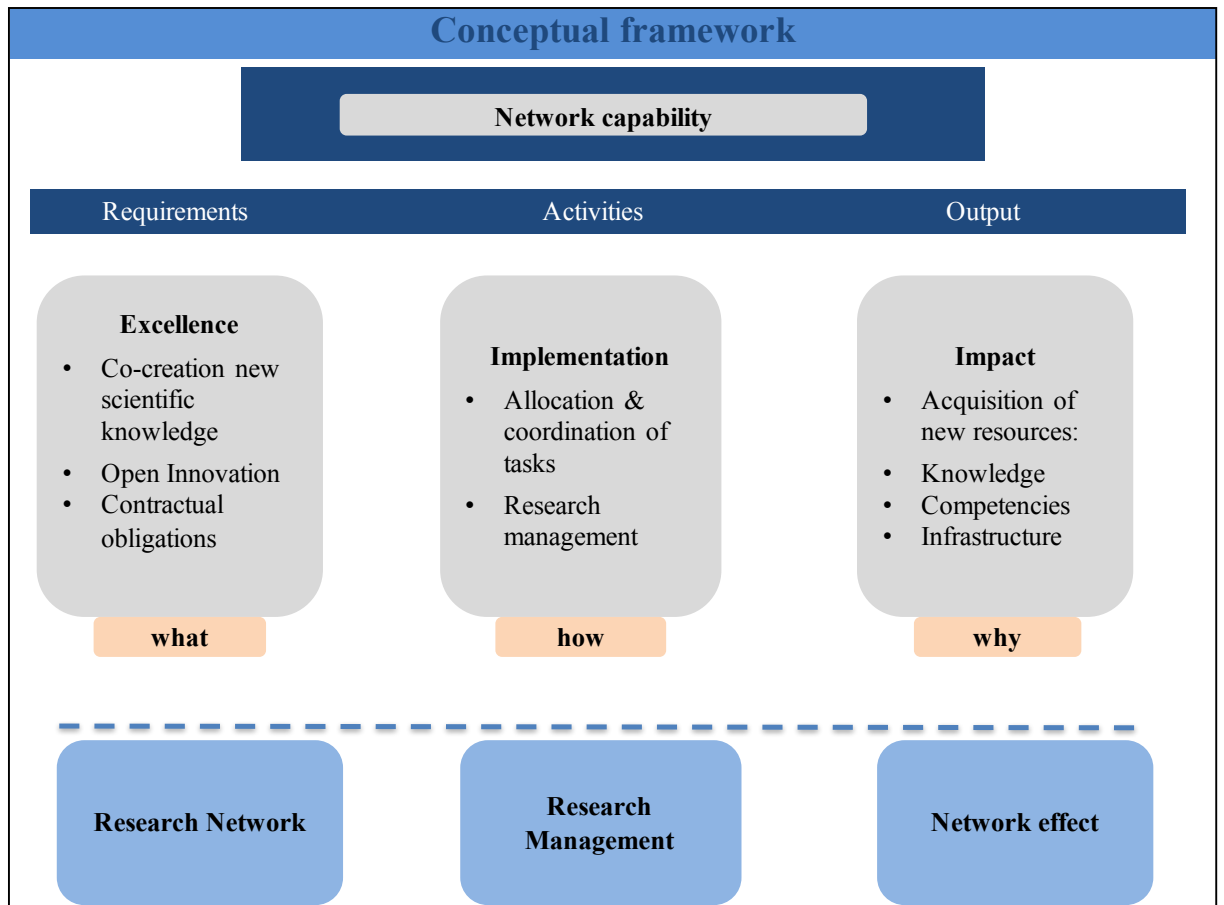


Figure 4: Advanced conceptual framework

Research networks involve multiple actors/nodes with complex links/ties; the norms, behaviours and attitudes prevalent in these networks contribute toward varying levels of impact on technology, economy and society. This paper proposes to explore how research networks facilitate resource acquisition through research. The proposed research plans to tackle this overarching research objective and address the following questions that have arisen from the review of the literature:

- RQ1** What significance does motivation and culture have within inter-organisational research networks and network capability?
- RQ2** What are the difficulties encountered with research networks in relation to cooperation and confidentiality?
- RQ3** How do business and learning research networks evolve?

Links between the proposed research questions and the literature are presented in Table 1 and these will be further developed in phase one of the research design phase.

The next section interweaves the potential impact of this research into the discussion of the research questions. It is credible to envisage that gaining a deeper understanding of the inter-personal relationships within research networks and the complexity of collaboration in EU funded research could have three major strands of implication in relation to practice, theory and policy. The impact of research spans societal and economic implications and the potential return on investment is high.

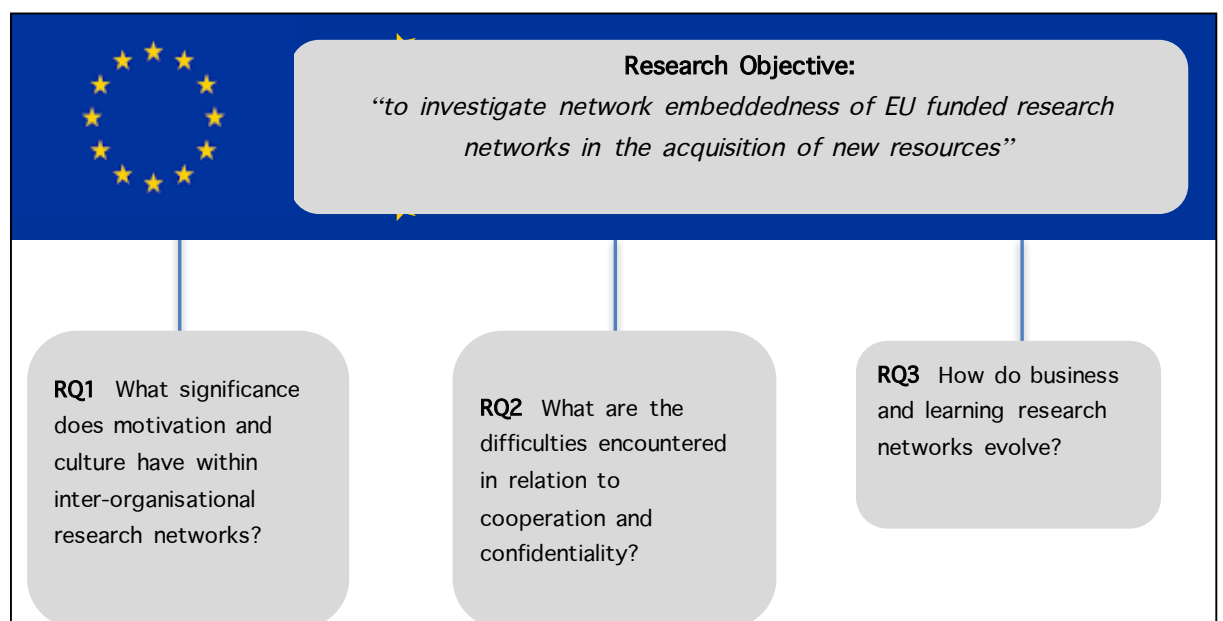


Figure 5: Proposed research objective and research questions

These propositions can be overlaid on the presented conceptual frame, research question one (RQ1) is concerned with pillar one, motivation and culture, are key components within the analysis of the research network (Shane *et al.*, 2003; Papadaki and Hirsch, 2013; Bozeman and Gaughan, 2007). The impact of this research can provide tangible justification to organisations to commit and actively engage with EU research highlighting the potential opportunities and benefits. Particularly, this study will explore the research network and its findings may or may not concur with the evidence in the domain with regard to strength of network ties and structural holes.

Research question two (RQ2) is related to challenges encountered within the implementation of the research such as open data and actor confidentiality (Perkmann and Walsh, 2007; Perkmann *et al.*, 2013; Perkmann and Schildt, 2015; Fleming and Frenken, 2007; Owen-Smith and Powell, 2004). The overall research objective is aligned to practice of which the researcher is actively engaged; EU research networks complexity due to the varying organizational motivations, cultures and objectives for engaging in inter-organisational research. Recommendations for research management practice may emerge in relation to the enablers and barriers for research networks collaboration toward benchmarking. In line with the recommendations proposed by Papadaki and Hirsch (2013) this research may contribute toward best practice for research collaboration leveraging their stepped approach. It is expected that coordinators of research can implement best practice based on evidence after this research and that governance of funded research can minimise risk.

Finally, research question three (RQ3) is associated with the research sustainability and change. From a practice perspective, the researcher envisages that there is potential to identify patterns of network structures and relations. Considering the higher volume and nature of engagement activities in addition to patenting and entrepreneurship, it is essential that firms be well-equipped to effectively participate in collaboration (Perkmann and Salter, 2012). Specifically, there is potential to add to the current impact measurement type beyond licenses, spin-outs and publications toward network capability.

In addition, there is opportunity that that this research could assist policy makers to enhance existing work programmes to mutually benefit the stakeholder groups. If policy aims to successfully increase the impact of academic research through fostering engagement, not only academics but firms too need to be skilled in initiating and maintaining such collaborations, crucially recognising that collaborating with academia presents distinct challenges, separate to those of customers or suppliers. Blackstock *et al.* (2007) suggest further evaluation of partnership, coalition and community based research projects can provide guidance to the development of an evaluation framework. The following section briefly outlines the research plan.

7.0 Next Steps toward the Research Methodology

This section outlines the research philosophy and methodology adopted for this research. For the purpose of fulfilment of the research objectives in line with recommendations from Cagnazzo *et al.* (2009) an intermediate philosophical approach has been adopted which allows the researcher to match philosophy, methodology, and the research problem. Taking an epistemological purist approach would stifle research progress (Miles and Huberman, 1994).

“An intermediate position implies that reality is tangible yet humans have an input into forming its concreteness” (Holden and Lynch, 2004, p. 14)

Concurring with Holden and Lynch’s position above the following section will introduce the adopted research philosophy and defend its views of reality and knowledge with supporting evidence. Argument in favour of the chosen methodology is briefly presented in line with objectives and details of the research process employed. The evidence presented to date in the research domain emphasises the complexity of inter-organisational research and the benefits and constraints of strategic alliances between academia and industry. There is scope to support and extend existing literature in this domain by engaging in inductive research in this area.

The research adopts an interpretivist approach, management and organizational research needs a specific set of assumptions that are not explicitly aligned to positivism due to the social nature of the research problem. The approach will assess the methodological rigor of the research in terms of validity and reliability by applying an assessment of the four criteria for internal, construct, external validity and reliability and their sub-criteria (Gibbert *et al.*, 2008; Yin, 1994; Eisenhardt and Graebner, 2007; Campbell, 1975). Pettigrew (1997) advocates the dynamic quality of human conduct in organisational settings focusing on emerging process and presents processual analysis as a viable research method using iterative cycles of deduction and induction. The case study approach suits the exploratory nature of this study and quantitative methods might limit results and insights to our understanding of inter-organisational collaboration of research networks. Yin (1994, p. 13) argues that:

“case studies are the preferred strategy when ‘how’ or ‘why’ questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon .. desire to understand complex social phenomena”

Tools such as social network analysis tool Pajek will be adopted for analysis and visualisation of the networks. In addition, NVivo will be adopted to analyze the unstructured data. The software allows users to classify, sort and arrange information; examine relationships in the data; and combine analysis with linking, shaping, searching and modeling. Within each project (research network) a semi-structured interview will be conducted with at least six people from each project (four projects in total) this will include a combination of roles; project coordinator, technical lead, developer and project officer representing the three main actor types, academia, industry and institution. The strength of the network ties will be examined and the relationship between consortia members will be analysed.

Cognisant of the nature of social science research the method will comply with best practice. Ethical considerations are central to the conduct of legitimate research. Prior to conducting this research an ethical assessment will be carried out to ensure that the research is in line in line with international standards in relation to ethics. The planned interviews aim for voluntary participation and informed consent and privacy. Participation will always be entirely voluntary and all participants of interviews will be requested to give informed explicit consent to participate. All plans for data collection will be sent for a prior ethical evaluation to the Ethical Research Committee at the Waterford Institute of Technology.

8.0 Conclusion

Inter-organisational European networks are becoming more innovation and value focussed compelling industry and academia to link together toward growth and competitiveness. The changing role of academia to a quasi-business has a knock-on effect to the holistic research network as it becomes a business to business (B2B) network whereby new actor roles such as academic entrepreneurs are added into the equations, possibly curtailing levels of trust for collaborative idea-sharing and new product realisation. There is a gap in the literature in relation to understanding network

embeddedness in depth. Network theory is relevant to investigate inter-personal relationships, links and ties between the network actors. The ‘valley of death’ gap as coined by Maughan *et al.* (2013) has the potential to widen where trust and reputation are integral to open data policies and confidentiality clauses. The planned research has mapped out this context and environment in which the research network resides and has the knowledge to ensure that the appropriate contextual considerations are given priority in the planning of the research execution. Therefore, this increases the possibility for success in relation to potential to contribute to practice, theory and policy. Additionally, the arguments presented provide a justification that the type of links, collaboration processes and research environment is unique and merits further investigation.

The conceptual model structures this contextual environment, research objective and research questions to provide a setting that defines the scope of the planned research. EU research networks bring together stakeholders aiming for research and innovation beyond state of the art, the complexity of the motivations, competencies, cultures, and working ethics should not be underestimated. There is a growing literature in this domain and the research objective and questions presented in Section 6 will contribute to knowledge and practice in this area.

Specifically, research network relationships have evolved and a deeper understanding has the potential to reveal practical implications for changes to research management of these relationships. In addition, the type of output is also evolving and is not restricted to the traditional output type presented in the literature. Opportunities are currently camouflaged while research network actors scamper to meet contractual deadlines often through constraints that are not openly congruent. Deeper understanding can be obtained through operationalizing the planned research agenda in line with a detailed data collection phase. Measurements and metrics are inconclusive for addressing the research problem as the links between the network actors rely on sensitive data not easily released. The proposed research plan, described above, consisting of qualitative research in the form of a 3-phased approach to data collection which includes semi-structured interviews will counteract the short-comings of other methods in this regard.

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Preface to Paper 2 - Methodology

A proposed methodology for this research formed part of the initial proposal. However, the DBA workshops and advice from supervisors and academics through the research journey played a critical element of the refinement of the research objective and its approach. Following the submission and presentation of Paper 1 in April 2016 and with the external examiner recommendations, the development of Paper 2 methodology commenced. The examination panel included; Prof. Alan Wilson, University of Strathclyde, UK and Dr. Thomas O'Toole, Head of School of Business, WIT.

The DBA process provides the opportunity to gain feedback both written and verbal from the internal and external examiners. The development of Paper 2 used an iterative approach and was submitted to the WIT portal on 13th March 2017. During this period, the conceptual framework was developed and refined, the research questions were formed and reformed and my own research philosophy was more accurately assessed and documented. Furthermore, the research strategy, case study approach, data collection and analysis and ethical assessment were established. Feedback from the proposal document and workshops which included discussions with academics Prof. Bill O'Gorman, Prof. Gary Davies, Dr. Felicity Kelleher and Prof. Denis Harrington contributed significantly to the refinement of the research topic and enhanced the justification process to progress with the specific research objective and questions.

During this period, ethical approval was sought and granted from the WIT Business School Ethics Committee. There were several recommendations from the Ethics Committee which were subsequently addressed by the researcher. These included the addition of a publication agreement to be signed by supervisors, tick boxes and the intention to record the interviews to be stated in the consent letter and inclusion of a statement to ensure compliance with data protection legislation. The Ethics Committee approved the application following the updates. The feedback from Paper 1 did generate additional paths of enquiry as I tried to ensure that the research objective and questions were unambiguous and find the most appropriate method to adopt for my study. I had explored Open Innovation models and Wenger *et al.* (2011)'s value creation matrix as possible frameworks (Whelan *et al.*, 2014; Vega, 2012; Perkmann and Walsh, 2007;

Chesbrough and Crowther, 2006; von Krogh *et al.*, 2003). The feedback from Paper 1 suggested to refine the scope as it was overly ambitious and thus in line with the adopted philosophy of interpretivist value appropriation was not deemed within scope for Paper 2. Thus, the scope changed toward research networks in innovative, B2B, value oriented environments. Network theory was central to the study, this included the consideration of social capital but excluded collaborative working theory as concepts such as absorptive capacity and open science were deemed not core (Granovetter, 1973; Burt, 2009; Bourdieu and Wacquant, 1992; Putnam, 1993; Portes, 2000).

This research adopts an intermediate philosophical approach. It applies appropriate levels of methodological rigor in relation to validity and reliability. The study whilst exploratory is aware that qualitative research expectations are not assuming generalizability but assume a structured, detailed approach to data collection and analysis phases. I persevered with the multiple case study approach but upon recommendation from the external examiners, and a refinement of the research questions a single case study was adopted. The methodology literature highlights the merits of different case study designs and the researcher decided that a single case design, a holistic research network was most appropriate (Yin, 1989; Yin, 1994; Walsham, 1995). Other similar research supported the case study approach, linking qualitative method with network theory (Cassell and Gummesson, 2006). Furthermore, the literature on network research purports that where complexity and dynamism of relationships limit the applicability of positivist research, based on inferential methods, qualitative case study methods are preferential (Hite, 2005; McGrath and O'Toole, 2014; Krippner *et al.*, 2004). Beckmann and Padmanabhan (2009) contend that a study of institutional and contextual influences warrants a case study approach.

Appropriate consideration was given to other qualitative methods, before selecting the most appropriate; ethnographic, narrative, phenomenological, grounded theory and case study. The researcher has experience in conducting case study research and has been trained in the biographic narrative interpretive method. Furthermore, the researcher considered the available data collection methods, which included, focus groups, interviews, observation and action research. Deciding on a single case study and coverage of all network nodes was a turning point as it helped to focus on the specific research

objective and how I would set about investigating it thoroughly. A sampling strategy was developed, and consent obtained for participation. Following on, briefing of participants, and formulation of the interview guide contributed to the rigor of the research process. This supplementary documentation was supplied as appendices to Paper 2. Additionally, the use of archival data was agreed with the network coordinator and is common in this domain (Greer and Lei, 2012; Geisler, 2003; Kirschner *et al.*, 2004; Perkmann and Schildt, 2015).

Having refined the three research questions, the research strategy was defined to operationalise the research approach. The research strategy is how one intends to go about answering the research question (Saunders and Lewis, 2012). Yin (1994) recommends the assessment of three key criteria; the type of research questions, the level of control over behavioural events and the focus of the study in contemporary versus historical events. The natural construction of the interaction within the network is core to the conceptual framework. This is best understood in its natural environment rather than through experimentation or action of the researcher. Furthermore, Yin (1994) highlights the richness of interpretivist research, where the research process includes deciding on what to further explore, and drawing conclusions that are supported by evidence. As recommended by Eisenhardt (1989) I used previous literature to formulate the research questions, and to identify concepts that may be important. The suitability of the case for the requirements of the study was presented in Paper 2.

Initially the data collection strategy explored the possibility of a pilot, a database analysis, single and multiple case study approach, through qualitative means. The study rationale emerged from my own practical experience. At this stage, I contacted Dr. Thomas Scherngell, senior scientist at the Austrian Institute of Technology, to ascertain access to EUPRO via the RISIS platform (risis.eu). This was to facilitate a multi-case study investigation and feedback was positive. Having presented Paper 2 to include multiple cases and use the RISIS database the feedback from external examiners indicated it was overly ambitious and not feasible DBA scale research. The decision to exclude the RISIS database was a critical design decision that upon reflection would have diluted the study and the results. Following on, I refined the Miles and Huberman (1994; 1984) qualitative data analysis framework aided by Tracy (2013)'s model to include additional iterations

as necessary. The presented data management process included collection, implementation and evaluation of appropriate supporting software tools, such as NVivo and Pajek. I proposed that the access to the research site would commence in April 2017, and be complete by July 2017. The emerging conceptual framework still included many practitioner elements, and the more literature I read, the more refined this became. I eliminated and refined the research jargon from the European Commission, to ensure that the concepts are accessible. The unit of analysis is the network, focusing on network structure, the individuals in the network will form part of the data collection. The planned semi-structured interviews targeted all members of the network, with one person from each organization. The adopted qualitative method of case study, using in-depth interview, did not aim for a reductive process of generalisation, but a sophisticated in-depth explanation of unique cases transforming data through interpretation (Husserl, 2002).

The interviews were supplemented by “gathering and analysing documents produced in the course of everyday events, or constructed specifically for the research at hand” (Marshall and Rossman, 1989; Marshall and Rossman, 2014). Furthermore, document reviewing is a largely unobtrusive method useful in gaining understanding. Documentation can support the verbal accounts of informants (Remenyi *et al.*, 2002) as well as supplement and verify data from other sources (Yin, 1994). The data collection approach included field notes, documentary sources, and interview scripts, stored in the data analysis software (NVivo), for this research study. To identify convergence of themes and patterns (Miles & Huberman, 1994; Yin, 2003), the data and literature was iteratively examined, with initial codes or themes developed, based on patterns between the data and the conceptual framework. Coding in this manner facilitated insight and comparison through segmenting the data into units (Hammersley & Atkinson, 1983).

I had already been introduced to reflective writing at a continuous professional developmental module and I had started to keep regular entries since we had begun the DBA process through the workshop periods. Thus, this also assisted with the process to keep abreast of relevant literature as I also developed a literature database which included some metadata for easy retrieval and classification of material. This has proved an excellent resource over the lifetime of the DBA and in addition to my DBA progress

reporting spreadsheets that I maintained it has assisted this part of the writing of the thesis to help bring it all together. Even though I was confident of the robustness of the research questions at this stage further refinement did emerge in later iterations.

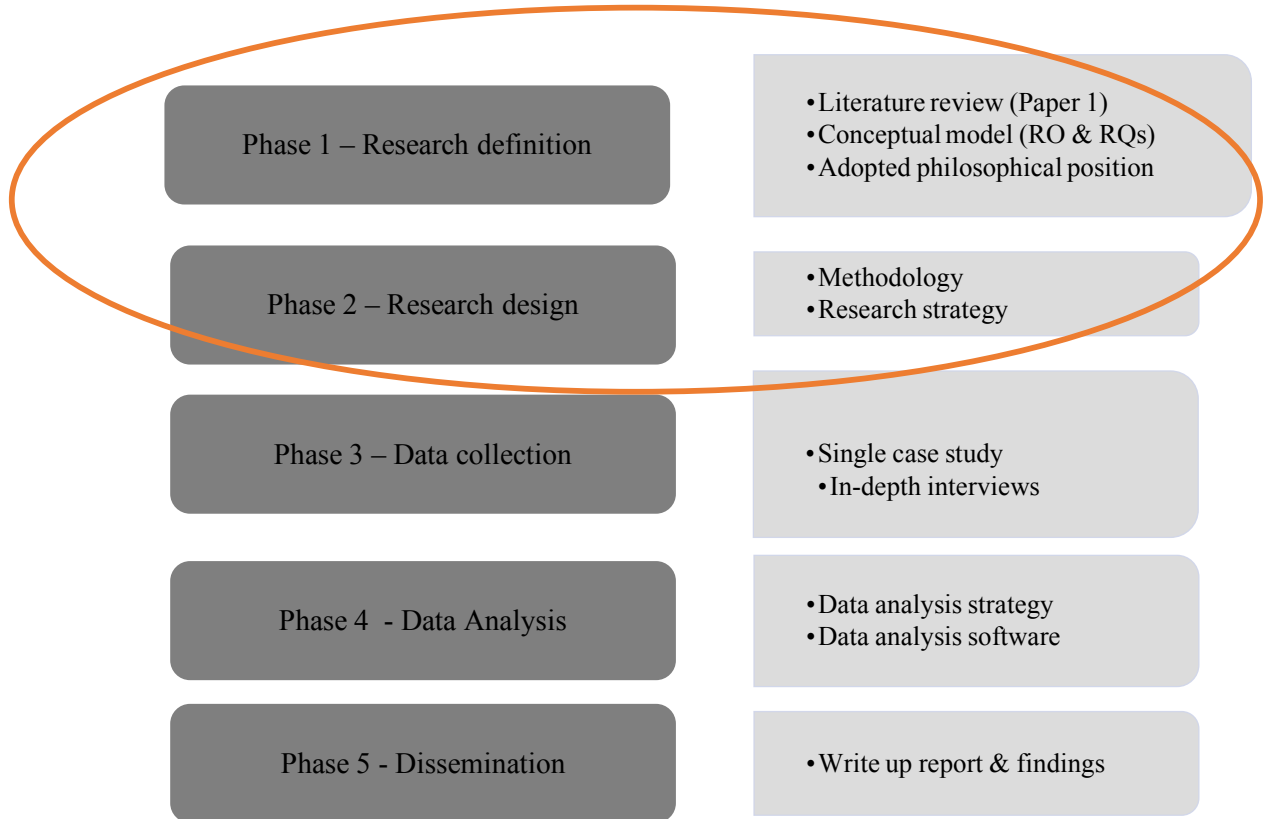


Figure 6: Research Summary

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Paper 2

METHODOLOGY

**An Investigation of Social and Economic Aspects of
Structural Embeddedness in an ICT Research
Network Based In the European Union**

Abstract

The aim of this paper is to outline the adopted research process, focussing on the methodology, data collection and data analysis implementation. The research objective, to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union and its associated research questions are presented in tandem with the research design. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). Network embeddedness is central to this study, the conceptual model highlights the social and economic aspects of structural embeddedness within EU research networks. The results from this research contributes directly to theory by providing rich insights in structural embeddedness which is primarily quantitative rather than qualitative (Herz *et al.*, 2014). This context for an investigation in structural embeddedness will provide novel contextual insights. Furthermore, the contribution to practice aids the development of a robust research network strategy, cognisant of social and economic aspects. In addition, the research management function will gain insights to enablers and barriers of structural embeddedness which supports their operations. From a policy perspective, funding agencies will further understand the structural embeddedness of research networks and the complexities therein.

Our economies are now more than ever dependent upon the digital world that connects us all, in terms of the rapidly growing digital services and commerce industry. Therefore, the scope of the study focuses on high tech companies, a particularly pertinent sector in research networks. This paper details the selected methodology to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The research follows an interpretive, qualitative paradigm. A single case study approach is presented as a suitable method to investigate this phenomenon in its natural context, as it allows for the subjective and contextual experiences of the participants supported by in-depth interviewing and documentation analysis. Data will be analysed using NVivo and the findings will be presented in a future paper.

1.0 Introduction

This paper details the theoretical and philosophical perspectives (Section 2.0) influencing the research inquiry and presents the adopted methodology (Section 3.0) for conducting the planned research. Furthermore, evidence to support the adopted approach is presented (Section 3.0) with ethical considerations (Section 5.0) inherent in the research addressed. Considering the current state of research in the field (Burt, 2009; Granovetter, 1985; Cook and Whitmeyer, 1992; Ahuja, 2000; Kim, 2014; Moran, 2005; AlKuaik *et al.*, 2016) and cognisant of the research question and objectives, an interpretivist, qualitative approach was considered the most appropriate for investigating to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union (Gergen, 1985; Guba and Lincoln, 1994; Schwandt, 1994; Kelliher, 2011). Furthermore, section 3.0 describes the research strategy to use a single case study approach in a high-tech, ICT network, while section 3.5.2 details the adopted approach for data analysis within the case. The paper concludes with a summary of the research process.

1.1 Framing the research

While the rationale for the research was presented in Paper 1 of the DBA Paper Series, it is useful to outline the theoretical and practitioner aspects to further understand the context of the research objective and research questions through its conceptualisation. The following sections present the conceptual framework and details the scope of this holistic research.

1.2 Conceptual Framework

The conceptual framework is a key mechanism to develop ideas that feed into the research process. The conceptual framework helps to structure the research question and objectives to deliverable a viable concept and approach, which converts to an implementable research plan presented in sections 3.0 and 4.0 of this paper. The identification of a clear and focussed research objective and question(s) are critical to effective research and form the precursor for the research implementation. Paper 1 provides the theoretical background for the conceptual framework which has been further developed and refined during the research process. This research framework is informed by evidence gathered from the literature that acts as a lens for this study. Figure 2 below

presents the conceptual framework to illustrate the research objective and shows the connectivity of the presented research themes and avenues for inquiry. It is relevant to discuss the term embeddedness to illustrate the understanding of the core principals of this study. In Krippner *et al.* (2004) they discuss how the concept of embeddedness has evolved and present a number of arguments in defence of its widespread use in research. Granovetter (1985) and Polanyi (1957) use the term embeddedness differently, and this study adopts Granovetter’s meaning of embeddedness. The EU H2020 funding programme is tasked to support ICT research networks to develop new products and services, employment and new spin-out organisations, therefore it is clear that Granovetter (1985) work in relation to markets and social structures is relevant. Granovetter recommends that embeddedness be further investigated as behaviour and institutions are so consumed by ongoing social relations. The connectedness between economic and social activities, as illustrated in the conceptual framework is also adopted by other authors (Burt, 2009; Baker *et al.*, 1992; Krippner and Alvarez, 2007). Furthermore, Granovetter states that embeddedness is an umbrella term that is ubiquitous and is not measurable. The conceptual framework based on the literature places network embeddedness as central to the study, and focuses on the analysis of structural embeddedness within a research network taking into consideration social characteristics as illustrated on left of the diagram and economic aspects on right. Following on, the author presents the research questions and approach to address the research objective.

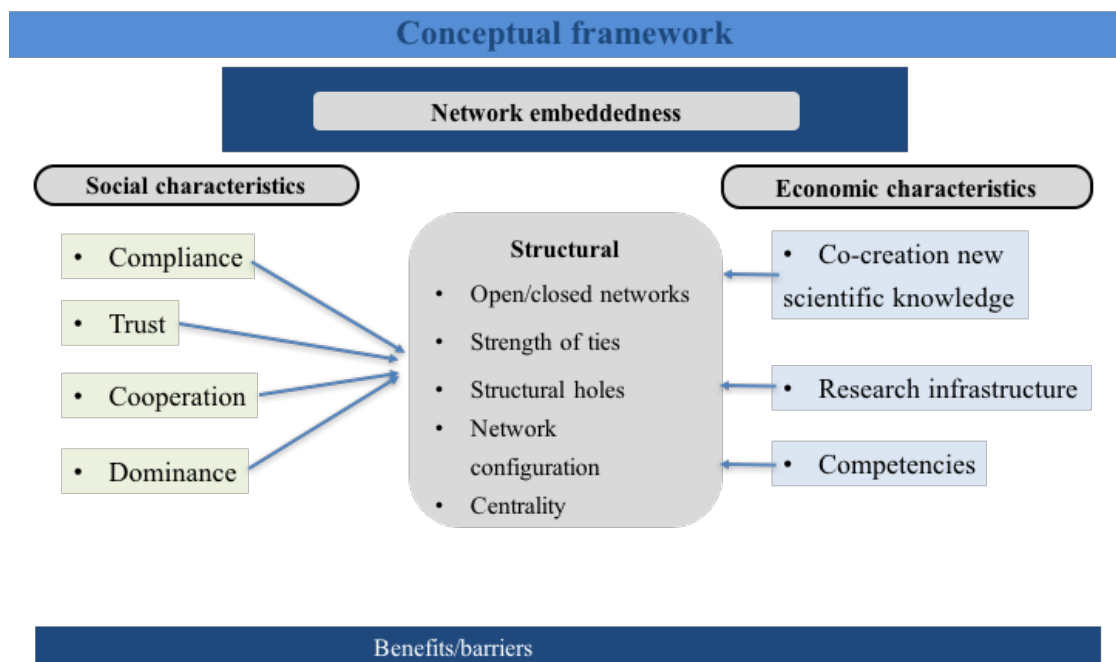


Figure 1: Conceptual framework

1.3 Research Objective

This concept is reflected in the essence of the literature review as presented in Paper 1 and in the research questions in section 1.4 below. The formally stated research objective for this study is:

*to investigate social and economic aspects of structural embeddedness in an ICT
research network based in the European Union*

The results from this research contributes directly to theory in two ways, firstly, by providing rich insights in structural embeddedness which is primarily quantitative as qualitative structural analysis is still emerging (Herz *et al.*, 2014). Secondly, structural embeddedness has not previously been investigated in this context, a European Union research network and it will provide novel contextual insights. The contribution to practice will equip research networks to pursue an optimised network strategy, cognisant of social and economic aspects. In addition, the research management function will gain insights to enablers and barriers of structural embeddedness which supports their operations. From a policy perspective, funding agencies will further understand the structural embeddedness of research networks and the complexities therein.

This study will support or negate theory in relation to structural dimensions (Burt, 2009; Granovetter, 1973; Kim, 2014; AlKuaik *et al.*, 2016). In addition to the theoretical aspects the rationale for the research objective and research questions emerged from the author's previous practical experience managing EU funded research projects and previous research experience. The author contends that unravelling the complexity of EU research networks could inform research management to enhance economic output such as co-creation knowledge in the form of process or product. In recent years, the author has engaged in exploratory secondary research in open source communities, communication networks, collaborative working environments, open standards, interoperability and open innovation which has informed the research and provided much contextual knowledge (Dooly *et al.*, 2014; Dooly *et al.*, 2015; Doyle *et al.*, 2015; Power and Dooly, 2014).

1.4 Research Questions

The proposed research plans to tackle the overarching research objective and address the following questions that have arisen from a review of the structural embeddedness literature:

RQ1 How are research networks structurally embedded?

The literature suggests that network configuration is a significant influencing factor within research networks and network capability (Granovetter, 1973; Granovetter, 1985). Specifically, structural holes and how advantage or disadvantage is perceived by the network actors in relation to how much they are embedded in the network and whether access to knowledge differs (Burt, 2009; Moran, 2005; Uzzi, 1997). Specifically, dimensions within the position of the actors in a research network can be significant in relation to centrality, stability, power and legacy relationships (Gulati and Gargiulo, 1999; Burt, 2009; Cook and Emerson, 1978; Cook and Whitmeyer, 1992).

Furthermore, evidence points to embeddedness within open and closed networks and new knowledge creation and cooperation between network partners (Gulati, 1995). Commercialization, generating intellectual property (invention disclosures and patenting) and the creation of spinout companies or the licensing of inventions are common output from research network collaboration (Agarwal and Selen, 2009; Bolzani *et al.*, 2014; Rothaermel *et al.*, 2007). Evidence indicates that the value chain within service organizations increasingly creates new service offerings that are the result of collaborative arrangements operating on a value network level. Furthermore, Agarwal and Selen (2009) suggest this leads to the notion of “elevated service offerings,” and coin it “service innovation”, implying new or enhanced service offerings that can only be eventuated as a result of partnering, and one that could not be delivered on individual organizational merits. This points to increased justification for inclusion and continued participation in research networks, however, the optimal structure and configuration of these networks are not evident (Geisler, 2003; Kirschner *et al.*, 2004; Stuart *et al.*, 2007). This study will discover how the network nodes within the network interact and how the network is configured, thus its contribution is linking the narrative story with the network which builds upon the qualitative contribution. This context is novel for studies on

structural embeddedness and will provide contextual insights. Practically, the study will equip researchers to define and pursue structural embeddedness in their network strategy.

RQ2 How is structural embeddedness interconnected with social and economic characteristics?

Granovetter (1985), Krippner *et al.* (2004); Krippner and Alvarez (2007) identify the social characteristics investigated in this study; compliance, dominance, cooperation and trust. Investigating structural embeddedness in the network includes the interactions of the network nodes, these social characteristics provide a frame around which to compartmentalise these interactions. While the theory discusses the economic characteristics, this study has used economic characteristics specific to this context; new knowledge, such as new products, services or spin-outs, research infrastructure or new competencies or skills. Finding solutions to the research question resides in further understanding of the contextual players and their actions. The *a priori* network formation, network literature and open innovation evidence provides a basis upon which to investigate these phenomena in more detail. These social interactions from prior networks play a significant role in relation to the social characteristics and can impact future network configuration. In addition, the economic aspects impact the structural embeddedness in relation to success or failure to achieve desired research output. Within institutionally funded research there is increased emphasis on research and market adoption, university-industry relations and commercialization, but with little qualitative inquiry in this domain (Bozeman *et al.*, 2013; Maughan *et al.*, 2013; Perkmann *et al.*, 2013). Furthermore, the emergence of ‘open data’ initiatives has initialised new challenges in relation to industry and academic partnerships in relation to leaking data to competitors and demotivating academics highlighting the concepts of dominance, cooperation, compliance and trust (Perkmann and Schildt, 2015). These new challenges add complexity to the already diverse research networks. Previous studies focussed on measuring specific aspects without gaining a holistic picture of a full network and not within a research network context, hence the potential contribution of this study in relation to depth and understanding.

RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

The literature reveals that trust (Uzzi, 1997; Granovetter, 1985; Larson and Starr, 1993), power (Gulati and Singh, 1998), co-operation (Coleman, 1988; Burt, 2009) and governance (Rowley, 1997; Rowley *et al.*, 2000; Oliver, 1991) are key enablers and barriers to structural embeddedness. Collaboration strives toward mutual benefit where self-interest is unsatisfied in isolation. Trust is a significant factor with regard to collaborative relationships due to the nature of reciprocity, shared responsibilities, shared accountability and power and authority (Aryee *et al.*, 2002; Blau, 1964). It is essential to consider the body of literature from learning networks, collaboration and communities of practice (Brown and Duguid, 2001; Jewson, 2007; van Amersfoort *et al.*; Wenger *et al.*, 2011; Wenger, 2010). Furthermore, the network connections are considered as a critical factor in relation to embeddedness particularly joint problem-solving and information sharing initiatives which remains under-explored. (Durkheim, 2014; Granovetter, 1973; Granovetter, 1985; Hansen, 1999; Uzzi, 1997; McGrath and O'Toole, 2014). Larson and Starr (1993) identify high-tech organisations as being reliant on network ties that stem from relational embeddedness. This study will contribute to the practitioner's toolbox in relation to defining a network strategy taking into consideration the results in relation to enablers and barriers of structural embeddedness. The contribution to practice is the focus of this research question, there is some slight overlap with RQ2 in relation to the concepts that form the enabler and barrier aspects, however, this research question accentuates the steps from theoretical to practical to emphasis the contribution to the practitioners.

2.0 Philosophical Perspectives

Contemporary philosophers continue to debate ontology and epistemology and the dominance of science in the twenty first century (Ward, 2008). My own philosophical assumptions are scientific based, whereby interaction with the phenomena; facts and evidence are pivotal elements. This search for reality and knowledge concerns itself with inquiry into the domains of both natural and social science and my personal belief system considers that management and organizational research needs a specific set of assumptions. The relevance of theory and subjective research in managing our current technical, economic and cultural challenges is significant and was recently highlighted by the Irish President¹⁵ to further understand management and organizational phenomena

¹⁵ <http://www.president.ie/en/media-library/speeches/speech-at-the-ieee-ssit-conference>

(Bacon and Anderson, 1960; Husserl, 2002; Kant and Guyer, 1998). This approach resonates with the purpose of the study and the objective to further understand the network embeddedness and resource acquisition.

In the past natural philosophy was what we now refer to as science (natural science) and was initially translated to wisdom and learning and has been complemented by social science, which is the study of human society, relationships and co-existence resulting in deep understanding and explanations of phenomena. Both natural and social lenses are helpful to understand phenomena in a comprehensive way, and they continue to form academic debate (Husserl, 2002; Smith and Heshusius, 1986; Sutton and Staw, 1995). However, the argument made by Comte (1868) and Durkheim (2014) that both natural and social science are suited predominantly to a positivist mode of inquiry is disputed here as the author considers them incommensurable. Indeed, this is one of the oldest tenets of modern philosophy, whether knowledge is independent of experience (a priori) or whether social experiences are critical (a posteriori). Marx, Weber and Durkheim are considered the fathers of contemporary social science and even though they adhered to different assumptions, their work covers many of the social challenges we currently face globally (Marx, 2008; Weber, 2009). Capitalism, communism, bureaucracy, collective action and organic solidarity convey the complexities of our reality. Based on the foregoing, it is essential to highlight that the proposed research is not a study of philosophy but the impact of the adopted philosophical approach on the research topic.

2.1 Ontology

In relation to ontology in social science, the researcher agrees with the literature (Gioia and Pitre, 1990; Mills *et al.*, 2010) that a single research paradigm is too narrow a view to represent reality and believes that reality is subjective for similar reasons to those presented by scholars in relation to the previous epistemic debate on experiences influencing knowledge. Social phenomena are influenced by individuals who are in a constant state of revision. In modern philosophy and moving toward social theory, Burrell and Morgan (1979) discuss the nature of science and the variance of the two dimensions of subjectivity and objectivity. Furthermore, they present a framework for the analysis of social theory utilising four paradigms; radical humanist, radical structuralist, functionalist and interpretive; these four views of reality bind theorists to illustrate the

nature of science and of society. They postulate that this tool will aid researchers to determine their position and potentially map one's journey while recognizing other assumptions within the subject area. It is clear now having looked deeper into research philosophy that this type of tool is a mechanism to critique social theory and present a holistic picture of the research domain. Moreover, Gioia and Pitre (1990) present a metaparadigm perspective and demonstrate the function of transition zones and their blurred nature. Therefore, the researcher adopts the interpretivist paradigm but is cognisant that one's position may be in the transition zone between interpretivist and functionalist. The aim of the research, to investigate social and economic aspects of structural embeddedness in an ICT research network based in the EU is in line with the interpretivist perspective using an inductive approach.

Particularly in natural science, realism is the dominant school of thought; however, idealism, critical realism and pragmatism are also significant components. Berkeley (2012), defends idealism; the view that reality consists exclusively of minds, ideas and immaterialism. Furthermore, he proposed that matter doesn't exist and that physical objects are connected combinations of ideas and supports God and deity. This extremist view accentuates the author's decision to adopt an intermediate stance in relation to philosophy as described earlier to support the proposed research objective and questions.

To examine relationships in research networks it is expected that epistemic reflexivity is relevant and should be considered. A researcher's epistemological assumptions are important to the mode of inquiry and can influence how the research is carried out. The mode of inquiry will look for validation from experiences, aiming for particularization, idiographic and praxis results. For this research a reductive process of generalisation is exchanged for an in-depth explanation of relevant cases (Leshem and Trafford, 2007). Contributions to understanding society are embedded in analysing patterns utilising qualitative methods often with low levels of predictability. The proposed research is in social science and the danger here is normally considered to be that the findings could be distorted and contaminated by the values and purposes of the researcher. This bias has been referred to by Russell (1945) as the "fallacy of subjectivism". This risk is addressed in the implementation of the research design and is further detailed in section 4.1.

In conclusion, constructivism is in line with the author's view based upon the preceding philosophical discussion (Schwandt, 1994; Guba and Lincoln, 1994; Gergen, 1985). It is clear that there is no paradigm consensus and as Gage (1989) argue research in this area is inconclusive and constantly evolving. The adopted research paradigm is an interpretivist approach, which sits appropriately with the research context and the research purpose and is supported widely in the literature (Berger and Luckmann, 1991; Klein and Myers, 1999; Morgan and Smircich, 1980; Myers, 1997).

2.2 Epistemology

As previously mentioned, philosophy has several branches of which epistemology is a major consideration for management research regarding how knowledge is acquired, translated to theory and implemented in practice. The evaluation of theory is complex, with merits often assigned for predictability, usefulness and popularity (Bacharach, 1989; Corley and Gioia, 2011). Furthermore, Davis (1971, p. 309) argues that:

A theorist is considered great, not because his theories are true, but because they are interesting. Interesting theories are those that deny certain assumptions of their audiences, while non-interesting theories are those which affirm certain assumptions of their audience.

Epistemology, the branch of philosophy concerned with the nature and scope of knowledge, poses questions with great complexity such as how knowledge is created and what is knowledge. The researcher adopts the epistemological belief that knowledge in social science is subjective, and in line with other philosophers (Bacon and Anderson, 1960; Kant and Guyer, 1998; Kuhn, 1974; Polanyi, 2009) it is socially constructed through experiences. In Kant and Guyer (1998), a clear argument is presented for the difficulty of knowledge to strive independently of experiences. The dispute between rationalists and empiricists was stagnant and Kant and Guyer (1998) provided some synergies to consider such as innate ideas having 'a priori' and knowledge attained through experiences "without experience, they [conceptions] are a merely arbitrary conjunction of thoughts".

In modern philosophy there is a growing trend toward reflexivity and Johnson and

Duberley (2000) postulate that epistemic reflexivity is at the nexus of theory and practice, with potential benefits for economic and social impact. This trend resonates with the pragmatism perspective supported by the literature (Comte, 1868; Darwin and Bynum, 2009; Dewey, 2007). According to Bourdieu and Wacquant (1992) reflexivity is a fundamental dimension of epistemology akin to knowledge creation and wisdom literature. In implementing epistemic reflexivity, the major challenge remains that of achieving democratic co-operation between researchers and the researched.

2.3 Methodological Debate

Contrary to the many attempts made by academics (Dilthey *et al.*, 1991; Putnam, 1993; Weber, 2009) to synthesise natural science and social science, the context of human values prevails as significantly relevant and the differences between the two platforms cannot match to fit a set of generic guidelines and methodological recommendations. There is an abundance of literature focusing on two main research methods with quantitative methods championed by positivists and qualitative by interpretivists (Miles and Huberman, 1984; Bryman, 2003). However, more recently multi-methods and a less aggressive approach to criticism of each other's stance is evident (Leech and Onwuegbuzie, 2007; Bell and Bryman, 2007). Generally, quantitative analysis depends largely on numeric data as input whereas qualitative depends more on abstract subject matter captured by narrative description. Formal structured methods are feasible across quantitative and qualitative forms of inquiry and the procedural variation does not impact the validity and reliability of research results. Many of the critiques of qualitative research (Daft and Lewin, 1990; Fitzgerald *et al.*, 2000; Taylor and Bogdan, 1980) highlight that researcher bias is the main difficulty for validation of results, but with an increase of literature supporting qualitative research in recent years (Eisenhardt and Graebner, 2007; Pettigrew, 1997; Weick, 2007) the author plans to address researcher bias explicitly and adopt an iterative approach to data collection as recommended (Groenewald, 2004). Figure 2 illustrates a philosophical taxonomy and is useful to get a bird's eye view of the underlying assumptions of the proposed research as described in this section.

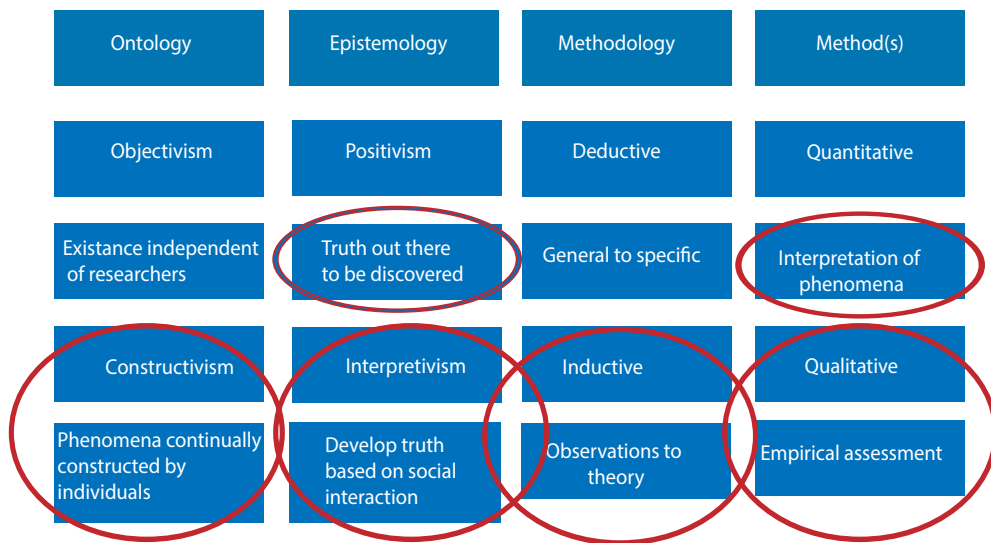


Figure 2: Adopted philosophical assumptions

2.4 Justifying the research approach

The philosophical positioning of this research study is relevant to understand the impact these arguments have on choosing the appropriate method for conducting the research. The adopted philosophical assumptions of the researcher have a direct impact on operational research design and method. Building upon the work of Burrell and Morgan (1979) Kilduff *et al.* (2011) present a new wave of research assumptions contextualized in modern society along with the emergence of technical transfer, disparate philosophical groups within organisations and open innovation. This is particularly relevant in this research as it is conceivable that the research networks comprise of disparate philosophical groups. To date much of the empirical evidence presented in relation to European funded research networks is quantitative, while providing excellent insights, adopting a qualitative approach has opportunity to provide deeper insights through the narrative of the active research network participants (Scherngell and Barber, 2011; Scherngell and Lata, 2013; Wanzenböck *et al.*, 2015). Further justification rests heavily on the ability of qualitative data to offer insight into complex social processes that quantitative data cannot easily reveal. For example, Greenwood and Suddaby (2006) studied how a known instance of institutional change at the centre of the accountancy domain occurred (i.e., promotion of change by elite firms within the accounting profession). They justified their approach in terms of extending institutional theory and the ability of qualitative data to explicate the complex social processes involved, difficult

to establish using quantitative methods. In relation to research networks, the author is cognisant of the existence of the concepts of cooperation, dominance, trust and compliance as illustrated in the conceptual framework, which are more appropriately addressed through qualitative inquiry. It is argued that qualitative methods introduce bias and are subjective, however, there is sufficient rigor and structure planned to minimize this bias and conduct qualitative research in a suitable context. Inductive inquiry is a mode of discovery that sets about the tracking down of patterns and consistencies in raw data (Mintzberg, 1979) which meets the criteria for this study. The inductive research process in Figure 3 illustrates the iterative approach between the analysis and the recursive link back to the relevant theories and concepts.



Figure 3: Iterative approach

Furthermore, (Marshall and Rossman, 2014) provide a framework, described in Table 1 for evaluating research methodologies in the context of the available literature. The framework shows that the purpose of research can be exploratory, explanatory, descriptive, and/or predictive. For this research, the purpose of the research is exploratory.

Purpose of the Research	Research Question	Research Strategy	Examples of Data Collection Techniques
<u>Exploratory</u> To investigate little understood phenomena. To identify/discover important variables to generate hypotheses for further research.	What is happening in this social program? What are the themes and patterns in participants meaning structures? How are these patterns linked?	Case Study Field Study	Participant-observation In-depth interviewing Elite interviewing In-depth interviewing Document analysis
<u>Explanatory</u> To explain the forces causing the phenomenon in question. To identify plausible causal networks shaping the phenomenon.	What events, beliefs, attitudes, and policies are shaping this phenomenon? How do these forces interact?	Field Study Case Study Ethnography	Participant-observation Unobtrusive measures Survey questionnaire
<u>Descriptive</u> To document the phenomenon of interest	What are the salient behaviours, events, beliefs, attitudes and processes occurring in this phenomenon?	Field Study Case Study Ethnography	Participant-observation In-depth interviewing Document analysis Unobtrusive measures Survey questionnaire
<u>Predictive</u> To predict the outcomes of the phenomenon. To forecast the events and behaviours resulting from the phenomenon.	What will occur because of this phenomenon? Who will be effected and how?	Experiment Quasi-Experiment	Survey Questionnaire (Large Sample) Kinetics/Proxemics Content Analysis

Table 1: Matching the Research Purpose with Research Approach (Marshall and Rossman, 1989)

The following section details the options available for qualitative research, then it justifies the adopted approach and details the method chosen for this research. A qualitative approach to research is a natural fit for an interpretivist paradigm (Kelliher, 2011). The case study approach is an appropriate method where the research aim is to explore, in depth, complex issues in their real-life context (Crowe *et al.*, 2011). To complete the ambition for a comprehensive network perspective this study requires interviewees from all networks nodes in the EU research network.

3.0 Research Strategy: Operationalising the Research Approach

The research strategy is how one intends to go about answering the research question (Saunders and Lewis, 2012). To choose the most appropriate research strategy Yin (1994) recommends the assessment of three key criteria; the type of research questions, the level of control over behavioural events and the focus of the study in contemporary versus historical events Yin (1994). The rationale for strategy selection and its operationalisation pertinent to the current study is presented.

The study is coming from an interpretivist frame and is not looking for a cause and effect type explanation that would be more characteristic of positivist research paradigms. Instead it aims *to* investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The natural construction of the interaction within the network is core to the conceptual framework and is best understood in its natural environment rather than through experimentation or action of the researcher. Furthermore, Yin (1994) highlights the richness of interpretivist research where the research process includes deciding on what to further explore and drawing conclusions that are supported by evidence. However, this process is not chaotic, researchers use previous literature to formulate the research problem and to identify concepts that may be important (Eisenhardt, 1989). These concepts are represented in this study and the capture of additional concepts and understanding is facilitated through the phased approach to data collection and analysis.

3.1 Selecting A Research Method

As described in the previous section a qualitative approach is considered best suited for this research to attain the research objectives. Cassell and Gummesson (2006) support linking qualitative method with network theory akin to the proposed research. There are many types of qualitative methods to consider before selecting the most appropriate; ethnographic, narrative, phenomenological, grounded theory and case study. The researcher has experience in previously conducting case study research and has been trained in the biographic narrative interpretive method. Furthermore, to ensure that the data collection phase is effective the researcher considered the available data collection methods, which included, focus groups, interviews, observation and action research. The aims of this study, to investigate social and economic aspects of structural embeddedness

in an ICT research network based in the EU, relate to further understanding structural embeddedness in EU ICT research networks and a single case study involving all nodes of the network is considered appropriate. Coverage of all network nodes to gain insights from each member of a network rather than dilute the investigation to a portion is a crucial design choice. The researcher is confident that this approach will deliver the insights required to contribute to new knowledge in this domain, while cognisant that the objectives of the research are exploratory rather than attempting to apply the research findings to the whole population. Furthermore, section 3.3 gives detail on the case study selection.

Sekaran (2006) describes research as ‘a systematic and organised effort to investigate a research problem that needs a solution’. Use of archival data is common in this domain (Greer and Lei, 2012; Geisler, 2003; Kirschner *et al.*, 2004; Perkmann and Schildt, 2015). A case study is undertaken when the researcher aims to understand in depth an event, activity or process engaged in by one or more individuals. Yin (1994) describes and presents effective case study research as a linear but iterative process. The selection of a single case study fits particularly well with the qualitative approach required in this study as “rigorous qualitative case studies afford researchers the opportunities to explore or describe a phenomenon in context using a variety of data sources” (Baxter and Jack, 2008).

Table 2 highlights the adopted case study dimensions as categorised by Scholz and Tietje (2002). In line with the research objective and questions, the characteristics of the case studies form a central component of the research design. The conceptual framework presented in section 3.0 details how the qualitative data (secondary and primary) will jointly provide rich and complementary information.

Dimensions	Classifications
Design	Holistic Single case
Motivation	Intrinsic
Epistemological Status	Exploratory
Purpose	Research
Data	Qualitative
Format	Semi structured

Table 2: Case Study Dimensions and Classifications Adapted Scholz and Tietje (2002)

Following on from the selection of case study dimensions, Table 3 illustrates the detailed selection criteria and assumptions within the data collection protocol for the chosen case for the study.

Criteria for Selection of Single Case for this Study
The network coordinator must agree to participate fully in this study
The network coordinator must support publication of the findings from the study
The Coordinator of the network must be located in Ireland to minimise the research costs
The network coordinator must consider structural embeddedness in networks as important
The network coordinator must grant the researcher access to project documentation, communication material and research artefacts, and any other documentation deemed necessary for the study (e.g. code of ethics, project handbook and reports).
The network coordinator must provide the researcher with access to network nodes for the purpose of interviewing and to provide a room suitable for such activities where required

Table 3: Criteria for Organisational Participation in the Study

The previous sections outline the links between the research objective, the research questions, the current empirical evidence, the adopted philosophical approach and justification for the adopted research approach. Table 4 demonstrates the linkages between the requirements of the research and the characteristics of the case study. This linkage is particularly useful to bring together the available empirical evidence in relation to the research objectives and highlights the suitability of the case study approach to meet the aforementioned objectives.

Requirements of the Study	Case Study Characteristics
<p>RQ1: The study seeks to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union.</p>	<p>The case study facilitates a deeper understanding of the structural dimensions of embeddedness (ties, centrality, configuration, holes, openness (Granovetter, 1973; Granovetter, 1985; Burt, 2009; Kim, 2014; Moran, 2005; AlKuaik <i>et al.</i>, 2016).</p> <p>The strength of the case study is that it enables the capture of reality in more significant detail and permits the analysis of a greater number of concepts than is possible with any other research method. (Galliers and Sutherland, 1991)</p>
<p>RQ2: The study aims to uncover how structural embeddedness in research networks is interconnected with social and economic characteristics.</p>	<p>The case study approach is appropriate because it enables the researcher to explore an area in which few previous studies have been carried out (Perkmann and Schildt, 2015; Wanzenböck <i>et al.</i>, 2015; Bozeman and Gaughan, 2007; Bozeman and Melkers, 2013; Cook and Whitmeyer, 1992). In Krippner <i>et al.</i> (2004) social and economic aspects are discussed and contributed to their inclusion in this study. Furthermore, the literature on network research purports that where complexity and dynamism of relationships limit the applicability of positivist research based on inferential methods, qualitative case study methods are preferential (Hite, 2005; McGrath and O'Toole, 2014; Krippner <i>et al.</i>, 2004). Beckmann and Padmanabhan (2009) contend that a study of institutional and contextual influences warrants a case study approach.</p>
<p>RQ3: The study aims to identify the enablers and barriers to structural embeddedness encountered within EU ICT networks.</p>	<p>The case study approach provides context within which exploratory research can be conducted, and it is an appropriate strategy where a contemporary phenomenon is to be studied in its natural context and the focus is on understanding the dynamics present (Myers, 1997; Agarwal and Selen, 2009; Brown, 2015; Wenger, 2010; Wenger <i>et al.</i>, 2011).</p>

Table 4: The Suitability of a Case Study for the Requirements of the Study

By adopting Yin (1994) and applying it to this case study, Table 5 presents the steps within the case study design that address validity and reliability. One of the main advantages of the case study approach is that of the opportunity for obtaining a holistic view of a specific phenomenon or series of events, which will be a key consideration for

this topic. The aim of this research is to investigate social and economic aspects of structural embeddedness in an ICT research network based in the EU. Furthermore, the literature on network research purports that where complexity and dynamism of relationships limit the applicability of positivist research based on inferential methods, qualitative case study methods are preferential (Hite, 2005; McGrath and O'Toole, 2014; Krippner *et al.*, 2004). Beckmann and Padmanabhan (2009) contend that a study of institutional and contextual influences warrants a case study approach. Research by its nature is subjected to external examination. (Easterby-Smith, 2002) propose that there is an underlying anxiety amongst researchers that the research will not stand up to outside scrutiny. In order to assess whether research will stand-up to outside scrutiny researchers are often concerned with reliability, validity and ability to generalise findings and conclusions drawn from research studies (Mays and Pope, 2000; Yin, 1994). Table 5 illustrates the specific validity and reliability tests related to case study design and their applicability to this study.

Tests	Case Study Design	Application to this Study
Construct Validity	Use multiple sources of evidence	This study uses a combination of in-depth interviews with multiple sources, corporate records, archival material, project handbooks, codes of ethics, project communications documentation, policies and other research management correspondence.
	Establish a chain of evidence	Evidence from each of the data collection sources was inter-linked across multiple time frames in order to establish continuity of data.
	Have key informants review draft case study report	Following each in-depth interview, the researcher transcribed the discussion and presented a written copy to the interviewee to sign off on. Each network actor was also presented with a copy of the case report for review prior to publication.
Internal Validity	Do pattern matching	A pattern of data collection and analysis was established to ensure that the frequency of data collection and data analysis was consistent across all cases.
	Do explanation building	Multiple sources of data were consulted in order to build explanations of the phenomenon discovered. These multiple sources of data enabled cross-referencing of explanations of the same event in order to build a more complete and accurate description.

Tests	Case Study Design	Application to this Study
External Validity	Use replication logic in multiple case studies	Prior theory is used as a template with which to compare the empirical results of the case study.
Reliability	Use case study protocol	The researcher developed a case study protocol, which was tested during a pilot case study.
	Develop case study database	The researcher developed a case study database for its iterative cycle document management.

Table 5: Case Study Design and Tests of Validity and Reliability (Adapted from Yin, 1994)

Following on from the initial conceptual paper and literature review for this research a full analysis was done on the related literature to identify the research methodology and its classification, and the findings from this are presented in appendix A.

3.2 Single case or multiple case design

According to Yin (1994) there is no ideal number of cases but the case should serve the purpose of the inquiry. Single case studies allow researchers to investigate phenomena in-depth to provide rich descriptions and understanding (Walsham, 1995). Yin (1989) classified different case study designs as illustrated in figure 4 to highlight the merits and differences between the available research methods. In a single case design, the phenomenon is studied in one organisation whereas a multiple case design compares the phenomenon as found in multiple organisations (Yin, 1994). When there is a single unit of analysis, for example, the network as a whole, the case study design is a holistic one. When multiple levels of analysis exist, it is called an embedded design (Yin, 1989). As illustrated in figure 4, this produces four different case study designs. This research study fits as a type 1 case, a holistic research network.

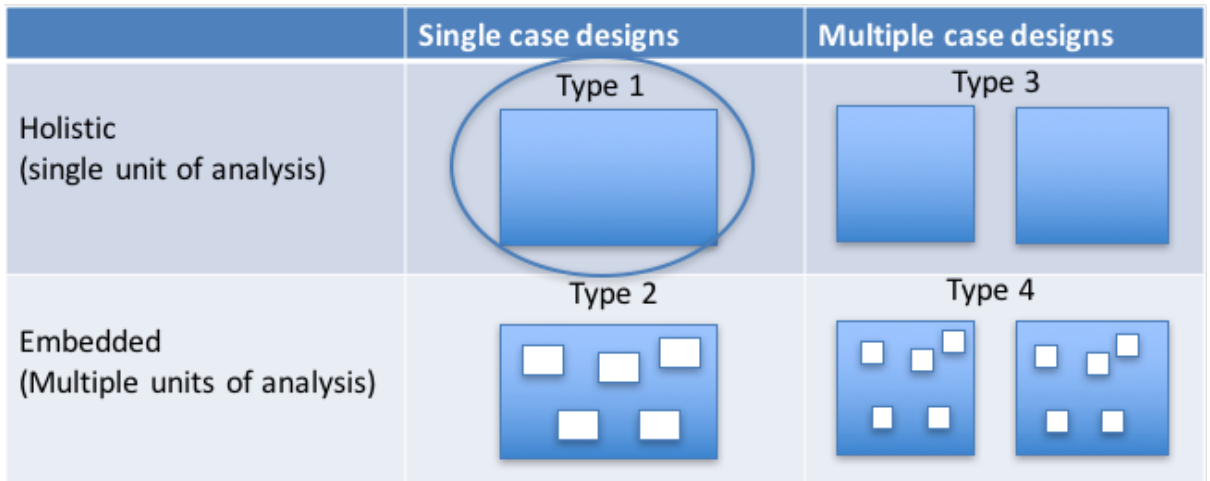


Figure 4: Basic types of case study design (Yin, 1989)

Single case studies allow researchers to investigate phenomena in-depth to provide rich descriptions and understanding, ideal for complex contexts (Yin, 1994; Walsham, 1995). However, single case studies have been criticised for a lack of generalisation and replication (Lee, 1999). Multiple case designs are desirable when the intent of the research is description, theory building, or theory testing (Benbasat and Zmud, 1999; Benbasat *et al.*, 1987). As previously established, this study is exploratory in nature focusing on discovery.

Holistic case research is useful when a phenomenon is broad and complex, and the phenomenon is difficult to be studied outside the context in which it occurs. Holistic case studies are qualitative in nature, narrative, phenomenological descriptions their merits in line with this research study (Noor, 2008). As previously stated, this study adheres to the interpretivist paradigm, has a qualitative methodology and is exploratory in nature.

3.3 Selection of a suitable single case

The contextual setting is a high-tech¹⁶ information communication technology (ICT) network funded by EU Horizon 2020 research programme, the network (project) is called AquaSmart¹⁷, Aquaculture Smart and Open Data Analytics as a Service. The high-tech

¹⁶ <https://www.een-ireland.ie/eai/assets/documents/uploaded/general/ICT%20Fact%20sheet.pdf>

¹⁷ <http://www.AquaSmartdata.eu>

sector of the economy uses the most advanced technology available, it is often seen as having the most potential for future growth and this perception has led to high investment in high-tech sectors of the economy. High tech is often viewed as high risk, but offering the opportunity for high profits. The Internet has profoundly changed our perception of society and our approach to everyday life with a key role in commerce and society. The European Commission places a large emphasis on its H2020 research programme to foster innovation and competitiveness in Europe through excellence in ICT research and development. High technology is an international phenomenon, spanning continents, epitomized by the worldwide communication of the Internet, key high-tech industries include areas such as Pharmaceuticals, Bio Technology, Medical Devices, ICT and Financial Services. The adoption of a single case study and semi-structured interviews supported by documentation analysis emerged as the optimum approach aiming to achieve a significant level of depth for the investigation.

AquaSmart is using ICT to improve its data utilization and operations. In Europe, the Aquaculture industry accounts for about 20 per cent of fish production and directly employs some 80,000 people. Aquaculture is identified as a key focal point of the *EU's Blue Growth Strategy*¹⁸. It is the fastest growing animal food producing sector in the world. Global forecast on production is set to increase from 45 million tons in 2014 (Eisenhardt, 1989) to 85 million by 2030. The European Commission has pointed and flagged for prompt action to stimulate large number of aquaculture businesses with ICT innovation.

AquaSmart aims to enable fish farmers to use open data technological solutions built for the industrial sector to enhance their operations. It is the network's challenge to bring real value to the market with the state of the art technology in multi-lingual open data to the aquaculture stakeholders. To understand structural embeddedness, it is important to engage with these network nodes at a depth that allows their perceptions to be exposed. When selecting such a case environment, full and complete network access is vital (Kelliher, 2011) and 'random selection is neither necessary, nor even preferable'. Thus, following identification of a suitable case environment (that is, a network in ICT

¹⁸ http://ec.europa.eu/maritimeaffairs/policy/blue_growth

research), access was negotiated via personal contact in the author's own work setting. The host network Aquasmart is a 24 month engagement with eight partners across five European member states. Appendix C presents the AquaSmart factsheet and brochure.

Case selection was specifically controlled for location and industry by selecting from EU funded research networks within the information communication technology (ICT) domain. The choice of a high-tech context for this case study builds upon recent research on research networks in high-technology industries (Perkmann *et al.*, 2013; Perkmann and Schildt, 2015; Perkmann *et al.*, 2015; Scherngell and Barber, 2011; Scherngell and Lata, 2013; Wanzenböck *et al.*, 2015; Hite, 2005). In addition, high-tech organisations provide a rich context for the study, given their heavy reliance on network ties that stem from and are embedded within social relationships (Larson and Starr, 1993).

To complete the ambition for a comprehensive network perspective this study requires interviewees from all networks nodes in the EU research network. A purposive sampling strategy of approximately 8-targeted researchers engaged in the EU ICT research network, AquaSmart was chosen. This network includes participants from five different EU member states and the roles are detailed in

Figure 5, both industry and academia organisations active in ICT research.

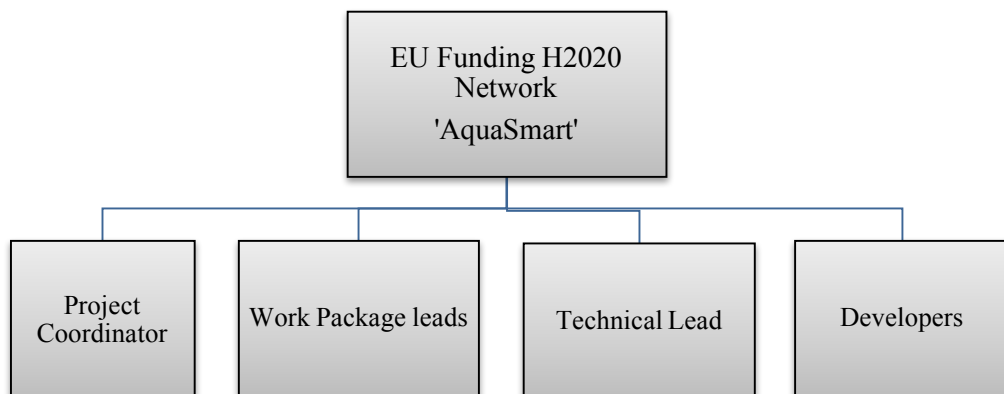


Figure 5: AquaSmart network

There is no one classification of networks types, they range in their composition, there are collaborative networks, temporary networks, social networks, this research aims to answer the research questions in relation to research networks, taking European funded research as the context. The merits of adopting a single case study as opposed to multiple are related to the depth and coverage level that this approach facilitated. A deeper understanding of structural embeddedness within research networks was sought. Specifically, for the first research question, the whole network will be interviewed as part of the data collection phase therefore a more complete picture is gained. For RQ2 the connection between structural embeddedness in the network and research output is pursued enabled from an in-depth dialogue with the network node. Given its sensitive nature, a discussion (interview) on connectedness between structural embeddedness and social and economic characteristics was deemed more appropriate than the level of data that would be feasible to collect via a questionnaire. For example, the questionnaire could only determine if there was a connection between structural embeddedness and social and economic attributes it could not determine the nature of this connection. RQ3 investigates the nature of enablers and barriers to structural embeddedness encountered by EU ICT research networks, given the sometimes negative and sensitive nature of barriers within research networks, interviews open-up new dimensions and provide an opportunity for the researcher to probe deeply into problem areas.

3.4 Design: Defining the Unit of Analysis and Binding the Case

The identification of the unit of analysis for study is related to the research questions and the concepts for investigation. In examining these research questions, we can define the criteria for case selection. As described in section 1.4, the identified research question are:

RQ1 How are research networks structurally embedded?

RQ2 How is structural embeddedness interconnected with social and economic characteristics?

RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

In relation to the structural embeddedness of the network, the study explores the ties within the network, the openness of the network, the gaps or holes between one cluster and another, and the centrality of the node in the network. The unit of analysis is the AquaSmart network and it is selected to understand structural embeddedness within this research network. The network includes industry and academic nodes. Where there is a single unit of analysis (i.e. network as a whole) the case study is a holistic one, as in this research. Research networks are central to innovation development and by their nature illustrate collaborative networks between industry and academia. In Krippner *et al.* (2004), Granovetter identified the social characteristics; compliance, trust, cooperation and dominance that are considered in RQ2 and also discussed economic factors, however the conceptual framework identified economic factor more aligned to research output as identified in this particular context (Bozeman and Melkers, 2013; Bolzani *et al.*, 2014). RQ3 is aligned to a practitioner and policy perspective in this novel area.

3.5 Data collection techniques

Given the adopted research design the literature supports looking at the data holistically rather than breaking the data into parts for analysis. This method is called explication (Hycner, 1985; Groenewald, 2004). Preliminary data collection through the planned pilot, external datasets and early stages of main data collection phase will facilitate early pattern recognition, thematic clustering and refinement of the data collection instrument and research process. Multiple phases of data collection and pattern recognition will facilitate the iterative approach in this voyage of discovery.

The challenge of interview data is best mitigated by data collection approaches that limit bias. A key approach is using numerous and highly knowledgeable informants who view the focal phenomena from diverse perspectives. These informants can include organizational actors from different hierarchical levels, functional areas, groups, and geographies, as well as actors from other relevant organizations (Eisenhardt and Graebner, 2007). The case study is based on the EU H2020 funded AquaSmart network and will include the Project Coordinator, technical lead, work package lead and developers from AquaSmart

3.5.1 Semi-structured interviews

Semi-formal interviews will be conducted in the network between June and Dec 2017. The researcher wanted to conduct an in-depth analysis of the research problem and determined that semi-formal interviews would best facilitate this process. Sekaran (1992) highlights some of the advantages and disadvantages of face-to-face interviews. Within an interview the interviewer can adapt questions as necessary. It is possible to clarify doubts easily and ensure that responses are properly understood by repeating or rephrasing questions. One can pick up non-verbal clues for example, frowns or discomfort. Overall it provides rich dataset which helps to explore and understand complex issues and by introducing some formality to the process the interviews were kept focussed by intermitted reference to the agenda so that all topics were addressed that were relevant to the research questions and overall objective. Disadvantages outlined by Sekaran (1992) include: the cost and feasibility of conducting interviews; respondents may feel uneasy about the anonymity of their responses; and by adhering to an agenda it may restrict the participant leading the discussion.

Kvale (1996, p.42) advocates the qualitative research interview as a “construction site of knowledge” providing opportunity to build new knowledge. Furthermore, Alvesson (2003, p.13) defines qualitative interviews as “relatively loosely structured and open to what the interviewee feels is relevant and important to talk about, given the interest of the research project”. The researcher plans to spend considerable time reflecting on the process of questioning and on the meaning of the results. This is in line with increased attention to the use of a reflexive approach in management research (Baxter and Chua, 2003; Dumay, 2009; Nadin and Cassell, 2006).

Each interview will follow a documented, semi-structured approach. Interviewees will receive a formal request (detailed in Appendix D) to participate in the study, followed by an informal communication (email) to schedule and provide an interviewee briefing at least one week prior to the interview. The researcher plans to ask interviewees for supporting documentation (e.g. description of work) in relation to the case study network configuration, collaboration and innovation. Any data made available will be analysed and used as a secondary data source.

Data for this study, both interview data and documentation, will be collected over a 7-month research period. In line with Yin (2003) data analysis consists of examining and categorising the evidence to address the objective of the study. Consistent with other qualitative, case based research; there will be a frequent overlap of data analysis with data collection (Eisenhardt, 1989) and field notes. Comprehensive preparations (analysis of website, open data records) prior to each interview will ensure some element of familiarity for the researcher with the network. The preparation for the semi-structured interviews included an interviewer guide (Appendix B) which included a series of themes to be explored with each research network actor prior to interviewing in line with the research questions (Patton, 1999; Qu and Dumay, 2011). The question structure is flexible, allowing for variations to emerge on an interview-by-interview basis. All the interviews are recorded and transcribed immediately following the interviews.

Within the case study (research network) a semi-structured interview will be conducted with all nodes from the network (eight in total). This will include a combination of roles; project coordinator, technical lead, developers. The research questions will be addressed in detail. In line with the constructivist paradigm all variables in this qualitative study are not pre-determined, some variables may emerge from the study (early phases) and promote flexibility to gather experiences (Guba and Lincoln, 1994; Weaver and Olson, 2006; Blumer, 1956). The adopted qualitative method of case study using in-depth interview does not aim for a reductive process of generalisation but a sophisticated in-depth explanation of unique cases transforming data through interpretation (Husserl, 2002).

3.5.2 Documentation Analysis

Researchers can supplement in-depth interviewing by “gathering and analysing documents produced in the course of everyday events or constructed specifically for the research at hand organization” (Marshall and Rossman, 2014; Catherine Marshall and Gretchen Rossman, 1989). Furthermore, document reviewing is a largely unobtrusive method useful in gaining understanding. Documentation can support the verbal accounts of informants (Remenyi *et al.*, 2002) as well as supplement and verify data from other sources (Yin, 1994). As shown in Table 6 this study made full use of documentation in this research network.

Document type	Source	Purpose of document analysis
Description of work		
Project brochure		
Project deliverables		
Project newsletters		
Code of ethics		
Project handbook		
Workshop reports		
Research management reports		

Table 6: Documentation register

Access to a full network (all network nodes of an EU funded network) has been agreed with the project coordinator to ensure full cooperation, access to resources, experienced personal and documentation. Baxter and Chua (1998) argue that it is only through arranging full access that the potential of case studies can be fully realized. Multiple data collection methods can include documentation, archival records, interviews, direct observations, participant observation and physical artefacts. This study uses documentation and interviews. Gummesson (1991) acknowledges that obtaining a holistic view of your research issue through a case study can be a very time consuming job and as such it is generally not possible to carry out more than one or a very limited number of in-depth case studies in a research project. The type of targeted documentation included code of ethics, project handbook, workshop reports, description of work, research management reports and grant agreement.

Documents attained for analysis for this study included code of ethics, project handbook, workshop reports, descriptions of work, research management reports and grant agreements. Following the interviews, the interviewees validate the interview report and the additional material analysed in conjunction with the interview notes to ensure consistency with the findings. The diversity of sources facilitates the validity of structural embeddedness in research networks through triangulation (Yin, 2003) and enriches the contextual understanding of the study. To identify convergence of themes and patterns across interviews, the data and literature is iteratively examined with initial codes or themes developed based on a pattern between the data and the conceptual framework

(Hite, 2005; McGrath and O'Toole, 2014; Miles and Huberman, 1994; Yin, 2003), Coding in this manner facilitated insight and comparison through segmenting the data into units (Hammersley and Atkinson, 1983; Saldana, 2009; Saldaña, 2015; Auerbach and Silverstein, 2003). The next section discusses this further.

4.0 Data Analysis

Data for this study, both interview data and documentation, will be collected over a 7-month research period. In line with Yin (2003, p.109) data analysis consists of examining and categorising the evidence to address the objectives of the study. Consistent with other qualitative, case based inductive, iterative research; it is expected that there will be a frequent overlap of data analysis with data collection (Eisenhardt, 1989). This approach includes field notes, documentary sources and interview scripts stored in the data analysis software (NVivo) for this research study. To identify convergence of themes and patterns (Miles & Huberman, 1994; Yin, 2003), the data and literature will be iteratively examined with initial codes or themes developed based on a consistent pattern between the data and the conceptual framework. Coding in this manner facilitates insight and comparison through segmenting the data into units (Hammersley & Atkinson, 1983). In addition,

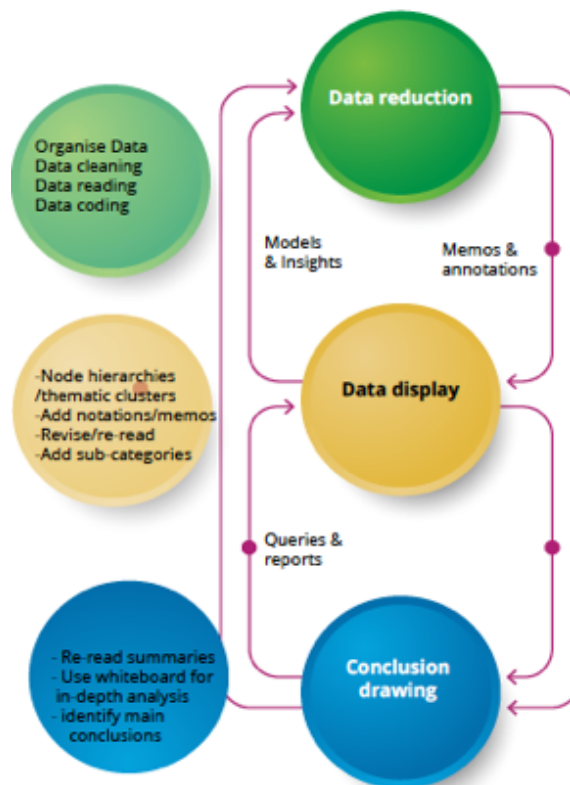


Figure 6: QDA approach adapted (Miles and Huberman, 1984; 1994)

Miles and Huberman (1994) influenced the decision to adopt and enhance their three-step approach to data analysis as illustrated in Figure 6.

This iterative approach will increase the reliability of the research, which adopts a semi-structured approach. The data analysis process leverages the work of Tracy (2013) as illustrated in Figure 7 focusing on a recursive process. NVivo provides a platform that is flexible in relation to variable definition during the initial phase, however data transfer and a data management plan will be actively addressed in the iterative cycles. Tools for data analysis will be employed using state of the art technology to assist the researcher to detect patterns and compare cases. The data will not be presented solely as a descriptive case study but will be analysed within the context of existing comparable empirical findings. In addition to the software tools the researcher plans that the audio records will be transcribed and coded. This iterative approach will increase the reliability of the research, which adopts a semi-structured approach. The data analysis process leverages the work of Tracy (2013) as illustrated below in Figure 7 focusing on a recursive process.

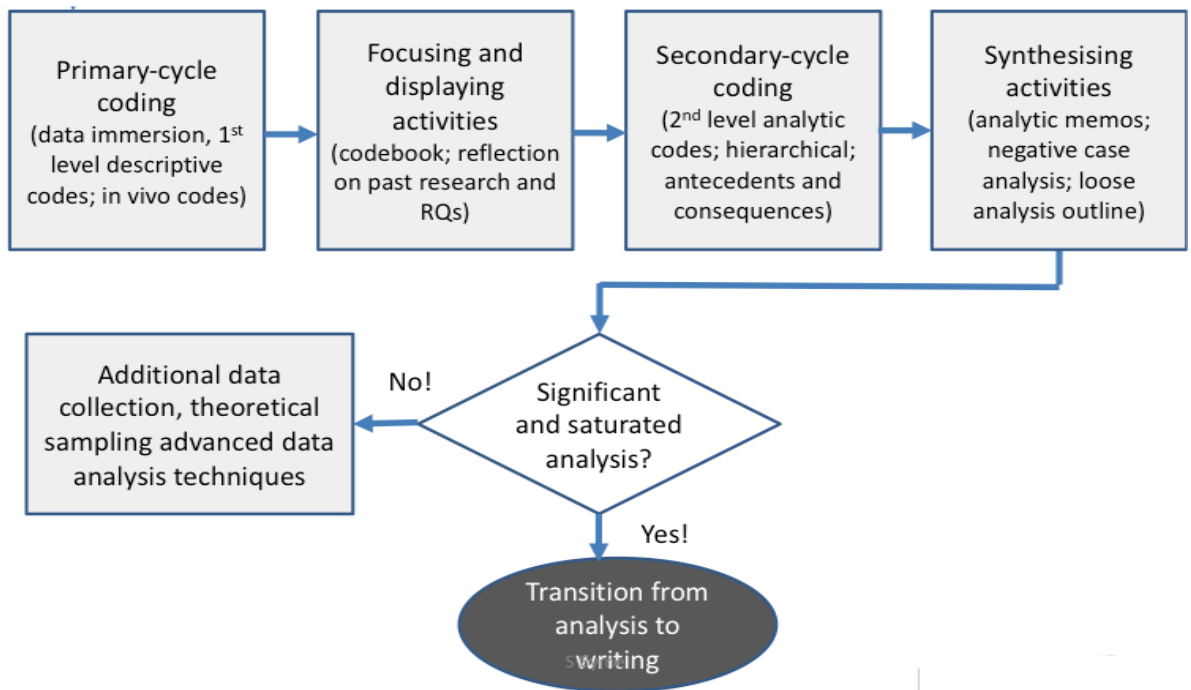


Figure 7: Tracey (2013) Iterative analysis process

NVivo provides a platform that is flexible in relation to variable definition during the initial phase, however data transfer and a data management plan will be actively addressed in the iterative cycles. Tools for data analysis will be employed using state of the art technology to assist the researcher to detect patterns and compare cases. The data will not be presented solely as a descriptive case study but will be analysed within the context of existing comparable empirical findings. In addition to the software tools the researcher plans that the audio records will be transcribed and coded. Field notes are an essential part of the researcher toolkit and processes to maximize their use and benefit are documented (Lofland and Lofland, 2006). Separately it is planned to compile session debriefing notes as soon as possible after each session to get ‘down on paper’ the initial feelings, responses and concerns. These initial debriefings are the basis for first order analysis and research path-finding.

NVivo (version 11) will be adopted to analyze the unstructured data from interview scripts and documentation analysis. The software allows users to classify, sort, code and arrange information; examine relationships in the data; and combine analysis with linking, shaping, searching and modeling. Furthermore, the functionality of NVivo facilitates the use of memos, node summary reports, node hierarchy reports, and summary details, which further aids the data analysis phase. NVivo will increase the efficiency to identify trends and cross-examine information in a multitude of ways using its search engine and query functions. NVivo assists the researcher to manage, shape and make sense of the data quickly and easily, while also having the advantage of a data audit trail to track changes. Using NVivo 11 is essential in managing the collected data, and complements the interpretive skills of the researcher in relation to analysing the data and breaking the volumes of information down (Easterby-Smith, 2002). NVivo is only a software tool, and the researcher needs to “reduce the volume of the information, identify significant patterns and construct a framework for communicating the essence of what the data reveals” (Patton, 1999). The data inputted into NVivo combines both the interview transcripts and notes that were taken, before being arranged into documents and nodes. NVivo nodes are physical locations where one stores the groups of ideas that can be coded. Nodes can be further segmented into free and tree nodes. Free nodes were initially used to openly code the transcriptions. These free nodes are then assigned into the hierarchical structure of a tree node. The coding process used in NVivo for the present study incorporates three phases as follows:

- a) Structuring of responses by question (guided by the literature review)
- b) Analysis of responses into sub themes
- c) Thematic analysis

4.1 Researcher Profile and Minimizing Research Bias

The researcher has experience formulating qualitative research questions and is cognisant of the requirement for attention to detail and thorough preparation in relation to conducting semi-structured interviews. The researcher has gained a master by research through inductive enquiry and has also been engaged in European funded research for more than ten years. Interviews will be audio-recorded and interview guide (Appendix B) is provided supporting the interviewer. The trustworthiness of the researcher was also taken into consideration as suggested by Thomas (2006) in relation to credibility as the researcher had previously engaged in qualitative data analysis and was able to reapply the experiences and lessons learned.

Section Summary	
Data analysis approach	Description
Data analysis strategy	Iterative research analysis cycles
Data analysis software	<ul style="list-style-type: none"> • Excel • NVivo
Researcher profile	<ul style="list-style-type: none"> • Experienced in conducting in-depth interviews • Experienced in multiple data analysis methods • Experienced within the research context

Table 7: Section summary: Data Analysis

5.0 Ethics

Ethical considerations are central to the conduct of legitimate research. Prior to conducting this research an ethical assessment will be carried out to ensure that the research is in line in line with international standards in relation to ethics. The planned interviews aim for voluntary participation and informed consent and privacy. Participation will always be entirely voluntary and all participants of interviews will be

requested to give informed explicit consent to participate. They can withdraw their consent and request to have their data deleted any time. During the project, personal data will only be collected, processed and protected in accordance with the Charter of Fundamental Rights of the European Union, the EU Data Protection Directive 95/46/EC as well as national data protection legislation.

We will apply privacy principles regarding data collection and processing; anonymity, data minimisation and purpose binding, for example, data will only be collected and processed for the specific purposes for that volunteers have given informed consent. An informal consent agreement will be drawn up with participants and procedures implemented according to best practice to protect confidentiality (Arksey and Knight, 1999; Bless *et al.*, 2006; Kvale, 1996; Street, 1998). The plans for data collection were sent for an ethical evaluation to the Ethical Research Committee at the Waterford Institute of Technology and an approval confirmation letter has been received and is detailed in Appendix E.

6.0 Summary of the Research Process

The research process is divided into five phases (Figure 8), however, the approach is not sequential. The research design is a recursive process based on the worldview that findings are constructed and subjective, an interpretivist, inductive approach is adopted. Consolidated with qualitative data collection mechanisms the interpretation of the research phenomena is considered critical and the research design addresses the challenges therein. The research is exploratory, the data collection strategy is multi-modal and includes a pilot, database analysis, a single case study and qualitative semi-structured interviews. The data analysis strategy focuses on iterative research analysis cycles using state of the art software and research processes. Finally, the dissemination phase reaches out to the research community to add to the knowledge in research networks.

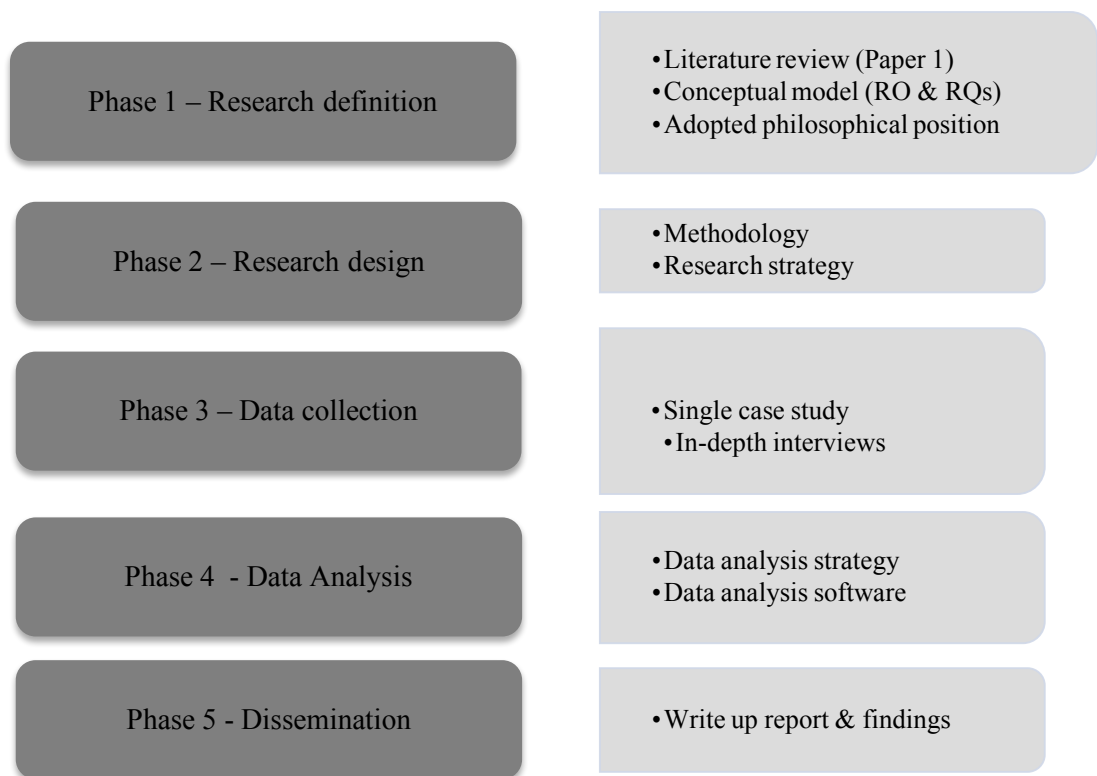


Figure 8: Summary of the overall research process

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Appendix A - Research Literature, Research Method And Classification

Social and economic characteristics (RQ2)	Research Method	Method classification	Research management theory, academic/industry liaison (RQ3)	Research Method	Method classification	Network and social network theory (RQ1 an)	Research Method	Method classification
Agarwal and Selen (2009) Agarwal and Selen (2011)	Survey SEM	Quantitative	Bozeman and Melkers (2013)	Book	Qualitative	Wasserman and Faust (1994)	Book	Qualitative
Wenger <i>et al.</i> (2011)	Literature review /foundation paper	n/a	Bozeman and Gaughan (2007)	RMV dataset	Quantitative	Fleming and Frenken (2007)	Dataset	Quantitative
McGrath and O'Toole (2014)	Qualitative case study - semi-structured interviews	Qualitative	Perkmann <i>et al.</i> (2013)	SLR systematic literature review	Mixed Quantitative/ Qualitative	Wellman and Berkowitz (1988)	Book	Mixed
Walter <i>et al.</i> (2006)	Survey/statistics	Quantitative	Perkmann and Schildt (2015)	Semi-structured interview, document analysis, Nvivo	Qualitative	Granovetter (1973, 1985, 1992)	Conceptual/theory building	n/a
Hall and Hofer (1993)	Semi-structured interviews and verbal protocol analysis	Qualitative	Maughan <i>et al.</i> (2013)	Conceptual/new model	n/a	Williamson (1979, 1998, 1981)	Conceptual	Quantitative
Steier and Greenwood (2000; 1995)	Longitudinal case study (1 case)	Qualitative	David (2004)	Conceptual/literature review	n/a	Coleman <i>et al.</i> (1966)	Literature review/theory building	Quantitative
Baron and Markman (2003)	Questionnaire /2 studies	Quantitative	Bolzani <i>et al.</i> (2014)	Document review	Qualitative	Strang and Macy (2001)	Field experiments	Quantitative

Social and economic characteristics (RQ2)	Research Method	Method classification	Research management theory, academic/industry liaison (RQ3)	Research Method	Method classification	Network and social network theory (RQ1 an)	Research Method	Method classification
Social and economic characteristics (RQ2)	Research Method	Method classification	Research management theory, academic/industry liaison (RQ3)	Research Method	Method classification	Network and social network theory (RQ1 an)	Research Method	Method classification
Martens <i>et al.</i> (2007)	Document review	Qualitative	Etzkowitz (2003)	Literature review	n/a	Freeman (2011)	Literature review/theory building	Qualitative
Roediger-Schluga and Barber (2008)	Document review	Quantitative	Jain <i>et al.</i> (2009)	In-depth interviews/document review	Qualitative	Bourdieu and Wacquant (1992), Bourdieu (2011)	Theory building	Quantitative
Bolzani <i>et al.</i> (2014)	Document review	Qualitative	Owens (2012)	In-depth interviews	Qualitative	Putnam (1993)	Theory building	n/a
Rothaermel <i>et al.</i> (2007)	Literature review - new framework	Qualitative	Roediger-Schluga and Barber (2006)	EUPRO dataset	Quantitative	Portes (2000)	Theory building/literature review	Qualitative
Kirschner <i>et al.</i> (2004)	Document review & semi-structured interviews	Qualitative	Beckmann and Padmanabhan (2009)	Literature review		Marwell and Oliver (1993)	Book	Mixed Quantitative & Qualitative
Stuart <i>et al.</i> (2007)	Document review	Quantitative				Monge <i>et al.</i> (1998)	Case study	Mixed Quantitative & Qualitative
Geisler (2003)	Survey & exit interviews	Mixed Quantitative & Qualitative				Bienstock and Bonacich (1992; 1997)	Experiments	Quantitative

Social and economic characteristics (RQ2)	Research Method	Method classification	Research management theory, academic/industry liaison (RQ3)	Research Method	Method classification	Network and social network theory (RQ1 an)	Research Method	Method classification
van Amersfoort <i>et al.</i> (2012)	Conceptual - poster on new framework					Burt (2009)	Book -theory building	n/a
Trompenaars and Hampden-Turner (1998)	Book - multiple case studies	Qualitative				Blau (1964)	Book -theory building	n/a
Hofstede and Bond (1984)	Survey	Quantitative				Emerson (1976)	Literature review	n/a
Steenkamp and Geyskens (2012)	Datasets	Quantitative				Mejias (2005)	Conceptual	n/a
Perkmann and Schildt (2015)	Document review & semi-structured interviews	Qualitative				Borgatti <i>et al.</i> (2009)	Literature review	n/a
Mehlman <i>et al.</i> (2010)	Focus groups	Qualitative				Vandenbergh (2002)	Conceptual	n/a
Melese <i>et al.</i> (2009)	Literature review /magazine article	n/a				Schergell and Barber, 2011	EUPRO dataset	Quantitative
Rawlings and McFarland (2011)	Longitudinal case study (1 case)	Quantitative				Schergell and Lata, 2013	EUPRO dataset	Quantitative
Hite 2005	Case study - grounded theory	Qualitative						
Wanzenböck <i>et al.</i> , 2015	Document review	Quantitative						

Appendix B – Interview Guide

The aim of this research is:

“to investigate structural embeddedness in an EU ICT research network”

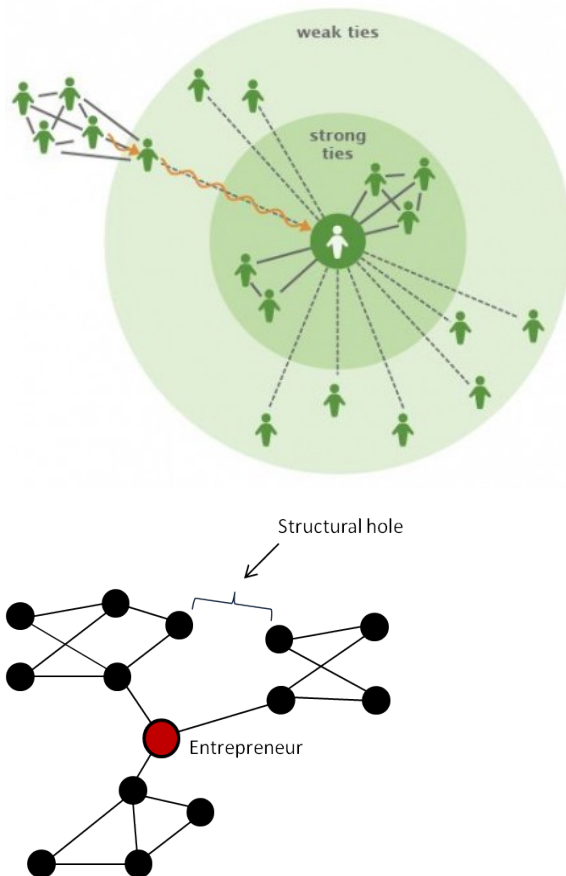
”

Points to remember –

- Thank the interviewee for their contribution
- Summarise the purpose of the research
- Explain the format of the interview and expected timeframe
- Discuss confidentiality and anonymity of the results
- Confirm permission for audio-recording

Relevant concepts

- Network theory proposes the optimal way of doing something.
- The first proof Seven Bridges of Königsberg (Newman *et al.*, 2006).
- **Structural embeddedness** is how many participants interact with one another, how likely future interactions are among participants, and how likely participants are to talk about these interactions (Granovetter, 1985, 1992).
- **Social network theory** studies how structure of relationships affects behaviours and beliefs.



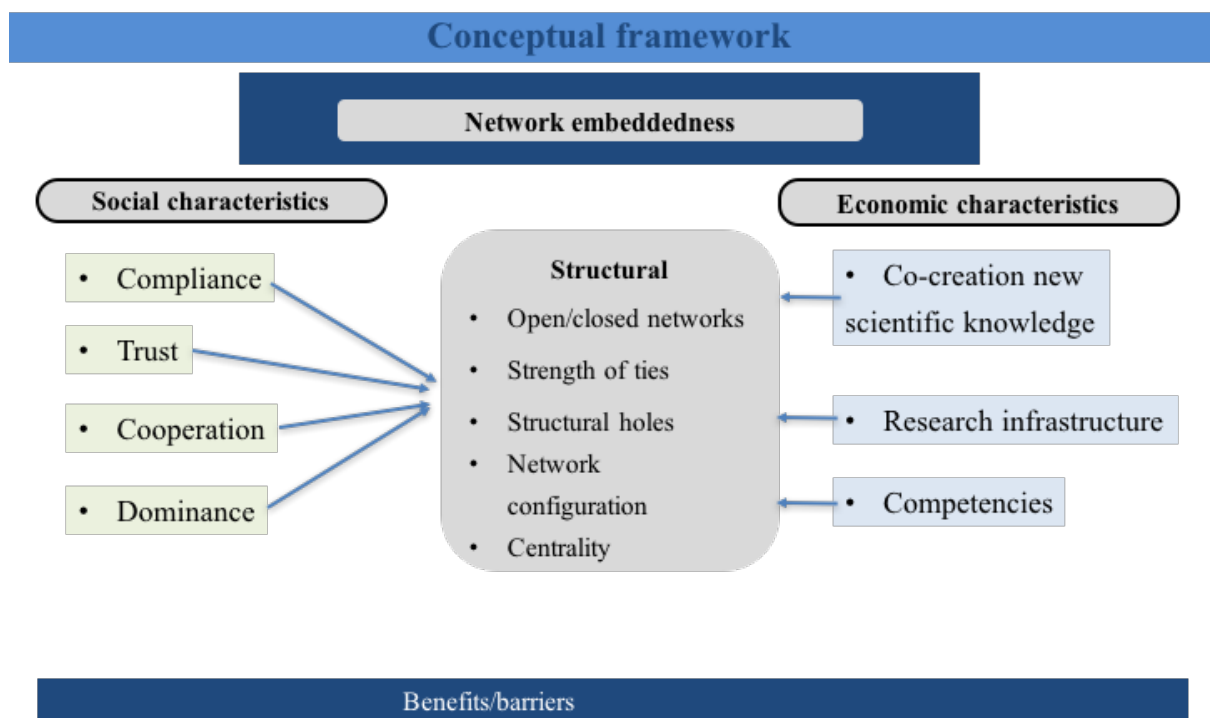
Granovetter 1973, Burt 2009

Research Overview

Network embeddedness is central to this study, the conceptual model highlights the social and economic aspects of structural embeddedness within EU research networks. The results from this research contributes directly to theory by providing rich insights in structural embeddedness which is primarily quantitative rather than qualitative (Herz *et al.*, 2014). This context for an investigation in structural embeddedness will provide novel contextual insights. Furthermore, the contribution to practice aids the development of a robust research network strategy, cognisant of social and economic aspects. In addition, the research management function will gain insights to enablers and barriers of structural embeddedness which supports their operations. From a policy perspective, funding agencies will further understand the structural embeddedness of research networks and the complexities therein.

Our economies are now more than ever dependent upon the digital world that connects us all, in terms of the rapidly growing digital services and commerce industry. Therefore,

the scope of the study focuses on high tech companies, a particularly pertinent sector in research networks. This paper details the selected methodology to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The research follows an interpretive, qualitative paradigm. A single case study approach is adopted as a suitable method to investigate this phenomenon in its natural context, as it allows for the subjective and contextual experiences of the participants supported by in-depth interviewing and documentation analysis. Data will be analysed using NVivo and the findings will be presented in a future paper.



Research networks provide a rich setting to analyse structural embeddedness in networks. The effects of network embeddedness are recognized in the as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000).

The following research questions frame the overall research objective:

RQ1 How are research networks structurally embedded?

RQ2 How is structural embeddedness interconnected with social and economic characteristics?

RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

Organisation profile

This information is for administrative and comparative purposes and responses are confidential.

Organisation Name	_____
Industry	_____
Contact Name	_____
Position	_____
Email	_____
Phone number	_____
Number of years' experience with current organisation	_____
Educational qualifications	_____
<u>Please circle your answer</u>	
Are research networks an area of interest for you personally at present?	Yes No
Are you involved in research networks?	Yes No
If yes please describe	
Please indicate if you are willing to participate in further research for this study	
	Yes No

RQ1: How are research networks structurally embedded?

- a. Can you describe the AquaSmart research network that you have been involved with in the last 2 years?
 - *Include your role/position, your organisations, other nodes(actors) ties (links)*
 - *Composition of the research network*
 - *Partners, Competition, knowledge providers, support*
 - *Structural holes and role they played, if any in this research network*
 - *Openness of the network*
 - *frequency of communication*
 - *depth – quality of relationships*
 - *Roles, behaviours , attitudes over time of the project*
- b. Can you describe the prior relationships you had with other actors in the network prior to the research and how these did/didn't influence behaviour?
- c. *How do factors such as; trust, reputation, open data policies affect cooperation among nodes?*
- d. *Describe any existing partnering arrangements (before & after research)?*

RQ2: How is structural embeddedness interconnected with social and economic characteristics?

- a. Can you describe the social characteristics of your research network?
 - *Compliance*
 - *Trust*
 - *Dominance*
 - *Cooperation*
- b. What was the primary output of that network?
 - *Co-creation of new knowledge*

- *Major milestones?*
- c. How did the network nodes competencies and skills differ in relation to the structural embeddedness
- d. Can you describe collaboration in the research network
 - a. *in relation to competition nodes*
 - *the perks and any difficulties of collaboration*
 - *nature of reciprocity,*
 - *shared responsibilities, shared accountability and power and authority*
 - *describe output from collaboration*
 - i. *joint publications*
 - ii. *new service offerings*

RQ3: What enablers and barriers to structural embeddedness are encountered within EU research networks


- a. Can you describe the enablers of structural embeddedness within this research network
- b. Can you describe the barriers to structural embeddedness within this research network

Concluding remarks

Points to remember –

- Thank the interviewee for their contribution
- Summarise the purpose of the research
- Discuss confidentiality and anonymity of the results
- Confirm permission for audio-recording
- Request that the interviewee might consider a review of the transcript report
- Ask if you can revert with any clarifications


Appendix C – Aquasmart Case Details





The banner features two images: on the left, a wide view of numerous circular aquaculture cages floating on a body of water; on the right, two men in work clothes and waders are handling a cage. The word 'AQUASMART' is overlaid in white text on the right image.


AQUACULTURE SMART DATA DRIVEN AND OPEN ANALYTICS


AQUACULTURE SMART DATA DRIVEN AND OPEN ANALYTICS


 **TSSG**
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 **GRAMMOS**
www.grammos-sa.gr


 **ANDROMEDA**
www.andromedagroup.eu

 **QVALIDUS**
www.q-validus.com




 **UNINOVA**
www.cts.uninova.pt

 **IJS**
www.ijs.si

 **ARDAG**
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The aquaSmart project is about enhancing innovation capacity within the aquaculture sector, by helping companies to **transform captured data** into knowledge and use this knowledge to **dramatically improve performance**. It also supports production benchmarking through access to global data.

The project is based in the **real world**, **addressing actual problems** that aquaculture producers face and is run by a skilled and experienced consortium including **top research institutes**, a major player in the **aquaculture IT sector** and three **highly innovative aquaculture companies**.

 **TOOLS**
Provides the necessary tools to turn the large volumes of heterogeneous aquaculture data into knowledge.

 **KNOWLEDGE**
Extracts the knowledge from current data and experiences of the sector.

 **ANALYSIS**
Enables companies to access and analyse global open data.

 **SOLUTIONS**
Quickly evaluate and identify the best management practices and rapid solutions for problems or issues that arise.

www.aquaSmartdata.eu



The vision of AQUASMART is to enhance innovation capacity in the aquaculture sector by addressing the problem of global knowledge access and data exchanges between aquaculture companies and its related stakeholders. By offering aquaculture production companies the tools to access and share global open data along with strong data analytics in a multi-lingual, multi-sector and cross-border setting we aim to strengthen their competitiveness and growth potential.

At a glance

Project title:
AQUASMART – Aquaculture Smart and Open Data Analytics as a Service (IA).

Project coordinator:
Steven Davy (sdavy@tssg.org)
Telecommunications Software and Systems Group (www.tssg.org).

Partners:
TSSG (IE), I2S (GR), Uninova (PT), Grammos (GR), Ardag (IL), Andromeda (GR), Q-Validus (IE), JSI (SI).

Duration:
February 2015 to January 2017 (24 months).

Total cost:
€3.1M (€2.7M funded).

Programme:
H2020-ICT-2014.1 - "Big Data and Open Data Innovation and take-up".

Further information:
www.aquasmartdata.eu

Social Media:
Facebook: fb.com/aquaSmartData
Twitter: twitter.com/aquaSmartData
LinkedIn: linkedin.com/grp/home?gid=8254447

AQUASMART – where Aquaculture meets Data Science...

Driven by the business needs of the European aquaculture companies and supporting the EU'S Blue Growth Strategy for marine and maritime sustainable growth Strategy, AquaSmart aims to radically enhance the innovation capacity within the aquaculture sector by helping companies to transform the large volumes of heterogeneous captured data into knowledge, through identification and analysis of this production data, and subsequently using this harvested knowledge to improve performance.

AQUASMART Objectives

The goal of AquaSmart will be achieved through six key objectives:

1. To facilitate technology transfer in multi-lingual data collection and analytical solutions and services;
2. To implement a multi-lingual Open Data framework that enables companies to seamlessly access global data in order to make knowledgeable decisions;
3. To promote best practices for aquaculture production management in core activities;
4. To develop innovation and deliver state of the art services in the aquaculture sector by tackling the new opportunities to access global data integrated from heterogeneous sources;
5. To develop a training programme and training activities;
6. To deliver a draft CEN standard on 'Reference Model for Open Data in Aquaculture'.

AquaSmart Vision

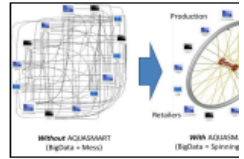


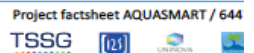
Figure 1: The AquaSmart Vi

Although production optimization factor for greater competitiveness impossible for aquaculture co capture the relationships between factors and turn data into valuable information. This cannot be done using on-hand database management traditional data processing application use of data mining technologies aquaculture companies to get insights in the data resulting decisions and better business results be able to look at past performance understand those performances based related data to look for the reasons past successes or failures and decisions going forward. To achieve necessary to build a framework interoperability between the heterogeneous sources of information support reference ontology management, data analysis and mining.

AquaSmart aims

AquaSmart aims to provide the means to turn your large volumes of heterogeneous aquaculture data into valuable knowledge. By using AquaSmart you will be able to feed, feed suppliers, hatchery policies, people and management through this identify patterns in your production, identify issues, appropriate corrective measures, improved production and therefore profits.

AquaSmart aims to allow you to understand your local data and benchmark this against global data. Using the AquaSmart system you will



Appendix D – Participant/Consent Request Letter



Letter of consent

Zeta ~~Dooley~~
Post Graduate Researcher
School of Business
Waterford Institute of Technology
Cork Road
Waterford

June 2017

Ref: Letter of consent for Research Project conducted by Ms. Zeta ~~Dooley~~ School of Business, Waterford Institute of Technology

Structural Embeddedness in a Research Network

Dear invited participant,

I refer to our recent correspondence regarding my DBA research

Best practice in this process requires agreement with the host organisation for the use of the research data in the dissertation and later published work. Following discussions with my supervisors ~~Prof. Aidan O'Donnell~~ and ~~Dr. Aidan Duane~~ I am writing to obtain this consent. Please feel free to contact either of them if you wish to clarify any aspect of this dimension of the research.

Your participation in the project involves completion of a face to face interview and access to review relevant network documentation. I wish to obtain your consent for the academic use of the material and information provided by you. In return I undertake to treat such material with the high degree of confidentiality appropriate for the commercial sensitivity it commands. This means that the primary data will only be used for academic purposes.

It is meaningful for the research to mention the host name and positions/responsibilities of those who participate but the not names of those interviewed. Therefore, I propose to include reference to (AquaSmart network).

- 1 -



If you wish I will submit
examiners as part of the

The research data will be
required by academic sta
assist in reducing risk ex

Other academic outputs
journal articles, contribu
technical bodies, and res
participating organisatio

I am a Researcher at TSS
my email address is zdo
knowledge bases, theret
intellectual capital.

On a personal note I wo
engagement. Indeed, I ho
future.

Best regards,
Yours sincerely,

Zeta Dooley

Zeta ~~Dooley~~
TSSG, WIT

Appendix E – Ethics Board Approval Confirmation Letter

Waterford Institute of Technology

WIT

Institiúid Teicneolaíochta Phoirt Láirge
Waterford, Ireland.
TEL: +353-51-302000
WWW: www.wit.ie
EMAIL: info@wit.ie



April 12th 2017

Dear Zeta,

Thank you for submitting your revised proposal to the School Ethics Committee and for taking the time to address the recommended changes.

I can confirm that we are now satisfied to approve your revised submission

We wish you well with your future research endeavours.

Yours truly,

Denis 

Professor Denis Harrington
Head of Graduate Business, and Chair of the School of Business Ethical Committee, WIT

Paper 3



**Doctorate in Business Administration
(DBA)**

Participant Name: Ms. Zeta Dooly 20064960

Supervisors: Prof. Aidan O'Driscoll/Dr. Aidan Duane

Date: 24th October 2017

Paper 3

DESIGN AND INITIAL FINDINGS

**An Investigation of Social and Economic Aspects of
Structural Embeddedness in an ICT Research
Network Based In the European Union**

Preface to Paper 3 – Design and Initial Findings

The development of Paper 3, Research Design and Initial Findings, occurred between March 2017 and September 2017. It was presented to an internal and external examiner panel at WIT which included; Prof. Jean-Anne Stewart, Henley Business School, University of Reading, UK and Dr. Thomas O’Toole, Head of School of Business, WIT. The development of Paper 3 focussed on operationalising the research process planned in previous papers. Paper 2, Research Design and Initial Findings, outlined the research approach and implementation plans to support a qualitative methodology to further understand structural embeddedness in a European research context. Paper 3 further detailed the implementation of the research and offers initial insights and findings useful to the identified stakeholders. Furthermore, the paper demonstrates the appropriateness of the selected data collection and analysis and identifies implications for the remaining cycles and results, which are presented in the final paper of the series, Paper 4. The challenges of developing Paper 3 included the difficulties associated with scheduling interviews during the summer holiday period and the time-consuming nature of conducting case study research (Gummesson, 1991). This restrictive timeline was highlighted to the DBA Programme Coordinators to consider in future DBA scheduling as it impacts both industry and academic researchers. This didn’t limit the availability of participants for the data collection phase but added to the administration effort for gaining consensus on timings for interviews and follow-up through email.

The feedback from the examiners included a suggestion to increase the sample size by two participants; this ensured a more thorough perspective of the network. They also requested further justification of the methodology; a single case study, document analysis and semi-structured interviews. As a result I re-examined the literature in this area to support the adopted approach (Kelliher, 2011; Yin, 1989; Yin, 1994). The case study facilitates a deeper understanding of the structural dimensions of embeddedness ties, centrality, configuration, holes, openness (Granovetter, 1973; Granovetter, 1985; Burt, 2009; Kim, 2014; Moran, 2005; AlKuaik *et al.*, 2016). The strength of the case study is that it enables the capture of reality in more significant detail, and permits the analysis of a greater number of concepts than is possible with any other research method. (Galliers and Sutherland, 1991). Thus, the depth is captured across multiple concepts identified in

the conceptual framework in Paper 1. Indeed, I was overwhelmed at one stage with the abundance of network literature, but some peer discussion helped with the identification of tensions within the network and the links with embeddedness and structure.

The case study approach is appropriate as it enables the researcher to explore an area in which few previous studies have been carried out (Perkmann and Schildt, 2015; Wanzenböck *et al.*, 2015; Bozeman and Gaughan, 2007; Bozeman and Melkers, 2013; Cook and Whitmeyer, 1992). In Krippner *et al.* (2004) social and economic aspects are discussed and contributed to their inclusion in this study. Furthermore, the literature on network research purports that where complexity and dynamism of relationships limit the applicability of positivist research, based on inferential methods, qualitative case study methods are preferential (Hite, 2005; McGrath and O'Toole, 2014; Krippner *et al.*, 2004). Beckmann and Padmanabhan (2009) contend that a study of institutional and contextual influences warrants a case study approach. The case study approach provides context within which exploratory research can be conducted. It is an appropriate strategy where a contemporary phenomenon is to be studied in its natural context, and the focus is on understanding the dynamics present (Myers, 1997; Agarwal and Selen, 2009; Brown, 2015; Wenger, 2010; Wenger *et al.*, 2011). The examiners comments triggered some investigation into processual analysis and longitudinal studies. Upon obtaining a deeper understanding of these approaches, and considering the constraints of the DBA process, and the objectives of this research, these approaches were deemed unsuitable for this study, but are discussed in Section 3.2 for future research.

Writing Paper 3 was done in parallel to the implementation of the research process, it focussed on turning plans into reality for research design, execution and analysis of the research data. This was deemed the busiest period of the research process, as there was numerous supporting documents required to administer the data instruments. These included interview guides, request to participate, introductory emails, letters of consent, interviewee briefings and a re-familiarisation with the supporting data analysis software NVivo.

During the implementation period, it was necessary to re-read the pertinent literature, to inform the interview guide, and reflect on the approach to meet the research objectives. Even though the research design had identified just one cycle of data collection, the

timing of the completion of Paper 3 meant that only 50% of the interviews were conducted at the time of the data analysis toward Paper 3. A revision to the interview guide was completed mid-implementation to address feedback during the initial interviews, and adding quality to the interviewee briefing documentation. During this time, the case profile was built, using available online information and repository documentation, that the researcher had gained access to. The choice of a high-tech context for this case study builds upon recent research on research networks in high-technology industries (Perkmann *et al.*, 2013; Perkmann and Schildt, 2015; Perkmann *et al.*, 2015; Scherngell and Lata, 2013; Scherngell and Barber, 2011; Wanzenböck *et al.*, 2015; Hite, 2005). In addition, high-tech organisations provide a rich context for the study, given their heavy reliance on network ties, that stem from, and are embedded within, social relationships (Larson and Starr, 1993). Given the guidelines from the funding agency, there is a certain amount of information available to citizens, in relation to the research network, through its website and associated documentation. I continued to update my reflective diary and the DBA progress report spreadsheet during this period. At one stage, there was a plan to include a pilot study. I had conducted two interviews with WIT colleagues, involved in other research networks, as part of Workshop 5 (Advanced Statistical Analysis). This helped gain confidence for the research implementation. Following on from discussions with my supervisors a pilot study was not deemed necessary for this single case research.

The refinement of the research questions, literature scope and conceptual model continued into Paper 3. The examiners recommended further clarity for the proposed contribution to theory and contribution to practice, which was added. During this period I discussed perspective a lot in my reflective diary in relation to the knowledge and experience that I have gained over my career in interviewing and learning about the research landscape. The available literature on reflective writing was useful to capture how to change my actions as a result of my learning and reflection and the impact life-long learning has on professional development and enterprise management (Moon, 2006; Zwozdiak-Myers, 2012; Thompson, 2008; Schön, 1983; Bradbury *et al.*, 2012). My supervisor ensured that I considered this experience as beneficial to the research process and case study in particular rather than researcher bias. My professional experience included recruitment interviews and quality interviews in relation to software standard accreditation for ISO and CMM. Furthermore, I attended a course on research

interviewing prior to the commencement of the DBA in Biographic Narrative Interpretive Method, which augmented my knowledge of research methods. Given the exploratory nature of the study, it was necessary to ensure that the semi-structured approach was sufficiently flexible, for the interview participant, as highlighted by Sekaran (2006). I also considered the advice of Kvale and Brinkmann (2008) and Alvesson and Deetz (2000) to keep the interviews loosely structured. There was a distinctive difference in the bibliography of Paper 2 and Paper 3 as the content moved into the implementation phase. The material available to researchers to support this stage of research has increased considerably in recent years and includes practical elements in relation to interview guides, coding for data analysis and the use of research memos (Saldaña, 2015; Saldana, 2009; Qu and Dumay, 2011; Pink, 2013; Kelliher, 2011).

The data collection phase included the review of relevant documents through agreed access with the coordinator and publically available content. In line with Remenyi *et al.* (2002) this documentation did support the verbal accounts of informants and also provided contextual information in relation to the pride of the network members in promoting the work of the network internationally.

Following on the data analysis design aimed to identify convergence of themes and patterns across interviews. The data and literature was iteratively examined with initial codes or themes developed based on a pattern between the data and the conceptual framework (Hite, 2005; McGrath and O'Toole, 2014; Miles and Huberman, 1994; Yin, 2003). Coding in this manner facilitated insight and comparison through segmenting the data into units (Hammersley and Atkinson, 1983; Saldana, 2009; Saldaña, 2015; Auerbach and Silverstein, 2003). These units were then manipulated into different clusters and some visualisation techniques (mind maps, posters) were adopted to help make sense of the data. There was frequent overlap of data analysis with data collection (Eisenhardt, 1989). The data analysis phase collated field notes, documentary sources and interview scripts stored in the data analysis software (NVivo) and Google Drive for this research study. The iterative research cycles conducted consisted of data reduction, data display and conclusion drawing, building upon the work of Huberman and Miles (2002) and Tracy (2013). These data analysis models were identified in Paper 2 as the most appropriate, however, mid-way through the analysis phase the Braun and Clarke (2006) model was deemed more comprehensive and thus it was adopted.

The initial findings presented in Paper 3 demonstrated the appropriateness of the data collection, implementation and analysis strategies. The decision to manually transcribe all transcripts provided familiarisation as recommended by the Braun and Clarke (2006) model. The paper presented initial interpretation, coding and insights. On March 2nd 2017 an application was submitted to the WIT Business School Ethics Committee during the development of Paper 2. It was necessary to revisit this during the development of Paper 3, to address the recommendations. This study includes explicit, transparent procedures, in relation to; consent, recruitment of participants and detailed selection criteria. Data sharing and data storage conforms to general EU regulation in line with EU H2020 research guidelines, and gender balancing was sought. The trustworthiness of the researcher was also taken into consideration, as suggested by Thomas (2006), in relation to credibility, as the researcher had previously engaged in qualitative data analysis, and was able to reapply the experiences and lessons learned.

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Abstract

The collaborative European funded research and development landscape has changed in recent years. Funding competitiveness and compulsory public private partnership (PPP) has significantly altered the dynamics of research networks, how they operate, collaborate, and acquire new knowledge and products. The emergence of the academic entrepreneur has also changed the focus of educational institutions to that of quasi-businesses (Etzkowitz, 2003; Perkmann *et al.*, 2013; Bolzani *et al.*, 2014). Research networks provide a rich setting to analyse structural embeddedness. Structural embeddedness refers to the nature of relationships, links and nodes within a network, specifically their structure, configuration and quality. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). Central to this research are the theories of Granovetter (1973), Burt (2009), Coleman (1988) and Bourdieu (2011), who present dyadic arguments for structural and relational embeddedness.

Thus, there is an opportunity to investigate the core research network within a research project to further our understanding of the social and economic aspects of structural embeddedness. An initial paper presented in this series suggested a conceptualisation of structural network embeddedness. This was followed by methodological design paper which outlined the research approach and implementation plans to support a qualitative case study methodology to further understand structural embeddedness in a European research context. This paper further details the implementation of the research and offers initial insights and findings useful to the identified stakeholders. Furthermore, the paper demonstrates the appropriateness of the selected data collection and analysis and identifies implications for the remaining cycles and results which will be presented in the final paper of the series.

1.0 Introduction

This paper is the third of four in a cumulative research paper series, the objective of which is to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). Structural embeddedness is central to this study, and the conceptual model (Appendix B) highlights the social and economic aspects of structural embeddedness. The results from this in-depth qualitative study contributes directly to theory and practice by providing rich insights into structural embeddedness. The contextual setting for the study as described in Section 3.0, is a European funded research network, specifically, the AquaSmart network, a project funded by the European Commission Horizon 2020 research programme that converges aquaculture and technology. This single case study approach is presented as a suitable method to investigate this phenomenon in its natural context, as it enables the capture of the subjective and contextual experiences of the participants, supported by in-depth interviewing and documentation analysis. Data is analysed using both manual and computer assisted methods (NVivo). The initial findings are presented in this paper, these will be developed further in Paper 4 and the discussion of these findings will be presented in the final DBA thesis. The formally stated research objective for this study is:

“to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union”

The proposed research plans to tackle the overarching research objective and address the following questions that have arisen from a review of the structural embeddedness literature and the practical experience of the researcher. To address this research objective, several research questions are outlined below.

- RQ1 How are research networks structurally embedded?
- RQ2 How is structural embeddedness interconnected with social and economic characteristics?
- RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

As detailed in Paper 2 the results from this research aim to provide justification for network actors to develop a network strategy based on structural embeddedness and for funding agencies to further understand the benefits and barriers of research networks. In addition, it can support or negate theory in relation to structural embeddedness within this context. The rationale for the research objective and research questions emerged from the literature and the author's own professional experience of managing EU funded research projects. The author contends that unravelling the complexity of EU research networks could positively impact the economic output of research networks.

The structure of this paper begins with a presentation of the research design, which includes a description of the qualitative data collection process adopted for the study. Subsequently, the research implementation phase is detailed which includes an overview of the single case study, primary and secondary data collection phases. Finally, an initial findings section present the preliminary results at this stage of the research

2.0 Research Design

The adopted research paradigm is an interpretivist approach, which sits appropriately with the research context and the research purpose, and is supported widely in the literature (Morgan and Smircich, 1980; Berger and Luckmann, 1991; Myers, 1997; Klein and Myers, 1999). A qualitative approach (detailed in Paper 2 of this paper series) was adopted for this research to attain the research objectives. Cassell and Gummesson (2006) support linking qualitative method with network theory akin to the proposed research. The aims of this study, to investigate social and economic aspects of structural embeddedness in an ICT research network based in the EU, is suited to a single case study involving all nodes of the network. Coverage of all network nodes to gain insights from each member of the network rather than dilute the investigation to a portion of the network, is considered a crucial research design choice. In addition, use of archival data is common in this domain (Greer and Lei, 2012; Geisler, 2003; Kirschner *et al.*, 2004; Perkmann and Schildt, 2015), and a documentation analysis is underway as described in Section 3.3). A case study is undertaken when the researcher aims to understand in depth an event, activity or process engaged in by one or more individuals. Yin (1994) describes and presents effective case study research as a linear but iterative process. The selection

of a single case study fits particularly well with the qualitative approach required in this study as “rigorous qualitative case studies afford researchers the opportunities to explore or describe a phenomenon in context using a variety of data sources” (Baxter and Jack, 2008). Table 1 highlights the adopted case study dimensions as categorised by Scholz and Tietje (2002). In line with the research objective and questions, the characteristics of the case studies form a central component of the research design. The data collection protocol details how the qualitative data (secondary and primary) will jointly provide rich and complementary information.

Dimensions	Classifications
Design	Holistic Single case
Motivation	Intrinsic
Epistemological Status	Exploratory
Purpose	Research
Data	Qualitative
Format	Semi structured

Table 1: Case study dimensions and classifications adapted from Scholz and Tietje (2002)

Following on from the selection of case study dimensions, Table 2 illustrates the detailed selection criteria and assumptions within the data collection protocol for the case study.

Criteria for Selection of a Single Case for this Study
The Network Coordinator has agreed to participate fully in this study
The Network Coordinator supports publication of the findings from the study
The Coordinator of the network is located in Ireland to minimise the research costs
The Network Coordinator considers structural embeddedness in networks as important
The Network Coordinator has granted the researcher access to project documentation, communication material and research artefacts, and any other documentation deemed necessary for the study (e.g. code of ethics, project handbook and reports).
The Network Coordinator has provided the researcher with access to the network nodes for the purpose of interviewing and has made the appropriate introductions

Table 2: Criteria for organisational participation in the study

To satisfy the research objective and to establish a comprehensive network perspective, this study has approached interviewees from all network nodes in the EU research network, AquaSmart. A purposive sampling strategy of approximately 8-10 targeted researchers was chosen. This network includes participants from industry and academic organisations active in ICT research, from five different EU member states (Ireland, Greece, Spain, Portugal and Slovenia) and one associated country (Israel). The participant roles are detailed in Section 3.2. The research design follows an inductive research process, and Figure 1 illustrates the iterative approach between the analysis and the recursive link back to the relevant theories and concepts.



Figure 1: Iterative approach

There is no one classification of networks types, they range in their composition and include; collaborative, temporary and social networks. This research focuses on distinctive European research networks. The merits of adopting a single case study as opposed to multiple case studies are the in-depth, rich contextual insights that this approach is associated with. Given that the whole network will be interviewed as part of the data collection phase, a comprehensive picture is gained. Given its sensitive nature, a discussion (interview) on connectedness between structural embeddedness and social and economic characteristics was deemed more appropriate than the level of data that would be feasible to collect via quantitative methods. Where the research question explores the connection between structural embeddedness in the network and research output, an in-depth dialogue with the network node will provide the required level of detail. Table 3

details the different data collection instruments and associated literature. The reflective diary is an ongoing researcher journal updated throughout the phases of the research design and implementation, and will be included as an annex at the end of the paper series.

Data Collection Instrument	Source	Date Completed
Semi-Structured Interviews	Myers and Newman (2007); (Qu and Dumay, 2011); Patton (1999); Saldaña (2015)	October 2017
Document/Content Analysis	Krippendorff (2004); (Bell and Bryman, 2007); Herz <i>et al.</i> (2014); Borgatti <i>et al.</i> (2009); Seidel (1998)	Planned December 2017
Reflective Writing	Scanlan <i>et al.</i> (2002); Moon (2006); Schön (1983); Bolton (2010); Golding and Currie (2000); Boud <i>et al.</i> (2013); Ghaye (2010) Dumay (2009); Baxter and Chua (2003)	Planned April 2018

Table 3: Data collection instruments

Sections 2.1-2.3 outline the research design which includes the semi-structured interviews, documentation analysis and the approach to data analysis. Following on, the implementation of the research to date is outlined with the details mid-implementation, followed with some preliminary results.

2.1 Semi-Structured Interview Design

The research data collection phase is mid-way through implementation with an expected completion date of December 2017. This section details the research design with the details of the implementation provided in Section 3.2. To meet the research objective, the study sought an in-depth analysis of the research problem and determined that semi-structured interviews are most appropriate. Sekaran and Bougie (1992) highlights some of the advantages and disadvantages of interviews. Within an interview the interviewer can adapt questions as necessary. It is possible to clarify doubts easily and ensure that responses are properly understood by repeating or rephrasing questions. Overall it provides a rich dataset which helps to explore and understand complex issues. The

interviews were semi-structured by intermittent reference to the interview guide so that all targeted themes were addressed relevant to the research questions and overall objective. Disadvantages outlined by Sekaran and Bougie (1992) include: the cost and feasibility of conducting interviews; respondents may feel uneasy about the anonymity of their responses; and by adhering to an agenda, it may restrict the participant leading the discussion.

Kvale (1999) advocates the qualitative research interview as a “construction site of knowledge” providing opportunity to build new knowledge. Furthermore, Alvesson and Deetz (2000) defines qualitative interviews as “relatively loosely structured and open to what the interviewee feels is relevant and important to talk about, given the interest of the research project”. The researcher has adopted a reflective approach and this is evident in the changes implemented within the interview guide following the first interviews. The interviews were a mix of face to face and skype audio interviews with further details provided in Section 3.2.

2.2 Documentation Analysis Design

Qualitative researchers often supplement in-depth interviewing by combining with observation and analyzing documents which form the core of their inquiry and as document reviewing is a largely unobtrusive method useful in gaining understanding it is also adopted in this study. Documentation can support the verbal accounts of informants (Remenyi *et al.*, 2002) as well as supplement and verify data from other sources (Yin, 1994). As described in Section 3.3 this study has begun to make full use of documentation available from this research network and this has already informed the research process (through the network blogs) to consider relevant events, community groups and as a signpost to other relevant documentation.

Access to a full network (all network nodes of the EU funded network ‘AquaSmart’) has been agreed with the project coordinator to ensure full cooperation, access to resources, experienced personal and documentation. Baxter and Chua (1998) argue that it is only through arranging full access that the potential of case studies can be fully realized. Gummesson (1991) acknowledges that obtaining a holistic view of your research issue through a case study can be a very time consuming job and as such it is generally not

possible to carry out more than one or a very limited number of in-depth case studies in a research project. As discussed later in section 3.3, the type of targeted documentation included code of ethics, project handbook, workshop reports, and description of work, research management reports and grant agreement. Following the document analysis, the interviewees and Coordinator are available to clarify or discuss the additional material analysed in conjunction with the interviews to ensure consistency with the findings. The diversity of sources facilitates the validity of structural embeddedness in research networks through triangulation (Yin, 2003) and enriches the contextual understanding of the study. To identify convergence of themes and patterns across interviews, the data and literature is iteratively examined with initial codes or themes developed based on a pattern between the data and the conceptual framework (Hite, 2005; McGrath and O'Toole, 2014; Miles and Huberman, 1994; Yin, 2003). Coding in this manner facilitated insight and comparison through segmenting the data into units (Hammersley and Atkinson, 1983; Saldana, 2009; Saldaña, 2015; Auerbach and Silverstein, 2003). The next section discusses this further.

2.3 Data Analysis Design

Data for this study, both interview data and documentation, will be collected over a 7-month research period and is currently mid-way through the data collection cycle. However, the data analysis is only in its preliminary stages. In line with Yin (2003), data analysis consists of examining and categorising the evidence to address the objectives of the study. Consistent with other qualitative, case based, inductive, iterative research; it is expected that there will be a frequent overlap of data analysis with data collection (Eisenhardt, 1989). This is already evident as having conducted five interviews it was necessary to analyse and present preliminary results within this paper. This approach collates field notes, documentary sources and interview scripts stored in the data analysis software (NVivo) and Google Drive for this research study. Using the adopted iterative approach to identify convergence of themes and patterns the data and literature has been, and will continue to be, iteratively examined with codes or themes developed based on patterns between the data and the conceptual framework. For this study, an initial set of thematic clusters were established and coded into NVivo as shown in Table 4. However, these were regarded as inconclusive and additional sub-themes were added as shown in Table 5. It is expected that as the data analysis process evolves, codes will continue to be

added, merged or deleted as appropriate, and the final set of codes will be presented in Paper 4. Following on from data collection an iterative approach has been adopted building upon the work of Miles and Huberman (1994) as illustrated in Figure 1. Currently, the research has conducted an initial cycle of data reduction, data display and conclusion drawing, however there are many further iterations required to fulfil the research objective.

Collaboration	Network composition
• Difficulties of collaboration	• Centrality
• Enablers of collaboration	• Competition
• Reciprocity	• Depth of relationship
• Responsibilities	• Frequency of communication
Economic characteristics	• Openness of the network
• Co-creation of scientific knowledge	• Prior relationships
• Competencies and skills	Social characteristics
• Joint publications	• Compliance
• Major milestones	• Cooperation
• New Service offerings	• Dominance
• Research infrastructure	• Trust
Structural embeddedness in EU research networks	
• Barriers to network optimisation	
• Enablers of network optimisation	

Table 4: Initial NVivo themes

• Formation
• Friendships
• Formal network strategy
• Open data policy
• Recommendations for EC
• Future of AquaSmart

Table 5: New NVivo themes added during initial analysis

This iterative approach will increase the reliability of the research. As illustrated in Figure 2, this research is in the second cycle of coding. NVivo provides a platform that is flexible in relation to variable definition during the initial phase. However, this research is not rigid and a flexible approach has been actively addressed in the iterative cycles. To support the software tools the researcher has recorded and transcribed the interviews. After each session, the debriefing notes are transcribed as soon as possible to get ‘down

on paper' the initial feelings, responses and concerns. These transcriptions and initial debriefing notes have formed the basis for first order analysis and research path-finding.

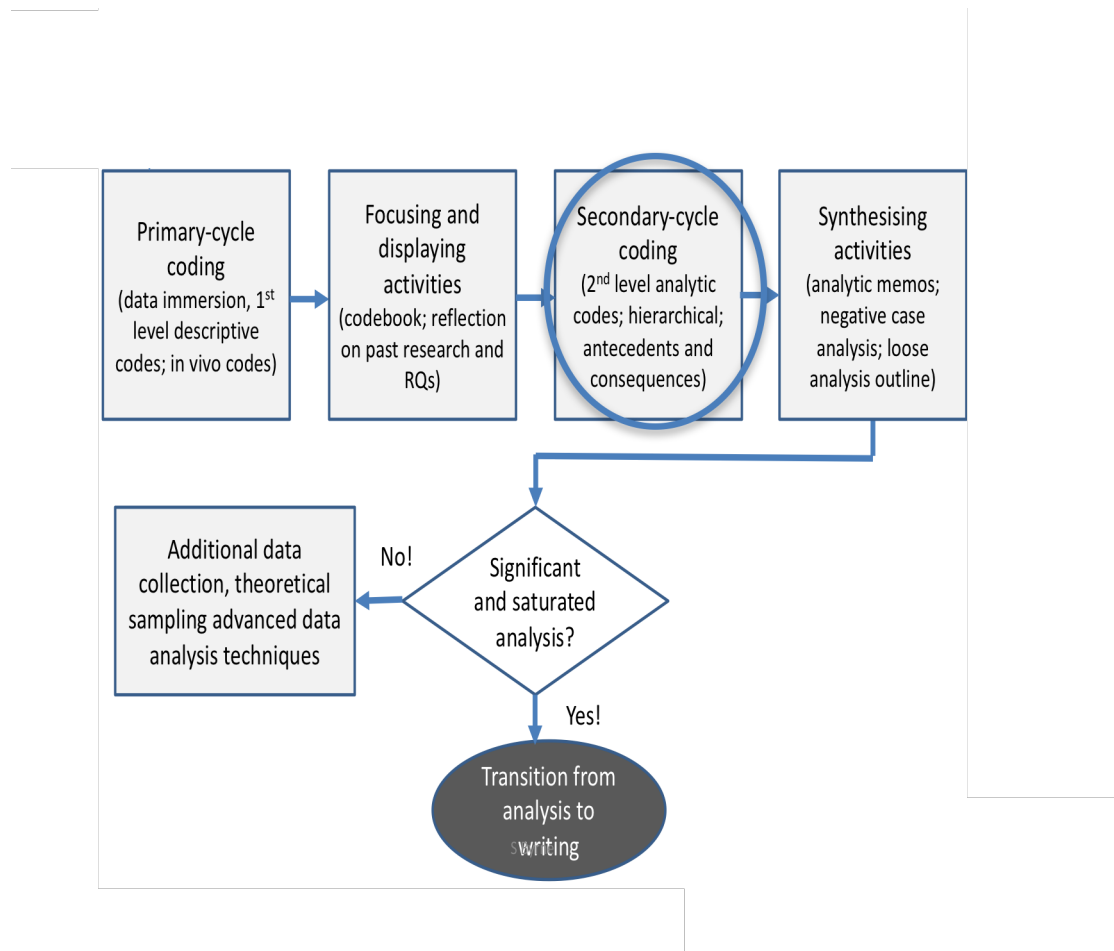


Figure 2: Tracey (2013, p.219) Iterative

3.0 Implementation

Sections 3.0 to 3.4 detail the implementation of the research and the activities and tasks therein. This section describes the challenges and operational issues encountered in executing the research design, and describes the measures enacted to overcome these difficulties in order to align the study with the research objective.

3.1 Overview of the Case Study Network

The contextual setting is a high-tech¹⁹ information communication technology (ICT) network funded by EU Horizon 2020 research programme, the network (project) is called AquaSmart²⁰, Aquaculture Smart and Open Data Analytics as a Service. The high-tech sector of the economy uses the most advanced technology available, it is often seen as having the most potential for future growth and this perception has led to high investment in high-tech sectors of the economy. The European Commission places a large emphasis on its H2020 research programme to foster innovation and competitiveness in Europe through excellence in ICT research and development. Case selection was specifically controlled for location and industry by selecting from EU funded research networks within the information communication technology (ICT) domain. The choice of a high-tech context for this case study builds upon recent research on research networks in high-technology industries (Perkmann *et al.*, 2013; Perkmann and Schildt, 2015; Perkmann *et al.*, 2015; Scherngell and Barber, 2011; Scherngell and Lata, 2013; Wanzenböck *et al.*, 2015; Hite, 2005). In addition, high-tech organisations provide a rich context for the study, given their heavy reliance on network ties that stem from and are embedded within social relationships (Larson and Starr, 1993). While the researcher is experienced in conducting qualitative research as outlined in section 4.1 of paper 2, the researcher is an employee of the project coordinator organisation, TSSG. However, the potential for bias is minimal given that the researcher was not active in any form or knowledgeable of the AquaSmart network at any stage and had no previous relationships with other AquaSmart network nodes prior to the collection of research data.

AquaSmart is using ICT to improve its data utilization and operations. In Europe, the Aquaculture industry accounts for about 20 per cent of fish production and directly employs some 80,000 people. Aquaculture is identified as a key focal point of the EU's Blue Growth Strategy²¹. It is the fastest growing animal food producing sector in the world. Global forecast on production is set to increase from 45 million tons in 2014 to 85

¹⁹ <https://www.een-ireland.ie/ei/assets/documents/uploaded/general/ICT%20Fact%20sheet.pdf>

²⁰ <http://www.AquaSmartdata.eu>

²¹ http://ec.europa.eu/maritimeaffairs/policy/blue_growth

million by 2030. The European Commission has pointed and flagged for prompt action to stimulate large number of aquaculture businesses with ICT innovations.

AquaSmart aims to enable fish farmers to use open data technological solutions built for

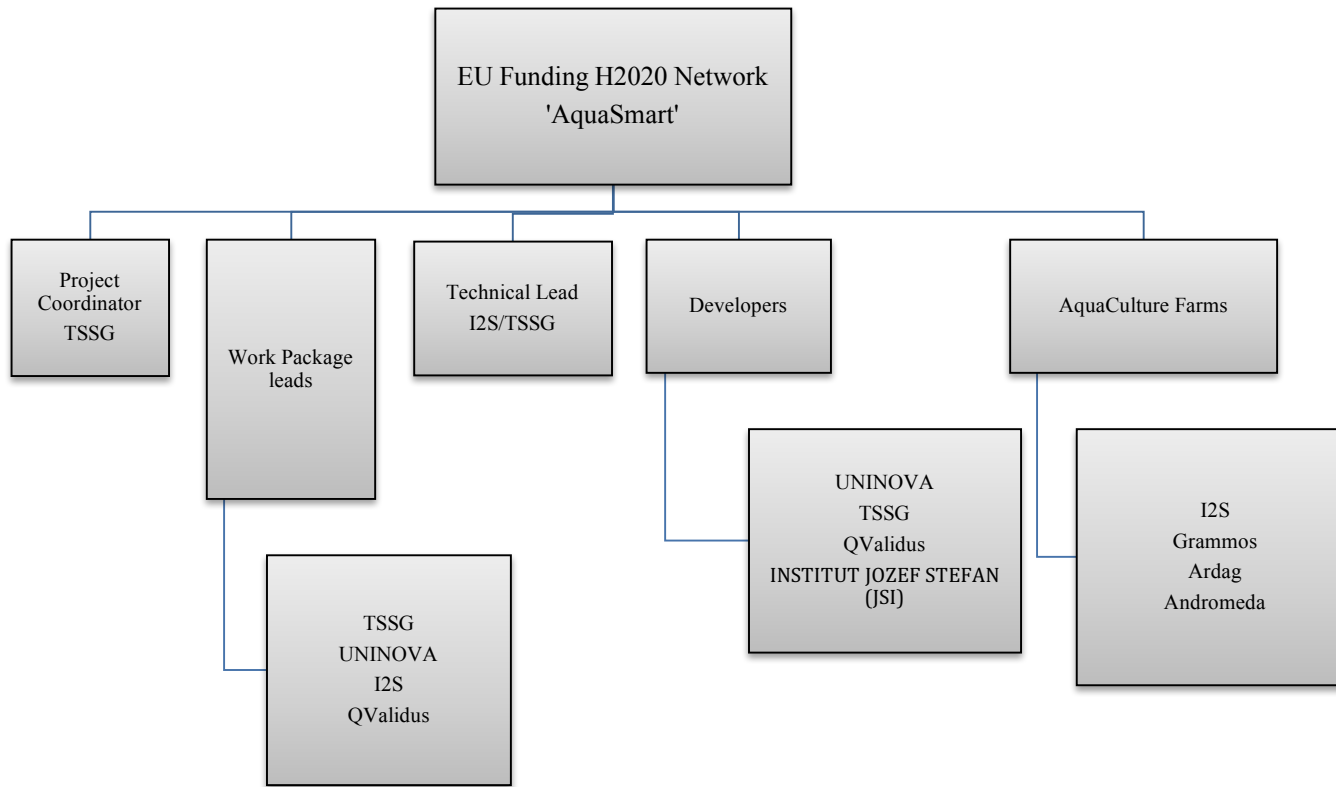


Figure 3: AquaSmart network and role identification

the industrial sector to enhance their operations. It is the network's challenge to bring real value to the market with the state of the art technology in multi-lingual open data to the aquaculture stakeholders. To understand structural embeddedness, it is important to engage with these network nodes at a depth that allows their perceptions to be exposed. When selecting such a case environment, full and complete network access is vital (Kelliher, 2011) and 'random selection is neither necessary, nor preferable'. Thus, following identification of a suitable case environment (that is, a network in ICT research), access was negotiated via personal contact in the author's own work setting. The host network, AquaSmart was a 24-month engagement with eight partners across five European member states and 1 associate member. Appendix G presents the AquaSmart factsheet and brochure. Figure 3, illustrates the AquaSmart network nodes and the following section describes the partners involved and their areas of expertise.

The AquaSmart consortium comprises of 7 partners from 5 member states and 1 associated country as illustrated in Table 6. The consortium is coordinated by TSSG (Ireland), who are an internationally recognized centre of excellence for ICT research and innovation. TSSG have coordinated several high-profile research projects funded through the EU, including OPEN-I and Societies, both of which have a strong focus on the use of Cloud Computing and Data Analytics. The Greek company, I2S is a major player in the European Aqua Culture sector, with global clients, based in Canada, Russia, Mexico, Bahrain as well as European countries. I2S bring vast in-depth knowledge of the market, the product and senior executives who are the decision makers. Participating with I2S are their existing customers from Greece; Grammos (SME), Israel, Ardag (SME) and Spain, Andromeda (Large), who form the basis for requirements, trial and the business showcase for AquaSmart. They provide the non-centralised sources of dynamic and heterogeneous multilingual data for the analytics solutions and services, which will be turned into semantically interoperable data assets and knowledge that is distributed across the value chain. The additional technology providers are the research and development institutes, JSI from *Slovenia*, who play an important role in the cross lingual technology integration and the is the *Portuguese* research institute UNINOVA, who specialize in ICT scientific research & development, advanced training and education. Their specialist areas include strategies for interoperability and information integration using standards intelligent mapping; meta-modelling, intelligent infrastructures and architectures; multilingual ontologies and semantic Interoperability. Supporting these partners is the Irish SME partner Q-Validus who specialize in the field of standardisation and ICT training. In addition, the AquaSmart network is supported by the European Commission and an expert advisory group that they established Overall, the consortium forms a team with experts in the fields of Aquaculture, Fish farming, Cloud, ICT Semantic analytics and multilingual technologist and scientist education and training and standardisation.


	WATERFORD INSTITUTE OF TECHNOLOGY (TSSG) COORDINATOR	IRELAND
	INTERGRATED INFORMATION SYSTEMS (I2S) (OLOKLIROMENA PLIROFORIAKA SISTIMATA)	GREECE
	UNINOVA - INSTITUTO DE DESENVOLVIMENTO DE NOVAS TECNOLOGIAS (UNINOVA)	PORTUGAL
	GRAMMOS S.A. (GRAMMOS)	GREECE
	ARDAG COOPERATIVE AGRICULTURAL SOCIETY LTD (ARDAG)	ISRAEL
	NIORDSEAS SL (ANDROMEDA)	SPAIN
	Q-VALIDUS LIMITED (Q-VALIDUS)	IRELAND
	INSTITUT JOZEF STEFAN (JSI)	SLOVENIA

Table 6: AquaSmart network nodes, logo and location

The AquaSmart project is about enhancing innovation capacity within the aquaculture sector, by helping companies to transform captured data into knowledge, and sharing this knowledge to improve efficiency, increase profitability and carry out business in a sustainable, environmentally friendly way. In addition, AquaSmart contributes to the development of highly skilled workforce through on-line training programs. The improvement of the efficiency and profitability of the businesses, together with the reduction of the environmental impact will contribute to the increase of the production and the generation of new jobs in the sector. The project consortium includes prominent industrial organization's and research institutes from six countries: Ireland, Israel, Slovenia, Spain, Portugal, and Greece. This case organisation meets the characteristics of

the context taken as a single case study and is considered appropriate based on a common case rationale and the ability of such an approach to illuminate the circumstances and conditions of an everyday situation (Yin, 2013). Such illumination is essential to understand the underlying social processes associated with the theoretical concepts of structural embeddedness in EU networks.

3.2 Network Node Interviews

The researcher has conducted 5 interviews and plans to conduct 10 interviews in total during the data collection phase of the research. As described in the research design section, semi-structured interviews were deemed appropriate as a means for data collection to reach the research objectives. Initially, to begin the implementation phase of the research the network coordinator was approached to gain consent (Appendix C) and subsequently the AquaSmart Coordinator sent an introductory email (Appendix D) to all eight nodes of the network. Each interview informally followed a documented, semi-structured approach (Appendix A), however, this is not proposed to be exhaustive or prescriptive and the researcher used probes where appropriate specific to the context. Interviewees received a formal request (Appendix E) to participate in the study, followed by an informal communication (email) to schedule and were provided with an interviewee briefing at least one week prior to the interview. These interviews were recorded using a voice recorder tool (Quicktime) subject to the agreement of the participant for ease of transcription. These interviews were transcribed manually within a week of the interview along with a note of any researcher reflections. The researcher regards this manually transcription process as valuable to become familiar with the data. The researcher requested supporting documentation (Section 3.3) in relation to the case study from the AquaSmart Coordinator, however there is a large quantity of documentation data available and the analysis is at early stages. The researcher has the support of the Coordinator in obtaining continued access to participants to clarify points that remain unclear after the initial round of interviews. Upon recommendation from the feedback in Paper 2 to increase the quantity of interviewees, three additional interviewees (nodes) have been identified as being relevant to this network and the researcher is currently aiming to add these nodes to the research design and implementation. These new target nodes have emerged through the initial interviews where interviewees were asked whom else might be relevant to invite to participate. Table 7 details the interviewee register.

Interviewee Title	Organisation	Affiliation	Country	Interview Date
Project Coordinator	TSSG/WIT	academic	Ireland	30/08/17
Fish Farm Manager	Ardag	industry	Israel	Not yet scheduled
CEO i2S - Business Development Manager at AquaManager	i2S	industry	Greece	21/08/2017
Researcher at UNINOVA	UNINOVA	academic	Portugal	27/07/2017
Technical Manager en Andromeda Iberica	Andromeda	industry	Spain	17/08/2017
Marketing and Business Development Manager	Grammos	industry	Greece	03/08/2017
Managing Director	QValidus	industry	Ireland	Not yet scheduled
Software Engineer and Computer Consultant	Institute "Jozef Stefan"	academic	Slovenia	Not yet scheduled
Innovation and Business Development Manager	QValidus	industry	Ireland	Not yet scheduled
EC PO	TBC	n/a	Belgium	Not yet scheduled
Advisory board member	TBC	TBC	TBC	Not yet scheduled
AquaSmart Technical Lead	TBC	academic	Ireland	Not yet scheduled

Table 7: Interviewee register

Data for this study, both interview data and documentation, will be collected over a 7-month research period and the researcher is currently mid-way through this data collection process. Consistent with other qualitative, case based research; there has been a frequent overlap of data analysis with data collection and field notes, and this is expected to continue in the next period gaining refinement throughout. Comprehensive preparation (analysis of website, open data records) prior to each interview has enabled a thorough level of familiarity for the researcher with the network. The preparation for the semi-structured interviews required an interviewer guide (Appendix A) which included a series of themes aligned to the research questions to be explored with each research network actor (Patton, 1999; Qu and Dumay, 2011). The question structure was flexible, allowing for variations to emerge on an interview-by-interview basis which has been beneficial while dealing with different aspects of the case study. All the interviews are recorded and transcribed immediately following the interviews. Currently five interviews have been conducted as per Table 5. Four of these interviews have been transcribed and

coded, and uploaded to the NVivo tool for the analysis and re-coding stage. Stemming from these four interviews, the researcher presents the initial findings and reflections in Section 4 of this paper.

The interview guide is a central implementation tool for the data collection phase and the thematic areas identified help the researcher to keep focused while gathering data to align with the research questions. This paper demonstrates an ability to understand and follow the steps necessary to produce competent case research through the presentation of a case study protocol. The case study protocol was structured to include an overview of the case study project, detailed plan for implementation, data collection procedures and questions, the secondary sources for achieving data triangulation and the protocol for data analysis and the presentation of findings.

Table 8 outlines the thematic areas from the literature that formed the initial set of themes for the interview guide. Several new themes and questions have emerged upon reflection having conducted five interviews, including, the formation of the network, the future of the network, and some refinement of the research questions in relation to centrality of the network, intensity of ties and recommendations to funding institutions.

RQ1	How is the AquaSmart research network structurally embedded?	Publications
	<ul style="list-style-type: none"> • Composition of the research network • prior relationships • Partners, Competition, knowledge providers • Openness of the network 	(Burt, 2009; Granovetter, 1973; Granovetter, 1985; Gulati, 1998; Gulati and Gargiulo, 1999; Cook and Emerson, 1978; Cook and Whitmeyer, 1992)
RQ2	How is structural embeddedness interconnected with social and economic characteristics?	(Agarwal and Selen, 2009; 2011; Bolzani et al., 2014; Rothaermel et al., 2007; Krippner et al., 2004)
	<p>a. Can you describe the social characteristics of your research network?</p> <ul style="list-style-type: none"> • Compliance • Trust • Dominance • Cooperation 	

	<p>b. What was the primary output of that network?</p> <ul style="list-style-type: none"> • Co-creation of new knowledge/infrastructure/competencies • Major milestones • Joint publications • New service offerings 	
RQ3	What enablers and barriers to structural embeddedness are encountered within EU research networks	(McGrath and O'Toole, 2013; Rubach <i>et al.</i> , 2014; Zaheer and Bell, 2005; Pedersen, 2007)
	<p>a. Can you describe the enablers of structural embeddedness within this research network</p> <p>b. Can you describe the barriers to structural embeddedness within this research network</p>	

Table 8: Interview guide questions and associated literature

3.3 Documentation Analysis

The AquaSmart network has provided several documents to the researcher as identified in Table 9, and a documentation review is underway in parallel to the primary data collection phase. In particular, the AquaSmart project deliverables and AquaSmart description of work detail the operations of the network throughout its duration. Furthermore, the AquaSmart website has 37 blog entries which followed the events and achievements of the network and the website has a detailed training module. This type of media material gives further insight to the network activities and relationships and has been identified in the literature as useful for qualitative studies (Hookway, 2008; Snelson, 2015; Pink, 2013). The researcher is in the process of reviewing this material at this stage of the research and the analysis tool NVivo facilitates the analysis of different media types.

Document type	Review in progress
Description of work	√
Project brochure	√
Project deliverables (AQUASMART_Dissemination Plan V1.0 (D5 2).docx, Grant Agreement-644715-AquaSmart-5.pdf, Aquasmart D2.1_v1.0_Final Toms (updated) QA Approval Version.pdf, AQUASMART D1.2 Project Plan v1.0_Final.docx)	√
Project newsletters/37 blog entries	√
Code of ethics	
Project handbook	
Workshop reports	
Research management reports	√

Table 9: Document Register

3.4 Data Analysis Protocol

In assessing methods for data collection during the planning phase it is beneficial to consider what data analysis procedures will be used (Guba and Lincoln, 1994). Eisenhardt (1989) suggests that researchers should overlap data collection and analysis because this will speed up the analysis phase and allow the researcher to refine the data collection especially if issues arise during the data collection. As mentioned this approach has been adopted for this study. Once a version of the interview guide was complete and reviewed with supervisors, the researcher developed spreadsheets in preparation for the data collection and analysis phase. Each section of the interview guide was referenced to the literature where applicable and an interview schedule and document register were managed through use of spreadsheets. This facilitated an initial analysis of respondent data which included positions held by respondents and classification of respondents into industry and academia. During the data collection cycles the researcher kept a log of events to ensure accurate records which was supplemented by the researcher's reflective journal. Seidel (1998), Figure 4, highlighted the need to take time to reflect within research, which has been an effective consideration during this research.

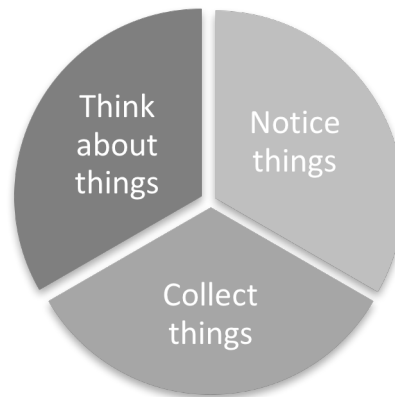


Figure 4: Siedel (1998)

While a rationale for the use of the NVivo for the analysis of data was presented in paper two of this series, it is only one tool in the array of mechanisms (excel, whiteboards, document maps) adopted by the researcher for this case study which helped the researcher to visualize and connect the data with the theory and research objective.

The researcher set up a new project in NVivo running on an encrypted laptop. A back-up of this project was saved to Google Drive. The data (interview transcripts and secondary data extracts) were added to the project as internals. Within the internals section of NVivo, folders were set up for each category of internal. A link to the voice files was created as externals for referral access to the context or tone of a comment. Nodes were set up to represent the structure of the a priori codes (using the literature and interview guide) and included an initial hierarchical structure drawing from the conceptual framework. The researcher has created an initial and second round list of codes presenting themes in NVivo. The reporting function in NVivo has been useful to summarise nodes, hierarchies and interview output (Appendix H). Interpretation was aided using hierarchy, relationship, annotations and memo functionalities in NVivo. Implementation of this strategy is divided in to three stages, prepare to analyse, analyse, and interpret as recommended in the models by Tracy (2013) and Huberman and Miles (2002) and illustrated previously in Figure 2.

4.0 Initial findings

The findings presented are from the first round of interpretation and coding of transcripts. The researcher has conducted 5 interviews as detailed in Table 10 and plans to conduct 10 interviews in total during the data collection phase of the research.

Interviewee	Interviewee Title	Organisation	Affiliation	Country	Interview Completed
A	Project Coordinator	TSSG/WIT	Academic	Ireland	30/08/2017
B	CEO i2S - Business Development Manager at AquaManager	i2S	Industry	Greece	21/08/2017
C	Researcher at UNINOVA	UNINOVA	Academic	Portugal	27/07/2017
D	Technical Manager Andromeda Iberica	Andromeda	Industry	Spain	17/08/2017
E	Marketing and Business Development Manager	Grammos	Industry	Greece	03/08/2017

Table 10: Completed Interviewee register

The first cycle of interviews included 4 males and 1 female interviewee, further depth in relation to their profiles will be described in Paper 4 of this paper series. The initial findings were supported by a coding summary report by node, an individual coding by node chart per interviewee and a review of field notes. Initial insights are drawn from the data and presented alongside the key areas of the conceptual framework; structural embeddedness, social characteristics and economic characteristics. The following subsections focus on the initial findings aligned to the original research objective and research questions presented in Paper 2 and outlined in Table 11. The emerging themes and findings will be introduced in this paper and further described in Paper 4.

<p>The research objective for this study:</p> <p style="text-align: center;"><i>“to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union”</i></p>
RQ1 How are research networks structurally embedded?
RQ2 How is structural embeddedness interconnected with social and economic characteristics?
RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

Table 11: Research objective and questions

4.1 Structural Embeddedness

Structural embeddedness is central to the objectives of this study, the emergent themes include centrality, network configuration, network policy and prior relationships. The following sub-sections detail the findings to date in relation to these themes.

4.1.1.1 Centrality

Figure 5 illustrates the grouping of industry (depicted in green) and academia (blue) while also highlighting the centrality of two of the organisations. Findings show that the objective for the network emerged from the i2S organisation and the formation of the network emerged through the contacts of QValidus. According to Interviewee B from i2S:

“The purpose of AquaSmart is to develop data mining and analytics for aquaculture. That was originally my idea and then together with QValidus we formed the consortium that is composed of three of my customers. Our company i2S, along with TSSG, UNINOVA, and JSI as each of the partners. We all had experience in a specific area; TSSG as the cloud expert; UNINOVA as the training expert, and JSI as the analytics experts. We are the business experts, we know the industry and have the contacts, and this is how we all came together to try to make this data analytics platform”.

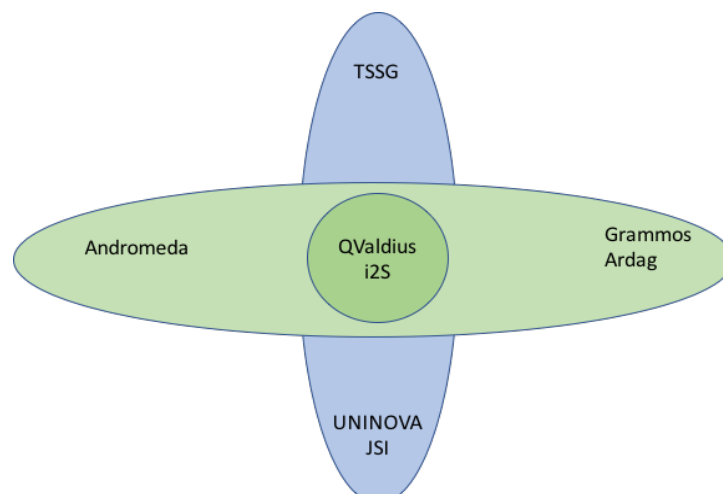


Figure 5: Clusters of AquaSmart network

This centrality at formation stage also emerged during a discussion on power and authority with Interviewee A and adds to the depth of understanding the structure of the AquaSmart network. Interviewee A from TSSG states:

“Yes, [redacted] would have thought that he was the controller of everything”.

Centrality will be further analysed in the next cycle of data collection and analysis.

4.1.2 Network Configuration

Section 3.1 previously detailed the basic characteristics of the 8 partners (nodes) in the AquaSmart network. This section uses the data from this research to provide further insights and detail to this network and its configuration. Figure 6 shows the logos from the 8 nodes.



Figure 6: AquaSmart Network

Generally, the network was described as two clusters of node types, industry and academia, however, some respondents further grouped the consortia into three clusters. These included the end users who were the Aquaculture business partners, the researchers, who could develop a platform to combine technology and aquaculture know-

how, and the trainers, who could educate and spread the new knowledge through the industry. This provides a more detailed understanding of the network as it reveals the sets within the network. However, it is too early in the analysis to detail this further.

There are several different interpretations of the network composition and it seems that this is related to the timing of joining the network and prior relationships within the network. Interviewee B from i2S believes;

“Now that I am thinking about it again I believe that it was because [REDACTED] was a nice person and he knows nice people. He brought together people who had the same mentality. I think that [REDACTED] was the catalyst for the consortium”.

Having a network broker (catalyst) for the network seems to indicate that the network was efficient to launch itself and become established. Indeed, this process has been repeated and a new network established during the lifetime of AquaSmart in a parallel domain. Furthermore, the network broker was described by Interviewee B from i2S as *“building a family of researchers with common goals”*. Due to multiple references to this specific individual who played a significant role within the network, this researcher has decided that it is important to target this individual. Therefore, he has been added to the data collection register and an invitation to participate in the research has been initiated.

UNINOVA identifies the network composition of academics and business organisations as an area of high difficulty and that they had to overcome this by building a bridge between the two perspectives to gain common understanding and language. According to Interviewee C from UNINOVA:

“We had to build a bridge between them and us; the way we handle knowledge from one side is not the same as the other side, and what we think is important on one side may be different on another ...this is very difficult, different profiles and different views. This was the main issue and it's not easy to take the knowledge from both sides and it has been very difficult”.

Furthermore, the distinct competencies of each of the network nodes was recognized by Interviewee D from Andromeda as a key success factor, when stating:

“Once we have the tools, we should spread this knowledge within the sector and disseminate this type of analysis to those who don’t understand the potential of the tool”.

4.1.3 Network Policy

Several of the academic network participants employed a formal network policy. This was most prominent in organisations who continued to write research proposals and engage in research activities with a funding institute. The industry participants focussed attention on very specific alliances and links with trade and service providers who were outside of their core competency and skill base. Interviewee C from UNINOVA believes:

“When we go to conferences or meet people, we add everyone to our network without any policy or criteria, whereas our established AquaSmart network has a proven track-record yet we have failed to extend its longevity”.

4.1.4 Prior Relationships

While some of the partners had strong ties, this was not common throughout the network, there was evidence of weak ties and structural holes that will be further detailed in Paper 4. Furthermore, priori relationships seem a significant factor in relation to research networks. It is apparent that prior relationships are a contributing factor for new and emerging networks. Interviewee D from Andromeda stated:

“We got involved because of our previous engagement with the Greek company and AquaManager helping them to improve the tool, I think since we had already established good collaboration between our technicians and their technicians they initiated our involvement in this network”.

4.2 Social And Economic Characteristics

The social characteristics arising from the literature and outlined in the conceptual model are compliance, trust, cooperation and dominance. It is clear from the initial cycle of data collection and analysis that these characteristics are prevailing within the case study and

there are possibly other sub-themes within these concepts. For example, within trust the concept of friendship emerged as a catalyst for trust. In addition, research networks bring together various types of people with differing personal and professional characteristics. For example, in the case of Interviewee C from UNINOVA recalls how shyness was a contributing factor for network relationships when stating:

“it is important to build up interpersonal relationships, initial face to face meetings are important followed up by audio calls where you can continue the work remotely and explain your work without any additional stress caused by shyness – I personally prefer 3 year projects as the 1st year you get used to knowing each other and then you have 2 years to do the project work. In AquaSmart – for me it was a pity that we had to finish in 2 years”.

Furthermore, the closeness of the different relationships was evident, social and sport activities were recognised as contributory to building positive network relationships.

4.2.1 Trust

There were several interviewees who mentioned temporal considerations in relation to building up trust and its connection with the effectiveness of the network. Interviewee A from TSSG initially mentioned one or two months to build up trust, but as we continued our discussion, he changed that to four or five months to correspond with the second face to face meeting of the network.

“The first meeting is a kick-off meeting, then you have 3 months of work before the next meeting so that’s kind of 4 months really to get going”.

Interviewee E from Grammos believed that there was trust between partners by the milestone of the second meeting, *“At first, we didn’t know each other well, but we worked closely together and we faced issues of trust which improved by the second and subsequent meetings”.* Interviewee C from UNINOVA believes it took about a year to build trust between the network nodes. Furthermore, Interviewee A from TSSG believes

that the jargon in relation to aquaculture and technology creates an adverse impact on trust within a network.

“It was 8-9 months into the project when we were able to talk a common language, our understanding of aquaculture was completely off the wall”.

4.2.2 Communications

Generally, all partners were positive when discussing the communication between nodes within the network. Regular communication sessions were arranged and there were no issues in relations to attendance or cooperation at the communication sessions. Indeed, when critical milestones were imminent additional communication activities were initiated between the relevant network nodes “we had a skype call every morning during this period where the technicians explain what advances were progressed in the system and an opportunity was given to ask questions which facilitated a fast development process”.

Interviewee D from Andromeda highlights the benefits of the structured process:

“This is important because when you try to explain the business to a person who doesn’t normally know the business unless you have a good communication process it is almost impossible to work together”.

Furthermore, the cooperation between network nodes were identified as critical to the success of the network while cognizant of the potential impact of the network outcome.

Interviewee E from Grammos describes the cohesion between nodes:

“We managed to work together very closely and accomplish a lot of things to make this project a success, we had excellent cooperation”.

“...we worked like a well-oiled machine. We understood the capacity and greatness of the project – an innovative project for this industry and in the future, it will help the Aquaculture industry to grow”.

There was a common sense of positivity in relation to the network where only one aspect was considered arduous, this was the travel for plenary meetings mentioned by Interviewee E from Grammos.

4.2.3 Business Opportunity and Industry Vision

While considering the conceptual model and research objectives the economic characteristics are linked with the output of the network such as business opportunity and network benefits. It is relevant to explore the enthusiasm expressed by the network nodes toward a common goal, Interviewee A emphasised “*Partners had a common goal and interest to succeed*”. Furthermore, the scale to which some network nodes viewed the network benefits and potential impact on the aquaculture industry.

Interviewee E from Grammos illuminates the opportunities this network would achieve “*we understood the greatness of the project – an innovative project to help the Aquaculture industry to grow*”. In addition, Interviewee E links these opportunities directly to maximise profit and minimise loss. The combined vision of AquaSmart was beyond any individual partner vision, as Interviewee E suggests, “*AquaSmart as a project uses open data enablers to enable Aquaculture companies to realise things that were not even an idea before*”.

4.2.4 Benefits

The initial findings identify new scientific knowledge and competency levels as key benefits of network engagement, Interviewee D from Andromeda suggests:

“The trust between us emerged when we started to play and practice with the tools, we realised that the potential of the analysis was high giving us a fast return on investment that you could visualise early on in the project, and we never had before in the sector”

Each network node had both a collective and an individual view of benefits. Interviewee C from UNINOVA recognised the network itself as the outcome of the engagement “*This*

research organisation – the possibility of having a certain set of people that we trust for new proposals and new projects, that’s the main output”. Furthermore, Interviewee D working with Andromeda highlighted this major milestone;

“One of the items was that multi-variable analysis in aquaculture is possible, normally when we realise value of data we focus on mainly 2 or 3 main factors but if you delve deeper you can see more variables/factors. When you have the capacity to extend the potential of the analysis to many factors you see the results of the analysis is much better. Thus, the primary and secondary impact of those KPIs were identified”.

From an economic perspective, a major achievement from an investment or funding institution is the creation of new jobs new companies, while at the early stages of negotiation it is clear that the AquaSmart network sees the emergence of a new company as a real possibility. Interviewee A from TSSG believes the formation of a new company is imminent, however, there is little detail at this stage, *“a new company.... that is still being discussed”*.

4.2.5 Implications for Subsequent Research Cycles

Having completed some of the data collection and a preliminary data analysis cycle, several items have emerged that need to be reflected upon and actioned for the remainder of the research implementation. Specifically, the interview guide was reviewed following the emergence of new themes from the interviews. The emergence of new themes led to the addition of two new nodes to the network where the importance of their role in the network had not previously been apparent, the technical lead and the dissemination node.

Following the initial data analysis cycle new themes were identified and added to the research tool NVivo, these were identified earlier in Table 5. As previously mentioned the researcher continues to use a reflective diary which aids this process of noticing, thinking and collecting as identified in Figure 4 and also aids the research process as outlined in the adopted qualitative data analysis and iterative research process (Figure 2).

5.0 Conclusions and Next Steps

Structural embeddedness refers to the quality and configuration of the interactions between nodes in a network. The data has identified insights in relation to the configuration of research networks, the distinct qualities and social characteristics prevalent in these types of networks. From the initial findings, diversity within research networks between academia and industry is identified as a challenge and that convergence of research priorities is difficult but can yield successful outcomes. The additional data collection planned for the remaining cycles as identified in table 3 will support the analysis and integration of findings toward rich contextual results and discussion.

The formation of network seems to be indicative of the quality of the network nodes and their ability to work effectively together. The foresight of specific partners to join network nodes seems remarkable and they had not emerged from strong ties. Centrality within the research network was cited as significant, there was a strong influence of the network nodes with power and prior relationships to network formation were evident. The continuation of the network beyond the temporal nature of AquaSmart is indicative of this significance.

There was a focus from respondents on the social characteristics in relation to a strong correlation about reaching the research objectives and trust between nodes within the network. Social intensity of ties was cited as significant. In addition, trust had a cumulative nature and the milestones of the project was a significant constraining factor for the network. This paper has demonstrated the implementation of data collection and initial analysis (using the first 5 respondent interview transcripts). While this only represents a small part of the planned data collection metrics it demonstrates the appropriateness of the data collection, implementation and analysis strategies. Over the coming period the research implementation will complete the data collection (further 5 interviews, relevant blogs and documents until data saturation is reached). Furthermore, the analysis cycles will continue and use the more complex tools within NVivo toward a robust research study and fulfilment of the research objective. Additional sources of data have been identified as relevant through the interviews and the next stage will undertake a comprehensive and rigorous approach to successful completion of the implementation.

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Appendix A – Interview guide

The aim of this research is:

“An investigation of social and economic aspects of structural embeddedness in an ICT research network based in the European Union”

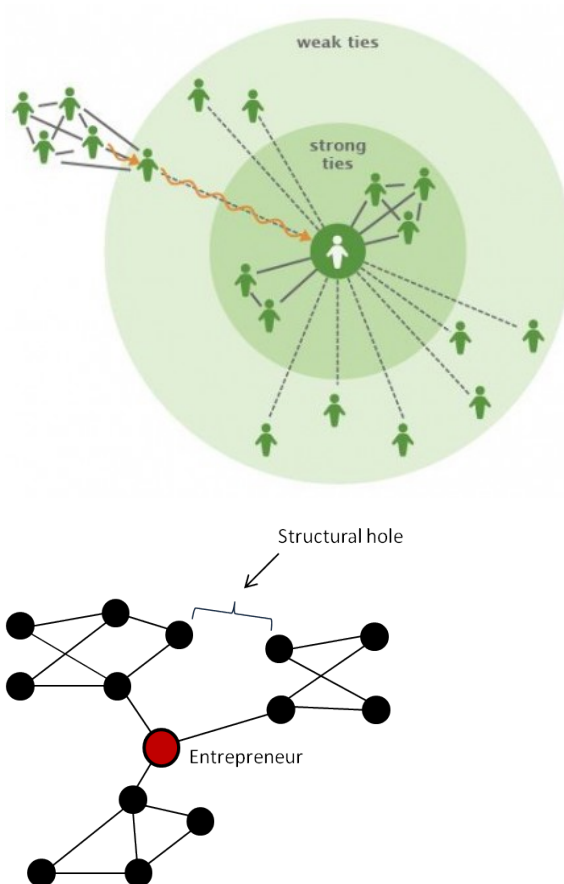
Points to remember –

- Thank the interviewee for their contribution
- Summarise the purpose of the research
- Explain the format of the interview and expected timeframe

- Discuss confidentiality and anonymity of the results
- Confirm permission for audio-recording

Relevant concepts

- Network theory proposes the optimal way of doing something.
- The first proof Seven Bridges of Königsberg (Newman *et al.*, 2006).
- **Structural embeddedness** is how many participants interact with one another, how likely future interactions are among participants, and how likely participants are to talk about these interactions (Granovetter, 1985, 1992).
- **Social network theory** studies how structure of relationships affects behaviours and beliefs.
- Include social embeddedness here – good paper is SNA_03senc_sozen

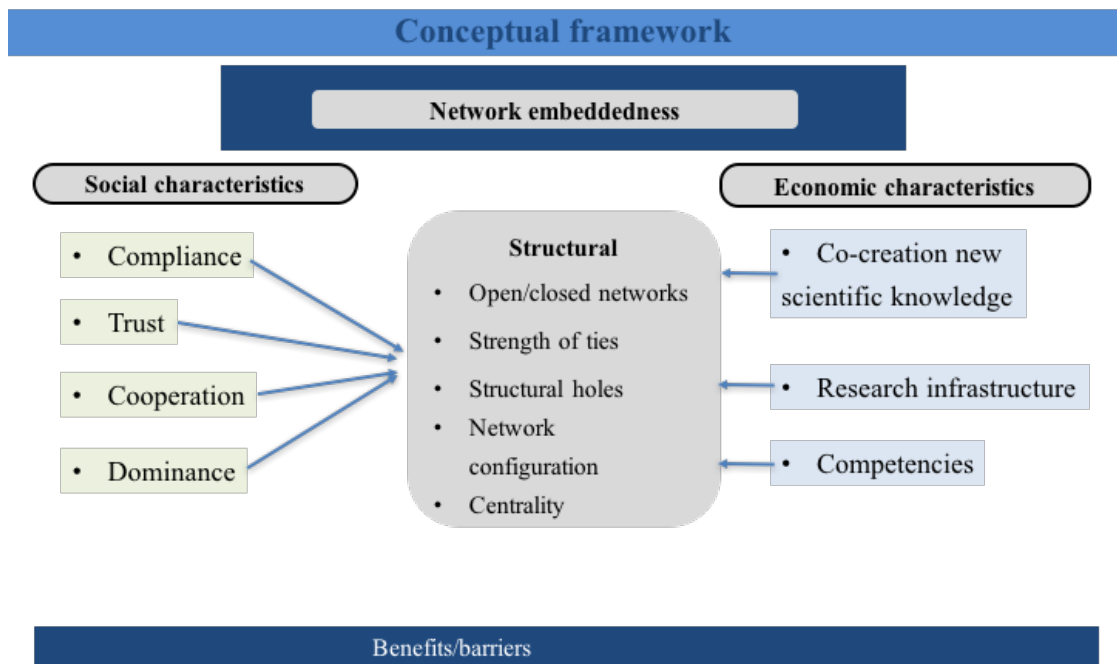


Granovetter 1973, Burt 2009

Research Overview

Network embeddedness is central to this study, the conceptual model highlights the social and economic aspects of structural embeddedness within EU research networks. The results from this research contributes directly to theory by providing rich insights in structural embeddedness which is primarily quantitative rather than qualitative (Herz *et al.*, 2014). This context for an investigation in structural embeddedness will provide novel contextual insights. Furthermore, the contribution to practice aids the development of a robust research network strategy, cognisant of social and economic aspects. In addition, the research management function will gain insights to enablers and barriers of structural embeddedness which supports their operations. From a policy perspective, funding agencies will further understand the structural embeddedness of research networks and the complexities therein.

Our economies are now more than ever dependent upon the digital world that connects us all, in terms of the rapidly growing digital services and commerce industry. Therefore, the scope of the study focuses on high tech companies, a particularly pertinent sector in research networks. This paper details the selected methodology to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The research follows an interpretive, qualitative paradigm. A single case study approach is adopted as a suitable method to investigate this phenomenon in its natural context, as it allows for the subjective and contextual experiences of the participants supported by in-depth interviewing and documentation analysis. Data will be analysed using NVivo and the findings will be presented in a future paper.



Research networks provide a rich setting to analyse structural embeddedness in networks. The effects of network embeddedness are recognized in the as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). The following research questions frame the overall research objective:

RQ1 How are research networks structurally embedded?

RQ2 How is structural embeddedness interconnected with social and economic characteristics?

RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

Organisation profile

This information is for administrative and comparative purposes and responses are confidential.

Organisation Name	_____
Industry	_____
Contact Name	_____
Position	_____
Email	_____
Phone number	_____
Number of years' experience with current organisation	_____
Educational qualifications	_____
<u>Please circle your answer</u>	
Are research networks an area of interest for you personally at present?	Yes No
Are you involved in research networks?	Yes No
If yes please describe	
Please indicate if you are willing to participate in further research for this study	
	Yes No

RQ1: How are research networks structurally embedded?

- e. Can you describe the AquaSmart research network that you have been involved with in the last 2 years?

- *Include your role/position, your organisations, other nodes(actors) ties (links)*
 - *Composition of the research network*
 - *Partners, Competition, knowledge providers, support*
 - *Structural holes and role they played, if any in this research network*
 - *Openness of the network*
 - *frequency of communication*
 - *depth – quality of relationships*
 - *Roles, behaviours , attitudes over time of the project*
- f. Can you describe the prior relationships you had with other actors in the network prior to the research and how these did/didn't influence behaviour?
- g. *How do factors such as; trust, reputation, open data policies affect cooperation among nodes?*
- h. *Describe any existing partnering arrangements (before & after research)?*

RQ2: How is structural embeddedness interconnected with social and economic characteristics?

- e. Can you describe the social characteristics of your research network?
- *Compliance*
 - *Trust*
 - *Dominance*
 - *Cooperation*
- f. What was the primary output of that network?
- *Co-creation of new knowledge*
 - *Major milestones?*
- g. How did the network nodes competencies and skills differ in relation to the structural embeddedness
- h. Can you describe collaboration in the research network
- a. *in relation to competition nodes*
- *the perks and any difficulties of collaboration*
 - *nature of reciprocity,*

- *shared responsibilities, shared accountability and power and authority*
- *describe output from collaboration*
 - i. joint publications*
 - ii. new service offerings*

RQ3: What enablers and barriers to structural embeddedness are encountered within EU research networks?

- c. Can you describe the enablers of structural embeddedness within this research network*

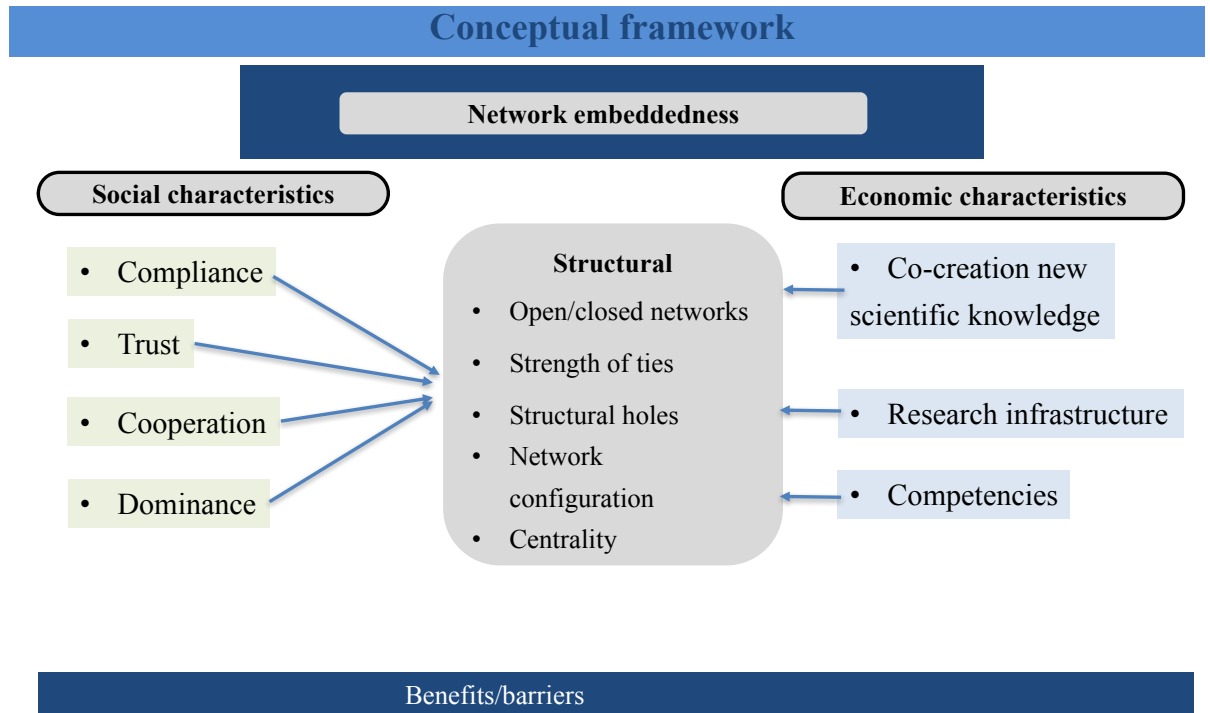
- d. Can you describe the barriers to structural embeddedness within this research network*

Concluding remarks

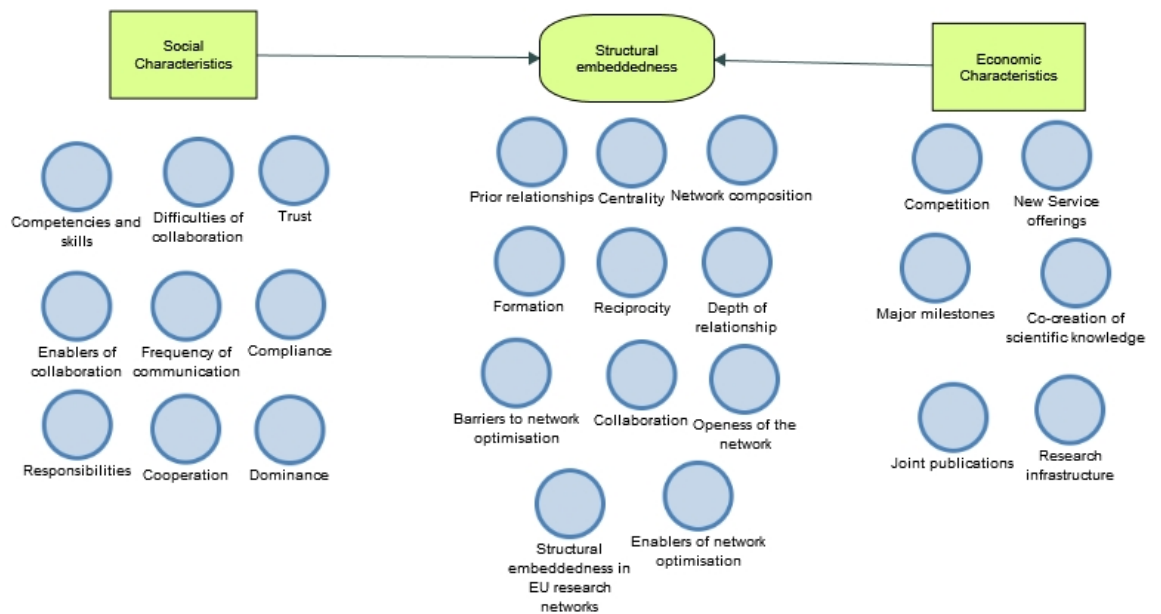
Points to remember –

- Thank the interviewee for their contribution
- Summarise the purpose of the research
- Discuss confidentiality and anonymity of the results
- Confirm permission for audio-recording
- Request that the interviewee might consider a review of the transcript report
- Ask if you can revert with any clarifications

Appendix B – Conceptual Model



Benefits/barriers



Appendix C – Network Letter of Consent for Participation

Zeta Dooly
Post Graduate Researcher
School of Business
Waterford Institute of Technology
Cork Road
Waterford

July 2017

Re: Structural Embeddedness in a Research Network

Dear AquaSmart Coordinator,

I am undertaking a doctorate investigating the social and economic aspects of structural embeddedness in an ICT research network in the EU and request that the AquaSmart research network participate. Best practice in this process requires agreement with the host network for the use of the research data in the dissertation and later published work. Following discussions with my supervisors Prof. Aidan O’Driscoll and Dr. Aidan Duane I am writing to obtain this consent. Please feel free to contact either of them if you wish to clarify any aspect of this dimension of the research.

Your participation in the project involves completion of a face to face interview (or Skype) and access to review relevant documentation. I wish to obtain your consent for the academic use of the material and information provided by you. In return I undertake to treat such material with the high degree of confidentiality appropriate for the commercial sensitivity it commands. This means that the primary data will only be used for academic purposes.

It is meaningful for the research to mention the host name and positions/responsibilities of those who participate but the not names of those interviewed. Therefore, I propose to include reference to (*AquaSmart network*) but not individual names.

If you wish I will submit this to you for review prior to submission of the dissertation to internal/external examiners as part of the examination process. In addition, their attention will be drawn to these assurances.

The research data will be used only for academic research purposes and will be maintained for as long as is required by academic standards designed to uphold the integrity of findings and publications. These protocols assist in reducing risk exposures that may exist.

Other academic outputs from this project may include conference papers and presentations, peer reviewed journal articles, contributions to professional journals such as those published by the relevant organisational or technical bodies, and research monographs for Waterford Institute of Technology. This is only possible if the participating organisation provides consent for this purpose.

I am a Researcher at TSSG in Waterford Institute of Technology and my telephone number is 051-302943 and my email address is zdooly@tssg.org. Through this research, I look forward to expanding our respective knowledge bases, thereby making an economic and social contribution to the community and building its intellectual capital.

On a personal note I would like to express warm appreciation to you for your participation and I hope that further opportunities for mutually satisfactory cooperation will emerge in the future.

Best regards,
Yours sincerely,



Zeta Dooly
TSSG, WIT

Appendix D – Aquasmart Coordinator Introductory Email

Hi [REDACTED],

I hope all is good with you since the end of the project.

One of my colleagues (Zeta Dooly) here in the TSSG is doing her doctorate, investigating the social and economic aspects of structural embeddedness in an ICT research network in the EU. As such, she would like to request that the AquaSmart research network participate, and so I hope you do not mind but I thought that you might be able to assist her with some questions she has.

I have cc'd Zeta on this email, and she will follow up with specific details.

Of course, if you do not wish to participate please let me know.

Thank you

[REDACTED]

--

[REDACTED]

Project Manager
DMSC Unit, TSSG
Telecommunications Software & Systems Group (TSSG),
ArcLabs Research and Innovation Building,
Waterford Institute of Technology,
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E-mail: smcmanus@tssg.org

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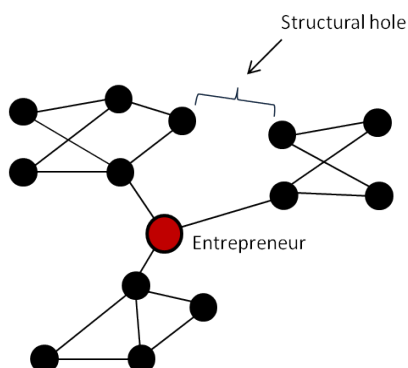
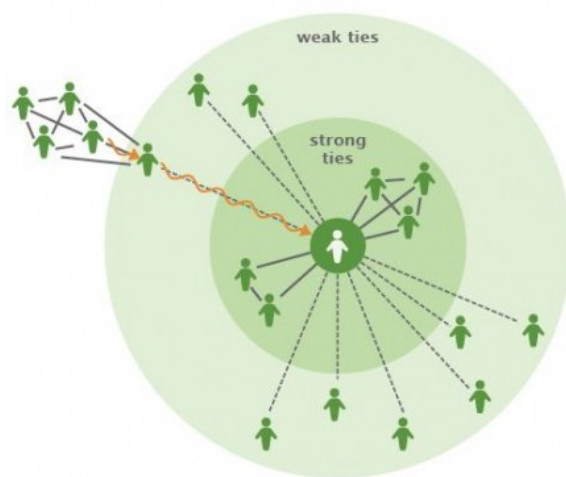
Appendix F – Interviewee Briefing

The aim of this research is:

“An investigation of social and economic aspects of structural embeddedness in an ICT research network based in the European Union”

Relevant concepts

- Network theory proposes the optimal way of doing something.
- The first proof Seven Bridges of Königsberg (Newman *et al.*, 2006).
- **Structural embeddedness** is how many participants interact with one another, how likely future interactions are among participants, and how likely participants are to talk about these interactions (Granovetter, 1985, 1992).
- **Social network theory** studies how structure of relationships affects behaviours and beliefs.

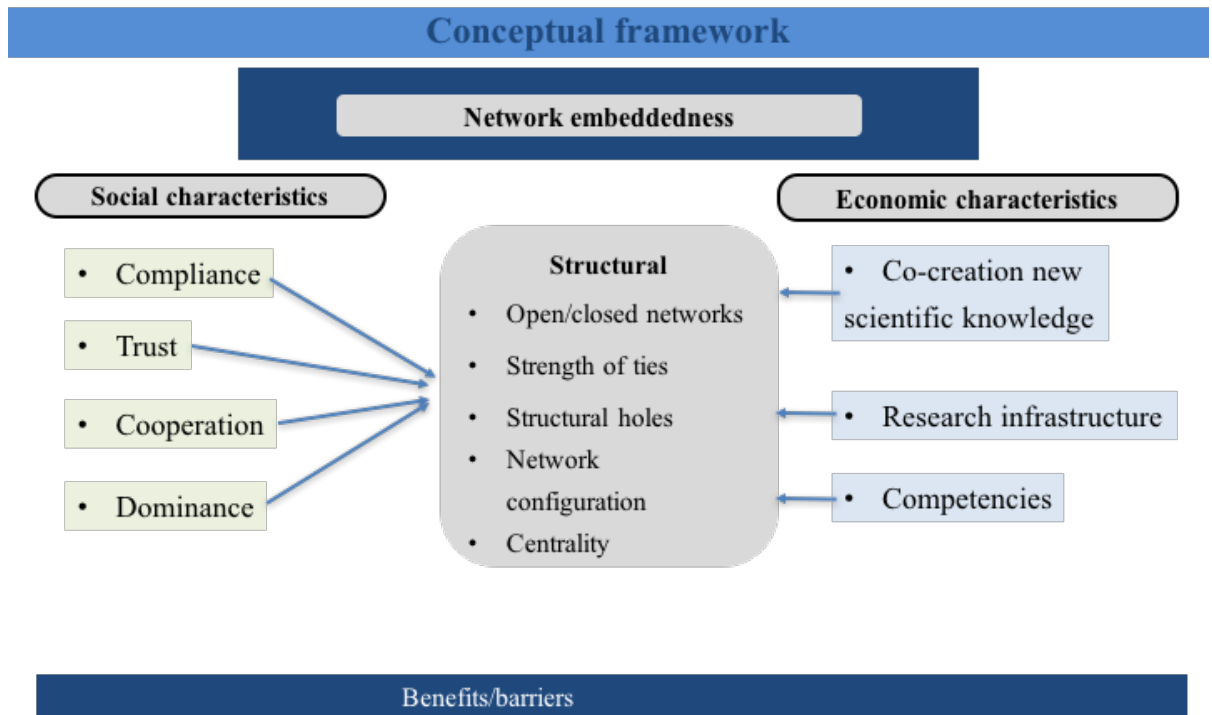


Granovetter 1973, Burt 2009

Research Overview

Network embeddedness is central to this study, the conceptual model highlights the social and economic aspects of structural embeddedness within EU research networks. The results from this research contributes directly to theory by providing rich insights in structural embeddedness which is primarily quantitative rather than qualitative (Herz *et al.*, 2014). This context for an investigation in structural embeddedness will provide novel contextual insights. Furthermore, the contribution to practice aids the development of a robust research network strategy, cognisant of social and economic aspects. In addition, the research management function will gain insights to enablers and barriers of structural embeddedness which supports their operations. From a policy perspective, funding agencies will further understand the structural embeddedness of research networks and the complexities therein.

Our economies are now more than ever dependent upon the digital world that connects us all, in terms of the rapidly growing digital services and commerce industry. Therefore, the scope of the study focuses on high tech companies, a particularly pertinent sector in research networks. This paper details the selected methodology to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The research follows an interpretive, qualitative paradigm. A single case study approach is adopted as a suitable method to investigate this phenomenon in its natural context, as it allows for the subjective and contextual experiences of the participants supported by in-depth interviewing and documentation analysis. Data will be analysed using NVivo and the findings will be presented in a future paper.



Research networks provide a rich setting to analyse structural embeddedness in networks. The effects of network embeddedness are recognized in the as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). The following research questions frame the overall research objective:

RQ1 How are research networks structurally embedded?

RQ2 How is structural embeddedness interconnected with social and economic characteristics?

RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

Organisation profile

This information is for administrative and comparative purposes and responses are confidential.

Organisation Name	_____
Industry	_____
Contact Name	_____
Position	_____
Email	_____
Phone number	_____
Number of years' experience with current organisation	_____
Educational qualifications	_____
<u>Please circle your answer</u>	
Are research networks an area of interest for you personally at present?	Yes No
Are you involved in research networks?	Yes No
If yes please name/describe them	

Please indicate if you are willing to participate in further research for this study	
Yes No	

RQ1: How is the AquaSmart research network structurally embedded?

- i. Can you describe your AquaSmart research network that you have been involved with?
 - *Composition of the research network*
 - *Openness of the network, weak/ strong ties, structural holes*
 - *Roles, behaviours, attitudes during the project*
- j. Can you describe the prior relationships you had with other actors in the network prior to the research and how these did/didn't influence behaviour?
- k. How do factors such as; trust, reputation, open data policies affect cooperation among nodes?

RQ2: How is structural embeddedness interconnected with social and economic characteristics?

- i. Can you describe the social characteristics of your research network?
 - *Compliance*
 - *Trust*
 - *Dominance*
 - *Cooperation*
- j. What was the primary output of that network?
 - Co-creation of new knowledge/infrastructure/competencies
 - Major milestones

RQ3: What enablers and barriers to structural embeddedness are encountered within EU research networks

- e. Can you describe the enablers of structural embeddedness within this research network
- f. Can you describe the barriers to structural embeddedness within this research network

Appendix G – AquaSmart Factsheet and Brochure

AQUACULTURE SMART DATA DRIVEN AND OPEN ANALYTICS

AQUACULTURE SMART DATA DRIVEN AND OPEN ANALYTICS

TSSG
www.tssg.org

I2S
www.aqua-manager.com

GRAMMOS
www.grammos-sa.gr

ANDROMEDA
www.andromedagroup.eu

QVALIDUS
www.q-validus.com

UNINOVA
www.cts.uninova.pt

IJS
www.ijs.si

ARDAG
www.ardag.co.il

The aquaSmart project is about enhancing innovation capacity within the aquaculture sector, by helping companies to **transform captured data** into knowledge and use this knowledge to **dramatically improve performance**. It also supports production benchmarking through access to global data.

The project is based in the **real world, addressing actual problems** that aquaculture producers face and is run by a skilled and experienced consortium including **top research institutes**, a major player in the **aquaculture IT sector** and three **highly innovative aquaculture companies**.

TOOLS
Provides the necessary tools to turn the large volumes of heterogeneous aquaculture data into knowledge.

ANALYSIS
Enables companies to access and analyse global open data.

KNOWLEDGE
Extracts the knowledge from current data and experiences of the sector.

SOLUTIONS
Quickly evaluate and identify the best management practices and rapid solutions for problems or issues that arise.

Funded by the Horizon 2020 Framework Programme of the European Union

For further information or to sign up to keep up to date with all the latest news please visit:
www.aquaSmartdata.eu

[fb.com/aquaSmartData](https://www.facebook.com/aquaSmartData) twitter.com/aquaSmartData [linkedin.com/group/home?gid=8254447](https://www.linkedin.com/group/home?gid=8254447)

www.aquaSmartdata.eu



The vision of AQUASMART is to enhance innovation capacity in the aquaculture sector by addressing the problem of global knowledge access and data exchanges between aquaculture companies and its related stakeholders. By offering aquaculture production companies the tools to access and share global open data along with strong data analytics in a multi-lingual, multi-sector and cross-border setting we aim to strengthen their competitiveness and growth potential.

At a glance

Project title: Aquaculture Smart and Open Data Analytics as a Service (A).
Project coordinator: Steven Davy (sdavy@tssg.org)
 Telecommunications Software and Systems Group (www.tssg.org).
Partners: TSSG (IE), J2S (GR), Uninove (PT), Grammos (GR), Ardag (IL), Andromeda (GR), Q-Valdus (IE, JSI (SI)).
Durations: February 2013 to January 2017 (24 months).
Total cost: €3.1M (€2.7M funded).
Programme: H2020-ICT-2014.1 - "Big Data and Open Data Innovation and take-up".
Further Information: www.aquasmartdata.eu
Social Media: Facebook: [fb.com/aquasmartdata](https://www.facebook.com/aquasmartdata)
 Twitter: twitter.com/aquasmartdata
 LinkedIn: [linkedin.com/company/aquasmartdata](https://www.linkedin.com/company/aquasmartdata)

AQUASMART – where Aquaculture meets Data Science...

Driven by the business needs of the European aquaculture sector, Aquaculture Smart and Open Data Analytics as a Service (A) is a Growth Strategy for marine and aquaculture sustainable growth. Strategy, Aquasmart aims to radically enhance the innovation capacity within the aquaculture sector by helping companies to transform the large volumes of heterogeneous captured data into knowledge through identification and analysis of this production data, and subsequently using this harvested knowledge to improve performance.

AQUASMART Objectives

- The goal of Aquasmart will be achieved through six key objectives:
1. To facilitate technology transfer in multi-lingual data collection and analytical solutions and services;
 2. To implement a multi-lingual Open Data framework that enables companies to seamlessly exchange data in order to make knowledgeable decisions;
 3. To promote best practices for aquaculture production management in core activities;
 4. To develop innovation and deliver state of the art services in the aquaculture sector by tackling the new opportunities to access global data integrated from heterogeneous sources;
 5. To develop a training programme and training Model for Open Data in Aquaculture.

Aquasmart Vision

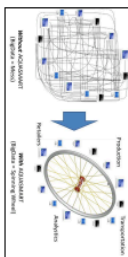


Figure 1: The Aquasmart Vision

Although production optimization is a key focus of the project, it is almost impossible for aquaculture companies to capture the relationships between all the factors and turn data into valuable actionable information. This cannot be done alone by using on-hand database management tools or traditional data processing applications. The use of data mining technologies will enable aquaculture companies to get actionable insights in the data resulting in smarter decisions and better business results. They will be able to look at past performances and understand those performances by mining the related data to look for the reasoning behind past successes or failures and make better decisions going forward. To achieve this it is necessary to build a framework for the integration of information from heterogeneous sources of information supported by reference ontology management system for big data analysis and mining.

Aquasmart aims

Aquasmart aims to provide the necessary tools to turn your large volumes of heterogeneous aquaculture data into valuable knowledge. By using Aquasmart you will be able to evaluate feed, feed suppliers, hatcheries, feeding policies, people and management practices and through this identify patterns and trends in your production, identify issues and take the appropriate corrective measures, which lead to improved production and therefore increased profits.

Aquasmart aims to allow you to analyse, and understand your local data and allow you to benchmark this against global data. Using the Aquasmart system you will be able to

continuously evaluate the performance of your production (see Fig 1) and in turn compare this against similar companies, while adhering to strict privacy rules to protect your specific data from being visible to external parties.

Aquasmart aims to provide the necessary training programme to improve your skills and competences in the aquaculture industry.

Our training programme offers, through adaptable multi-lingual training material, the opportunity to learn about the results of the project as well as specific aquaculture industry knowledge. This is all delivered through the medium of traditional, webinars or mobile.

Aquasmart aims to initiate new working groups within the CEJN standardisation body in order to draft a new CEJN standard for aquaculture data. Within Aquasmart, we are interested in understanding the use of Open Data in the aquaculture field and standardising the types of analytics that can be sought from big data platforms.

Aquasmart Impact

Aquasmart is an innovative, multi-lingual cloud based tool that uses state of the art technologies and global data access to help the aquaculture sector to 1) lower production costs, 2) improve profitability, 3) improve operational efficiency and 4) carry out their business in a sustainable, environmental friendly way.

Aquasmart enhances innovation capacity to the aquaculture sector by addressing the problem of global knowledge access and seamless data exchange for reuse between aquaculture companies and their stakeholders.

Aquasmart will enable aquaculture companies to perform data mining at the local level and get actionable results, and to further benchmark these results on the global scale through the availability of multi-lingual Open Data.

Further Details :

For further information please see:
<http://www.aquasmartdata.eu>
 Email: info@aquasmartdata.eu

Appendix H – Node Structure Report

24/08/2017 22:47

Node Structure

Aquasmart

24/08/2017 22:47

Hierarchical Name	Nickname	AggregateUser	Assigned
Node			
Nodes			
Nodes\\Collaboration		No	None
Nodes\\Collaboration\\Difficulties of collaboration		No	None
Nodes\\Collaboration\\Enablers of collaboration		No	None
Nodes\\Collaboration\\Reciprocity		No	None
Nodes\\Collaboration\\Responsibilities		No	None
Nodes\\Economic characteristics		No	None
Nodes\\Economic characteristics\\Co-creation of scientific knowledge		No	None
Nodes\\Economic characteristics\\Competencies and skills		No	None
Nodes\\Economic characteristics\\Joint publications		No	None
Nodes\\Economic characteristics\\Major milestones		No	None
Nodes\\Economic characteristics\\New Service offerings		No	None
Nodes\\Economic characteristics\\Research infrastructure		No	None
Nodes\\Network composition		No	None
Nodes\\Network composition\\Centrality		No	None
Nodes\\Network composition\\Competition		No	None
Nodes\\Network composition\\Depth of relationship		No	None
Nodes\\Network composition\\Formation		No	None
Nodes\\Network composition\\Frequency of communication		No	None
Nodes\\Network composition\\Openness of the network		No	None
Nodes\\Network composition\\Prior relationships		No	None
Nodes\\Social characteristics		No	None
Nodes\\Social characteristics\\Compliance		No	None
Nodes\\Social characteristics\\Cooperation		No	None
Nodes\\Social characteristics\\Dominance		No	None
Nodes\\Social characteristics\\friendships		No	None

Nodes\\Social characteristics\\Trust	No	None
Nodes\\Structural embeddedness in EU research networks	No	None
Nodes\\Structural embeddedness in EU research networks\\Barriers to	No	None
Nodes\\Structural embeddedness in EU research networks\\Enablers of	No	None
Nodes\\Structural embeddedness in EU research networks\\Formal network	No	None
Nodes\\Structural embeddedness in EU research networks\\Open data	Yes	None

Appendix E – Interviewee Request To Participate

De: Zeta Dooly [<mailto:zdooly@tssg.org>]
Enviado el: miércoles, 19 de julio de 2017 0:18
Para: [REDACTED]
Asunto: Re: Possible assistance required

Dear [REDACTED]

Firstly, thank you for agreeing to participate in this research. The interview is expected to take 1 hour and we shall use skype along with an audio recorder if this is OK with you? I think that the best approach to record the audio is if each participant can record themselves via their laptop built in audio recorder (e.g. quicktime or sound recorder) and then send these files to me for transcribing. The research aims to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union.

There is no preparation on your side, the concepts I have attached in the interview overview give some detail if you have time to take a look in advance that would be great. I look forward to linking up with you to schedule in a time that suits you? Maybe this Thurs or any morning next week?

Best wishes,

Zeta

Zeta Dooly

IPACSO Coordinator

Telecommunications Software & Systems Group (TSSG),
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Carriganore Campus, Carriganore,
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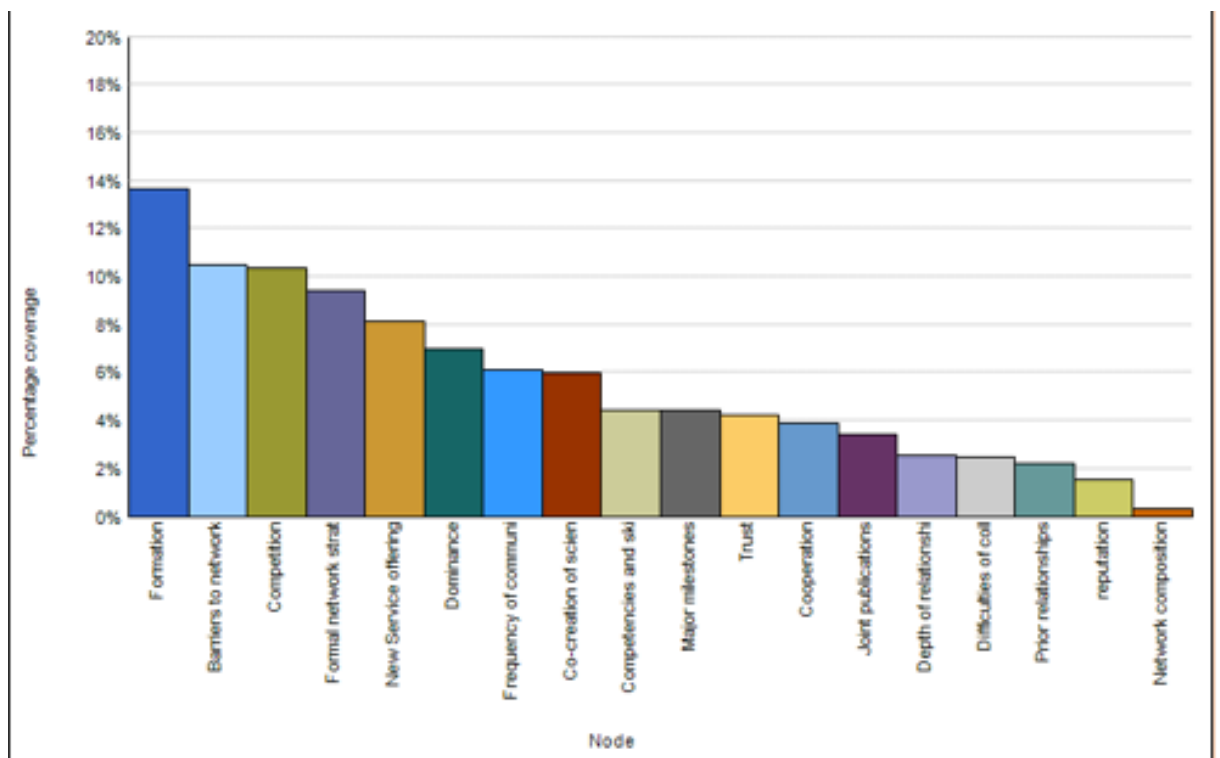
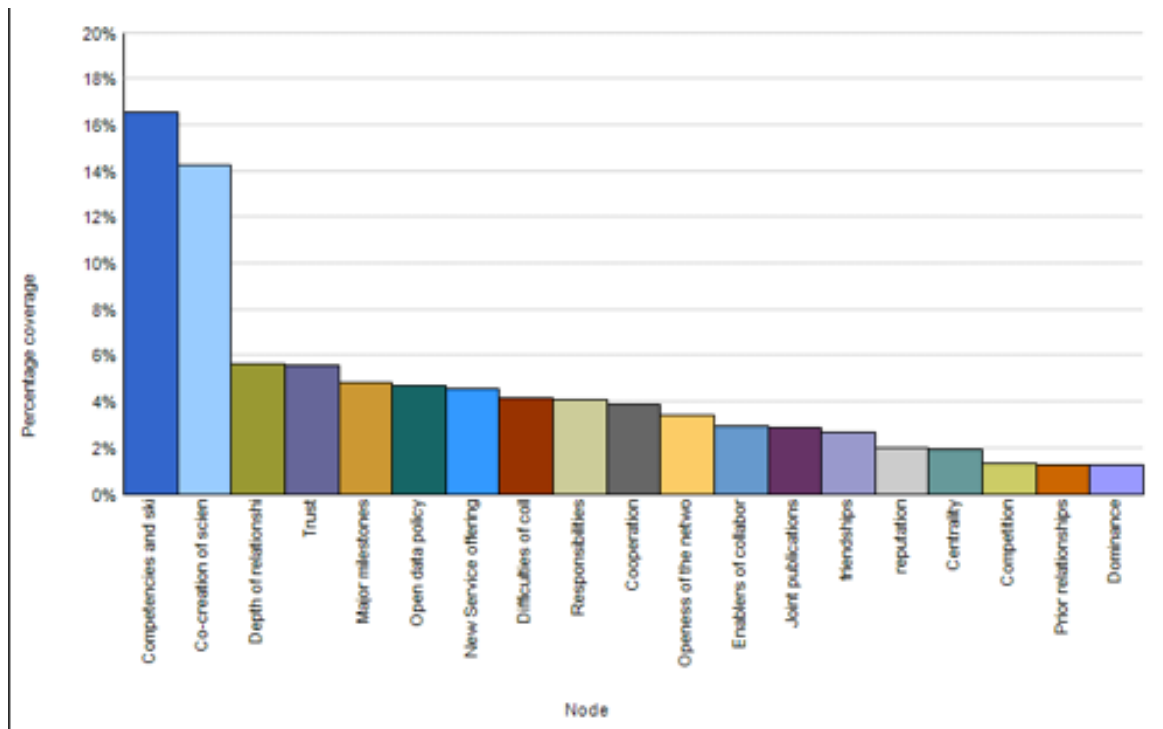
E-mail: zdooly@tssg.org

LinkedIn: [ie.linkedin.com/zdooly](https://ie.linkedin.com/in/zdooly)

Skype: zdooly

www.tssg.org

Appendix I – Sample Coding by Node Charts



Participant Name: Ms. Zeta Dooly 20064960

Supervisors: Prof. Aidan O'Driscoll/Dr. Aidan Duane

Date: 4th May 2018

Paper 4

RESEARCH FINDINGS

**An Investigation of Social and Economic Aspects of
Structural Embeddedness in an ICT Research
Network Based in the European Union**

Preface to Paper 4 – Research Findings

The development of Paper 4, Research Findings, was done between October 2017 and March 2018, when it was presented to the internal and external examination board at WIT, and recommended without changes. The examination panel included; Prof. Joseph Coughlan, Maynooth University and Dr. Collette Kirwan, WIT. The option was available within the structure of the DBA programme to submit the findings and discussion within Paper 4. However, given the depth of the study, and the limitations on narrative text, the findings are presented here in Paper 4 and the discussion is presented in Section 3. Paper 4 includes a full analysis of the case study, this gave a holistic view of the network. Furthermore, it provided deep contextual insights in relation to the type of network member, their level of experience, area of expertise and other relevant profile information. The sampling strategy was presented along with the selection criteria. The study adopted a purposeful sampling method, the most common technique for qualitative research (Marshall and Rossman, 2014). My own role in TSSG, WIT was clarified following a request from the examiners. TSSG is an ICT research department, linked with the Maths and Computing department within WIT. I am a researcher in TSSG, WIT, but I had no previous knowledge of the AquaSmart network prior to this study, and could only consider the TSSG/WIT members as part of my own personal network. Therefore, researcher bias is minimal.

The main data collection instrument was the qualitative interview, common across philosophies and methodologies (Myers and Newman, 2007; Qu and Dumay, 2011; Herz *et al.*, 2014). These interviews were interactive, with some participants recommending that I interview other specific network members and suggesting accompanying documentation to support the collected data in line with the literature (Remenyi *et al.*, 2002). I used the conceptual model, literature review material from previous papers and the research questions to create two versions of the interview guide. One of these was used to share with the interview participant and another more detailed version to refer to whilst administering the data instrument. The available literature on developing the interview guide for qualitative research was particularly helpful at this time (Qu and Dumay, 2011; Myers and Newman, 2007; Kvale and Brinkmann, 2008). This interview guide was useful if clarification was sought during the interview to ensure that the

answers to questions were consistent across the network. For this study, unstructured interviews were deemed unsuitable as these tend to be very open-ended and informal. The adopted semi-structured interview format provided an open forum for discussion within a frame of professional context aligned to the research themes. Ideas and discussions were followed through allowing the respondent to lead the discussion within the thematic landscape. The structured interview format was also deemed inappropriate as it did not match the objective of the study. Structured interviews are mostly used for statistical surveys and limit the in-built flexibility to develop lines of enquiry and explore emergent themes pertinent to the objectives of this study.

Following on, Paper 4 details the implementation of the data analysis phase. Unlike Paper 3, it documented the full research process for this phase and gave a comprehensive account of the adopted approach. The initial research design adopted an iterative approach for data analysis and was guided by Tracy (2013) and Miles and Huberman (1994). However, prior to implementation, the model developed by Braun and Clarke (2006) was employed as a more comprehensive guide.

To identify convergence of themes and patterns across interviews, the data and literature was iteratively examined with initial codes or themes. This was developed based on a pattern between the data and the conceptual framework, in line with literature and a priori themes (Hite, 2005; McGrath and O'Toole, 2014; Miles and Huberman, 1994; Yin, 2003). Coding in this manner facilitated insight, and comparison, through segmenting the data into groups. This technique gave me the flexibility to expand the codes and hierarchies in NVivo, and enable interpretations to be made and findings to be finalised. The application of this technique in conjunction with the extensive use of the memoing function in NVivo facilitated the interpretation of findings. I kept a process memo to track the steps taken during analysis and this was guided by the Braun and Clarke (2006)'s data analysis model. There were many iterations of searching, reviewing and eventually finalising the themes. The tools used during this process was NVivo for reports and visuals on the collected data, MS Excel for comparison of themes and sub-themes across cycles, and manual visuals to decipher the weighting, crossovers, and clarity of the defined themes. Paper 3 provided the initial findings for the research, and was a critical milestone to enable me to reflect upon the research objectives and research questions, in line with the literature, the methodology and the first data collection cycle.

During the development of Paper 4, I used the excerpts from my reflective diary to make sense of the findings and to interpret the meaning. One such entry describes the decision to adopt Braun and Clarke 2009 whilst still considering the usefulness of Miles and Huberman (1994) and Tracy (2013). Another notable entry was gaining feedback from my supervisors about my immersion in the data, and the need for better familiarity with the data and its meaning, to heuristically discover new knowledge in this domain. The external examiners did highlight that there was an emphasis on the output from the NVivo tool and given that the study is qualitative not quantitative that statistical evidence is not expected. However, the structured qualitative approach is recognised as a reliable, valid approach. Rather than a reliance on the tool, I believe that it accentuates the study, to use both manual and software driven approaches, and present the findings in different ways to aid its interpretation.

The work from Paper 3 fed directly into the development of Paper 4, where the initial findings were accumulated with the remaining data collected. At this stage, I had also improved my analysis skills and competencies to see the data from different perspectives, and eliminate the material that wasn't relevant to the research questions. This facilitated the convergence of data and meaning into clusters and eventually into the presented thematic areas. Three thematic areas were presented in addition to a section on recommendations to the European Commission, who are the funding agency. These represented the findings associated with volumes of transcribed data, online information and material from the AquaSmart repository. Paper 4 details the path of adding, merging, deleting the themes from the findings and their associated data. The use of tables facilitated a depth of analysis whereby data such as documentary analysis could be weighted into levels of importance, accessibility and include reflective comments. Additionally, the usefulness of the documentation analysis was divided into categories, for example, where it informed the interview questions, augmented the interview data, corroborated the interview data or provided valuable background. This meant that I could effectively link the findings from the interviews with the documentation and online information.

The first rounds of generating the codes used a flat, non-hierarchical approach, followed by clustering and descriptions for the categories of coding with parent and child nodes

added and adjusted as deemed necessary. Each transcript was coded in great detail with the resultant data able to identify the theme, the source of the finding and how many times it was referenced. This enabled further rounds of analysis to develop an appropriate hierarchy which was testable to ensure accuracy and consistency across my adopted process. The rough data from these iterations was shared with my supervisors and some were included in the appendices of Paper 3 and Paper 4 to provide additional justification for their inclusion. The study included reviews to try to manage consistency across theme and related data. At this stage, the conceptual map and node hierarchy were amended in line with the findings.

The final phases of data analysis included retracing my steps back to Paper 1, the conceptual framework and associated literature to re-familiarise myself with the theory having been immersed in the case study itself. Prior to producing Paper 4, I re-read the organisational profile sheets completed by each interview participant and checked field notes, the raw interview transcripts and summative NVivo data reports. Additionally, I revised the qualitative data analysis training working material (video notes, assignment) to capture best practice. This part of the process was tedious and slow however, it contributed to an accurate refinement of the conceptual framework and enhancement of the project items (memo's, transcripts, documents, blogs, reflective thoughts). Following on, I created a final checklist and used Padlet to capture my research journey visually. Padlet is an online virtual "bulletin" board, where students and teachers can collaborate, reflect, share links and pictures, in a secure location. This Padlet board (Paper 4, Appendix 5) included feedback from conference submissions and presentations, and other relevant research events, in addition to feedback from internal/external examiners, and the WIT Ethics Committee. A reflection upon all the paper series submissions was conducted and the evolution of themes and direction of the study was captured for inclusion in the final thesis. I also contacted the interview participants to give them an update on the research and thank them for their contributions.

Paper 4 presents the main findings by theme, utilising the full data set, linked to the conceptual model, research objective, and research questions. The structural embeddedness of the network highlights four main sub-themes, formation and incubation, competition and configuration. The findings indicate that it is the configuration of the network; strength of the ties, links between individuals and connectedness that aids the

longevity of the network. There are further concepts that were identified that are related to this such as network hopping in the aftermath of AquaSmart to access investment funds. Generally, it was evident that there was no pattern or formality within the AquaSmart network in relation to network policy. The findings concluded that diversity within research networks between academia and industry is a major challenge, and that convergence of research priorities is difficult but can yield successful outcomes. This diversity is positive and contributes to innovation and economic impact but poses challenges at the operational layer and is often inevitable where research is linking multi-disciplines. The development of disruptive technologies is an exemplar domain for the inclusion of weak ties and structural holes in its network. Paper 4 and the discussion in Section 3 provides further details on this.

This findings in relation to economic aspects explores the input and output of the network in economic terms, costs and benefits. The interviews focussed on the co-creation of scientific knowledge, joint publications, competencies, skills and new service offerings. As the findings illustrate, economic aspects and its sub-themes are the least frequently described theme in the participant's interviews, (10) sources. This shows us how the different organisation types responded to the economic sub-themes and it is evident that the smaller and micro organisations highlighted their competencies and skills as major area of focus. The medium organisations were predominately concerned with new service offerings and the small organisations highlighted the co-creation of scientific knowledge as important.

The literature identifies social aspects as important in structural embeddedness in networks; the empirical results support this view. The findings identified cooperation, reciprocity, exchange, friendships, depth of relationships and trust as the key considerations. The findings illustrate social aspects and its sub-themes are a frequently described theme in the participant's interviews. This shows us how the different organisation types responded to the social sub-themes and it is evident that all organisation types highlighted cooperation, reciprocity and exchange as the major area of focus. Trust was highlighted more acutely by the micro and small organisations.

Several recommendations were suggested for the funding agency in relation to network member inequality, measuring impact, usability and reputation. The initial themes

presented in Paper 3 had not been linked with extant literature and thus the linked narrative was less thorough.

Upon further analysis, two of the sub-themes; network policy and communication were deemed less important to the study in relation to the research questions. Network policy formulation is only relevant for network members that are long-term researchers. Practical guidelines for implementation might be envisaged but the concept itself is not under investigation for this study. In Paper 3, communication was identified as a relevant theme. However, it was clear within the full set of findings, that the positive reports of effective communication in the AquaSmart network was common throughout, and that there was no benefit to explore it further. My reflective diary includes some reference to this and the different nuances of communication in relation to the process of communication and the actual communication itself. The effects of network configuration on understanding jargon is further detailed in Paper 4 and possible remedies identified in the recommendations section. The full set of findings were presented in Paper 4 and linked to the research questions. Subsequently, these were used as input to the discussion in Section 3.

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Abstract

The objective of this research is to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. The collaborative European funded research and development landscape has changed in recent years. Funding competitiveness and compulsory public private partnership (PPP) has significantly altered the dynamics of research networks, how they operate, collaborate, and acquire new knowledge and products. The emergence of the academic entrepreneur has also changed the focus of educational institutions to that of quasi-businesses (Etzkowitz, 2003; Perkmann *et al.*, 2013; Bolzani *et al.*, 2014). Research networks provide a rich setting to analyse structural embeddedness. Structural embeddedness refers to the nature of relationships, links and nodes within a network, specifically their structure, configuration and quality. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). Central to this research are the theories of Granovetter (1973), Burt (2009), Coleman (1988) and Bourdieu (2011), who present dyadic arguments for structural and relational embeddedness. Thus, there is an opportunity to investigate the core research network within a research project to further our understanding of the social and economic aspects of structural embeddedness. An initial paper presented in this series presented a conceptualisation of structural network embeddedness. A methodological design paper and an initial findings paper followed. This final paper in the series details the full research findings through the phases of description, analysis and synthesis offering insights for this context.

The findings are divided into three major themes; Structural Embeddedness Composition, Economic Aspects and Social Aspects. The findings identify a positive role for weak ties and structural holes in the AquaSmart network. It is evident that diversity of the industry focus initially created tensions in the AquaSmart network but also contributed significantly to the network output. The results show that the depth of interpersonal relationships and cultivation of friendships had a positive impact on research output and network satisfaction. Competition in the network configuration had a negative impact on research output. Industry jargon and trust during network incubation illustrated a lag in

network cohesion and increased network tensions. Openness and trust were explicitly boosted at events where network individuals had an opportunity for informal dinners, breaks and exercise. The challenges encountered in the network were impacted by the quality and configuration of inter-relationships. The effect of network formation and prior relationships was significant. Trust within the network emerged as both an enabler and a barrier.

1.0 Introduction

This paper is the fourth and final paper in a cumulative research paper series, the objective of which is to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. Paper 1 identified the research rationale, conceptualisation and relevant literature in this domain. Paper 2 focussed on the research methodology, adopted research process, data collection and data analysis toward implementation of the adopted research design. Paper 3 presented the final research design and initial findings from the preliminary research results. The aim of Paper 4 is to present the findings from the data collection and analysis phases within the context of the research study. The paper presents the results from the research implementation phase; it outlines the research journey, detailing the case profile, data collection and analysis phases and the adopted cyclical approach to research. Following on it provides a description of the main themes; it discusses the links between evidence from the different data sources and presents the findings from the data analysis phase.

The rationale for the research objective and research questions emerged from the literature and the author's own professional experience of managing EU funded research projects. The author contends that unravelling the complexity of EU research networks will positively impact the economic and social output of research networks. The research is executed within this EU funded ICT research environment and aims to explore structural embeddedness using a social and economic lens of investigation. Specifically the research questions explore how these networks are structurally embedded, what social and economic characteristics are dominant, and the enablers and barriers to structural embeddedness.

The contextual setting for the study as described in Section 2.3, is a European funded research network, specifically, the AquaSmart network, a project funded by the European Commission Horizon 2020 research programme that converges aquaculture and technology. The researcher is an employee of the project coordinator organisation, TSSG (a research department within Waterford Institute of Technology) and has twelve years experience in this environment leading and working within EU funded research networks. However, the research is cognisant of researcher bias. The researcher has identified a variety of types of bias and has put measures in place to minimize the risk. However, the potential for bias is minimal given that the researcher was not active in, or knowledgeable of, the AquaSmart network, and had no previous relationships with other AquaSmart network nodes prior to the collection of research data.

The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000). Structural embeddedness is central to this study; the conceptual model highlights the social and economic aspects of structural embeddedness within EU research networks. The results from this in-depth qualitative research contributes directly to theory by providing rich insights in structural embeddedness which is primarily quantitative rather than qualitative (Herz *et al.*, 2014). This context, aquaculture, provides novel contextual insights. Furthermore, the contribution to practice aids the development of a robust research network strategy, cognisant of social and economic aspects. In addition, the research management function gains insights to enablers and barriers of structural embeddedness, which supports their operations. From a policy perspective, funding agencies can further their understanding of structural embeddedness in research networks.

Our economies are now more than ever dependent upon the digital world that connects us all, in terms of the rapidly growing digital services and commerce industry. Therefore, the scope of the study focuses on high tech companies, a particularly pertinent sector in research networks. A single case study approach is presented to investigate this phenomenon in its natural context, as it allows for the subjective and contextual experiences of the participants supported by in-depth interviewing and documentation analysis. The research data is collected through semi-structured interviews and documentary analysis. The presented findings build upon the initial findings presented in

Paper 3, and will later contribute to the discussion, conclusion and recommendations chapters in the final DBA thesis.

The findings from the research highlight insights in relation to the configuration of structural embeddedness within networks, the role of prior relationships, competition, collaboration, trust and the value related to network output among other themes.

The structure of the remainder of this paper begins with an overview of the research implementation. This includes an outline of the case context, research design, data collection and data analysis. Following on, the paper focuses on the research findings, which are presented using an array of presentation mechanisms and supportive text.

2.0 Research Implementation

This section details the core processing mechanisms of the research; it provides an overview of the research implementation, the adopted and adapted approach through a number of iterative cycles. Given the exploratory nature of the research it was not prescriptive in nature but was guided by relevant frameworks and practices to ensure a consistent approach throughout the research lifecycle. The following sub-sections provide detail in relation to the case study, data collection phases and data analysis phases to support the emergence of the research findings.

2.1 Research Design

The adopted research paradigm is an interpretivist approach, which fits succinctly with the research context and the research purpose, and is reflective of prior studies reported in the literature including Morgan and Smircich (1980); Berger and Luckmann (1991); Myers and Newman (2007); Myers (1997); Klein and Myers (1999). The research design follows an inductive research process, and an iterative approach between the analysis and a recursive link back to the relevant theories and concepts. A qualitative methodology (detailed in Paper 2 of this paper series) was adopted for this research to attain the research objectives. The contextual setting for the study is a European funded research network, specifically, the AquaSmart network, a project funded by the European Commission Horizon 2020 research programme that converges aquaculture and technology. This case organisation meets the characteristics of the context taken as a single case study, as shown

in Table 1, and is considered appropriate based on a common case rationale and the ability of such an approach to illuminate the circumstances and conditions of an everyday situation (Yin, 2013). Such illumination is essential to understand the underlying social processes associated with the theoretical concepts of structural embeddedness in EU networks. A number of possible case study sites were identified and were informally ranked in relation to location, number of partners, researcher bias level and access to network nodes. AquaSmart proved to be the most suitable site and was thus adopted as the research network.

2.2 Sampling Strategy

A purposive sampling strategy of 10-targeted researchers was chosen. This non-probability sampling technique leverages the experience and judgement of the researcher. The AquaSmart network includes participants from industry and academic organisations active in ICT research. Before selecting the case study a number of criteria were identified to increase the feasibility of research implementation.

Criteria for Selection of a Single Case for this Study
The network Coordinator has agreed to participate fully in this study
The network Coordinator supports publication of the findings from the study
The Coordinator of the network is located in Ireland to minimise the research costs
The network Coordinator considers structural embeddedness in networks as important
The network Coordinator has granted the researcher access to project documentation, communication material and research artefacts, and any other documentation deemed necessary for the study (e.g. code of ethics, project handbook and reports).
The network Coordinator has provided the researcher with access to the network nodes for the purpose of interviewing and has made the appropriate introductions

Table 1: Criteria for Organisational Participation in the Study

The unit of analysis is the individual in the network (network node). Figure 1 illustrates the organisation of the AquaSmart network and the roles therein, previously detailed in Paper 3. In accordance with best practice the researcher investigated all network nodes within the network. This helped to gain insights from each member of the network rather than dilute the investigation to a portion of the network, and is considered a crucial research design choice. Furthermore, the researcher analysed archival data, which is common in this domain as evidenced by studies by Greer and Lei (2012); Geisler (2003); Kirschner *et al.* (2004); Perkmann and Schildt (2015).

2.3 Case Profile - AquaSmart

High-tech organisations provide a rich context for the study, given their heavy reliance on network ties that stem from, and are embedded within, social relationships (Larson and Starr, 1993). As previously described in Paper 2, the contextual setting for this study is a network (project) called AquaSmart²² (Aquaculture Smart and Open Data Analytics as a Service), a high-tech²³ information communication technology (ICT) network funded by the EU Horizon 2020 research programme. Figure 1 outlines the roles within the AquaSmart network and the associated partners.

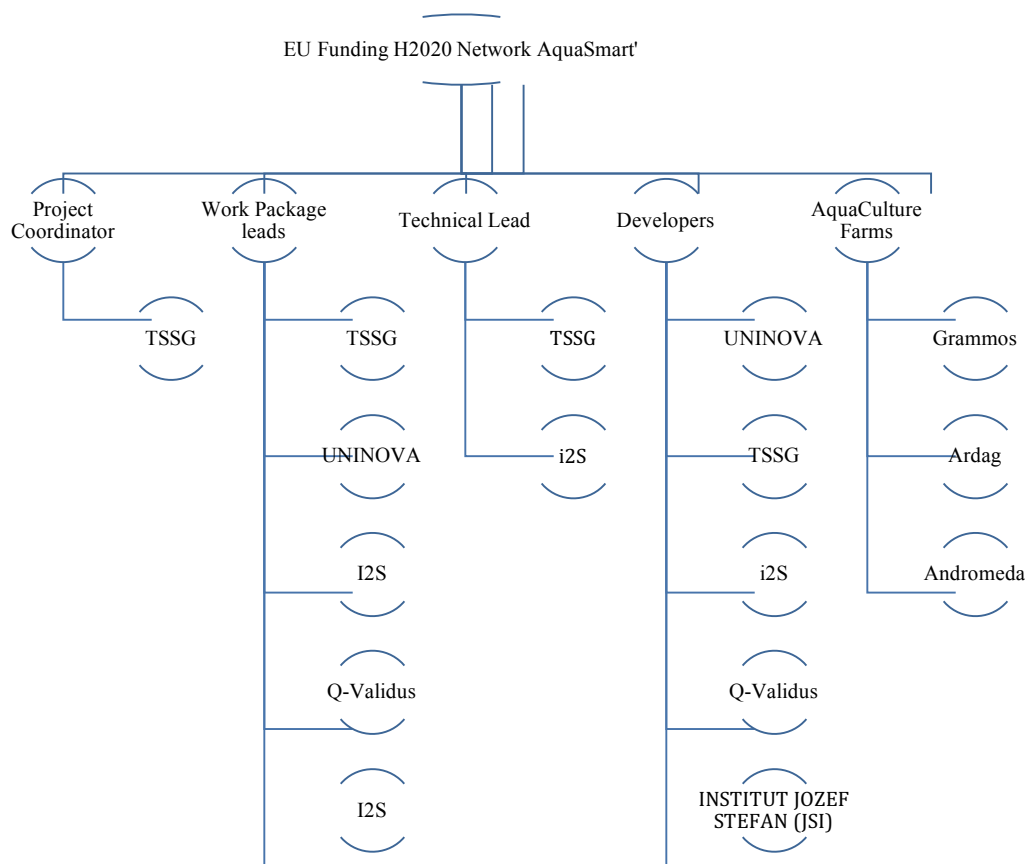


Figure 1: AquaSmart Network

²² <http://www.AquaSmartdata.eu>

²³ <https://www.een-ireland.ie/eai/assets/documents/uploaded/general/ICT%20Fact%20sheet.pdf>



AQUASMART consortium profiles.pdf

Figure 2: Documentation example

AquaSmart is using ICT to improve its data utilization and operations. In Europe, the Aquaculture industry accounts for about 20 per cent of fish production and directly employs some 80,000 people. Aquaculture is identified as a key focal point of the EU's Blue Growth Strategy²⁴. It is the fastest growing animal food-producing sector in the world. Global forecast on production is set to increase from 45 million tons in 2014 to 85 million by 2030. The European Commission has pointed and flagged for prompt action to stimulate large number of aquaculture businesses with ICT innovations.

AquaSmart was established to enable fish farmers to use open data technological solutions built for the industrial sector to enhance their operations. The network engaged state of the art technology in multi-lingual open data to the aquaculture stakeholders in order to advance the aquaculture industry's use of data analytical technology. The AquaSmart project is about enhancing innovation capacity within the aquaculture sector, by helping companies to transform captured data into knowledge, and sharing this knowledge to improve efficiency, increase profitability and carry out business in a

²⁴ http://ec.europa.eu/maritimeaffairs/policy/blue_growth

sustainable, environmentally friendly way. To understand structural embeddedness, it is important to engage with these network nodes at a depth that allows their perceptions to be exposed. When selecting such a case environment, full and complete network access is vital (Kelliher, 2011). This study of the AquaSmart network took place over a twenty-four-month period. The AquaSmart consortium comprises of 7 partners from 5 member states and 1 partner from an associated country as detailed in Table 2. Proximity to partners, language and culture were discussed in the results as both challenging and rewarding. The consortium profiles are fully described in Paper 3.









	Waterford Institute Of Technology (Tssg) Coordinator	Ireland
	Integrated Information Systems (I2s) (<i>Olokliromena Pliroforiaka Sistimata</i>)	Greece
	Uninova - Instituto De Desenvolvimento De Novas Tecnologias (Uninova)	Portugal
	Grammos S.A. (Grammos)	Greece
	Ardag Cooperative Agricultural Society Ltd (Ardag)	Israel
	Njordseas Sl (Andromeda)	Spain
	Q-Validus Limited (Q-Validus)	Ireland
	Institut Jozef Stefan (Jsi) Ljubljana, Slovenija	Slovenia

Table 2: AquaSmart Network Nodes, Logos and Location

The case study included eight organisation partners in the AquaSmart network. There were ten participants interviewed and 70% of participants had greater than ten years' experience in their domain. The network consisted of 1 micro organisation, 3 small organisations, 2 medium organisations and 2 large organisations. The network included 3 academic partners, 3 end-user partners and 2 ICT partners. 90% of the participants were

male. These findings in relation to the case study context informed the data analysis phase to gauge the interrelationships within the network and the external context within which each partner resides. In order to fully understand the context of the findings, it is essential to reflect upon the case study itself and the individuals within this case study.

During the data collection phase, the participants provided profile information, which gave a descriptive background for the case study and the individuals (network nodes). There were a number of different roles identified within the case study (Figure 1) and the collected data provides some descriptive data in relation to these roles and related attributes identified in Table 3. The source of this data is detailed in Paper 3 as the individual participants completed an organisation profile questionnaire; this was requested during the interviews and followed-up by email communications. The majority (70%) of participants were ICT focussed with 30% from industry. The participant gender was predominately male 90%, and the organisation sizes varied: 1 micro organisation, 3 small organisations, 2 medium organisations, and 2 large organisations. The participants were highly experienced with 70% having more than 10 years-experience in their field. The funding of the participants was divided evenly with 50% privately funded and 50% publicly funded. Table 3 details all the case categories, which includes gender and years' experience.

Stakeholder Type	Industry Focus	Gender	Organisation Size	Role	Years Experience	Funding	Location
Industry	Non-ICT	Male	Medium	Aquaculture Expert	Unassigned	Private	Spain
Academic	ICT	Male	Small	Software Engineer	> 10 years	Public	Portugal
Industry	ICT	Male	Micro	Project Manager	> 10 years	Public	Ireland
Academic	ICT	Male	Small	Project Manager	> 10 years	Public	Ireland
Academic	ICT	Male	Large	Software Engineer	> 10 years	Public	Ireland
Industry	ICT	Male	Small	Software Engineer	> 10 years	Private	Greece
Academic	ICT	Male	Large	Software Engineer	< 10 years	Public	Slovenia

Stakeholder Type	Industry Focus	Gender	Organisation Size	Role	Years Experience	Funding	Location
Industry	Non-ICT	Male	Medium	Aquaculture Expert	< 10 years	Private	Israel
Industry	ICT	Male	Micro	Project Manager	> 10 years	Private	Ireland
Industry	Non-ICT	Female	Small	Aquaculture Expert	< 10 years	Private	Greece

Table 3: Individual and Organisation Attributes for Case Study

The collated tables provide a mechanism for analysis in relation to whether the participant is funded by public or private funds, whether it is industry or academic focussed, the organisation size and location, and whether the industry focus is ICT or non-ICT. The findings from this analysis show that the network could be categorised into two main categories: the end-users who are privately funded and are non-ICT focussed; and, the academics who are publically funded and ICT focussed. This illustrates the demographics of the network at a glance. Many of the participants were cognisant of the divide between academics and industry, and evidence has emerged in relation to the challenges and opportunities a network of this variance provides. Only 30% of the participants had less than 10 years-experience, the gender balance was low with 10% female participants, which is reflective within ICT research. A good mix of industry focus, organisation size, funding and location offers excellent diversity for analysis.

2.4 Data Collection

The data collection phase was seven months in duration between July 2017 and January 2018. This included formal requests for participation, scheduling, preparation of the participant guide, conducting the semi-structured interviews, documentation analysis and reflective writing. The merits of adopting a single case study as opposed to multiple case studies are the in-depth, rich contextual insights that this approach is associated with. As part of the data collection phase, participants from every level of the entire network were interviewed which ensured a more comprehensive perspective was achieved.

Table 3 details the different data collection instruments and associated literature. The reflective diary was an integral part of the researcher journey which was updated throughout the phases of the research design and implementation, and was instrumental

in gathering thoughts, ideas and cross-analysis of data. A sample of reflections is below and all relevant excerpts will be included as an annex in the final thesis.

“An article on LinkedIn in fostering teamwork triggered my thoughts on my work in networks as we configure and self-manage networks all the time. Fostering trust within global teams is a big part of tech MNCs and startups in virtual offices. I think that the configuration of the network is relevant, we configure a network each time we assign a piece of collaborative work. choice, leadership, dominance all come to play here. Self-choosing teams, partners, task collaboration avoidance, cherry-picking, all these configuration mechanisms were discussed in the interviews by some and others are less cognisant”.

“In one of the meetings with my supervisor we discussed Maughan (2013) and the concept of a black hole between entrepreneurs and academia in research. It was evident in the data analysis phase of research when I immersed myself in the data that creating a societal impact can be more tangible where technology is a facilitator of life. Industry has social and economic implications and thus when applied in an instrument such as an IA it needs to validate and test before release to market. This was evident in the interview with Participant F from Grammos and other interviewees when the AquaSmart network had issues with jargon and had to talk fishy language and eventually after nearly 1 year they found common ground. The immersion into the fish farm (actual onsite visit) at a plenary was a fantastic facilitator. Equally students need immersion in industry to understand where they might work or how they might contribute to society or economy. This is a high level finding and worth discussion”.

Data Collection Instrument	Source	Date Completed
Semi-Structured Interviews	Myers and Newman (2007); (Qu and Dumay, 2011); Patton (1999); Saldaña (2015)	October 2017
Documentation Analysis	Krippendorff (2004); (Bell and Bryman, 2007); Herz <i>et al.</i> (2014); Borgatti <i>et al.</i> (2009); Seidel (1998)	January 2018
Reflective Writing	Scanlan <i>et al.</i> (2002); Moon (2006); Schön (1983); Bolton (2010); Golding and Currie (2000); Boud <i>et al.</i> (2013); Ghaye (2010) Dumay (2009); Baxter and Chua (2003)	April 2018

Table 4: Data Collection Instruments

The researcher was determined to overcome the disadvantages of interviews as highlighted by Sekaran and Bougie (1992) which included: the cost and feasibility of conducting interviews; respondents security in relation to the anonymity of their

responses; and constraints imposed by adhering to an agenda. Thus, within the interview phase the interviewer did adopt flexibility and adapt questions as necessary in relation to minor ambiguities of language and the addition of relevant probes. The interviews were conducted by Skype and in person (see Table 5 for more details), and were recorded with the permission of the participant with Quicktime, transcribed by the researcher, and stored in the NVivo project repository. The interviews were semi-structured with intermittent reference to the interview guide, so that all targeted themes were addressed relevant to the research questions and overall objective. The researcher kept the costs to a minimum with the use of technology but did encounter some challenges in relation to availability of participants during the summer months, which did not impact the research quality but was inconvenient for scheduling purposes.

This research supplemented in-depth interviewing with an analysis of supporting documentation. The documentation analysis was an unobtrusive method, useful in gaining understanding of the context. Documentation can support the verbal accounts of informants (Remenyi *et al.*, 2002) as well as supplement and verify data from other sources (Yin, 1994). This study made full use of the documentation available from this research network including news blogs, project deliverables and workshop reports.

2.5 Implementation of Data Analysis Process

The initial research design adopted an iterative approach for data analysis and was guided by Tracy (2013) and Miles and Huberman (1994). However, upon implementation, the model developed by Braun and Clarke (2006) was employed as a more comprehensive guide. To identify convergence of themes and patterns across interviews, the data and literature was iteratively examined with initial codes or themes developed based on a pattern between the data and the conceptual framework in line with literature and a priori themes (Hite, 2005; McGrath and O'Toole, 2014; Miles and Huberman, 1994; Yin, 2003). Coding in this manner facilitated insight and comparison through segmenting the data into units. This technique gave the researcher the flexibility to expand the codes and hierarchies in NVivo to enable interpretations to be made and findings to be finalised. The application of this technique in conjunction with the extensive use of the memoing function in NVivo facilitated the interpretation of findings. The researcher kept a process

memo to track the steps taken during analysis and this was guided by the data analysis model outlined in Figure 3.

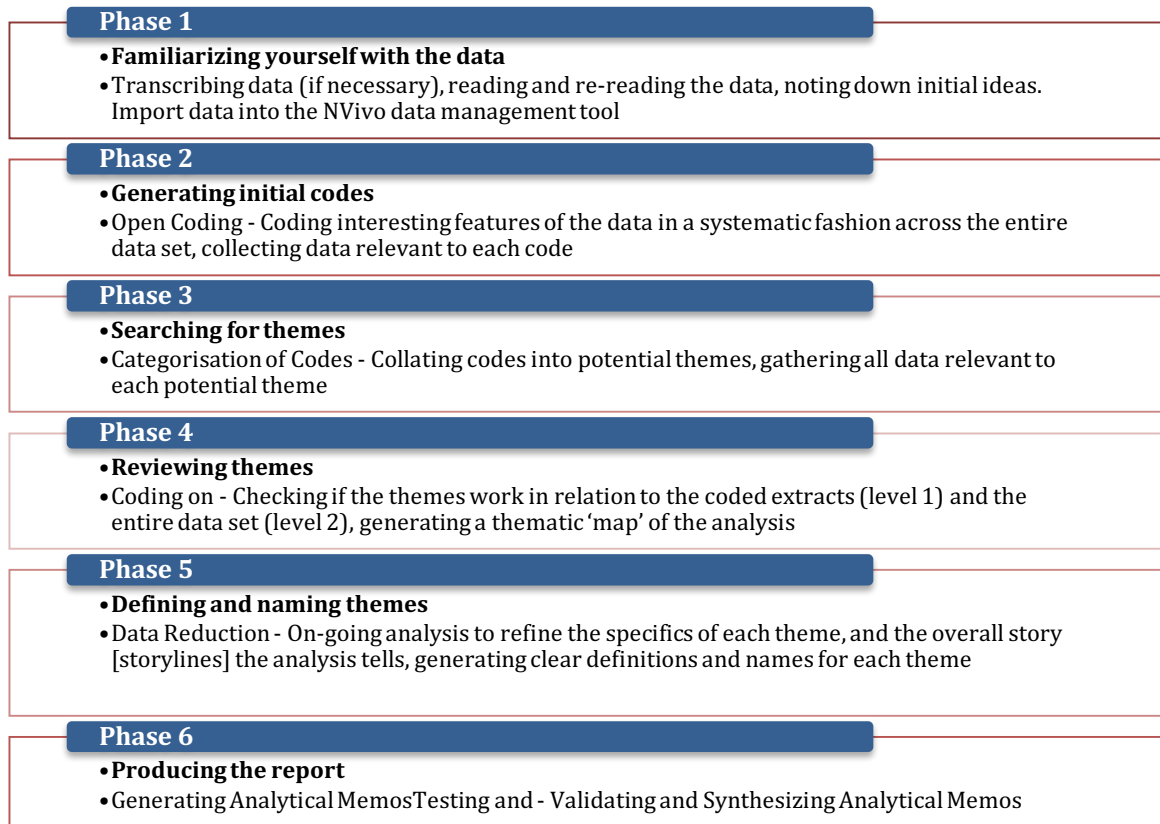


Figure 3: Braun and Clarke (2006)

2.5.1 Phase 1 – Familiarisation with the Data

Phase 1 involved familiarisation with the data; this included multiple sources of data, and many rounds of data familiarisation, reading, sorting, summarising and making notes and memos in relation to the data. The primary data collection was during the semi-structured interviews. The participant register (Table 5) provides details of the interviews including the format and timing.

Code	Participant Title	Organisation	Interview Completed	Interview Format	Interview Duration	Associated Documentation
A	Project Coordinator	TSSG/WIT	30/08/2017	In Person	1.04	Project Brochure Project Plan
B	CEO i2S - Business Development Manager	i2S	21/08/2017	Skype	0.50.34	Website Blog Articles
C	Researcher at UNINOVA	UNINOVA	27/07/2017	Skype	0.50.21	Website Blog Articles
D	Technical Manager	Andromeda	17/08/2017	Skype	0.54.56	
E	Marketing and Business Development Manager	Grammos	03/08/2017	Skype	1.02.2	
F	Fish Farm Manager	Ardag	02/10/2017	Skype	0.53.11	
G	Managing Director	Q-Validus	11/10/2017	Phone	0.55.5	CEN Standards Workshop Report
H	Software Engineer and Computer Consultant	Institute "Jozef Stefan"	19/10/2017	Skype	0.59	
I	Innovation and Business Development Manager	Q-Validus	13/10/2017	In Person	1.18	Dissemination Materials D5.6, D5.7, D5.8 Web Blog Articles, Website
J	Technical lead	TSSG/WIT	29/09/2017	In Person	1.26	Industrial and Business Report

Table 5: Participant Register

The interview transcripts (A-E) collected and detailed in Paper 3 were imported into NVivo, a preliminary analysis (basic visuals) performed, followed by the remaining interview transcripts (F-J) and the 37 news blogs and documentation as identified in Table 6.

Document/Artefact Title	Relative importance to research	Level of accessibility	Comments/reflection
Factsheet	Low	Public	Background information
Website	Medium	Public	Background information and event descriptions
Grant Agreement	Medium	Confidential	Detail on project implementation
Project brochure	Low	Public	Background information
Initial Dissemination plan	Medium	Confidential	Identified dissemination, position and exploitation strategy. Includes context and links between network nodes and external expert panel and the vision of the individuals.
Project Plan	Medium	Confidential	Background information and implementation processes.
Industrial and Business Showcase	High	Confidential	Positioning of the AquaSmart solution toward market uptake.
Dissemination Materials	High	Confidential	Detail on dissemination, events, publications, and social media. Identified links and relationships in network.
Dissemination Plan	High	Confidential	Presented the dissemination results, standardisation and network vision.
Big data CEN Standards workshop report	High	Public	Provided depth of impact and relational instances.
Final Dissemination Plan	High	Confidential	Reported on results of dissemination and identified main actors of dissemination.

Table 6: Documentation Register

Following on, it was appropriate to review the conceptual model and previous papers that detailed the literature. At this stage the relevant publications were added to the NVivo project repository to aid the data analysis phase and querying facility. Table 7 below identifies the documentation that was analysed and its usefulness to the research implementation.

Document Type	Source	Inform Interview Questions	Augment Interview Data	Corroborate Interview Data	Provide Background
Project Brochure	External	☒			☒
Initial Dissemination Plan	Internal		☒	☒	
Project Plan	Internal	☒	☒	☒	☒
Industrial and Business Showcase	Internal		☒	☒	
Dissemination Materials	Internal	☒			☒
Dissemination Plan	Internal	☒			☒
Big Data CEN Standards Workshop Report	Internal		☒	☒	
Final Dissemination Plan	Internal		☒	☒	☒
Web-Home Pages	External	☒			☒
Web-Blog Articles	External		☒	☒	
Organisational Chart	Internal				☒

Table 7: Summary of Documentation Analysis Deployed

2.5.2 Phase 2 – Generating Initial Codes

Phase 2 involved the first round of actual coding; a flat, non-hierarchical approach was adopted. This phase used both NVivo and Microsoft Excel Spreadsheets to summarise the relevant literature and cluster into usable themes that were added to NVivo. Data collected and detailed in Paper 3, contributed to the generation of initial codes as identified in Table 8. The 35 codes identified were applied to the full data set and relevant data was linked to each category.

Phase 2 - Generating Initial Codes	
A Priori Knowledge	Managements Influence
Barriers To Structural Embeddedness	Nature Of Relationships
Centrality	New Service Offerings
Co-Creation Of New Knowledge/Infrastructure/Competencies	Openness Of The Network
Collaboration	Open Data Policy
Competencies And Skills	Partners, Competition, Knowledge Providers
Competition	Prior Relationships

Phase 2 - Generating Initial Codes	
Compliance	Quality Of Network
Configuration Of Network	Social Characteristics
Convergence Of Priorities	Reciprocity
Cooperation	Reputation
Diversity	Responsibilities
Dominance /Power	Research Infrastructure
Enablers Of Structural Embeddedness	Spin Outs
Exchange Networks	Temporary Networks
Interactions Of Node	Trust
Joint Publications	Weak Ties/Strong Ties/Structural Holes
Major Milestones	

Table 8: Phase 2 - Initial Codes

2.5.3 Phase 3 – Searching for Themes

Phase 3 involved categorising initial themes into clusters and finding the meaning behind categories. This was essential to avoid duplication and mismanagement of ideas and themes. The functionality of NVivo to recognise patterns through colour-visualisations facilitated the clustering of themes that occurred in Phase 3. Additionally, the hierarchy function in NVivo was used to create parent and child nodes as illustrated in Table 9. This shows the sources of data and the number of times this data references this node.

Name	Sources	References
Collaboration	12	63
Difficulties of collaboration	11	18
Enablers of collaboration	8	16
Reciprocity	6	7
Responsibilities	9	22
Economic characteristics	10	88
Co-creation of scientific knowledge	9	13
Competencies and skills	10	22
Joint publications	8	10
Major milestones	9	20
New Service offerings	8	18
Research infrastructure	5	5
Future recommendations for EC	7	20
Network composition	11	87
Centrality	4	5

Name	Sources	References
Competition	10	13
Depth of relationship	9	12
Formation	8	15
Frequency of communication	9	12
Openness of the network	9	13
Prior relationships	10	15
Reputation	8	8
Social characteristics	12	75
Compliance	8	11
Cooperation	11	20
Dominance	10	13
Friendships	7	10
Trust	9	21
Structural embeddedness in EU research networks	10	51
Barriers to network optimisation	7	16
Enablers of network optimisation	8	13
Formal network strategy	7	9
Open data policy	9	13

Table 9: Initial Hierarchical Structure

2.5.4 Phase 4 – Reviewing Themes

Phase 4 focussed on reviewing the themes, considering the accuracy of the coded extracts within the context of the entire data set, and going through multiple coding iterations between the data and the themes. All data was added to the NVivo project repository in the form interview transcripts, relevant network documentation and blogs. To fully comprehend the landscape within the data set, a thematic map of the analysis was drawn through the use of NVivo report management, query analysis and visualisation functions (Appendix 3). This ensured consistency of use for the different themes and comparative analysis across participants to discover interesting discussions, events and activities relevant to the research objective and research questions. The cross-referenced nodes (themes and related data) were printed out and manually analysed using highlighters and summarising sheets. An interview thematic areas document was developed and field notes were reviewed. Following on, transcripts were re-analysed to identify unusual themes not initially covered in the literature and a number of annotations were created, often aligned with interesting quotes.

At this stage both the conceptual map and node hierarchy were amended to reflect the dominant themes, some redundant themes and sub-themes were removed and other themes merged. As detailed by Table 10 there were 22 sub-themes at this stage of the analysis.

Name	Sources	References
Future Recommendations for EC	7	20
T1 - Structural Embeddedness	19	163
Frequency of Communication	9	12
Reciprocity	6	7
Se Challenges	12	60
Competition	10	13
Difficulties of Collaboration	11	18
Enablers of Collaboration	8	16
Open Data Policy	9	13
Se Configuration	11	30
Formation	8	15
Prior Relationships	10	15
Structurally Embedded Attributes	9	18
Centrality	4	5
Openness Of The Network	9	13
T2 - Economic Characteristics	10	84
Barriers to Network Optimisation	0	0
Co-Creation of Scientific Knowledge and Joint Publications	10	19
Competencies and Skills	10	22
Expansion of Research Network	5	5
Major Milestones	9	20
New Service Offerings	8	18
T3 - Social Characteristics	13	85
Compliance	8	11
Cooperation, Reciprocity, Exchange Network	11	20
Dominance	10	13
Friendships and Depth Of Relationships	10	18
Motivation	0	0
Trust	9	22

Table 10: Phase 4 Node Hierarchy

2.5.5 Phase 5 – Defining and Naming Themes

Phase 5 involved the refinement of themes into clear well-defined categories. This phase included the on-going analysis of data to ascertain relevance and accuracy of the coding to ensure that the story behind the data did actually reflect alignment to the theme. Reconsideration of the relevant literature was also performed at this stage. Additional data was added to the network repository in NVivo at this stage as the documentation analysis phase ended. This cumulative stage was useful to re-familiarise oneself with the case nodes; for example, photos of participants and events that corresponded to the stories described at the interviews. This provided deeper insights to the context and relevance of codes and the emphasis placed on certain elements. The organisation profile sheet provided descriptive context for each participant and content for case classifications, further described in Section 2.5.1. Table 11 identifies the Phase 5 theme hierarchy, which illustrates three main thematic areas and nine sub-themes. Appendix 1 gives further detail on final nodes.

Name	Sources	References
T1 - Structural Embeddedness	19	143
Competition	10	26
Formation and Incubation	11	26
SE Configuration	9	17
T2 - Economic Characteristics	10	59
Co-creation of scientific knowledge and Joint publications	10	19
Competencies and skills	10	22
New Service offerings	8	18
T3 - Social Characteristics	13	100
Cooperation, Reciprocity, exchange network	12	60
Friendships and depth of relationships	10	18
Trust	9	21

Table 11: Phase 5 Theme Hierarchy

2.5.6 Phase 6 – Producing the Report

Phase 6 facilitated the on-going data analysis to refine the occurrences of coding relative to the themes based on the actual data and the interpretation of the data that included the case classification, description and tone of the data taken from the field notes and further summative data. NVivo facilitated data validation through access to the raw data when categorised in a hierarchy of themes. The researcher kept a separate notebook for all data collection to record mood and areas of importance for the research participant. This was

reviewed at this stage of the data analysis in tandem with raw participant transcripts and NVivo data reports.

In addition, notes and videos from in-class NVivo training and online training were studied to capture best approaches to visualising data and analysing qualitative data. While this process was slow, it contributed to an accurate refinement of the conceptual framework and enhancement of the project items in NVivo (memo's, transcripts, documents, blogs, reflective thoughts). Phase 6 included the development of summarised data for the final report and a final checklist. Other tools such as Padlet, were adopted to capture all the instruments used throughout the DBA journey (Appendix 5). This included feedback from conference submissions and presentations, and other relevant research events, in addition to feedback from internal/external examiners, and the WIT Ethics Committee. A reflection upon all the paper series submissions was conducted and the evolution of themes and direction of the study was captured for inclusion in the final thesis. In addition, the interview participants were thanked for their contributions and the interview transcriptions were returned for their perusal, where requested. Phase 6 also includes preparation for the discussion section of the final thesis. The NVivo functionality to search and create graphs and matrices that link the different data sources (literature, interviews, documents) provides visual and agglomerate support for the researcher.

Section Summary	
Research Process	Description
Research Design and Sampling	<ul style="list-style-type: none"> Purposive sampling strategy of 10-targeted researchers
Case Description	<ul style="list-style-type: none"> Single case study, AquaSmart network. 8 organisations, 1 micro, 3 small, 2 medium, 2 large.
Data Collection	<ul style="list-style-type: none"> Semi-formal qualitative interviews. Documentation analysis.
Data Analysis Process	<ul style="list-style-type: none"> Adopted Braun and Clarke (2006), 6 stage of data analysis. Using manual and NVivo methods.

Table 12: Section summary: Research Implementation

3.0 Findings

This section presents the main findings by theme, utilising the full data set (as detailed in Section 2.4) and considerate of the conceptual model, research objective, and research questions. Figure 5 summarises the findings and links to the research questions. Three main themes have been identified: structural embeddedness, economic aspects, and social aspects of structural embeddedness, which are detailed in the forthcoming sections. The rationale for the research is supported by the data, and a deeper understanding of the impact and influences of the social and economic aspects of network embeddedness, are recognised by the data, as being significant to the network output. The following sub-sections provide evidence to illuminate stories and accounts of the network nodes (individuals active in the network) in European research. The high-level challenges, opportunities and surprises are outlined below. The following sub-sections detail the findings from the research as classified into three major themes and illustrated in Figure 5. These themes form the basis of the research investigation.

3.1 T1: Theme One – Structural Embeddedness

Structural embeddedness is how participants interact with one another, how likely future interactions are among participants, and how likely participants are to talk about these interactions (Granovetter, 1985, 1992). Structural embeddedness is central to the objective of this study. The initial emergent themes related to structural embeddedness included centrality, network configuration, network policy and prior relationships. Having applied Braun and Clarke (2006) in the data analysis phase, the process included the merging and editing of the node hierarchy through a number of iterations to the current sub-themes for structural embeddedness. The results identified several sub-headings as detailed below.

Structural embeddedness refers to the quality and configuration of the interactions between nodes in a network. The findings identify several insights in relation to the configuration of research networks, distinct qualities and the social characteristics prevalent in these types of networks. From the initial findings, diversity within research networks between academia and industry is identified as a challenge, and that convergence of research priorities is difficult but can yield successful outcomes. Section

2.5 illustrates the manual process used to identify and confirm themes and sub-themes. This process supported the NVivo queries and coding so that the researcher had confidence in the coding process. This two-pronged approach to data analysis aids the reliability of the results.

3.1.1 Network Formation and Incubation

While some of the partners have strong ties, this was not common throughout the network. The evidence of weak ties and structural holes is clear in that the different participant types indicated a profile gap between those in ICT and those not. At the outset the end-users had no ties with any other partners with the exception of the organisation that introduced them to the network. It was clear that the majority of the partners indicated that they now have strong ties with all the partners in the network. One of the interviewees (Participant A from Andromeda) considered the incubation period as representative of the lack of strong ties in the network. Furthermore, priori relationships are emphasised in relation to research networks. It is apparent that prior relationships are a contributing factor for new and emerging networks. Participant D from Andromeda states:

“We got involved because of our previous engagement with the Greek company and their AquaManager tool. I think since we had already established good collaboration between our technicians and their technicians, they initiated our involvement in this network”.

Given the apparent divide between the ICT researchers and end-users, this prior relationship was a key element of this network’s formation; it is well-known in a practitioners’ environment, that research necessitates collaboration with end-users to apply a technical solution to an industry challenge. The consortia building (network formation) activity in a research network is often associated with the individual who has the idea for the research or the research network connections. For AquaSmart, there were two individuals involved in the formation of the network. Participant A from WIT described the depth of the relationship between the founding members of the AquaSmart network when stating:

“XX brought us into the network. His whole idea is to build a big family of workers to work together with a common goal. The family would be people that he has worked with before, say researchers, that he has met through

research projects or projects that he has reviewed, and he has picked out partners liked how they work and then brought them together to form a consortium”.

This comparison to a family was repeated in different instances in the data and is discussed further in Section 3.2.2 within a social context. When asked, “*how did you join the network?*” Participant I from Q-Validus replied, “*I didn’t join it, I created AquaSmart*”. There was obvious pride in this statement around the success of the network, and the participant did disclose the positive and negative examples of how the network functioned.

Using an existing network of contacts to build new networks was evident. Participant I from Q-Validus emphasised the importance of the EU network of evaluators, reviewers and researchers as a core input to growing and nurturing his own network. It was clear that this person was ‘cherry-picking’ appropriate organisations and individuals with whom they targeted to collaborate with for research purposes. Participant I from Q-Validus had a vision for the research, he attributed, “*skill base, personalities and expertise as the network formation evaluation criteria*”. Furthermore, he stated that the network required, “*time, intelligence, patience, know-how and trust to realise the AquaSmart vision*”. An informal reference system seems to be evident once the two founding members embarked on the formation exercise.

Participant C from i2S was also a founding member of the network and played a pivotal role in the network formation. He affirmed that the research was his idea. Subsequently, he invited three of his clients into the network, and then approached Participant I from Q-Validus who had network know-how, and they formed the network together. While both Participant C and Participant I had strong ties and considered that they led the network formation, the other eight participants had no strong ties. It is clear that Participant C urged the non-technical partners (fish farmers) to join the network and Participant I encouraged the technical partners. Whilst the communication issues in relation to jargon and industry knowledge were identified at network incubation stage, the other main challenges within the network in relation to data security and data privacy, were not identified until later stages in implementation. It was clear that the non-technical partners were sensitive in relation to data disclosure, as data is driving much of their profit margins in relation to fish numbers, fish feed quantities, fish growth and fish loss rates. Initially,

they were open to data sharing, however, when requested they were slow to deliver. The participants are protective of the security of their production data and this disclosure issue was a major area of concern for the network. Furthermore, this can be seen as a contributing factor toward trust within the network and the creation of a zone for conflict. Indeed, Participant I from Q-Validus described anger between two other members in the network “*some partners were angry as competencies in other partners were lacking*”. This type of emotion has the potential to radically curb tangible network output and the viability of the network reaching its contractual obligations.

It was also evident from the interviews (with Participant A from WIT and Participant H from JSI) that the network participants identified at network formation stage were not all active during the implementation stage. This could have the potential to affect trust levels as personnel changes affect interpersonal relationships. Additionally, some participants had no knowledge of the Aquaculture industry initially; their technical skills were aligned to the technical activities, not the business know-how. The challenges that this exposed are detailed further in this section. As the data reveals the first six months of the engagement included periods of change for the scope of the work engagement, as network participants figured out how they would actually approach the work. During this formation stage, trust emerged as a constraining attribute. This social characteristic is discussed in detail in Section 3.2.2.

Participant H from JSI seems to have been invited into the network purely because of competencies in machine learning and multi-language translation. It was interesting to see that they were the last to be invited into the network and this suggests an emerging gap in the competencies required to implement the planned research. Necessity also appears as a significant consideration for network formation. Participant G from Q-Validus, emphasised the challenges and complexities that the network encountered upon implementation:

“There was a lot of norming, forming and storming in the first period. The end-users had great expertise and knew vastly more than the techies and that was an important initial dynamic. One of the key phrases from Participant X was that you guys don’t know how to talk fishy”

This reference to ‘talk fishy’ was mentioned in a number of interviews and highlighted the difficulties that jargon and knowledge represented in the network. Furthermore Participant G from Q-Validus describes how “*it took time to understand each other. Face to face meetings are crucial toward understanding different partners*”. Partner H from JSI highlighted that network exclusion is evident in some cases:

“Groups form informal networks and they don’t let anyone else in. These closed shop type networks occur when there are calls that build on previous calls with closed consortia”.

3.1.2 Competition

This section describes the challenges encountered related to structural embeddedness within the AquaSmart network. The participant detail (Table 5) gives some insight into the dynamics of the case study and the different types of priorities and attributes of the participants. Many references were made to the gap between the academic partners and the industry partners. The literature is profuse in this domain and related domains such as innovation and competitive advantage. Authors such as Maughan *et al.* (2013), Perkmann and Walsh (2007) Perkmann and Schildt (2015) Bozeman *et al.* (2013) highlight the conflicting priorities and landscape environments in which both genre of researcher operates.

Role definition and authority within the network was well defined which facilitated a structured approach for collaboration. It seems some participants created their own sub-groups to focus on their output leaving issues such as inter-organisational competition for other participants to control. Participant J from WIT described their interaction with some participants and highlighted a collaborative sub-group:

“We worked very well together (i2S,JSI,WIT/TSSG) through regular conference calls we developed the approach, it was very goal oriented, nobody was trying to push their own agenda and it was very collaborative”.

Participant D from UNINOVA cited a main challenge as the division between academic and industrial participants and a gap in knowledge between the two sets of participants:

“We had to build a bridge between the two distinct partner groups (academia and industry) and address the way we handle and distinguish important knowledge”.

This highlights the differences between a temporary proposal network and a more stable research implementation. This bridge was required as the gaps between perceptions and views were sufficiently sizeable that it affected the output and potentially the performance of the network. The gaps in understanding were shortened in relation to social events and trustworthy activities. Participant A from WIT and Participant I from Q-Validus cited culture and language as contributing factors *“different cultures and different work practices can have a significant impact on the network”*. Furthermore, Participant F from Grammos identified location as a difficulty for collaboration, such as schedules for meetings and travelling for plenaries, which were identified as difficult but manageable.

In some cases, participants identified solutions to the aforementioned challenges. Participant J from WIT highlights that *“once we were aware of the constraints/complexities of open data, and we agreed to formulate a policy on benchmarking, it was fine for sharing data”*. Thus, this awareness and formalisation of the issue seems to have identified a possible solution for mitigating the risk this poses in future research networks.

It was clear that the network struggled in the early stages of the research as the relationships between the research partners were strained. Participant A from WIT highlighted some of the reasons behind the emergent issues:

“It was commercially sensitive production data. The option of opening up the data was very hard for the competitive partners. When the research implementation began some partners started to roll-back on some of their promises causing difficulties for the network”.

Participant J from WIT mentioned that where industry partners had been involved in previous EC funded research, their openness was more evident than those that had no previous EC funded network experience.

It is evident that private funding, market conditions and secrets of the trade were all relevant in relation to how competition was perceived within the network. Participant J commented, “*there was competition between industry partners and they were slow to share their knowledge*”. Having three industry partners from the same industry is a common occurrence for research but not common for competitive industry organisations, thus reaffirming the unique nature of this environment. As a result, to alleviate the incumbent issues, Participant J describes how “*we had to make sure that all the data was anonymised and protected. Negotiations, diplomacy and promises of security and protected data eased the tensions within the network*”. The research challenges identified in relation to data disclosure, re-emerged as a recommendation for other research networks to explicitly detail the internal policy for open data and sharing of data within the network.

From the previous discussion, it is clear that data sharing was a major source of conflict as it constrained progress within the network. Participant A from WIT states that generally openness was apparent within the consortium, but attempts to demonstrate it beyond the consortium (toward a market validation) were hampered by the data sharing issue:

“We were trying to move out into the market. We were trying to move the knowledge we gained in the project, to a product that could be trialled in the market. We needed data and our partners who were providing the data were slow to provide the data”.

Participant H from JSI acknowledges a potential link between the protection of commercial data sets and inequality of funding arrangements between different participant types. This risk, versus cost issue will be further discussed in the final thesis.

3.1.3 Structural Embeddedness Configuration

The literature has much evidence on the positive role of centrality and openness in a network (AlKuaik *et al.*, 2016; Freeman, 2011; Gulati and Gargiulo, 1999; Scherngell and Lata, 2013; Scherngell and Barber, 2011). This case study contributes to this body of knowledge in relation to identifying key influencers within this network and their role.

Participant C from i2S states “*XX brought people together who had the same mentality and was a catalyst for the consortium*”. Furthermore, Participant A from WIT attributes the centrality of Participant C and Participant I as a distinctive feature of the network that successfully merged the industry know-how to the ICT innovative solution. Their competencies were described as understanding, cohesion and translation rather than expertise. In other evidence gathered Participant B from Ardag and Participant I from Q-Validus recommend attributes related to the other person’s personal network. Particularly, whom they know, and the possibility for a natural migration to centralise activities on one person within the network. These are interesting findings as we move to the economic and commercial aspects. Participant D from UNINOVA cited a main challenge as the division between academic and industrial participants and a gap in knowledge between the two sets of participants:

“We had to build a bridge between the two distinct partner groups (academia and industry) and address the way we handle and distinguish important knowledge”.

This highlights the differences between a temporary proposal network and a more stable research implementation. This bridge was required as the gaps between perceptions and views were sufficiently sizeable that it affected the output and potentially the performance of the network. The gaps in understanding were shortened in relation to social events and trustworthy activities. Participant A from WIT and Participant I from Q-Validus cited culture and language as contributing factors “*different cultures and different work practices can have a significant impact on the network*”.

3.1.4 Insights and Summary of Theme One :T1

Structural embeddedness is the interaction of network participants, centrality, network configuration and quality. This is core to the objective of this research hence the focus on data collection and data analysis in this area. The exploration used mechanism in the interviews to tease out the importance of the concepts initially sourced in the literature and through the practical experience of the researcher. As the extracted NVivo codebook (Appendix 4) illustrates structural embeddedness and its sub-themes is the most

frequently described theme in the participant's interviews, in fact all participants contributed to the this theme (19) sources. The voice distribution shows us how the different organisation types responded to the structural embeddedness sub-themes and it is evident from Section 3.1.1 that the smaller organisations voiced their challenges in relation to formation and incubation period of the network.

The literature will be explored in line with the research findings in the discussion section of the DBA thesis such as Burt, 2009; Granovetter, 1973; Granovetter, 1985; Gulati, 1998; Gulati and Gargiulo, 1999; Cook and Emerson, 1978; Cook and Whitmeyer, 1992.

3.2 T2: Theme Two – Economic Aspects of Structural Embeddedness

The economic aspects of structural embeddedness describe the relationships between economics and a participant's behaviours or feelings. The case study profile (Section 2.3) highlights the commercial opportunities and vision employed by the network participants in relation to finding solutions to challenges in the Aquaculture Industry. This vision initiated the formation of the network and once funded, it was a core objective of the research. Participant G from Q-Validus describes how trust and economics in the requirements definition phase of the research network, necessitated significant levels of trust between network participants in order to meet the technical ambition of the research.

“At the mid-way point trust was established between partners. This was assisted by the tangibility of the research output whereby the fish farmers were now aware exactly how the technology could assist them to make more profit”.

While the research ambition focussed heavily on technical and industry progression, from a cost perspective, participants were cognisant of the role that the funding agency plays in facilitating the linkages between technical and non-technical research participants. Participant A from WIT admits “*without funding from the Commission it wouldn't have happened*”, while also highlighting the role that travel and frequent face to face meetings play in building trust. Following on, the dissemination of the network output was integral and it is evident from the results that the events were important milestones. Participant G from Q-Validus highlighted external collaborative partnerships as an opportunity to open

the network outside of the core participants. He described how *“In November 2016 we had a collaboration event with NSAI which was important in terms of how it opened up our research to a wider set of views”*. The economic and innovation opportunity for the Aquaculture Industry was evident and supported through the document D5.3 Industrial and Business Showcase document (Table 6).

This document describes output from the project in the form of a report or a software artefact. Specifically, this document provides model predictions and economic forecasting for the Aquaculture market. Further dissemination examples are relevant in relation to the possible application of the research solution to the Aquaculture market. Section 2.5.1 lists the dissemination documents D5.2, D5.6 and D5.7. It is evident from this set of documents that specific partners have specific geographic target markets. For example, partners from i2S and UNINOVA presented the results from AquaSmart in China, USA and Canada. Furthermore, the AquaSmart network’s rating on Google searches was highlighted by Participant I from Q-Validus:

“We got the number 1 position in Google searches for Aquaculture analytics and when we presented this to the EC they were impressed”.

There was a distinct sense of pride emulating from Participant I when discussing this result for their research output.

3.2.1 Competencies and Skills

Participants in research networks depend on the diversity of the research network to hone their competencies and skills toward higher levels of achievement. Partners leverage knowledge, competencies and skills from each other. Research networks are homes to test and validate ideas and procedures. These feelings or ‘comfort zones’ can act as a training ground to support and nurture European researchers. However, depending on the configuration of the network, the ability to attach an economic value to improvements in competencies and skills is not guaranteed. The complexities involved, centre on the composition of the network, willingness and capacity of participants to draw on interpersonal interactions. Inevitably there will be some move toward higher levels of competencies and skills and the evidence from the data corresponds to this. Participant A from WIT highlights the enhancement of both technical and non-technical skills:

“My negotiation and mediation skills have improved and from the technology side I gained skills around the architecture, core technologies, frameworks and services”.

Participant J also from WIT highlighted that it was the know-how from the network that provided the main achievement within the network, attributing the ability to link business knowledge with technology solutions as a core competency achieved.

While it is difficult to put an economic value on a research network the participants were cognisant that part of the output from this network was the network itself, the access to skill and expertise, and the opportunity for further research collaboration and commercial opportunity. Participant A from WIT highlighted the long-term continuing relationships as a significant part of the network output when stating, *“for future research we will target the companies that we are working with during this network. This expansion of our network is important for a research group”*. The relevance and importance of this output was also supported by Participant D from UNINOVA:

“The main output of AquaSmart is access to a set of people that we trust for new proposals and new projects and we plan to invite them to work on our next proposals”.

When assessing competencies and skills within a network it is feasible to envisage a formal network strategy expanding or refining an individual or organisation’s network. While this theme emerged from the data it is clear that each participant did not approach it from an individual perspective but an organisational one, and that each organisation has a different approach. The differences are across stakeholder type: for example, the academics link tightly with the National and European supporting mechanisms. The academics had an urgent tone in relation to funding and a necessity to get relevant industry partners interested in research. They described their willingness to guide these organisations through a research proposal. On the other hand, the AquaSmart industry end-users (fish farmers) were less assertive in this area while being strictly commercially aware with time, scheduling and networking of suppliers and customers being their primary consideration. The industry group’s networking activities are economically

driven, and it was clear that even though they had joined this network, it was not considered core business.

3.2.2 Co-Creation of Scientific Knowledge and Joint Publications

With a mix of stakeholder types in the network, different dissemination channels were targeted: peer reviewed journals and trade publications. For example, the ENS/CWA workshop agreement for standardisation and a global dissemination trade show in China where the AquaSmart software was demonstrated. Both the interview transcripts and the blog articles highlighted the impact of these activities. However, Participant H from JSI indicated that the levels of success attributed to AquaSmart from an academic perspective were low, but as expected, as this was applied research not focusing on new scientific knowledge. It is interesting to see that different participants entered the network with different levels of expectations for this type of output. In one case, it was evident that the research activities were customised to fit neatly into an innovation action accepting limitations on new knowledge and minimal opportunity for joint publications. Participant H from JSI used the network as an opportunity to demonstrate the contextual setting for the technical implementation using an unambitious tone in his description:

“Joint scientific publications with network partners was not possible. We didn’t invent anything new, therefore opportunities were not available. However, we had one publication after the project was finished”.

This view was inconsistent with other partners. Participant A from WIT and Participant D from UNINOVA expressed acknowledgement toward new knowledge, competencies and skills and evidence of successful joint publications. Participant A from WIT affirmed *“we worked with XX on publications and targeted Aquaculture conferences and then with XX targeted academic ICT conferences”.*

3.2.3 New Service Offerings

While the vision for AquaSmart was documented in D5.2 (Section 2.5.1 lists a sample of network documentation) detailing the ambition to form a new company, the participants were cognisant of this as a challenging undertaking. The evidence with which they

required to demonstrate its success within a two-year timeframe was difficult to gather. Participant G from Q-Validus highlighted the period post-research as a critical time for output to be realised and urged the funding bodies to consider the longer-term benefits and impacts. Participant I from Q-Validus also ratified this:

“These are long-term networks. It is pretty important to understand that achievements are often not met in the short-term. In the market place there are often lots of rules. Some areas are difficult to achieve in research projects such as operational support for live systems”.

Additionally, there was evidence to support the challenges of convergence of technology and Aquaculture business operations. Participant D from UNINOVA considered that the proposed technology advancements were difficult for the non-technical partners to grasp:

“The farms were backwards as regards the technology and as we got to know the farmers and how they operate we were able to advise them. They brought their wish lists to us as to what they would like to do based on the technology. This was reflective of the friendships that have been built, we can work together and play together”.

This reaffirms the economic and social ties within the network. Participant A from WIT outlined the commercial funding that his colleague has been granted to further develop the solution toward market release. Participant A from WIT informs *“Enterprise Ireland, WIT and i2S have set-up a new company”*. It is noteworthy that during the interviews three other participants asked the current status of this new endeavour looking for an update.

Participant E from Andromeda cited the take-over of their organisation by a US organisation as a disruptive factor to realising the potential of research output from AquaSmart. Furthermore, the timing of the organisational changes impacted the ability of the organisation to implement new AquaSmart technology within this unstable environment. Whereas, others such as Participant J from WIT highlighted that the scope of the research was reduced (and thus the capability of the new service offering), due to the absence of sufficient data to build a platform for larger quantities of data:

“The data was not available in the quantities that the technical partners expected. Thus, the final result was adapted as a result and the end-user organisations were not fully satisfied and expectations were not fully met”.

This highlights the impact that the challenges associated with data access (Section 3.1.2) had on the new service offerings (research output). While significant, this impact was not described as detrimental and some participants enthusiastically described the possible competitive advantage that might be attributable to the AquaSmart network. Participant E from Andromeda claimed *“we achieved new service offerings and an improved business model with ability to apply predictions for the future”*. Furthermore, in addition to a spin-out company, Participant I from Q-Validus attributed their new service offering to AquaSmart, which includes a number of new services; proposal writing, research crowded thinking, market outreach and standardisation. It was clear from all of the non-technical (end-users) that the tool will be instrumental in changing the current work practices of the Aquaculture Industry. Participant F from Grammos enthusiastically highlighted the anticipated impact:

“The funding is something important but the final outcome, the possibility of having the tool (enhanced technology), it will improve the production to maximise profit and minimise loss. The Aquaculture sector in Greece was considered under-developed. It is now a fast developing sector, until recently it operated the old fashioned way without technology”.

3.2.4 Insights and Summary of T2

This section of the findings explores the input and output of the network in economic terms, costs and benefits. The interviews focussed on the co-creation of scientific knowledge, joint publications, competencies, skills and new service offerings. As the extracted NVivo codebook (Appendix 4) and (Appendix 5) illustrates, economic aspects and its sub-themes are the least frequently described theme in the participant’s interviews, (10) sources. The voice distribution shows us how the different organisation types

responded to the economic sub-themes and it is evident from Section 3.2.1 that the smaller and micro organisations highlighted their competencies and skills as major area of focus. The medium organisations were predominately concerned with new service offerings and the small highlighted the co-creation of scientific knowledge as important.

3.3 T3: Theme Three – Social Aspects of Structural Embeddedness

The conceptual model placed the social aspects of structural embeddedness as an input of the network. It can contribute to understanding a research network environment and it justifiably describes the inter-personal relationships and how softer aspects influence the structural embeddedness of a network and ultimately the network value. The following sub-sections highlight the findings from the data analysis phases.

3.3.1 Trust

Trust is central to each and every inter-personal relationship and it affects behaviours of those in networks (Neves and Caetano, 2006). Section 3.2 highlighted the links between economics (cost and benefit) and trust. There were several participants who mentioned temporal considerations in relation to building up trust and its connection with the effectiveness of the network. Participant A from WIT initially mentioned one or two months to build up trust, but as we continued our discussion, it was recorded as significantly longer. Participant A from WIT maintains *“the first meeting is a kick-off meeting, then you have 3 months of work before the next meeting so that’s kind of 4 months really to get going”*. Similarly, Participant E from Grammos believed that there was trust between partners by the milestone of the second meeting when describing how *“at first, we didn’t know each other well, but we worked closely together and we faced issues of trust which improved by the second and subsequent meetings”*. Participant C from UNINOVA believes it took about a year to build trust between the network participants. Furthermore, Participant A from WIT asserts that the jargon in relation to aquaculture and technology created an adverse impact on trust within the network, explaining that *“it was 8-9 months into the project when we were able to talk a common language”*. It can be envisaged how this gap in understanding might impact other elements of the network. Many of the AquaSmart team (Participant A, D, C, E, I) linked the face to face aspects of the project; meals out, coffee breaks and informal discussions

as instrumental to alleviating the problems encountered in the network that were linked with trust. Participant J from WIT highlights *“if you only communicate with someone through a conference call it can be difficult to understand and get the context of someone. Whereas, when you see what they look like and their manner, then relations can be much easier”*.

Following on, Participant C from UNINOVA gave examples of comparable research networks where trust between partners was not evident and this had a negative impact on the research network output:

“I think it’s the people that made the difference. Previously I worked with a European project and there were cases that partners were trying to hide things from the others and take ideas from other people. In AquaSmart I never went to a meeting thinking that I had to be careful about what I say or how I present something, and I believe it was the same for the other partners in AquaSmart”.

As detailed in Section 3.2 the technical output from AquaSmart was dependent on the end-users providing accurate requirements and validation for the data analytics engine. This was highlighted as an economic aspect but linked with the social and trust perspective. The inter-personal relationships and behaviours within the network were pivotal for the network output. The incubation period at the beginning of the network engagement highlights collaboration difficulties. Responses were slow and work activities less efficient. During the incubation stage, Partner H from JSI’s described a change of scope and vision for the research. These insights are important as it suggest negativity in relation to satisfaction levels for research output and could be related to trust and disappointment between partners.

“I was dependent on them for data, there was a lot of issues around the access to the data since it was a big data research project. We only had access to a number of spreadsheets not several terabytes of data and this was a problem for machine learning methods as it’s difficult to have meaningful results from some spreadsheets of data”.

Participant G from Q-Validus distinguished the differences between the stakeholder types in relation to trust and embeddedness in a research network, which has emerged as a major theme in the results. The divide between the academics and the industry partners is significant, and trust between partners is evident as one of the factors that contribute to the success of the research output.

“Trust has to be there with people, they are involved in complex competitive activities, we all learned a lot about fish-framing operations. It is amazing really, they had to take a leap of faith with technology and the people they were working with, facilitated through face to face meetings and people developing relationships”.

The extent to which some partners trusted others was significant and it was evident that this trust went beyond professional requirements to a caring nature toward each other. Participant I from Q-Validus reported that the underlying trust in research networks is critical to the success or failure of the research network. Furthermore, Participant I from Q-Validus describes how he *“trusted XX and XX and there is nothing that I wouldn’t do for them or their organisations”*. As participants move around in different research networks it is understandable that the depth and quality of structural embeddedness will be carried from and to other research networks.

The network composition is a key factor to consider when a diverse network of researchers needs to understand each other’s knowledge. Participant D from UNINOVA highlights the understanding needed for both stakeholder types to handle knowledge and work with different jargon. They saw the need to build a bridge between them and take into consideration the gaps in knowledge and understanding as associated with their organisation and personal profiles. This was particularly relevant in relation to prioritisation and identification of crucial knowledge and knowledge handling. This identifies another disconnect between partner types as jargon was already identified as significant. Participant I from Q-Validus provided some advice and insights to help improve trust and coordination in a research network, citing listening skills, respect, diplomacy and problem-solving skills as critical competencies. The overarching legal governance of the institutional funding agency also affected trust between partners.

Participant I from Q-Validus reveals *“using the umbrella of the European community the consortium agreement gave some security and legal standing, enabling a sense of security”*. This illustrates that even though research networks are predominately self-managing they have rules and regulations imposed upon them from a contractual perspective that act as a net for building and maintaining trust between partners.

Participant A from WIT also notes there were other interpersonal incidents within the research network. For example, where a problem was being discussed and one person would give their view without listening to the other side. This created tension within the network and difficulties for the project to progress. In some cases the dependency on a specific knowledge or skill forced members of the research network to condone this type of behaviour. Perhaps this leads to a concept of network bullying where the direction of the research could be changed as a result of this type of behaviour. Interestingly, one of the participants (Participant E from Andromeda) cites themselves as a dominant organisation, which provides some insight into the dynamics of the end-user stakeholder category, not only from a research network perspective but also from a market leader perspective.

“In our case we are one of the biggest Mediterranean Aquaculture groups. Small companies tend to follow bigger companies. It is traditional that the big companies will test the tool and the small companies will adopt these tools based on our recommendation”.

Participant C from i2S identified themselves as a dominant party pushing other partners for results. Furthermore, they claimed that the initial research vision was not attained. They attributed this to the challenges of AquaSmart in relation to its industry type, jargon and gap of commonality between the technical partners and non-technical partners.

3.3.2 Cooperation, Reciprocity and Exchange Networks

Multiple participants (Participant A, B, J) regarded the general operations of the research network as high functioning with regard to direction, collaboration and communication. The research network did embark upon activities that included reciprocity and social exchange. However, it was clear that the expectation was more aligned to reaching the

overall objective and vision of the network participants than a payback type scenario. Participant H from JSI noted that *“as we had a deadline approaching we helped each other within our expertise. The collaboration was good and there was shared responsibility”*. Generally the AquaSmart participants reported a positive working experience between participants and many concurred with Participant I from Q-Validus *“we had optimum cooperation. It isn’t easy to get it right, it was very unique. Probably the best project that I’ve worked on”*. Furthermore, Participant H from JSI attributed this positive working environment to one particular participant. *“XX was a very good motivator he always gave motivational speeches and it was amazing. I would certainly say that XX’s motivational speeches were an additional push that I have not seen before in projects”*.

3.3.3 Friendships and Depth of Relationships

A key area of structural embeddedness is the network configuration and depth of interpersonal relationships. Whilst some elements of this have already been discussed in Section 3.1.1, some areas are more connected to social aspects within a network. Participant H from JSI reveals, *“I made some friends and we continue to have contact post AquaSmart, especially for this project I believe that the connections will keep on going”*. Participant B from Ardag highlighted that social time scheduled into each plenary face to face meeting was effective. He claimed making friends facilitated identification of expertise and work-related discussion. For example; *“dinners at end of day, the mingling time in between the working hours, at the end the friendships are even deeper and this helped to figure out expertise”*. This supports the recognition of informal interaction as significant. Similarly, Participant A from WIT highlighted other social activities such as running in the mornings prior to the scheduled meetings *“which helped with making partner negotiations easier”*. Following on from the previous discussion on trust, Participant I from Q-Validus was keen to describe the depth of the friendship that he had gained in this network:

“It was really strong and XX and I are good friends XX is a fantastic man I have nothing but the warmest heart for him and I could help him whether it be workwise, family wise I’m there, he is a very special man. We had a very open relationship to discuss the AquaSmart network and talked about partners, concerns and issues. It was like a marriage”.

Similar to Participant I from Q-Validus in Section 3.3.2, Participant D from UNINOVA emphasises the link between trust and friendships and affirmatively recognises the effectiveness of the AquaSmart network.

“I am working for 15 years on research projects and this one was the best for the friendships that we made, the trust and confidence was an enabler. We had discussions on overcoming difficulties and trust was the key. With social network conversations or social events outside we are able to heal”.

Participant C from i2S recognises the depth of the relationship as significant and resembles it to a family similar to Participant I from Q-Validus. As partner C from i2S has such a deep relationship and knowledge of the fish farmers there was an occasion in relation to data access where the network leveraged this position for the good of the network to progress the research. Participant I from Q-Validus recognises *“there was a lot of bureaucracy and we got Participant C involved because he had a relationship with XX and worked through it, we got what we needed”*. Overall, the AquaSmart network participants expressed very positive experiences. They mentioned the longevity of lasting friendships as primary output of the network and the growth of their professional network. Both the interviews and the website blogs provided proof that the network participants had great pride in the research and the events that they had participated in. This corroboration of evidence emphasises the importance of these events as both dissemination activities but also as motivational for the participants to succeed.

3.3.4 Insights and Summary of T3

The literature identifies social aspects as important in structural embeddedness in networks; the empirical results support this view. The findings identified cooperation, reciprocity, exchange, friendships, depth of relationships and trust as the key considerations. As the extracted NVivo codebook (Appendix 4) and Section 3.3 illustrates social aspects and its sub-themes are a frequently described theme in the participant’s interviews, (13) sources. The voice distribution shows us how the different organisation types responded to the social sub-themes and it is evident from Section 3.3.2 that all organisation types highlighted cooperation, reciprocity and exchange as the major

area of focus. Trust was highlighted more acutely by the micro and small organisations. Table 13 provides a summary of the main aspects of Section 3.

Section Summary	
Findings	Description
Participant analysis	90% Male, 50% public/50% private funded, 70% >10 years experience. 3 end-users, 3 academics, 2 ICT organisations
Theme One –Structural Embeddedness	<ul style="list-style-type: none"> • Formation/Incubation • Competition • SE Configuration
Theme Two – Economic Aspects	<ul style="list-style-type: none"> • Competencies and skills • Co-creation of scientific knowledge • New Service Offerings
Theme Three – Social Aspects	<ul style="list-style-type: none"> • Trust • Cooperation/reciprocity, exchange • Friendships

Table 13: Section Summary: Findings

4.0 Summary of Key Findings

This paper is the fourth in a cumulative research paper series, the objective of which is to investigate social and economic aspects of structural embeddedness in an ICT research network based in the European Union. This single case study is based on a European funded research network, the AquaSmart network, a project that converges aquaculture and technology. Several research questions are outlined below:

RQ1 How are research networks structurally embedded?

RQ2 How is structural embeddedness interconnected with social and economic characteristics?

RQ3 What enablers and barriers to structural embeddedness are encountered within EU research networks?

Table 14 identifies the key findings emerging from the data collection and data analysis phases. The key findings show the results from the qualitative semi-structured interviews and documentation review, followed by a six phase data analysis process. The results span three major research themes and ten sub-themes as illustrated in Appendix 1, final

code book. Table 14 shows the summative values per major theme and their alignment to the research questions.

RQ1 - How networks are structurally embedded	RQ2 - Social and Economic aspects of SE	RQ3 - Barriers and Enablers of SE
Huge diversity in the network.	Trust, cooperation, reciprocity, exchange and friendships emerged as significant positive attributes.	Trust being an enabler and a barrier e.g. the network formation stage depended on prior relationships to engage end-users.
Depth and wealth of industrial knowledge held by the end-users created challenges in relation to Aquaculture jargon.	Co-creation of knowledge was evident in some relationships and absent in others.	Trust also played a significant role in addressing interpersonal relationship challenges after the formation period and during incubation.
An elongated incubation period bridged the communication challenges.	Skills enhancement, and expansion of personal and organisational networks was significant.	While exchange and reciprocity were evident they were not significant for the operations of the network.
The formation of the network and prior relationships was significant.	Governance, disappointment and network bullying was obtrusive to optimisation of network effectiveness.	Funding enabled inter-organisational meetings, informal dinners, mingling during breaks and, bridging the divide between the diverse network configuration.
Building bridges between network participants was challenging. Trust and anger were identified as contributing factors.	New service offerings and the ability of partners to disseminate on a global level were emphasised.	Openness and trust were explicitly boosted at meetings where the partners were able to deepen their relationships through the informal dinners, mingling at break-times and even joint exercise programs between participants.
Network Centrality, idea generation and wide network knowledge were pivotal to network formation.	Commitment and trust impacted the research output and expectations of network participants.	Friendships affected skills and competencies and enabled effective problem resolution.
While strong ties were apparent, in some cases weak ties and structural holes were considered significant advantages for research networks.	The depth of the relationships, referred to as family and marriage, are apparent along with a caring approach.	Motivation was identified as a unique significant enabler.

RQ1 - How networks are structurally embedded	RQ2 - Social and Economic aspects of SE	RQ3 - Barriers and Enablers of SE
Generally, there was an openness in the network.	Complexity in relation to competition was evident in relation to the end-users. Anonymisation facilitated the sharing of trade secrets among unfamiliar network parties.	Barriers included inequality in funding ratios for different partner organisations, location of member states and brevity of the funded network duration.
Open data compliance adversely effected the relationships within the network. Competitive production data tensions were difficult to resolve.	High functioning collaboration and cooperation assisted the network efficiencies.	Competition was initially a barrier but mechanisms were established to overcome this challenge.
There was pride in the quality of the research output, the results they were developing, and the depth to which friendships and interpersonal relationships had cultivated.	The network created a joint vision to penetrate the global market.	Diversity of participants was key to successfully reaching the network objective, but its challenges were apparent and impeding progress at times.
		The convenience of clustering strong ties for network strategy is evident. This increases the limitations in relation to quality of research output, lost innovation opportunity and a diminishing impact on disruptive technologies.

Table 14: Summary of Key Findings

RQ1 findings indicated that there was great diversity in the network, particularly, in relation to the depth and wealth of industrial knowledge held by the end-users. The end-users were fish farmers and this diversity illuminated the challenges within the network for the partners to understand each other. The jargon used by the fish farmers created a division within the network and as a result the participants reported an elongated incubation period within which time network cohesion was absent and tensions were high. The formation of the network and prior relationships played a significant role in the configuration of the network. Building bridges between network participants was challenging, trust and anger were identified as significant issues. Centrality was evident within the network and the initiating participants highlighted their skills in relation to idea

generation, wide network knowledge, and know-how as imperative to the success of the network. While strong ties were evident across some relationships, they were not prevalent, and weak ties and structural holes were considered significant advantages for research networks. Generally, there was an openness within the network itself, however, some participants expressed frustration in relation to the level of closed networks accessing European funding. The depth of the relationships was described as akin to family and the majority of participants recognised the value of positive relationships.

A number of significant challenges affected the network, particularly the open data compliance that seemed to have an adverse effect on the relationships within the network. The network had agreed to share competitive production data and with three end-users from the same industry there were major tensions in relation to disclosure of this data. These tensions were difficult to resolve, and impacted the effectiveness of the network until a solution to anonymise, benchmark and change the scope of the research was agreed. There was clear pride expressed from the participants in relation to the quality of the network output, the results they were developing, and the depth to which friendships and interpersonal relationships had cultivated.

Trust, cooperation, reciprocity exchange and friendships emerged as significant attributes. Links between social and economic aspects were evident as friendships and tensions connected the quality of the network output. Co-creation of knowledge was perceived in some relationships and absent in others where contribution to research was downgraded as the scope of the research changed. Skills enhancement in competencies and the expansion of personal and organisational networks were cited as favourable to the network participants. The emergence of new service offerings and a widening of global contacts where network participants disseminated on a global level, were emphasised along with AquaSmart attaining a number one position in Google keyword rankings. When divided into industry focus the non-ICT participants (end-users) attributed the economic aspects as the most relevant area. Furthermore, the non-ICT participants recognised structural embedded configuration and trust as the least referenced themes. The enablers and barriers explored in RQ3 include trust from both perspectives. For example, the trust between the initiation partner and the end-users was pivotal in the network formation. Trust also played a significant role in addressing interpersonal relationship challenges after the formation period and during incubation.

While exchange and reciprocity were evident they were not significant on the operations of the network. Funding and costs in relation to inter-organisational activity were cited as significant influencing factors on network progress, bridging the divide between the diverse network configurations. Openness and trust were explicitly boosted at meetings where the partners were able to deepen their relationships through the informal dinners, mingling at break-times and even joint exercise programs between participants. Friendships affected skills and competencies and enabled effective problem resolution. The participants highlighted a unique approach to motivation as a significant enabler. In addition, deep interpersonal relationships matured as participants referred to the network as family and akin to marriage. Identified barriers included inequality in funding ratios for different partner organisations, location of member states, and brevity of the funded network duration. Competition was initially a barrier but as the research network matured there is evidence of a joint vision to penetrate the global market. Diversity of participants was key to successfully reach the network objective but its challenges were apparent and impeding progress at times.

The convenience of clustering strong ties for network strategy is evident but increases the limitations in relation to quality of research output, lost innovation opportunity and a diminishing impact on disruptive technologies. Table 3 shows the different organisations per size, micro, small, medium and large and it illustrates that the micro and small organisation's voice distribution focused on cooperation, reciprocity and exchange, competencies and skills and trust significantly more than the medium and larger organisations.

5.0 Conclusion

Structural embeddedness refers to the quality and configuration of the interactions between nodes in a network. The data has identified insights in relation to the structural embeddedness of research networks, the distinct qualities, economic and social characteristics prevalent in these types of networks. From the findings, many challenges and enablers have been identified within research networks. For example, the development of disruptive technologies is reliant on weak ties, even though prior relationships were evident. Communication within a network is critical, jargon and misunderstanding affect network optimisation. Social elements such as motivation, pride,

friendships and trust played a significant role in the realisation of successful network outcomes. Inequality in funding was identified between nodes and competition between nodes required intervention and policies to enable solutions. The remaining work will focus on linking the results and the literature in this domain toward the discussion, overall conclusions, limitations, and recommendations for future research.

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Appendix A - Final Code Book

Phase 5 - Defining and Naming Themes – Final Code Book

Nodes\\Phase 5 - Defining and Naming Themes

Data reduction - ongoing analysis to refine the specifics of each themes, overall story, storylines

Name	Description	Sources	References
T1 - Structural Embeddedness		19	143
Competition	Markets and economics illustrate competition effectively but nature also shows that competition is innate. This research focuses on a diverse mix of partners that form 3 main groups, end-users, researchers, ICT organisations. The different groups deal with competition in different ways and this impacts cooperation and trust.	10	26
Formation and Incubation	Formation of a network can be a complex process or a natural process. A family is a network but nature links them, for research consortia are built to avail of funding. For this research this theme includes an incubation period post forming stage.	11	26
SE Configuration	The structural embeddedness literature details evidence around centrality its impact on interpersonal relationships and networks. Centrality was evident in AquaSmart although there were 2 points of centrality. Openness is linked with it here in this theme as the literature also discusses open /closed networks and structural holes all configuration items discussed in the findings at AquaSmart.	9	17
T2 - Economic Characteristics	The input and output of the network reflects the cost and benefits illustrate the economic perspective.	10	59
Co-creation of scientific knowledge and Joint publications	EU funded research is collaborative, often located indifferent member states. Research aims to go beyond state of the art to discover and experiment. AquaSmart participants know the importance of scientific knowledge and the aim to co-create. Output is new scientific knowledge or an application of scientific knowledge in a new domain (Aquaculture) and a mechanism to show evidence are joint publications.	10	19

Name	Description	Sources	References
Competencies and skills	Output from a research network are both social and economic for competencies and skills they are related to career prospects, training and knowledge advancement and are thus included as economic benefits to the participants of the network and their organisations,*.	10	22
New Service offerings	Research networks are encouraged under the EU Digital Agenda. This research network included a vision to provide new service offerings from its partner organisations they did vary in their realisation.	8	18
T3 - Social Characteristics	The literature identifies social aspects as important in structural embeddedness in networks. The participants responses included many references to the social nature of activities in the operations of their network. There are a number of sub-themes within this theme.	13	100
Cooperation, Reciprocity, exchange network	The participants spoke regularly of cooperation and collaboration in the network. A network of diverse participants included incidents of reciprocity, exchange and regular cooperation and the challenges therein.	12	60
Friendships and depth of relationships	Depth of relationships is referred to a lot in the literature on structural embeddedness, about 50% of the participants spoke a lot about friendships and the impact of deep relationships within the network.	10	18
Trust	Trust is a major influencing factor in interpersonal relationships and can be linked to operations of the network, output of the network, enablers and barriers within the network. The literature states that trust is central to behaviours in networks. The participants spoke a lot about trust in the network	9	21

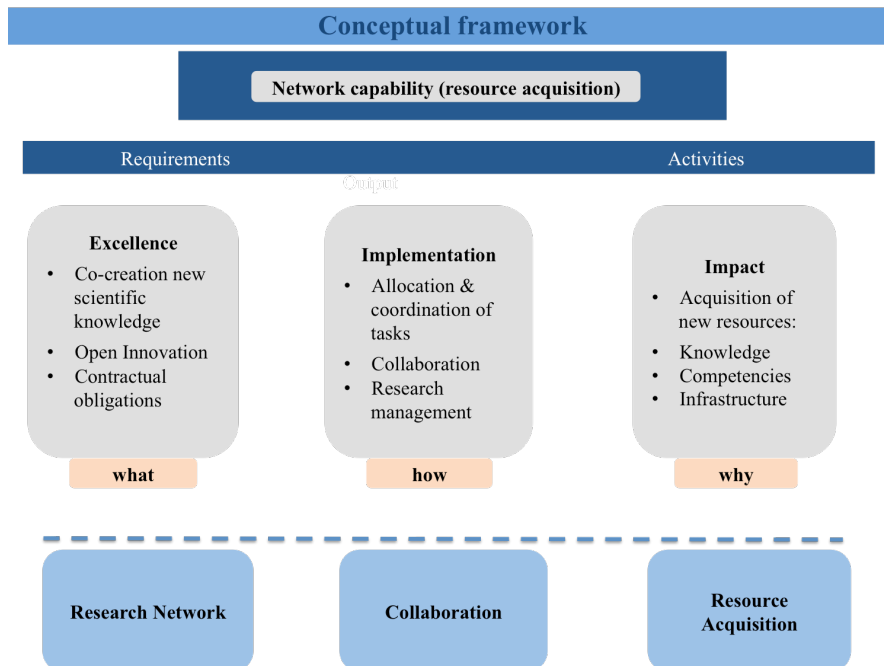
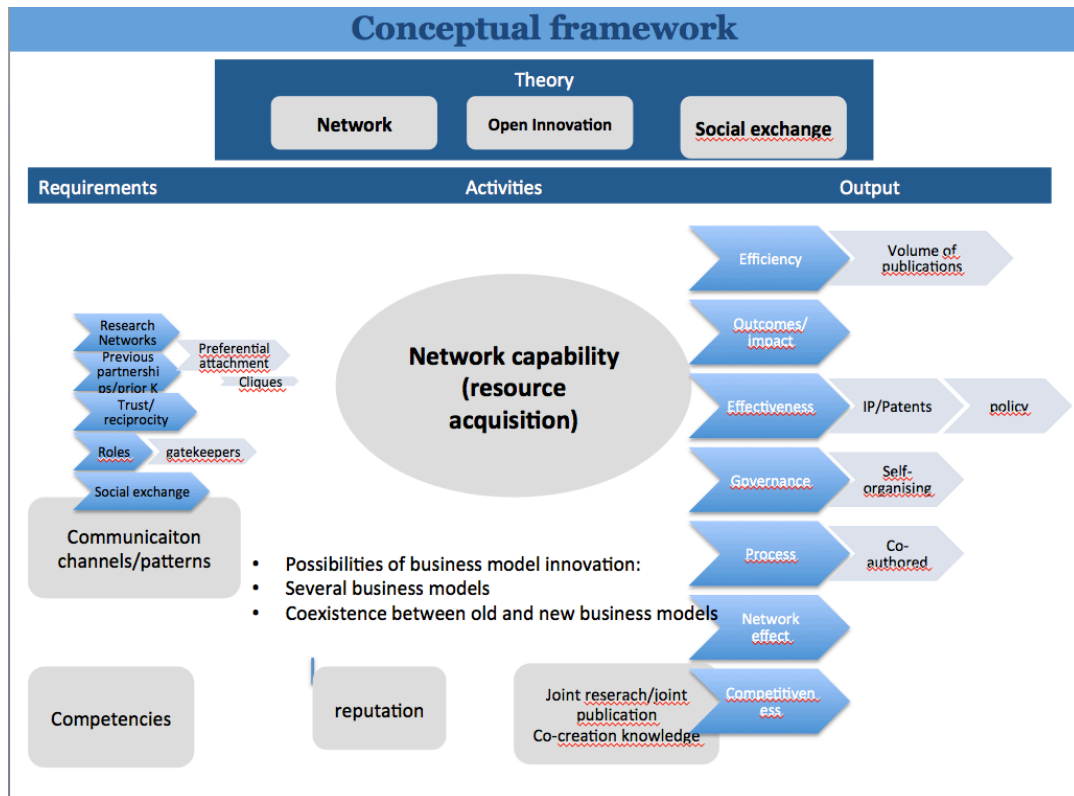
Appendix B - Iterations of Coding

Iterations of Coding through phases of data analysis

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Composition of the research network	Collaboration	Collaboration	structural embeddedness (config/quality/relationships)	Structural Embeddedness
prior relationships	Difficulties of collaboration	Difficulties of collaboration	Centrality	Structural Embeddedness Configuration
Partners, Competition, knowledge providers	Enablers of collaboration	Enablers of collaboration	Competition	Competition
Openness of the network	Reciprocity	Reciprocity	Depth of relationship	Formation / incubation period/temporary networks
Compliance	Responsibilities	Responsibilities	Formation	
Trust	Economic characteristics	Economic characteristics	incubation period/temporary networks	Economic characteristics
Dominance /power	Co-creation of scientific knowledge	Co-creation of scientific knowledge	Frequency of communication	Co-creation of scientific knowledge /Joint publications
Exchange networks	Competencies and skills	Competencies and skills	Openness of the network	Competencies and skills
Cooperation	Joint publications	Joint publications	Prior relationships	New Service Offerings
Spin outs	Major milestones	Major milestones	Barriers to network optimisation	
Co-creation of new knowledge/infrastructure /competencies	New Service offerings	New Service offerings	Enablers of network optimisation	
Major milestones	Research infrastructure	Research infrastructure	Formal network strategy	
Joint publications	Network composition	Network composition	Open data policy	Social characteristics
New service offerings	Centrality	Centrality	Difficulties of collaboration	Cooperation/Reciprocity/exchange networks
enablers of structural embeddedness	Competition	Competition	Enablers of collaboration	Friendships and depth of relationships
barriers to structural embeddedness	Depth of relationship	Depth of relationship	Reciprocity/exchange networks	Trust
weak ties/strong ties/structural holes	Frequency of communication	Formation	Economic characteristics	
centrality	Openness of the network	Frequency of communication	Co-creation of scientific knowledge	
diversity	Prior relationships	Openness of the network	Competencies and skills	

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
convergence of priorities	Social characteristics	Prior relationships	Joint publications	
a priori knowledge	Compliance	Social characteristics	Major milestones	
prior relationships	Cooperation	Compliance	New Service offerings	
managements influence	Dominance	Cooperation	Research infrastructure	
social characteristics	Trust	Dominance	Future of AquaSmart/spin-outs	
trust	Structural embeddedness in EU research networks	Friendships	Responsibilities	
temporary networks	Barriers to network optimisation	Trust	Social characteristics	
configuration of network	Enablers of network optimisation	Structural embeddedness in EU research networks	Compliance	
quality of network		Barriers to network optimisation	Cooperation	Recommendations for EC
interactions of node		Enablers of network optimisation	Dominance	
nature of relationships		Formal network strategy	friendships	
innovation /economy		Open data policy	Trust	
		Recommendations for EC	Descriptive	
		Future of AquaSmart	Responsibilities	
		reputation	Recommendations for EC	

Appendix C - Mapping of the Conceptual Framework



Appendix D - Memos and annotations

<Memos\\Trust> - § 1 reference coded [66.60% Coverage]

Reference 1 - 66.60% Coverage

Build a big family of workers to work together with a common goal- the family would be people that he has worked with before say researchers that he has met through research projects or projects that he has reviewed and he has picked out partners that he sees how they work and likes how they work and then brought them altogether to form a consortium

This was discussed by other network participants in relation to trust and setting up a local running group for a pre-breakfast run prior to face to face meetings. This level of depth in the interpersonal relationships seems to have had a resounding positive impact during the research network activities and afterward. It can also be linked with the unique ‘motivator’ of the network and how this role seems to have positively affected problem resolution and work ethics.

<Memos\\types of network people characteristics> - § 1 reference coded [19.12% Coverage]

Reference 1 - 19.12% Coverage

I was the middle man there – mediation

Annotations

¹ the recommendation for the EC to recognise the time required for consortia to trust each other to work efficiently together is important there is some conflicting evidence here that it take 2-5 months or a full year before partners are comfortable sharing data etc. the participant recommends that the EC show some value at evaluation stages to recognise previous relationships - potential strength of team

this is difficult to measure but recognisably significant for short network arrangements

² type my note

³ this is unique and given the levels of experience here it seems to have worked well for the success of this project

⁴ this is very clear here that Nir values the trust that was created in the network to a high level and that it was a very relevant factor for the success of the project

Appendix E - DBA Journey

DBA research path
Structural Embeddedness in EU Research Networks

Philosophical approach

Structured approach to review, summarise and record literature for easy retrieval

RQs

Data collection approach

Braun & Clarke Framework data analysis approach

Paper 3 initial themes

Emerging thematic clusters

Lit review analysis where I figured out about the landscape of network theory and its peripherals

Revised Conceptual map

Final conceptual map Phase 1

mapping out initial codes

T1: Network composition

Field notes subsequently included in Nvivo

Philosophical approach

Burt 2009

Initial Concept map

Data collection

Data collection

WIT Research Day 2017

IAM2018 CORK

SPACE NETWORK CONFERENCE

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SECTION THREE

DISCUSSION, CONCLUSION & RECOMMENDATIONS

1.0 Introduction

Section three of the thesis presents the research output in the form of discussion, conclusion and recommendations. It reflects upon the initial conceptual framework and presents the revised framework. It proposes recommendations for different targeted audiences and exhibits the research contribution. Subsequently, it outlines the limitations of the research and offers direction for further research. The research objective and research questions are presented:

“To Investigate Network Embeddedness Of EU Funded Research Networks Toward The Acquisition Of New Resources”.

RQ1 What significance does motivation and culture have within inter-organisational research networks and network capability?

RQ2 What are the difficulties encountered with research networks in relation to cooperation and confidentiality?

RQ3 How do business and learning research networks evolve?

The key findings as outlined in Table 1 are discussed in this section within the context of the theory and practice in this domain. The conceptual model has been revised (Section 5.1) and acts as a boundary tool to formulate a vision to house the research objective and questions from both a practitioner and theoretical perspective. The conceptual model was designed to reflect that of a typical research network context and thus it can be applied in research contexts other than Aquaculture and ICT. The AquaSmart network can be considered of average size and composition so it is typical of funded EC research networks.

Finding	Description	Impact area
F1	Formation of a new company from EU funded research goes beyond one network into another and is dependent on the drive of individuals with support of organisations.	Success of the network
F2	The network configuration for ICT EU research needs weak and strong ties to facilitate integration of technical and commercial expertise. Diversity within the network was conducive to a wide array of impact metrics	Network configuration
F3	Social aspects of diverse network configurations. Difficulties encountered building common understanding.	Tensions
F4	Network roles as enablers within the research network.	Success of the network
F5	Friendships affected skills and competencies and enabled effective problem resolution	Interpersonal relationships
F6	Intra-network competition increases tensions and impact trust	Barriers
F7	Tangible economic impact (e.g. skills and competency enhancement, new service offerings were critical)	Success of the network
F8	Measurement of network results and performance impact are collected and analysed too early to determine evaluation award	Success of the network

Table 1: Summary of main findings

5.1 R1: Recommendation to Funding Body

The data collection instrument included provision for the participants to voice their own recommendations to the funding body, the European Commission. Whilst the findings are presented here in this section the discussion, conclusion and recommendations in the final thesis will further detail the narrative thread.

Participant A from WIT highlights the longitudinal and depth of research network relationships to eliminate or reduce the resources required to rerun an incubation period for each new research network.

Participant G from Q-Validus and Participant H from JSI highlighted their view that there is inequality between EU funded research participants in relation to involving SME's and commercial partners. There is tension in relation to the practical considerations such as funds, incentives and risk. For example, small organisations cannot be test sites for large state intervention.

Participant J from WIT outlined the process used to move from a research initiative to a spin-out and how they envisage using the next tranche of funding to tweak the software and demonstrate its validity with other fish farmers. He argues that the duration of the AquaSmart network activities limited its exploitation possibilities. Regardless of a structured and successful approach to exploitation the research output had insufficient time for optimum realisation. Furthermore, Participant J from WIT suggested that a reputation system would facilitate visibility among organisations. Participant C from i2S criticised the proposal process used by the European Commission as overly administrative while the process encourages the formation of closed networks to capitalise on repetitive crowd proposal writing. Participant H from JSI supported this idea that groups form informal networks and that they don't let anyone else in. These closed shop type networks can build on previous calls with closed consortia and he suggests introducing criteria that the consortia needs to open up or add new partners. Alternatively, he suggested a mechanism to increasing transparency to improve the identification of open and closed groups. Following on, the informal requirement to include large industry players can cause uneasiness within the research network if they are dominant in the high level European research networks but less enthusiastic to deliver.

Participant B from Ardag recommended the need to further support industry partners to be active in EU funded research networks through incentives but also leveraging the role existing technical organisations have with end-users. This cherry-picking or talent spotting approach would accentuate the research opportunity and advance exploitation possibilities.

2.0 Revised Conceptual Framework

The initial conceptual framework (Figure 1) presented in Paper 1 focussed on the main components of an ICT research project; excellence, implementation and impact. It

considered an input, process, output framework as appropriate to address the research objectives and questions:

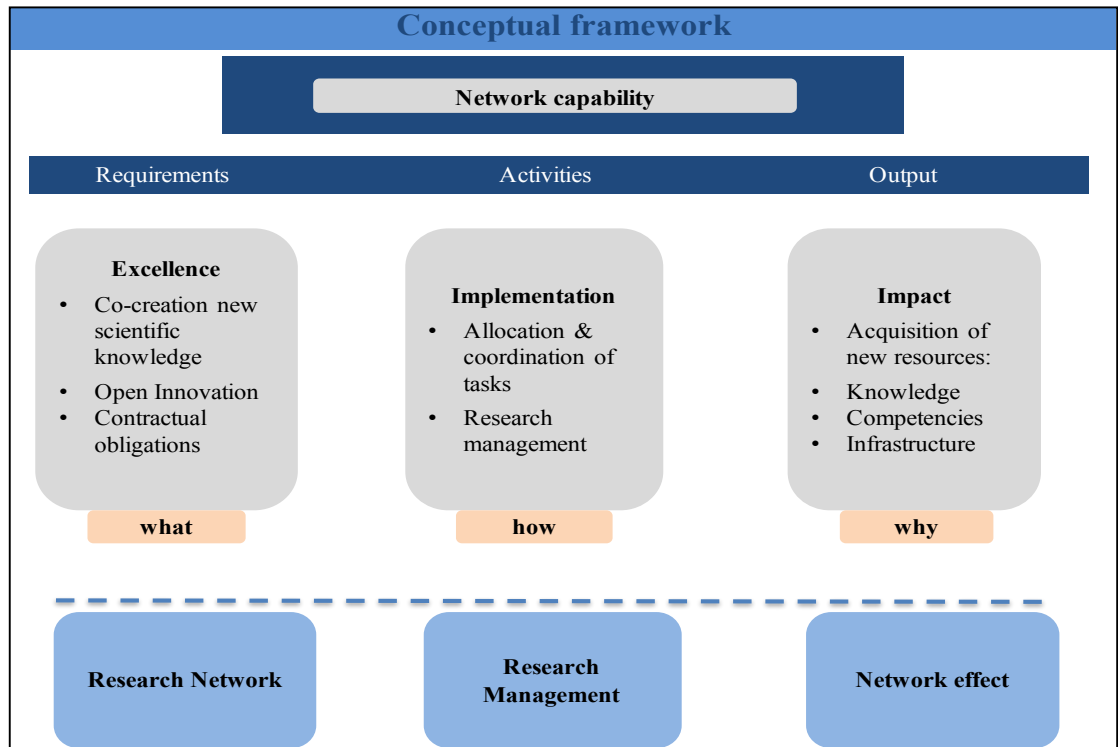


Figure 1: Initial Conceptual Framework

Whilst the network was core to the study, it was not clear what particular theories were relevant. Additionally, the scope of the research questions was too wide and not adequately focussed for the boundaries of the DBA programme. Following on from addressing the feedback from the examiners and reading the extant literature several iterations of the conceptual framework emerged over the duration of the study. An interim version of the conceptual framework is presented in this introduced the central concept of Figure 2 network embeddedness, and the related social and economic aspects. The interim version also introduced links between the concepts to visually connect the relationships.

This captured some of the broadness of the research topic prior to refinement where aspects such as dominance and cooperation were acknowledged but not core to the exploration of the research objective and related research questions. Whilst the separation of social and economic aspects was initially thought a relevant approach, upon reflection

and identification of linkages between the two major aspects, the study concludes that they are best examined in relation to network benefits and network challenges. The genesis of this research was cognisant of the build-up of frustrations within a multi-organisation network where the contributing factors inhibit research potential.

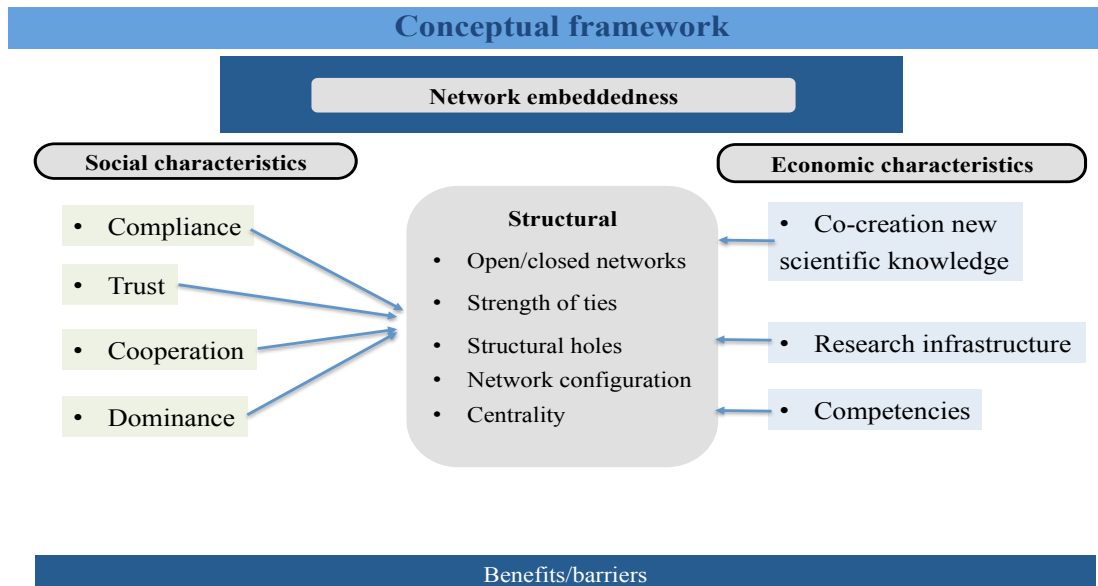


Figure 2: Interim Conceptual Framework

The context is well depicted within the study and reflects common aspects of EU funded research networks. The importance of the characteristics within the conceptual framework is supported by the data. Thus, Figure 3 presents the final conceptual framework as informed by the research findings. This clearly positions the theory, network composition, network challenges and network benefits within the framework. It leverages the knowledge gained in the study to exclude areas such as research infrastructure, compliance and cooperation as not being within the scope of this study. The final version of the conceptual framework is useful in the overall understanding of the research findings and the discussion toward future research.

To summarise the following concepts were considered out of scope for the study;

- i. Contractual obligations; dealing with the funding agency not the network members
- ii. Compliance; similar to (i) above
- iii. Implementation; part of the process of the research and not applicable to this investigation

- iv. Task allocation; similar to (iii) above
- v. Research management; similar to (iii) above
- vi. Cooperation; important for the network but not connected to the core research questions
- vii. Dominance; this was discussed in the interviews with the participants but was not sufficiently weighted for inclusion in the discussion
- viii. Infrastructure: an output of the research process, other research output was considered more relevant e.g. publications

The final conceptual framework introduced some concepts that were not initially recognised in the conceptual framework but were identified through the early phases of the study and merited inclusion.

- a) Prior knowledge; it emerged in the interviews that one of the selection criteria for network members was prior knowledge and that this was often a deciding factor for formation
- b) Previous partnerships; there was significant weight attached to the trust built up between members in previous research and industry engagements. For the study there were not many previous relationships but they filled an important bridging role in the network.
- c) Network roles; following on from (b) the role of bridge, centrality and motivator were key to the operations and success of the network
- d) Social exchange; there was evidence of social exchange but it was not central to the study
- e) Communication; similar to (d) above there was a high rate of discussion in relation to the positive communication but it was not central to the study however, it did impact the network when negative e.g. jargon issues.
- f) Research output, e.g. IP/Patents; all network members had identified their aims in relation to research output from the network, these differed between network member type in relation to publications with new knowledge and ability to provide new services or products.
- g) Co-authorship; research networks share knowledge and create new knowledge for society; co-authorship provides evidence that they can collaborate in multi-disciplines and across different organisation.
- h) Competitiveness; a major source of tension for collaborative research networks that provides opportunity to impact an entire industry.

- i) Self-organising networks; configurations of networks emerge and disband, network hopping, weak and strong ties are all longitudinal, it takes a different perspective to see that research network engagements are not temporary or short-term.

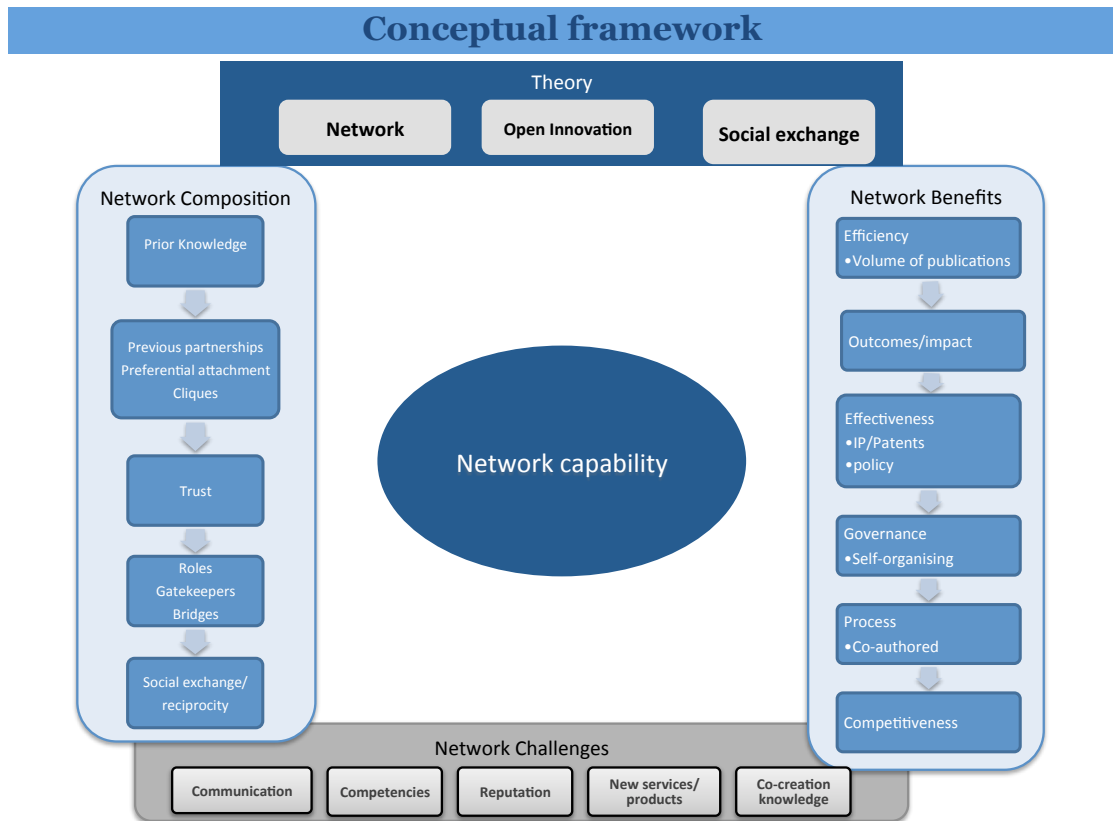


Figure 3: Revised Conceptual Framework

The results from this research contributes directly to theory in two ways, firstly, by providing rich insights in structural embeddedness. For example, the division between the type of network member; technical and business oriented. The research highlights tensions between ICT organisations and the fish farmers. This scenario is typical within research where technical and business experts converge. Particularly, the research gave details of anxiety in relation to sharing information and how this was resolved. The structure of the network illustrated how one network member provided a bridge between ICT and aquaculture. Furthermore, a unique ‘motivator’ role was identified within the network and insights illustrate the positive affect this node had in relation to problem resolution and work ethics.

Secondly, structural embeddedness has not previously been investigated in this context, a European Union research network and it provides novel contextual insights. The aquaculture industry has unique challenges that were identified in relation to the accuracy of the data (fish feed, fish deaths, counting juvenile fish). The research describes the difficulties encountered by the aquaculture industry in adopting ICT solutions and the complexities of sharing data with other network members. These insights and their tentative solutions provide a detailed picture of the network operations. Furthermore, the research details the approach taken to create a new company using the research output, knowledge and services. This unravelling of the complexities of EU research networks has aided understanding to illustrate the results of co-creation of new services. These insights in relation to the formation of the new company, the role of the academic entrepreneur and the prioritisation given to new services are key to contributing to theory in relation to structural embeddedness. It is evident that these rich and novel insights provide a deeper understanding of the research topic and its context not achievable through quantitative methods. Elements such as anxiety and entrepreneurship are difficult to measure.

The contribution to practice equips future research network members with the knowhow to pursue an optimised network strategy, cognisant of social and economic aspects. In addition, the research management function now has insights to enablers and barriers of structural embeddedness which supports their operations. For research networks a mix of weak and strong ties is recommended, however sufficient incubation is required to enhance socialisation. Prior relationships are common within research networks but structural holes and weak ties are also common. It was clear from the results that the open data policy recommended by the EC has conflicting priorities with competitiveness and that intra-network competition and the fear of sharing production data needs to be addressed and mechanisms employed to mitigate risk and alleviate tensions. The research provides insights that highlights the role of the academic entrepreneur and their position in the network to push the boundaries of the ICT solution to meet the current and visionary needs of the aquaculture industry. It was clear that the role of academics within the network is akin to quasi-business in relation to the impact of research at an economic level and an extension of their competencies and service provision capabilities. Practitioners also obtained insights to the difficulties of different funding instruments to attract academic partners that are focussed solely on new knowledge and not concerned

with research implementation. There was evidence that this potentially creates a barrier to cooperation and collaboration. These aspects of the network dynamics were evident through the examples that the network members described facilitated by the exploratory nature of the research and the flexibility to explain the nuances within the network in detail.

3.0 Discussion

Structural embeddedness is the quality and configuration within a network, how participants interact with one another, how likely future interactions are among participants, and how likely participants are to talk about these interactions (Granovetter, 1985, 1992). Structural embeddedness is central to the objective of this study. The emergent themes related to structural embeddedness are discussed in the following sections in the context of prior studies and extant literature, thus presenting the contribution to both theory and practice clearly.

3.1.1 The formation of a new company from EU funded research extends beyond one network into another and it is dependent on the drive of individuals with the support of organisations.

The vision to form a new company was included in the initial proposal in order to give a competitive edge to the proposal. Thus, subsequent to the completion of the EU funded research study, the AquaSmart network (ICT experts) have created a new company AquaKnowHow. It is one academic and one technology driven industry network member that formed the company and was granted additional funding to extend the research. Additionally, they have secured national funding under the Enterprise Ireland Commercialisation Fund and they secured further EC funded research in another context (health) which arose from the original network. Although a website was created for the new company, AquaKnowHow, at the offset of the research project, tensions were evident in relation to who (which network node) would eventually bring to company to fruition. This may be common to many research networks where potential opportunity is envisaged but the necessary entrepreneurial skills and commitment does not arise. Promises are made to meet proposal evaluation criteria but accountability and responsibility is difficult to manage, particularly at the end of the engagement. Indeed, I

believe that the absence of the central node and bridge node in the establishment of the new entity limits its possible application outside of the core network. The study reveals that their own research priorities positioned them to secure their own individual future vision. Furthermore, the study explained how the AquaSmart network would form the basis for the next endeavour.

The emergence of a new company illustrates the formation of a new network, this suggests network hopping, a term to describe the moving of some original network into the new network. This process used in AquaSmart, the creation of ties for one reason and used for a subsequent reason, supports the findings from earlier studies by Galaskiewicz (1989) and Gilsing *et al.* (2008). However, repeated network collaboration was not a priority with the Aquaculture farmers. Once they had achieved their research goals they were keen to implement improvements to their production or business models to exploit its economic worth. This is interesting, currently EU funded research promotes the creation of new companies, if certain network members are more probable than others to create new companies, perhaps supporting resources need to recognise this.

3.1.2 The network configuration for ICT EU research needs weak and strong ties to facilitate integration of technical and commercial expertise. Diversity within the network was conducive to a wide array of impact metrics.

The evidence from AquaSmart illustrates a transformative period for aquaculture farmers to use the technology developed through the research network to access opportunities and optimise the impact of the research. The results from the AquaSmart network show how network behaviour impacts the outcome and results from that network. Furthermore, it shows that the behaviour of the network is tightly linked with the depth and quality of interpersonal relationships within the network. Additionally, network configuration and diversity impact the formation and incubation of the network, which is also crucial to network output. From a practical perspective, the action of doing research is a cyclical process with researchers contributing to existing knowledge and building on previous research. This research demonstrates that there is some stability within this process and suggests that many researchers eat, sleep, research, and repeat. It is also important to

observe that, the composition of research networks is not limited to academic researchers. Academic research is quasi-business and it funds major elements of educational institutions. Industry are a major stakeholder, often driving the direction of the research toward market implementation and economic value (Etzkowitz, 2003; Perkmann *et al.*, 2013; Bolzani *et al.*, 2014).

At the research funding proposal stage the network participants form a temporal research network that may only last the duration of the proposal writing if the research is not funded. Thus, the strength of the network ties are affected. To gain funding, participants are required to demonstrate their ability to go beyond state of the art in many cases and if funded the research network may need to scale back the promises made due to their feasibility. Network participants cannot predict network convergence; there are many variables which may influence it, such as, inter-personal relationships or competitive needs. A recognition for diversity at proposal stage might aid network optimisation at implementation stage fulfilling the fundings agency objectives to drive existing industry and create new industry.

Furthermore, those network partners with experience of previous research networks have more knowledge of how to negotiate a consensus. Mitchell (1974) claims that intercorporate ties focus on their own interest and acting autonomously. However, there is a requirement within EU funded research for inter-organisational collaboration. Thus, to comply with EU funded research policy it is critical that roles are established that promote this diffusion and understanding. Wendt (2000) argues that strong players force other participants to use a certain solution. This needs to be considered especially in the case such as AquaSmart where the vulnerability of the smaller organisations was evident.

This research contends that it is essential that a wider EU network of evaluators, reviewers, and researchers are deployed as a core input to growing and nurturing a network. It is evident from this research, that networks can be limited by prior relationships and existing networks of contacts, when new project proposals are being considered. EU funded research promotes economic growth and the creation of the new company from the AquaSmart network meets this ambition leveraging its initial network configuration gained from the wider EU network. Fischer (1982) claims that within social networks that people with low incomes predominantly have dense cliques as they have

insufficient material and resources to manage dispersed networks. Thus, research networks need adequate funding and resources to ensure their networks are not limited to dense cliques and are more dispersed. This resonates with the impact of resource limitations highlighted in the innovation and entrepreneurial literature (Zimmer, 1986; Hoang and Antoncic, 2003). My own experience as an evaluator within the EU administration network, including staff members of the EU administration increases reliability and encompasses trustworthy processes and people. It was clear that some of the AquaSmart network was established through ‘cherry-picking’ appropriate organisations and individuals affiliated through other research purposes prior to drafting the proposal. However, other AquaSmart network members were invited to join the network through weak ties and bridges. Thus, there was little or no homophily which is beneficial toward the generation of novel ideas (Granovetter, 1973; McPherson *et al.*, 2001). Furthermore, prior relationships meant that the network participants already trusted some of the network members. This meant that not all links started at the same level of trustworthiness. There was clear evidence that this specific feature of the network solved problems and resolved tensions within the network at key junctures. Granovetter (1985), Krippner *et al.* (2004); Krippner and Alvarez (2007) claim that the social characteristics in this study such as cooperation and trust need a significant impact on network effectiveness. These network configuration aspects are intertwined with other findings within this study such as economic output and intra-network competition discussed in sections 3.1.7 and 3.1.6 (Bozeman *et al.*, 2013; Maughan *et al.*, 2013; Perkmann *et al.*, 2013).

There was huge diversity evident in the network, section 10.0 discusses the potential for future research in relation to diversity in networks. In many research networks there is amalgamation of more than one discipline involved to try to solve research challenges. In this study it was technology and aquaculture. It is possible that much of the EU funded research networks have similar network configurations. The network formation included many weak ties. The merits of structural dimensions such as novel innovation, enhanced operational and financial performance and increased understanding between relationships, support previous evidence in the literature (Burt, 2009; Granovetter, 1973; Kim, 2014; AlKuaik *et al.*, 2016). Some of the links were through prior relationships particularly for the relationship between i2S, the ICT partner who introduced his clients the Aquaculture SMEs to the research network. This diversity required bridges to find

understanding that enabled trust. iS2 was regarded by the network members as a bridging point, helpful in difficult times of conflict to resolve problems between the 2 distinct types of network members.

The findings of this research recognised the initial 6 months of AquaSmart's network activities as difficult, due primarily to the technical jargon and domain specific knowledge in relation to fish-farming.

Research networks are homes to test and validate ideas and procedures. These conditions can act as a training ground to support and nurture European researchers. However, depending on the configuration of the network, the ability to attach an economic value to improvements in competencies and skills is not guaranteed. The complexities involved centre on the composition of the network, willingness, and the capacity of participants to draw on inter-personal interactions. This study demonstrated great willingness and capacity that was leveraged to improve network competencies. Collective know-how and technical implementation was key to realisation of the research.

The network members placed a high value on the expansion of their network and possible future opportunities available to the network. However, evidence also supported the case that different types of network members have little capacity to resource weak ties and network engagement outside of their existing closed network. For example, priority is placed on common industry networking events as these were perceived more strategic and core business for the industry partners than research networks. Granovetter (1985) recommends that embeddedness be further investigated as behaviour and institutions are so consumed by ongoing social relations. The connectedness between economic and social activities, as illustrated in the conceptual framework is also adopted by other authors (Burt, 2009; Krippner and Alvarez, 2007; Baker *et al.*, 1992). Furthermore, Granovetter states that embeddedness is an umbrella term that is ubiquitous and is not measurable.

3.1.3 The Complexities of Social Relations within Diverse Network Configurations. Some Of The Difficulties Encountered Building Common Understanding.

It was evident from the study that social and interpersonal aspects enabled and hindered the operation of the research network. There were explicit activities identified that contributed to the openness and trust between network members. These included informal dinners, coffee breaks and pre-meeting exercise activities. Once openness and trust were established during network incubation, network cohesion improved and network tensions decreased.

The depth and wealth of industrial knowledge held by end-users created an initial barrier in relation to understanding the language of the industry requirements. However, it emerged that this converted to a running joke about ‘talking fishy’ once the initial difficulties were overcome and a common language was established. Other literature (Welch *et al.*, 2005; Fredriksson *et al.*, 2006) has managed to decouple language and culture in respect to global business effectiveness and further our understanding of the multiple facets of language and how it affects day-to-day operations. This study provides an additional context for similar complex challenges. This study provides strong evidence in relation to understanding the complexity of diversity in networks, specifically language, also identified in earlier international management research studies (Brannen *et al.*, 2014; Brannen and Doz, 2010).

The study demonstrated how network members teamed together to meet deadlines and milestones and share responsibility. The AquaSmart network evidenced effective social and behavioural aspects.

3.1.4 Network roles as enablers within the research network.

The study provided an analysis of the configuration of the network. Particular roles identified included that of Motivator, Bridging Member and Gatekeeper, aiding the network cohesion. These individuals and the roles they played fostered collaboration through their behaviour, for example providing motivational speeches at face-to-face

meetings, and providing a central point for network communications. The Motivator used techniques to mould the network to establish trust between members and brought friendships, family and interpersonal relationships to the fore of the network. Reinholt *et al.* (2011) argue that centrality needs to be supported by motivation and that trust and reciprocity don't thrive in larger networks but that motivation and centrality can counteract this to support knowledge sharing. This is evident in the AquaSmart case where initially trust and reciprocity were absent and techniques employed by the Motivator and Bridging Member aided the network operations. The motivational talks at AquaSmart plenary sessions were considered crucial to meeting milestones.

The AquaSmart network benefited from bridging between different types of network members. This study provides additional empirical evidence in relation to the advantage of brokering connections between otherwise disconnected segments as proposed by Burt (2009; 1992; 1982). Following on, the literature supplies evidence on how all behaviour can be motivated resulting in reward or punishment (Burt, 1982; Marsden, 1990; Feld, 1981; Fischer, 1982; Laumann and Marsden, 1982).

I believe that the cornerstone of society and the economy lies in our ability to link ICT research with application domains such as Aquaculture to realise the potential. These disparate communities do not naturally connect, but the funding allocated by the research of the European Commission facilitates this collaboration. The extant literature highlights the difficulty in capturing informal relationships (Contandriopoulos *et al.*, 2016). This study shows that the bridging role is an important aspect to positively affect scientific performance. The role of the Bridging Member was critical to aid problem-solving between the fish farmers and the technical personnel.

The existing trust established through prior relationships was a contributing positive factor to the scientific performance of the network. Whilst Contrandriopoulos *et al.* (2016) claim the role of brokerage is more significant than cohesion of the network, this study did not make the same distinction. The Bridging Member negotiated common ground for resolution and progression. The literature has much evidence on the positive role of centrality and openness in a network (AlKuaik *et al.*, 2016; Freeman, 2011; Gulati and Gargiulo, 1999; Scherngell and Lata, 2013; Scherngell and Barber, 2011). This study provides additional empirical evidence in relation to understanding centrality.

It is clear from this study, that funding agencies must consider the introduction of a mechanism to ensure openness in research networks. The existence of closed networks in consortia are frustrating to non-members; they build upon previous calls, the networks are longitudinal in nature and have informal inclusion and exclusion criteria. One of the interviewee participant's suggestion was to include a mechanism to ensure openness and adopt criteria for evaluation or weighting for openness at the stage of network formation. In my own experience, I have seen cliques exist in research networks, however it could be interpreted that although they may look like a closed shop, they are in fact, in their own vision, optimising an effective research network. Short-term networks often decide to cocoon themselves for a while to leverage their comfort of knowing each other well in relation to professional competencies and social nuances. Creating sub-communities in EU funded research/working groups has its advantages and disadvantages as you may be eliminating the positive innovative effect weak ties and structural holes have on a network. However, if the funding agency values the work of Burt (1992) and Granovetter (1985; 1992) as pertinent to reaching their funding objectives (increase in novel ideas) then perhaps they need to consider introducing a mechanism to facilitate openness in research networks. The evidence highlighted that prior engagement with EC funded research positively affected the openness within the network. Thus, it leads to the belief that openness can be managed and having network members familiar with EU funded research can influence the openness of the network.

If we compare a EU funded network (or formation of a new network) to a new job, the individual sends in a CV (proposal) to gain employment, just like a competitive funding application. Upon granting of the funding /acceptance of the job there is a period of time under probation where the employee is guided and both parties have to comply to their contractual conditions. While some may see EU funded networks as temporary networks, it is my belief that they are re-used for many different endeavours and are a worthwhile investment for longitudinal returns. For the proposal writing phase, the funding institute has recognised the difficulties for partners to meet-up and have established mechanisms similar to social networks online partner search functionality, partnering events, LinkedIn groups and databases of previous research to assist researchers in this network formation phase.

Similar to the findings of Bonebright (2010); Tuckman (1965), this study concludes that the forming, norming, storming and performing evidence in the first period is a critical stage of engagement. Bonebright (2010) reiterates the usefulness of the model aided by advancements in-group dynamics research in complexity around leadership, motivation and rewards. These models are relevant in research networks today. The stages of norming, forming, storming, performing and adjourning illustrate the role and depth of interpersonal relationships particularly within this context in EU funded group research. This study provides additional empirical evidence that understanding different partners, different cultures and different work practices has a significant impact on network performance.

Gulati and Gargiulo (1999) assert that relational embeddedness aids organisations to adopt reliable partners for alliances and inter-organisational network formation. This strategy minimises potential hazards of cooperation. However, they recommend further research on the trade-offs encountered on limitations of potential partners. Furthermore, they suggest that industry factors such as technological uncertainty and the rate of change could affect structural differentiation on alliance formation. This is relevant to this research as it highlights the issues encountered within the AquaSmart network where some of the network partners were not technically adept and the rate of change was slow. The adoption of solutions to address big data in the Aquaculture industry was low with the industry failing to recognise the potential benefits in relation to forecast modelling and cost processing. In addition, the findings revealed that the smaller organisations felt most challenged in the formation of the network and initial incubation period. The research work was outside of their normal operations and there was the EU research environment language and the ICT jargon to contend with. This suggests some intimidation from the larger experienced research organisations to the smaller participants in this collaborative research. It is feasible to suggest that other industry domains outside of aquaculture could face similar challenges in the formation and incubation period.

Granovetter (1985) in his work on how behaviour and institutions are affected by social relations argues that Williamson (1979) does not sufficiently consider personal relationships during economic transactions. Furthermore, Mitchell (1974) links transactional theories to network concepts claiming that intercorporate ties do promote self-interest and autonomous actions toward maximum profit. This study concurs with

Mitchell (1974) and shows that some AquaSmart network members engaged in self-interest and realisation of their own research objectives. The evidence shows how they created their own sub-groups to focus on their output leaving issues such as inter-organisational competition for other participants to control. Further research might explore this and uncover its prevalence across other EU research networks. The evidence from this study clearly indicates that an individual's behaviour, actions and exchange of knowledge or services can have an economic impact. Particularly, the network members from the fish farms indicated that the research enabled them to apply more accurate business models using the developed algorithms and were able to tweak their core business periodically. Additionally, they identified the new competencies they gained as enhancing the profitability of their organisations. Social exchange theory stresses the exchange aspects of all ties and the usefulness of distinguishing between positive and negative exchange experiences (Cook and Whitmeyer, 1992; Durkheim, 2014; Coleman, 1988; Blau, 1964).

3.1.5 How Friendships and Soft Skills Affected Competencies and Enabled Effective Problem Resolution

Some members of the AquaSmart network considered other members like their own family. This positively impacted learning and enhancement of skills and competencies. The actions of the Technical Lead to share knowledge of big data solutions and to bring together the machine learning models resulted in the emergence of a new company (AquaKnowHow), as previously described in Section 3.1.1 which has the potential to increase sales of the AquaSmart technology. These softer attributes such as friendships and knowledge sharing are relevant as the research output gets adopted outside of a trusted research network. These participants work well together as they trust each other's competencies and abilities to deliver quality research. The relevance of friendship should be recognised as a deciding factor for an adequate return on investment for tax-payers money. Further research might seek a solution to achieve this. Research is for society and the economy for all types of stakeholders, by not recognising the difference in research output in a structured (perhaps not yet measurable) manner we decrease the possibility of eliminating ineffective research and optimising effective research networks. In some cases associated competencies such as understanding, cohesion and translation were

emphasised above technical and business expertise. For some network members, trust went beyond their professional relationships to that of a caring, friendship cognisant of longevity and loyalty. Perhaps softer skills such as listening, respect and diplomacy are more relevant than previously considered for research network competencies.

3.1.6 Intra-network competition increases tension and negatively impacts trust.

This section discusses competition and tension within the network. It outlines the triggers and resolutions and gives some insight as to the operations within the network.

3.1.6.1 Tensions around data sharing

This study shows a major challenge in AquaSmart was the sharing of production data, which was regarded as a necessity for academic researchers and a risk for industry. The network members described the need for a re-evaluation of resources and research scope to resolve issues between network members. As identified by Perkmann and Schildt (2015); Perkmann *et al.* (2015) the emergence of ‘open data’ initiatives has initialised new challenges in relation to industry and academic partnerships. Risks in relation to leaking data to competitors and demotivating academics have increased, highlighting the complex concepts of dominance, cooperation, compliance and trust (Perkmann and Schildt, 2015). Participants in this study discussed the need to keep their data safe and secure, and it was apparent that the policy of open data increased the unease in relation to competitiveness between participants. During the network incubation period, evidence of intra-network competition between partners was hugely invasive to the progress of the research and trade secrets were closely guarded. The disruption did cause a negative impact on progress and final output. Whilst a solution to this issue was implemented, whereby a range of data per fish farmer was submitted and anonymised, it did highlight the competitive nature of EU funded research. This solution, along with techniques such as data anonymisation and data protection may have relevance in other research networks and could be implemented in other contexts.

3.1.6.2 Tensions in Relation to Different Funding Levels for Network Members.

The study provides strong evidence of the tensions created within the network in relation to inter-organisational competition where the financial support from the funding agency favoured one type of stakeholder above another. To aid understanding it is necessary to understand the context in which the network members operate. These EU networks rely on specific partners that are industry driven who provide market requirements, commercially sensitive production data and validation. A negative link between the protection of commercial data sets and inequality for funding arrangements between different participant types was evident. Disparities in funding among network participants negatively impacts on the participation rates, commitment of network participants increasing tensions in the network. The funding policy only facilitates the inclusion of network members from industry that can meet the financial burden of collaborative EU partially funded research, those that have the financial capacity to engage in research activities, and run the risk of making a financial loss on these research-based activities. Thus, it adds complexity to accurately measure the lost opportunity for non-participants due to entry restrictions.

The literature has considered a variety of EU programmes that researchers participate in, and details how the landscape has changed in recent years (Benner and Sandström, 2000; Gulbrandsen and Smeby, 2005; Scott, 1995). Research policy needs to reflect on the different needs of industry for research, and consider the structure within an EU research network to fully understand the impact of opportunities and tensions for different stakeholders within a network. Following on, the absence of funding to pay end-users adequately for the use of their market data needs to be addressed. Indeed, it was highlighted that the research network depends on the end-users for application specific requirements, validation and data but that their funding model was less advantageous than the academic model. The responsibility for research output is placed on those responsible for the technical solution (academic and technical organisations), those most probably to financially benefit will be the industry participants but the solution cannot be tested unless the data is released so that the research can move close to a market environment for validation. These complexities add to the operations of the network and have been highlighted in the literature. Additionally, the literature claims that companies not engaging in EU funded collaborative research are relying on internal R&D and miss out

on the advantages of accessing inter-organisational pools of knowledge especially where there is insufficient requirement to build technology capability (D'este and Perkmann, 2011; Perkmann *et al.*, 2015; Perkmann *et al.*, 2011; Perkmann and Salter, 2012; Prodan and Slavec, 2012)

3.1.6.3 Network Members Find It Difficult To Establish Trust

Trust emerged as significant for the configuration of the network, and the economic and social aspects of structural embeddedness within the network. During the network incubation period, trust was emphasised by each network node as a constraint to progress. Trust is central to each and every inter-personal relationship and it affects behaviours of networks participants (Neves and Caetano, 2006). It is necessary to explicitly address trust to establish boundaries and implement solutions for collaborative networks that include weak ties and structural holes permeable to innovation and creativity.

Furthermore, rather than focus on the duration of the network or its temporal nature, it is the longevity of the network ties that is a valuable resource. Research networks have a lifetime duration, ties built up over time and experiences are reused for different purposes (Galaskiewicz, 1989). Trust is an enabling factor for this reuse and subsequent engagement. This study purports that trust is aligned to the depth of the interpersonal relationship and that where trust is truly evident, the relationship is more innovative, less risk averse, and more open. Disruptive technological advancements thrive on the supports of the funding agency to commit to facilitation of engagement that surmounts superficial layers of trust and builds deeper relationships. Ultimately the success of the network and the optimisation of the research are affected by trust. This links with Section 3.1.5 on friendships established based on trusted relationships. Whilst the global economy has triumphed through many challenging aspects in relation to working in different geographical locations, cultures and time zones the findings from this research highlight the benefits of network participants meeting in person. The opportunities provided by face-to-face meetings to build trust, observe style and eliminate bias aids the trust-forming stage and accelerates toward the performing stage.

With regard to trust at formation stage research networks engage in a form of panic buying, it was evident from this network that core competencies were lacking at a late

stage in proposal writing and some partners were added ‘just in time’. Perkmann *et al.* (2015) claim that boundary organisations can act as trusted information brokers to aggregate and distribute information, a critical activity for collaborative virtual teams (Precup *et al.*, 2005; Cormican and O’Sullivan, 2004). Similarly, in this study, it was the Bridging Member that helped adequate trust develop between all network members. It was the Motivating Member that used trust to identify and resolve conflicts, for example arranging face to face meeting to resolve network issues. Within the AquaSmart network it was the small companies who cited trust as a major concern exposing their vulnerability within the network. The Bridging Member and Motivating Member addressed their sense of vulnerability and anxiety gaining the confidence of these network members. However, building relations is a slow process and perhaps the introduction of trust building activities can be promoted early by the funding agency. With abundant evidence that research collaboration has become the norm in every field of scientific and technical research the literature presents optimisation mechanisms in addition to malpractice (Bozeman *et al.*, 2013; Huang and Lin, 2010; Huijboom and Van den Broek, 2011; Roediger-Schluga and Barber, 2008; 2006; Melese *et al.*, 2009).

It may be useful to contrast a research network with a learning network and thus adopt strategies such as Vygotsky (1987) zone of proximal development to garner the skills and competencies required for research optimisation. Perhaps at the end of a contractual research network engagement we should objectively assess the impact and look deeper to the inclusion or exclusion of network members in initiatives such as joint publications. Furthermore, once we start to delve deeper into the relationships between network participants it is evident that trust played a significant role in the operations of the AquaSmart network. As research communities are longitudinal in nature it is no doubt that trust is a contributing factor in relation to priori relationships, consortia building and reputation management.

3.1.7 Tangible Economic Output from Network Activities

This study provides strong evidence that different network members had different visions in relation to the economic value of participating in the network. It is conceivable to claim that the research network results; new service offerings and the establishment of a new company, are significant contributions to our economy and society. The behaviour of

network members included positive exchange experiences creating valued items albeit not confined to material items. The expectation of network members presented great diversity with the academics describing their research results as moderate and the industry citing profound results. This study explores some of the economics within a research network. The literature indicates that dispersed networks need more resources than dense cliques, particularly for construction and maintenance. This study supports the literature in the view that collaborations enhance the productivity of scientific knowledge and thus research collaborations are integral to economic growth (Bozeman *et al.*, 2013; Huang and Lin, 2010).

Recently, both at a practitioner level and within the literature the focus has moved from research output to research impact (Perkmann *et al.*, 2015; Li *et al.*, 2013; Gonzalez-Brambila *et al.*, 2013; Bozeman and Melkers, 2013). Furthermore, Bozeman *et al.* (2013) highlight the differences between knowledge focussed research collaboration and property focussed collaboration. This distinction between marketable product and raw scientific knowledge has been the focus of numerous research strategies in relation to applied and basic research (Huang and Lin, 2010; Pravdić and Oluić-Vuković, 1986). The research results support the literature and contend that individual level collaborations and the social psychology of the collaborative teams drive the productivity and impact of the research. This research defends the literature that research collaborations can be dependent on the individuals within the network and the social interactions between network members. Furthermore, the emerging research on model based network theory and growing interest in the bond model is developing valuable new theory and progressing our understanding of network theory (Borgatti and Halgin, 2011). It is clear from this study that the AquaSmart network demonstrated the bond model, resulting in the transfer of capabilities.

This research urges funding agencies to aid network exploitation options by extending the research network to a longer timeframe e.g. implementation /market feasibility period. Ultimately, the AquaSmart network set up a new company, however, it seems that there is some confusion as to who is driving the initiative and perhaps some tension as to the inclusion or exclusion of network members. AquaSmart provided a revolution to the Aquaculture industry. This finding reaffirms the impact of linking academics with industry to apply disruptive technology to underperforming industries.

This research highlights cases of how the economic impact of improving competencies and skills and development of new service offerings is significant. This concurs with Agarwal and Selen (2009; 2011) who cite ‘elevated service offerings’ as only achievable through partnering highlighting collaborative agility, collaborative innovative capacity and entrepreneurial alertness as skills gained through partnering. The results from this research confirmed that more than 50% of the network members gained new service offerings as a result of network participation with further members claiming a profound impact on the Aquaculture industry in relation to enhanced technology adoption.

3.1.8 The Measurement of Network Results and Performance Impact are Collected and Analysed too Early to Adequately Determine the Research Results

This study provides strong evidence that the measurement of network results and impact are collected and analysed too early to determine fully an accurate evaluation award. There are many factors within a network that impact the success of the network. The context of this research is a European funded research network involved in optimising aquaculture through better use of technology. Overall, the results and impact of the AquaSmart research network is considered successful, as measured by the independent reviewers appointed by the EC. This is reflected in the milestones and research objectives that were measured during the network engagement period. However, even though the network itself is longitudinal, the specific network engagement supported financially by the EC is temporal. The findings from this study illustrate that post-AquaSmart the network members engaged in the formation of a new company (AquaKnowHow), a National funding initiative in aquaculture and in a EU funded non-aquaculture research project. These metrics were unavailable at the time of the final AquaSmart evaluation by the EC. The literature has highlighted complexities in this area and some member states have addressed some of the issues through regulatory frameworks and key performance indicator measurement. (Bolzani *et al.*, 2014; Perkmann *et al.*, 2015; Perkmann *et al.*, 2013; Bozeman and Melkers, 2013; Bozeman *et al.*, 2013). However, there is no consensus on policy measures undertaken to encourage the commercialisation of academic research activities. This research gives some insight to the realisation of planned company formation through research. It suggests that research network

configurations need to be inclusive of researchers willing to transform and drive the research into marketable services and products. Further research might discover how to address these challenges.

The manner in which embeddedness impacts performance is recognised in the literature as difficult to measure. This is consistent with the findings from the AquaSmart network. Interestingly, the creation of a new company by some of the AquaSmart network members to increase the absorption potential of the network output, did not seem to worry those network members already in the market. The Bozeman *et al.* (2013) and Bolzani *et al.* (2014) cite the difficulties in measuring the impact of the research network. This study gives insight as to why measuring research results directly post-funding is not conducive to commercial evaluation and is thus flawed.

4.0 Conclusions

Aquaculture is globally the fastest growing food industry that now accounts for nearly 50% of the world's fish that is used for food. In the last three decades, world aquaculture production increased from 5 million to 63 million tonnes²⁵. This study is unique as that there is no evidence that I am aware of in other studies which specifically links ICT research (open data analytics) with the Aquaculture industry.

The research landscape in European is dynamic, welcoming diverse combinations of research networks. My own professional experience has driven me to explore research networks. This research provides useful insight in relation to researchers forming networks based on individual experience, colleague recommendations and proposal necessity. This study has provided strong evidence to demonstrate the positive impact structural configuration and quality of inter-organisational relationships has on network operations. Specifically, the AquaSmart network configuration illustrates the inclusion of weak ties, structural holes, Bridging Members, Motivational Members, Academic Entrepreneurs who aided the performance and exploitation of the research network.

²⁵ <http://ref.data.fao.org/>

The study used the AquaSmart network as a single case study, it is a high functioning network with good efficiency and effectiveness. It is clear from the study that the depth of the relationships within the network contributed significantly to the positive collaboration, mutual respect and successful evaluation of the research. The study provides empirical evidence of social and economic aspects of structural embeddedness and highlights the barriers and enablers encountered within the AquaSmart network. The funding agency provides economic stimulus for the research network formation. Research networks depend upon the provision of adequate funding to arrange physical face to face meetings and social interaction. This study shows that these activities are integral to build trust within a research network. The high levels of trust between AquaSmart network members impacted competencies, problem resolution and in the case of AquaSmart initiated an informal running group within the network. These insights deepen our knowledge of effective research networks and provide the scaffolding for long-lasting structural innovation.

The EC repeatedly funds research in the €2-6M bracket which attracts, within eligibility criteria set by the EC, a mix of network members akin to the AquaSmart network. Thus, the findings are applicable in other contexts.

EU funded research follows an evaluation process at proposal stage but also at key milestones during the implementation of the research. This study claims that whilst it is necessary to evaluate the success or failure of the research at the end of the funded engagement it concludes that this stage gives insufficient weighting to the full impact or exploitation of the research. Whilst a full solution for measuring the longer term effects of research network is not yet clear the study suggests explicit monitoring of output in relation to company formation and provision of new service and product offerings.

Furthermore, the study suggests that network hopping is a common activity post-engagement that leverages the entrepreneurial skillset that has grown in one network and brings these skills to other networks, such as venture capitalists, angel funding and global dissemination.

Research networks encompass a unique profile that can be generalised somewhat across the common funded work programmes as the eligibility for inclusion in the network is set

by the funding agency and includes characteristics such as the inclusion of at least three partners from different EU member states. This study emphasises the need to include diversity in the network and be cognisant of the advantages of weak ties, structural holes, Bridging Members, Academic Entrepreneurs and Motivational Members. The tangible economic output gained from the network was recognised as a product of motivational techniques and effective problem resolution through interpersonal exchange.

Collaboration between disciplines is considered critical to push innovative solutions to market and also to discover disruptive innovative technologies. This resonates with evidence from the AquaSmart case and literature in this field in relation to structural embeddedness, innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley *et al.*, 2000).

A major area of concern for the network was intra-network competition that played havoc with the realisation of network benefit and value. The overall scope of the research was adversely affected through the issues encountered even though these were mainly resolved. The study proposes solutions to anticipate and resolve intra-network competition.

The pledges of aquaculture production data that encompassed metrics related to trade secrets such as feeding strategies, feed composition, production management practices and farm operations were not provided. Thus, the open data policy caused major tensions and impacted the network significantly. The complete findings are detailed in Paper 3 and Paper 4.

5.0 Contribution to Theoretical Knowledge

Overall, the findings from this qualitative research contributes directly to theory by providing rich insights of structural embeddedness in a research network that included diverse network members (ICT and Aquaculture experts). The following section, summarised in Table 2, presents the key contributions to theory.

Contribution	Description
C1	Guidelines for structure, configuration and composition of research networks
C2	Recognition and proposed resolution of language ambiguity
C3	Operation of Competitive nodes to manage challenges of EU Open Data Policy

Table 2: Key Contributions to Theory

C1. Guidelines for structure, configuration and composition of research networks

This study explores the structure and configuration of research networks and suggests guidelines for the EU funded research landscape. Specifically, this study provides empirical evidence in relation to the success of this network adopting a mixed configuration of weak ties, structural holes, pertinent to innovation and development of novel ideas (Burt, 2017; 1992; Granovetter, 1973). This research adds to the knowledge in this space by recognising the unique roles research networks necessitate. It enhances existing research recognising the connectedness of network members and demonstrates how weak ties, structural holes, bridging, motivation and entrepreneurial activities are realised. The effects of network embeddedness are recognized in the literature as significant to innovation and the economy (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Owens, 2012; Rowley *et al.*, 2000; Rowley *et al.*, 2011). Central to this research are the theories of Granovetter (1973), Burt (2009), Coleman (1988) and Bourdieu (2011), who present dyadic arguments for structural and relational embeddedness. For the AquaSmart network there is a core of interlinked actors who recognised the openness of the network. This study also presents examples of closed networks within the wider EU funded network landscape and the AquaSmart network members did suggest the need for further enquiry into the open or closed nature of such networks.

The significance and evidence of roles within research networks is immature. To date network theory has provided excellent contributions on concepts that map connectedness. This research provides details to support the implementation of these concepts within a particular context. This study provides examples of how, Academic Entrepreneurs, Bridging Members and Motivational Members have impacted the operations of the network through network formation and attainment of the research objectives. For example, qualitative studies illustrating commitment to market implementation are scarce. The findings from the study provide insights that enhances our understanding and

can be used going forward in future research. The study provides evidence that research networks are a sector in society that partakes in collegially based norms and are somewhat cocooned. For example researchers evaluating research, thus blurring the reality of open and closed networks. The roles identified in the AquaSmart network demonstrate the actions taken toward the opening up of research networks.

C2. Recognition and proposed resolution of language ambiguity

The findings of the study highlighted the tensions created through language ambiguity. There are multiple facets of language, such as, national, technical, corporate and industry jargon that affect day-to-day operations of the network. In addition to practical implications, the study suggests additional enabling solutions to gain common understanding which supports the extant literature (Welch *et al.*, 2005; Brannen *et al.*, 2014; Brannen and Doz, 2010). The study emphasises the barrier language created in the initial period of operation with a divide evident between business and technical network members. The measures to bridge this divide were significant. The configuration of the network included specific roles that addressed the language ambiguity and the impact it had on the performance of the network. The Bridging Member and Motivation Member adopted actions that significantly altered the direction of the research network. Additionally, greater priority on understanding the core business of Aquaculture facilitated common understanding and thus objective attainment. There seems to be little theoretical evidence of this in research networks.

C3. Operation of Competitive nodes to manage challenges of EU Open Data Policy

The recommendation by the EC to promote the EU Open data policy in EU funded research networks poses many challenges. The rationale for industry to participate is often to improve their market competitiveness. The findings from this study identify examples of the complexity of the challenges rooted in the network composition and intra-network competition. Whilst confirming existing theory this study increases our knowledge in depth and context for this research challenge (Perkmann and Schildt, 2015; Cormican and O'Sullivan, 2004). The AquaSmart network composed of three fish farm organisations, the ICT organisations were dependent upon them to provide an array and volume of data. The research shows that research network members were anxious and uncooperative before measures were adopted to protect network members sensitive data from each other and the outside research network community.

6.0 Recommendations for Practitioners

This study revealed several important findings from which key recommendations for practice-based individuals and organisations can be generated. In particular, these recommendations are of significant importance for organisations and individuals active in EU funded research networks, both inside and outside of the ICT Aquaculture domain. Table 3 presents these key recommendations for practitioners.

Recommendation	Description
R1	Practitioners need to recognise the diversity of network members and alleviate problems of language and jargon through training, workshops and a terminology report.
R2	Researchers need to approach network formation in a structured manner to include a diverse network composing of; weak ties, structural holes, Bridging Members, Motivational Members and Leaders. Use the proposed evaluation matrix to structure network formation.
R3	Explicitly address the complexity of EU Open data policy and how the network members can secure sensitive data during proposal development.
R4	Practitioners need to analyse the proposal in the context of achievable implementation once funding is awarded.
R5	Recognise how friendships affect skills and competencies and enable effective problem resolution. Introducing mechanism for socialisation in network incubation period.
R6	Practitioners need to justify and promote longitudinal support for research networks by reporting on research journeys beyond funding period. Practitioners must recognise the advantages of network hopping e.g. national and European initiatives to secure longitudinal support for research.
R7	The operationalisation of the conceptual framework presented as the Building Network Capability in Research Model (BNCR) provides a mechanism for practitioners to implement the recommendations and insights gained.

Table 3: Recommendations for Practitioners

R1. Practitioners need to recognise the diversity of network members and alleviate problems of language and jargon. The challenges of technical language and jargon may not be easy to eliminate, but measures can be taken to get multi-disciplinary networks understanding each other. For example, those in roles of Centrality,

Bridging Nodes and Leaders can address these barriers explicitly by providing training and/or workshops to reduce ambiguity and increase clarity and understanding. The network incubation period was frustrating for network members. This frustration could be alleviated by introducing mechanisms for socialisation and building trust. Similar to enhancing employee initiation periods, networks may benefit from approaching the network incubation period in a more structured manner by establishing mechanisms to include induction, training and mentoring within the research network. Leaders should prioritise funding to enable regular inter-organisational meetings, informal dinners, mingling during breaks and, bridging the divide between the diverse network configuration. Research network members should develop a common terminology report in first operational period.

R2. Researchers need to approach network formation in a structured manner to include weak ties, structural holes, Bridging Members and Motivational Members. This study shows that there is merit to structure your network, create new networks using a strategic approach and maintain existing networks. Utilising network theory there is benefit to gain from recognising optimum network composition, analysing requirements and identifying solutions. This will optimise network performance and provide opportunities for innovation and the development of disruptive technologies. To achieve this a practitioner may develop an evaluation matrix or framework to analyse the justification for inclusion or exclusion to a network. Table 4 illustrates an initial set of variables for the matrix. A gap analysis of skills and competencies is important but so is access to a dispersed network and softer skills such as access to different environments, ideas, novel approaches, test equipment, infrastructure and angel investors. For example, Practitioners need to reflect upon motivation as an enabler to success and network cohesion and adopt an implementation strategy that integrates motivation as a key enabler. It is recommended that the research network is not considered temporal, while reliant on EU funding but it has a longitudinal nature and the research network members may hop from one network to another or create new networks as deemed necessary.

> 2 Industrial members	Meet specific skills and competencies as identified in the research objective
> 3 EU Member states	Meet diversity requirements Weak ties, structural hole(s), Bridging Member, Motivational Member, Leader
Different types of partners to include; Academic member, SME, Large organisation	Access to production data and capacity to share data with other network members
Gender consideration	

Table 4: Criteria for Network Formation Evaluation

- R3. Explicitly address the complexity of EU Open data policy and how network members can secure sensitive data during proposal development. This study demonstrated how tensions emerge within a network in relation to open data. Practitioners need to adopt techniques such as data anonymisation and data protection to alleviate tensions between competitive partners. Access to production type data is critical for ICT research.
- R4. Practitioners need to analyse the proposal in the context of achievable implementation once funding is awarded. This up-front approach can save much negotiation and mis-understandings as the work progresses; if unaddressed it can adversely affect interpersonal relationships and trust levels. Researchers can leverage the literature in relation to espoused theory and theory in use (Argyris and Schon, 1974).
- R5. Practitioners and leaders of research networks should recognise how friendships affect skills and competencies and enable effective problem resolution. Network members need to be open to acquiring new skills and competencies through leveraging the knowledge of others. Introducing mechanisms for socialisation in network incubation period will achieve this, for example, break-out sessions, coffee breaks.
- R6. Practitioners need to justify and promote longitudinal support for research networks by reporting on research journeys beyond the funding period. Research networks are not temporal, they are initiated through EU funding but the partnerships and friendships formed are long lasting. Practitioners must recognise

the advantages of network hopping e.g. national and European initiatives to secure long-term support for research.

R7. The application of the research provided in the Building Network Capability in Research Model (BNCR) is a useful tool for practitioners to operationalise this research in practice. The insights and recommendations gained from this study of the AquaSmart network can be used by others in funded research networks to optimise their social and economic impact gained by their research.

The outcomes from the study suggests a number of recommendations that will assist research practitioners. These further our understanding of social and economic aspects of research networks, and highlight enablers and barriers so that research network members can be more effective in their role(s).

7.0 Recommendations for the funding agency

The EC plays a major stakeholder role in EU Funded research providing the direction of research through the Digital Agenda²⁶ and the Strategic Research Agenda and through their funding of research. This study reveals empirical evidence to inform the EC in relation to structural embeddedness in research networks and further their understanding from the researcher’s perspective in relation to social and economic aspects, enablers and barriers for the research network members and their organisations.

Recommendation	Description
i	The funding agency needs to provide resources to follow-through on monitoring research impact beyond the direct funding period so that it can support successful network members and accurately evaluate social and economic research output and impact.
ii	Include eligibility criteria for mixed networks, such as guidelines for network composition. Diversity nurtures innovation, the funding agency must consider network formation, incubation, configuration, strength of ties and necessity for structural holes as essential elements for network optimisation . The role of network members such as Bridging members, Leaders and Motivators also need consideration as critical enablers of research that drives the development of disruptive technology and innovation.

²⁶ <https://ec.europa.eu/digital-single-market/en>

Recommendation	Description
iii	The funding agency needs to resolve disparity of funding between research network members.
iv	The funding agency needs to listen and nurture its research networks, they are organic and susceptible to environmental influences. People drive innovation supported by systems and processes.
v	Extend the EC portal partner search capability to include network analysis functionality.

Table 5: Summary of recommendations for the Funding Agency

- i. The funding agency needs to follow-through on monitoring research impact beyond the direct funding period. Ideally this would link national and EU funded research. This study claims that whilst it is necessary to evaluate the success or failure of the research at the end of the funded engagement, it critiques that this gives insufficient weighting to the full impact or exploitation of the research. The assessment of the network itself, its longevity and contribution to further research networks and the eventual use of the research output is often not available for assessment during the period of the EC contract with the network members.
- ii. Diversity nurtures innovation, the funding agency must recognise the positive impact of weak ties, structural holes, Bridging members, Leaders, Motivators to drive the development of disruptive technology and innovation. Furthermore, recognising the roles and configuration of successful research networks can warrant further support of specific network members; Serial entrepreneurs, Motivators, Bridging Members and Leaders.
- iii. The divide between industry and academic partners is exacerbated through the funding model that gives financial preference to academic partners. The funding agency should take this into consideration and amend its funding policy as the impact of unbalanced support in collaborative environments can be negative. Whilst cognisant of the need to get commitment from industry stakeholders the funding agency also needs to understand fully that network members need to be treated equally or tensions will arise. Furthermore, the research needs critical input from industry partners in the form of market requirements, product and service user scenarios and access to production data.

- iv. The funding agency needs to listen and nurture its research networks, they are organic and susceptible to environmental influences. Feedback from researchers can ensure its sustainability for returning researchers, innovators and entrepreneurs, to encourage existing members to remain and new members to join. Successful competitive funding proposals are difficult to attain, the effort required is significant and the success rates are low (approx. 5-15% in H2020 ICT). For example, consideration of social aspects within the research network; trust, friendships, motivation. Interpersonal relationships in the research network are a significant enabler to support research optimisation. The funding agency acts as a gatekeeper for the knowledge economy, the wealth of expertise and knowledge that peers engage in during the network activities facilitate co-knowledge creation and enhancement of their competencies and skills. It is not always about network growth but quality and depth of relationships can enable further deep learning and technology advancements.
- v. Extend the EC portal²⁷ partner search capability to include network analysis functionality. This study recommends that they leverage network theory using structural attributes for networks. This will also facilitate a subtle reputation management system for research network members to refamiliarise themselves with their prior networks and access potential new network members.

The function that funding agencies play in relation to enhancing our economy and society through ICT research advancement is significant, and the major stakeholders (funding agency and research network members) need to work together to ensure optimum effectiveness is achieved and European citizens can benefit. From a policy perspective, this study gives funding agencies insight to further understand the structural embeddedness of research networks and the complexities therein.

²⁷ <https://ec.europa.eu/research/participants/portal/desktop/en/home.html>

8.0 Application of Building Network Capability in Research Model (BNCR)

This research has presented a refined conceptual model which has been applied to the research case study in Figure 4 below and can be used in further research to extend the relevant theory and operationalise the model. The BNCR cumulates the research concepts with the data and findings from the research. It identifies the recommendations from the study in tandem with the challenges from the research questions and provides a model upon which theory and practice can use and extend. The model illustrates the network composition inherent in research networks and the recommendations in relation to network formation, network composition and specific roles identified in the research findings.

Challenges in relation to the network structure are identified and linked with the case study insights such as the difficulties encountered in relation to the aquaculture jargon and the data analytics technical concepts. Possible solutions are identified such as the establishment of scaffolding to accommodate cooperation in research networks and contextual complexities are addressed early on to avoid problem cultivation. The network capability is enhanced by the adoption of the relevant theories; network theory, open innovation and social exchange with the understanding that the network structure has an impact on innovation and social exchange in research networks. Finally the network benefits are presented in the model with descriptive detail in relation to the output and potential of the research network which is a longitudinal resource. Thus, network optimisation strategies can use this model to accelerate and further understanding and implementation in this domain.

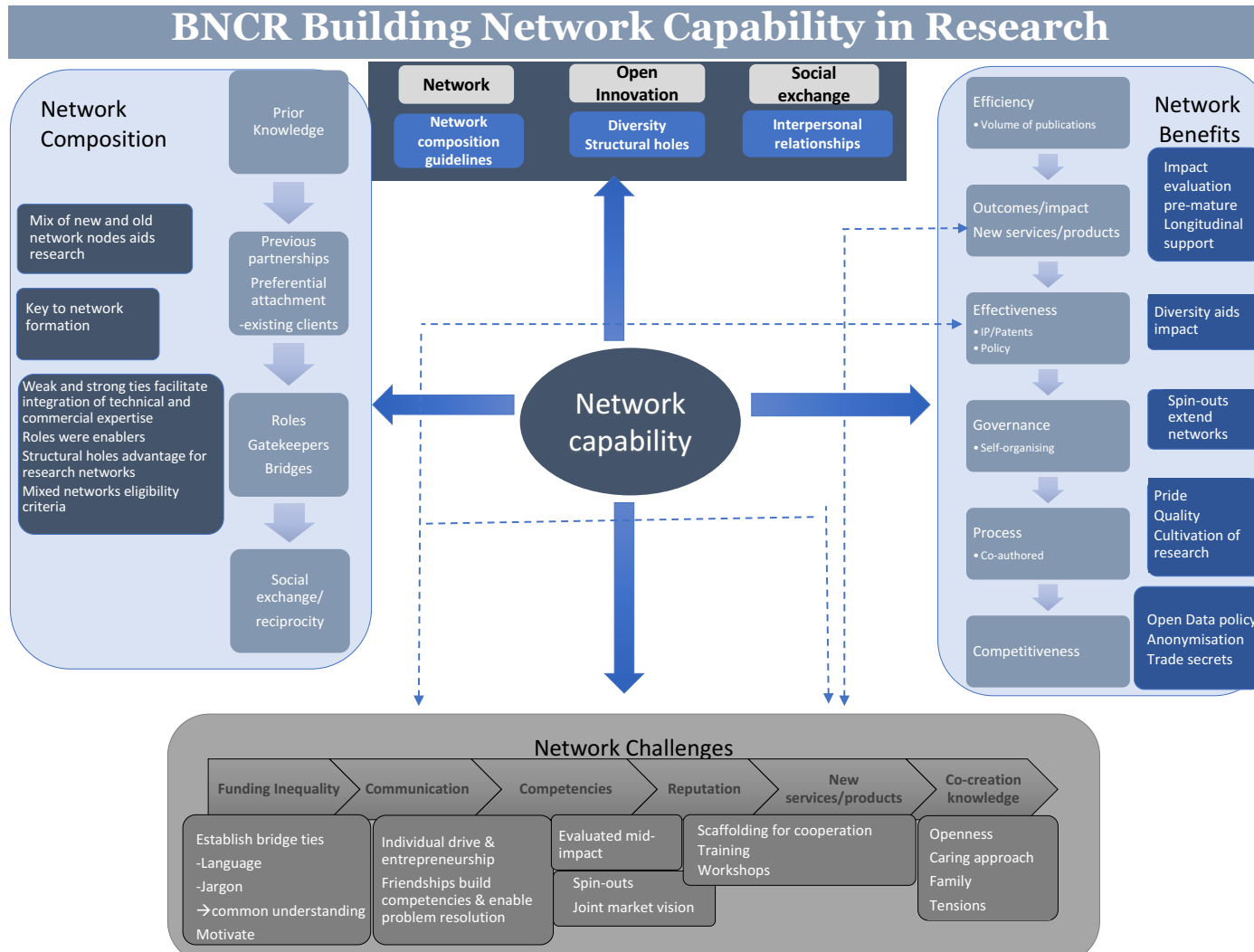


Figure 4: BNCR Model

9.0 Research Limitations

The nature of doctoral research, and in this case, its professional basis as a Doctorate in Business Administration, mean there are certain research limitations associated with this research.

- I. This study has been limited by resources. The DBA programme is an individual part-time endeavour and has a strict timeline within which to reach the structured milestones. The DBA cycle constrained the time for data collection and data analysis thus putting boundaries on the research scope and possible 'long tail effects'. Adoption of software can be slow and thus the context is curtailed by research that is not ready for market until further in the cycle often picked up by National initiatives post EC funding.
- II. Additionally, this study was faced with the complexity of scheduling interviews with researchers during the summer months, traditionally a difficult time to gain engagement and commitment outside of a person's core work commitments. Whilst this didn't impact the end result significantly it did impact on the time and resources used that could have been used elsewhere in the research process.
- III. The dataset, on which the research was focused, while both significant and comprehensive, was from a single network. While it provided access beyond what would normally be available to the research undertaking, nonetheless it was based on a single industry, Aquaculture, and, as such, may have missed some findings that might be nuanced somewhat differently in another industry.
- IV. Generalisability of the research findings was not an objective of the exploratory nature of the study. A larger dataset could facilitate more transferable findings. However, there are many similar research networks (size, funding, composition) in Europe that could apply the conclusions drawn from this study to other networks.

10.0 Future Research Roadmap

This research examined the operations of the research network during the research engagement with the EC, which was contracted over a twenty-four-month period. Future research could follow the path of the network members to investigate their structural embeddedness post-engagement. This Darwinian approach (survival of the fittest) is more evident when the support of the funding agency is absent and market and financing

conditions prevail. Furthermore, this could contribute to evidence of the role of the academic entrepreneur.

The AquaSmart network members created a new company AquaKnowHow²⁸. They have secured national funding from Enterprise Ireland Commercialisation Fund and further EC funded research within a health context. Thus, they have already developed a sustainable model for the short-term beyond AquaSmart funding. Further research could explore other cases that have also secured national funding to further the impact of the research into society and the economy. Additionally, this highlights the need for further enquiry to uncover network hopping or inclusion of some members of the original network into the AquaKnowHow network toward market absorption and other research networks. This process of the creation of ties for one reason but then used for another supports earlier network studies (Gilsing *et al.*, 2008; Galaskiewicz, 1989). These new network engagements emphasise the success of the network and its members to enhance the results from AquaSmart. The ICT network members obtained rich insights and understanding into the production and business models of aquaculture once they had overcome the challenges of the domain-specific jargon. This enhanced their competencies and knowledge to exploit the market and deliver research services.

Further research could focus on research policy to examine the different needs of industry for research and consider the reputational control, collegial based norms and evaluation mechanisms adopted across nations within the EU to fully understand the impact of opportunities and tensions on different stakeholders. Additionally, the inequality of financial support for different network members needs further enquiry to identify the possible affect this may have on inter-network relations.

This study explored the convergence of Aquaculture and ICT and has increased our understanding of this context. Studies into different contexts could widen our understanding of this research. Furthermore, studies into the same context might also reveal the value of friendships and expansion of network connections (structural holes and weak ties).

²⁸ www.aquaknowhow.com

The emergence of friendship as an integral element of the research network merits further exploration. Softer attributes such as friendships and knowledge sharing are relevant as the research output gets adopted outside of a trusted research network. Trusted participants work well together to deliver quality research. The relevance of friendship should be recognised as a deciding factor for an adequate return on investment for taxpayers money. Further research might seek a solution to achieve this. Granovetter (1985) in his work on how behaviour and institutions are affected by social relations argues that Williamson (1979) does not sufficiently consider personal relationships during economic transactions.

Furthermore, Mitchell (1974) links transactional theories to network concepts claiming that intercorporate ties do promote self-interest and autonomous actions toward maximum profit. This study provided significant evidence in relation to the behaviour of the network members, interpersonal relationships and self-interest. This study concurs with Mitchell (1974) and shows that some AquaSmart network members engaged in self-interest and realisation of their own research objectives. The evidence shows how they created their own sub-groups to focus on their output leaving issues such as inter-organisational competition for other participants to control. Further research might explore this and uncover its prevalence across other EU research networks.

Further studies might consider focusing on different aspects of the conceptual model such as (but not limited to) reciprocity, role of gatekeepers and self-governing networks as presented in Figure 3 in section 5.1. Furthermore, the advancement and refinement of the conceptual framework is envisaged and access to research funding could readily support further research in this domain.

This research gives some insight to the realisation of planned company formation through research. It suggests that research network configurations need to be inclusive of researchers willing to transform and drive the research into marketable services and products. Further research might discover how to address these challenges.

Research Area	Description
Network theory, Innovation	Post-engagement review of the network
Network theory	Network reuse/ Appropriability
Research Policy	Research policy in relation to networks and funding
Network theory, Innovation	Extending research in other contexts outside of Aquaculture and ICT
Social Network theory	Personal relationships, friendships within networks and self-interest
Innovation	Research Entrepreneurs

Table 6: Potential Future Research Topics

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SECTION FOUR

REFLECTIVE LOG - EXTRACTS

Reflective Log and Extracts

This section includes extracts from the reflective log that I have maintained throughout my DBA journey. When I started my DBA journey in 2014 I had previously completed a research supervisory module through continuous professional development. This module had introduced me to reflective writing, Moon (2006) and Hatton and Smith (1995) and had set a seed toward adopting regular reflective practice in my professional practice. Thus, the requirement introduced in our very first workshop for the DBA that we would keep a reflective journal was welcomed and was diligently maintained over my doctoral studies, both challenging and rewarding at times (Bolton, 2010). Early log entries were descriptive whilst the maturing of the process evolved I became more adept at reflective in action and reflection on action.

The first paragraphs detail my epistemological development path, followed by a summary of the critical milestones within the journey. Overall this section presents an indicative summary of the maturity level I have reached in relation to reflective practice and its associated competencies.

There were a number of critical junctures in this journey, the following list and subsequent quotes describe a sample of the milestones on this journey:

- Academic writing
- Establishing my own philosophy
- Getting the conceptual framework on the right track
- Reaching out to experts/publications
- Downfalls and challenges along the way
- Feedback, positive and negative, coping mechanisms
- Common themes across academia and industry/convergence of practice and theory
- Eureka moments

I found the process of reflective writing difficult, it makes oneself look deeper into our actions, values and beliefs. I started the process tentatively with short entries, embracing

it more fully as I began to see its value. It was an excellent tool to revise where my thoughts were during my work. The decision to start the DBA was not light and the commitment was significant, both in the early days when defining the research topic and later during the research process. Now looking back I can see the path I took and how it impacted my professional experience and my doctoral studies through the broadening of my academic horizons and landscape of my professional world. Thus, I have included a sample of the extracts from my reflective journal, highlighting some of the pivotal points in the decisions I made as a practitioner- researcher.

1.0 Academic writing

A significant learning point was the conversion of business writing to academic writing. In my initial skill and competency assessment I had identified academic writing as a challenging area for me and a priority to address as part of my overall rationale and motivation for starting the DBA. The reflective journey section of the thesis is presented as a narrative of sample extracts from my reflective log illustrating this knowledge journey, which included much profound learning, bridge construction and black holes.

Reflecting on my business experience in the implementation of research rather than the research itself I had to accept that my academic writing skills are weak. However, building on my masters by research in knowledge management in 2006 I did realise that I had more knowledge than I initially thought which was reassuring. I can see from my reflective log that my strategic thinking was improving with the inclusion and exclusion of relevant authors and topics and analysis of the different aspects of embeddedness. Using the log for a continuous analysis of extant literature while also as a professional diary for my own competencies and skills it became evident early that the log entries were fundamental to the DBA process. Whilst informal and unformatted they provided a roadmap for the research and a useful resource to check approaches and support justification of decision-making along the journey. They were used to document problems and eventual resolution and helped with the formulation of memo's and annotations in the data analysis phase of the research.

In February 2015, I attended the Waterford Business School writing lab. Even though this added to our already tight schedule of commitments and activities it was useful to improve

academic writing and analysis skills. I have highlighted this in my reflective log as a turning point for my understanding of academic writing and the available resources to researchers. This included Argyris and Schon (1974) and their espoused theory as to how what way we think we behave can be contrary to the reality of the actions. This analysis into espoused theory can highlight the dark side of learning as further described by Ecclestone and Hayes (2009) and evidenced by my professional practice where decisions are pre-defined in advance or 'staged' to fit nicely into political and 'power' agendas. The effectiveness of reflection to optimise behaviour is particularly evident through single loop and double loop learning whereby single loop learning demonstrates an ability to problem-solve and apply this learning to new situations whereas double loop learning deepens understanding so that the root cause of the problem is analysed and fundamental beliefs are amended. These methods for learning, described as model I and model II behaviours, succinctly illustrate the differences between 'doing things right' and 'doing the right things'. In my opinion this is the juncture in which there is an evident gap between fire-fighting to alleviate disaster and failure as opposed to strategic management fostering opportunity and innovation. One of the first significant learning points for me was the need to alter my previous business approach to reading and research and to start to think more academically. Extract 1 and 2 below show that this was instrumental in getting to grips with my previous learning and how everything would fit into place. Additionally, it was evident that my role in EU funded research was not primarily writing academic papers and thus I needed to be careful to address researcher bias.

Extract 1: date 2015 Feb 1st

Finishing up my assignment for the Writing lab, as I reflect on the articles I've read I think of my college years and the organisational management module. Some of the articles are quite old ranging from 1994-2003. This wave of research was instrumental in actively changing practice and norms for management education moving from module driven class-room to flexible toolkit type management recommendations. However, it is also clear to me that the female manager wasn't a huge part of this research. Gender balance has come to the fore in recent years and the distinct contribution mixed gender teams provide.

Extract 2: date 2015 Feb 23rd

So we had our WBS workshop live on Moodle last week on referencing and citing mostly and tips on academic writing. I feel that even though I got some of the references wrong it was sometimes cryptic to find the right version of book and I was happy with my submission generally in line with the discussion. We now need to resubmit by 6th March. Given the topic and its relation to my masters by research topic on knowledge management I'm happy to continue to review the relevant literature and plod through these types of assignments to try to improve my academic writing. It is frustrating that as EU coordinator much of tasks in my day job are not reading or writing papers and thus it's a bit like luxury activity.

These initial log entries were descriptive and not particularly reflective but illustrate the inclusion of previous experiences to my doctoral studies. As I gained knowledge I detailed a characteristic in myself as a tendency to criticise and constantly expect high levels of quality, opening a Johari window of 'unknown to self' (Luft and Ingham, 1961). The literature supports this recognition of difficulties to conduct regular reflective practice and how complex a self-analysis in relation to defensive mechanism identification or even collision within an organisation to cover up mistakes (Freud, 1992; Bolton, 2010). This emerged throughout the research process, and in the reflective log I made an effort to also include positive, motivating entries, taking control of my journey a little. I think that reflective practice is essential in a professional work environment and a very useful tool however, I would still find the practice difficult at times, it can be invasive as it forces justification for action taken and possible interventions or alternative approaches for future. We need to be cognisant of the depth to which we attribute our actions and relate these to our adopted philosophy, epistemology and ontology. Our beliefs and values don't always match the reality of our workplace environment and resources and attitudes can obstruct our approach and of course what we say and the reality of what we do (Argyris and Schon, 1974). The wide literature available in this domain supports this recognition of difficulties to conduct regular reflective practice and how complex a self-analysis in relation to defensive mechanism identification or even collision within an organisation to cover up mistakes (Freud, 1992; Bolton, 2010; Gibbs, 1988).

2.0 My philosophy

Early in my writings I explain my natural philosophical approach, in relation to ontology in social science, the researcher agrees with the literature (Gioia and Pitre, 1990; Mills *et al.*, 2010) that a single research paradigm is too narrow a view to represent reality and believes that reality is subjective. Social phenomena are influenced by individuals who are in a constant state of revision. In relation to natural science I tend toward objectivity and positivism as facts and figures provide evidence of our environments past. In modern philosophy and moving toward social theory, Burrell and Morgan (1979) discuss the nature of science and the variance of the two dimensions of subjectivity and objectivity. This tool can aid researchers to determine their position and potentially map one's journey while recognizing other assumptions within the subject area. It is clear now having looked deeper into research philosophy that this type of tool is a mechanism to critique social theory and present a holistic picture of the research domain. Moreover, Gioia and Pitre (1990) present a metaparadigm perspective and demonstrate the function of transition zones and their blurred nature. Therefore, the researcher adopts the interpretivist paradigm but is cognisant that one's position may be in the transition zone between interpretivist and functionalist. The researcher adopts the epistemological belief that knowledge in social science is subjective, and in line with other philosophers (Bacon and Anderson, 1960; Kant and Guyer, 1998; Kuhn, 1974) it is socially constructed through experiences. In Kant and Guyer (1998), a clear argument is presented for the difficulty of knowledge to strive independently of experiences. Extract 3 below shows how I was linking my previous learning and current research to further my understanding of my own philosophy and I might progress my work.

Extract 3: date 2015 Sept 16th

Really hitting on material that I can relate to in Evered & Lewis 1981 and some of the material from my masters thesis on what knowledge is and the link to wisdom and how immersion of the researcher in the situation provides rich data. The reference to Polyani 1964 and Russell 1945 'fallacy of subjectivism' meets my thinking on usefulness and impact of research and the challenges of reaching/targeting 2 audiences simultaneously (academia & industry/practice). I

really do feel that I am gaining clarity on my philosophical /epistemology stance and how I interpret existence and reality.

Extract 4: date 2015 Oct 29th

ha ha I knew it was somewhere clear distinction between natural science and social science and the Smith and Heshusius 1986 paper has given me all the evidence from Dilthey to support my beliefs. There was no objective reality as such that was divorced from the people who participated in and interpreted that reality (Bergner,1981, p. 64).

Around the time of extract 4 above I believe that I had some profound learning, I had previously read ontology and epistemology papers but until now I had not really understood it sufficiently. At this point of profound learning I hit a eureka moment and other areas of learning in relation to recognising what is important in the overall scheme of things and how teachers strive for human flourishing is not unlike what Socrates, Aristotle and Plato attempted to achieve with the student to develop new knowledge through dialogue. Recognising that reflection assesses dialogue and actions is key. Furthermore, when I got the opportunity to attend and present at the IEEE technology and society conference as described in extract 5 it reaffirmed my understanding and gave me a baseline from which to move forward in my doctoral studies.

Extract 5: date 2015 Nov 16th

I attended the IEEE technology and society 2 day conference last week which was relevant for my research. Of particular interest was our president's Michael D Higgins keynote, he presented his views on how society and technology can be useful and also difficult for each other globally. He spoke a lot about eAgri and Africa. but I understood and enjoyed his discussion on philosophers Bacon and Kant and the passion with which he gave his speech to ensure the audience knows of his interest in morals, society and the divide between the west and elsewhere to ensure that technology does not widen the societal gap. The US delegates were particularly impressed with his ability to speak to academics and voice his own opinion. Back to Kant and Bacon for me - nice to be getting a bit of a grip on what philosophy is all about. Tonight's new motto - go deeper, deeper still, understand

the nuances of philosophy, think its Kant I'm aiming toward and transcendental idealism.

3.0 Conceptual Framework Development

In my view a major challenge is the topic definition and figuring out the scope of the research. Indeed, papers 1,2 and 3 were instrumental in managing the research scope and identifying the relevant of theories and previous research. There were a number of mechanisms I employed during my studies to validate my approach, this included feedback from the paper series through my supervisors and external examiners but it also included some experts that I approached internally in WIT and externally in University of Limerick and in Europe through email. I am a visual learner and thus at different stages of the research process I would draw out the conceptual framework, its concepts and relations to the literature and my own experience. These posters were used in the brainstorming phases and in the analysis phases. Extract 6 below details one of the times that I 'discussed this with myself' in my reflective log.

Extract 6: date 2017 Jan 31

Read an article about an autistic boy who has used a mechanism to be able to communication after years of non-communicative, difficult behavior. He said pictures didn't work as a communicative tool for him in the past and words, intellect had now made him free – I had found sometimes that pictures on a mind map could increase confusion and additional explanatory text is essential. I also met with my supervisor Aidan Duane this week and we discussed the exclusion of culture in my research questions having reflected and reread the comments from the external examiners from paper 1. I am confident that its exclusion is an excellent decision for this research. Refer to Prof Alan Smearon's comments in feedback from Paper 1.

Extract 7: date 2017 Feb 16th

Effective reflective writing is difficult, the merits of online recording of material the ease to which the new and emerging technologies has facilitated ongoing work has advantages and disadvantages. I think the revolution has helped ideation and probably works well with certain types of styles. Having gone back to look at full theses and differing styles along with multiple intelligences theory that I've read about I can see

my affiliation to a visual thorough style - messages through diagrams - structured approaches. If I take an eagle view again on where I'm at and where I want to or can go to. A reflective journey of development, take a plane take a train, run slow, walk fast, where are we going to where have we been and on which tree did our roots emerge, flourish through learning and knowledge. Reflection and cyclical learning affects our professional approach and how we do our jobs the impact we have on the people around us whether we inspire them, help them to insulate themselves to surmount difficulties or flourish in their own learning and knowledge journey. My work is very related to new knowledge and new learning. Every time we learn more it deepens our knowledge and that provides opportunity for new insights, improved processes, methods and the recognition of new synergies. On DBA stuff I'm keen to discover the optimal network for research - what works and what the people on ground recommend in relation to networks, obscurities and research drivers, facilitators and generally anecdotal evidence in the field.

Each researcher and practitioner has their own mechanism for reflective writing my method was to write as often as possible, in excel, and I would start each entry by reading the previous five entries. Adopting a scientific, structured approach to self-assessment, and an initial skills and competency audit (recommended in our workshop 1 by Felicity Kelleher and Denis Harrington) revealed my competencies, skills and knowledge at the start of this process so that upon completion a comparative analysis could detect changes, improvements to practice and knowledge. I have started to do this final analysis of my own competencies but I do believe that like research, upon completion of the DBA there is a lag between completion and changes that may happen in my own professional practice. A systematic approach for analysis of skills is not suited to all types of people and learning styles but it reflects the environment I am accustomed to coming from a professional background in software quality and thus it is appropriate. Furthermore, the literature provides evidence that supports professional doctorate study and organisational change driven by action-orientation research such as this DBA (Coghlan and Shani, 2014). My reflective log was an essential tool for me to evaluate, interpret and remind me of how I justified my decision-making. In addition, it assisted my milestone tracking and motivation for completion. I also used an excel spreadsheet to track progress for my DBA for each workshop assignment and mini-milestones within the paper series. In addition, I used a database for my literature review throughout the DBA process so that I could use

meta data (abstract, key findings/results, method used) for quick reference of papers I had referenced or read that were or were not relevant. This was a critical tool that also tied in closely with my reflective log to provide supportive background for the assertions I made. Furthermore, I attended the reflective practice in education module as part of continuous professional development during the DBA process, this further equipped me to adopt mechanisms and ideas that I previously may not have accessed.

4.0 Feedback

Feedback drives motivation, reviewing feedback and identifying strengths and weaknesses has helped considerably in my learning during the DBA journey. This is formative feedback mostly informal except for conference blind reviewing. Unlike undergraduate studies level 10 assessment is different and involves self-assessment and facilitation of learning rather than a traditional behaviourist approach. However, the DBA programme does offer guidelines and opportunity for feedback at junctures. The following reflective log extracts show how I approached feedback and how I interpreted it to change actions on my DBA journey. Early in the DBA there was structured workshops with assessment, these were useful to put a framework around areas of critical understanding. This particular workshop in extract 8 was entitled Advanced Theory management facilitated by Dr. Gary Davies from Manchester University.

Extract 8: date 2015 May 7th

We got our result and feedback for our presentation at the last workshop, I'm delighted as I got 9/10 thus 90% toward final mark for this assignment, even though this is tiny compared to the main assignment which is 90% it is indicative of progress in the right direction. It has given me lots to be reflective on as the approach that I took for this presentation (learn something about theory in the way that I learn) has been a major milestone on this learning curve. I have done a degree in business studies then a masters by research and 2.5 year of PhD not really grasping the differences in theory from a multi-disciplinary perspective. Moving from business to technical back to business has been a huge step toward bridging the gap in my understanding of much socio-technical perspectives and how the world works in relation to baselines/theories. In the past this hasn't been much of an area of interest for me however I've found that it is now, I like that it

is systematic in some respects that is it structuring elements together to build something else and even though theory in general cannot really be proceduralised there is much scope for learning this topic in a structured manner which I think I'd like to proceed with more. I'll see how I get on now with the next steps of the assignment. The module owner (Gary Davies from Manchester Business school) said in his comments on my presentation that it was difficult to fault this is timely encouragement and motivation that I plan to utilise well and develop upon.

Presenting at conferences was a challenge that I was looking forward to, this involved extra work during my doctoral studies but provided good feedback, motivation and encouragement from the academic community. I look forward to disseminating my research results further over the coming period. This is an essential part of who I am and how I evaluate my own professional performance. Not all the conference submissions that I entered were accepted however, I did learn considerable from the reviewer's comments and have an opportunity for a journal paper in 2019 that I have been invited to submit to because of the Space conference. This phase grounded the conceptualization of the research and was instrumental in figuring out the research design.

Extract 9: date 2015 June 4th

I presented my paper today at UFHRD in UCC and it went down quite well, my main worry is that this interdisciplinary research is difficult and even though there is a lot of talk about it to get it to work is a whole different ballgame. I did value the questions asked, in addition I reckon that the research topic has changed dramatically but the underlying knowledge that I now have and the ability to put in and present papers and academic work has improved slightly although I have a long way to go yet. It was great to see another WIT DBAer at the conference, Louise Doyle and different aspects of our work which isn't related. While finishing my bit on TCE tonight though I wonder if it is the depths of mafia underworld that I have put myself into - I'm really enjoying it and feel I'd like to work through the night to make more progress. I'm currently reading the patents and standards report from the Commission and like to see that the stakeholders I'm targeting are involved in this discussion at this level. I have conflicting deadlines at the moment though I'd love to get my IEEE paper in but don't know

with my assignment due at the same time also I'm a little worried of publishing everything before the class in case I'll get in trouble with TurnItIn.

Extract 10: date 2015 Oct 26th

So got results from workshop module 3 75% happy with that and very keen to get further on paper submission. The feedback from Tom in relation to social exchange theory being relevant particularly in relation to most of the US network theory being positivist is important to take into consideration. Rereading the philosophy slides it is interesting to note the necessity to link the research question/philosophy and methodology. The process of collaboration in research groups is of interest and is close to the research question but I don't think that I'm yet clear on the outcome I want to specify. How researchers collaborate in innovation process is probably closer to the research question I am trying to uncover.

Extract 11: date 2015 Oct 29th

I was at the technology to society T2S conference today in DIT - it was very relevant and a joy to attend and listen to research that I'm very interested in, authors of papers that I have read and methods being presented. I have done up some notes and upon reflection of note to take is about the social capital theory but also with some of the discussions on quantitative work - I was interested to listen and even though I'm very happy with my philosophical stance. One of the items that was discussed was LinkedIn data and I question the validity and value of analysing some of this data in relation to networks compared to the richness of data available from in-depth interviews. The book I read a few chapters on last night is also relevant here as to the depth of description is has for inductive research and ethics of same and in-depth interview techniques (Hallebone, E. and Priest, J. (2009)). Also the importance of taking stock after the last workshop - re-reviewing the reading lists and material and thinking about what I have learned to date and the deeper understanding I have now of paradigms conceptualisation etc. compared to my research masters when I thought I knew something!

Extract 12: date August 29th

Feedback from Aidan Duane on paper 3 - it needs quite a huge amount of work. OK well it was rushed I am busy transcribing, scheduling interviews now and it's hard to come up for air and analyse half data stuff. But this is to be expected - it was 8 week turnaround after paper 2 and interviewees were not available. I have raised this before and now I have sent an email to Sean and Anthony to ask for an extension. It's been a frustrating summer and all kids are back to school tomorrow so I'm sure that I can turn it around in the 10 days.

Extract 12 above illustrates some of the operational frustrations of doing the DBA, the schedule was sometimes difficult to adhere to and with reflection I can see the merits and challenges of strict deadlines. My feedback has been given to the DBA programme coordinators to assess if there is a need to change the allocated time between paper 2 and paper 3. Extract 13 below illustrates the detail and action required as a result of feedback and the usefulness of the reflective log to evaluate scenarios and make choices for future action and direction.

Extract 13: date 2017 Oct 25th

About to do a to do list and update my progress planning doc, I was late at it last night to finish the edits to paper 3 and the response document for the external reviewers. However, to my delight both Aidan's agreed it was fine to send off and submit so that is a job done and ticked off. While on the thinking front I added a number of papers to the table 3 which was around RQ3 in relation to enablers and barriers of structural embeddedness and I haven't added these to my literature review database. There are so many knock-on effects. Also thinking back on comments and discussions post paper 3 there is a need now to look deeper at the documents in relation to AquaSmart and pick out the most relevant ones that match the themes emerging. Updating paper 3 on the section of research bias was interesting I have been so careful with the selection of the case and have been thrilled with the richness of the data to date that I have been blown away by the volume of relevant data and its alignment to everyday items such as the sharks swimming club, entrance criteria and closed networks. In addition I was delighted that I went back to my experience and training spreadsheet to see myself how my knowledge has progressed. It was nice to be reminded of my learning logo on my Moodle page, an eagle flying high with a good view and perspective of the bigger

picture - I am struggling to get there but am picking up the pieces again to fly high and keep trying, only 1 paper to go and tonight I've created a draft v1 of full thesis.

5.0 Reaching out to experts/publications

The feedback section is linked to this section on reaching out to the available local experts and gaining feedback and accessing the global research community through submitting toward conferences. Extract 15 and 16 refer to my daily job and how I am managing multi-tasking, while not directly impacting the research work, it was an operational challenge. As you can see from extract 17 there was a lot to digest within the third external examination, the examiners noted on the documented feedback that it was discussed briefly at the paper 2 external examination that the scope was too ambitious and that this was the core issue. On reflection, this was the most challenging pinnacle and paper 3 needed huge effort to change the scope and direction of the research. When I managed to surmount this and achieve excellent feedback on the revised paper with the challenges of preparing for the data collection simultaneously I did move on to a new phase within my DBA journey. Also noteworthy was the decision to drop the OpenSym conference submission to focus on the DBA and its immediate requirements. This ability to prioritise and meet the deadlines is a strength that I strive with.

Extract 14: date 2015 March 18th

Currently I'm writing the UFHRD paper that I got accepted and its tough going well there are 2 aspects that I am finding particularly challenging the absence of data. The other aspect is the comments from the reviewers on theoretical perspective. Maybe Kenny can help with this. However, even writing this I can see I should be asking what am trying to achieve from this and it's my writing skills so I should not worry so much maybe. It was good to go back to the theory literature and start to see how it influences the research and some discussion with Kenny on where the theory is relevant was also interesting - starting to put it all together I think.

Extract 15: date 2016 May 17th

Well I met with Pat Lynch, and the 2 Aidan's to discuss the feedback and the next steps, there is some frustration in the timing of the next workshop with the next paper due. Aidan D has sent on relevant papers to review in relation to methodology, both agreed that there are few changes required to the paper 1 before final submission and that many comments were in relation to the next steps. In relation to the decision between quantitative and qualitative both agreed that the research is equally valid with both approaches and indeed some extra depth may be added with the access to data. It was good to chat with Pat as he has done some research on networks with Tom and gave some relevant feedback and comments. on skype with AOD he mentioned a conversation with a colleague in relation to difference between DBAs and PhDs and that it is only 80% or a poor PhD, he is now off to Cardiff to review/viva his first DBA. An indication of changing times. Having finished the CPPP and now doing training with the Commission for the upcoming evaluations I am v busy again but happy to be gaining such relevant experience, I imagine I may drop the H2020 proposal for Aug if the SOLAS project comes through.

Extract 16: date 17 Feb 28th

On the train journey to meet with Prof Aidan O'Driscoll, I dealt appropriately with the issues at work yesterday. In addition, I did submit an abstract for IAM and agreed with Aidan on the Open conf with Lero. While ambitious I am confident that all of these activities will be done in March.

Extract 17: date 2017 April 18th

I had a good break over Easter and completed the external examination, this was a particularly difficult step in the DBA process, I had expected to get on really well, both supervisors had indicated that it was a strong paper and when the questioning had been so negative I knew that the external examiners were not on same page. In addition Pat from RIKON had indicated that the EU context was an issue and that jargon, terminology had been a barrier to our communications on the day of examination. I went through the comments from the external examiners in detail which were very paper 1 focused and am happier now to report back that I can move forward in a positive way, use the material for Open SYM paper and work with my supervisors to address the comments, given the panic I had in

relation to delaying the DBA process and the wind taken out of my sails in relation to conducting interviews I understand the need to get more focused try to achieve less and plan to reconvene with supervisors this week. Particularly noteworthy is risk of body of lit for each sub-question, unit of analysis, RQs, qual V quant, theoretical contribution, candidates involved. Interestingly I just noticed a post on facebook from flourish a concept that I've really gotten interested in through the MALT philosophy course and the topic is seeking perfection another concept I've decided to address face on this year. it says self-sabotage stop blocking your own potential!

6.0 Common themes across academia and industry/convergence of practice and theory

My rationale and motivation for doing the DBA was driven to immerse myself further into the environment in which I work, research in ICT that links industry, academia and society.

The research objective and associated research questions are related to my professional practice, however the reflective log was an essential tool to link both areas. Extract 18 below illustrates an example of becoming clear in my own mind as to how my research linked with my daily job and also coincided with the realization of the real value that could be gained from adhering to the reflective log process. Subsequently, over the coming months I would use the log both to clarify my current thoughts and to reflect on the build-up of the previous thinking that had delivered me to the current research spot. Then, once that crossroads was successfully negotiated, I would again use the reflective log to build on the previous reflections and to document how the resolution was reached. So through the reflective log over time the foundational stones on which the research progressed and which allowed the findings to be initially documented, analysed and confirmed. Extract 19 showed how the log was used during the data analysis phase to help decide on the significance of findings.

Extract 18: date 2016 Feb 29th

There is huge convergence on my DBA work and my proposal writing work at the moment - the papers and SOTA are relevant, I did a survey for the EI NCPs today

and offered to get involved in follow-up interviews and the work on the cPPP consultation is also very relevant with regard to Public private partnerships and alliances. And golly now I'm delving right back into some of the literature on knowledge and learning networks very interesting (Wenger et al., 2011).

Extract 19: date 2018 May 21st

The findings indicated that the smaller organisations were challenged significantly in the formation and incubation period there seemed to be a bit of an imbalance in the decision making and dependencies. This was also reflected in the financial support for the academics V industry partners. There may be a perception that the grass is always greener on the other side as smaller organisations struggle to participate in research due to the upfront commitment and slow turnaround of tangible success.

7.0 Eureka moments

As described in the previous section the log was the tool that facilitated deeper thinking through documenting the DBA journey, it supported the analysis and helped with justification for decision-making. Extracts 20 and 21 highlight areas of the DBA journey that illuminated my deeper learning to link unrelated things and to further my understanding of situations so that I can practice reflection in action in future. There is some overlap here with the section on my philosophy as I initially struggled with understanding philosophy authors, concepts and academic writing, challenges that I comfortably met and conquered.

Extract 20: date 2018 Jan 5th

Really looking to the future of this research now and trying to think out loud on the synergies between documentation literature and the interviews. This is the difficult phase for sure as I'm trying to remember everything and keep focused there really is a lot on my plate between now and the end. So my Jan plan is different to the one I originally sent my supervisors in Dec. I have now analysed the 37 AquaSmart blog entries and I have made annotations on them/comments to link my interview findings with these blogs. I have ramped up my knowledge of NVIVO and its functionality so that meant teaching myself to create a new Endnote library with

only the references from paper series then trying to find these pdfs - all a lengthy process but I'm confident that this will enhance my ability to analysis link think rethink on the research objectives and questions in this research journey. Already I am seeing the benefits. I have also started the linking prefaces although these also are not priority until I finish my documentation analysis. Even just looking at the blogs and the videos – re-familiarising myself with the network nodes and the areas they highlighted in their interviews and how their blog entries reflected these views or content. I did notify my supervisors of the change to planned submission date for draft 1 of paper 4 and Aidan D did reply to agree that there is sufficient time to do it the new way. From my discussion with Ben NVIVO expert it is essential to get this part right rather than fly into a weak findings chapter and audit trail.

Extract 21: date 2018 Feb 14th

Having met with Aidan D one of the items I've noted is the link between academia working in academia and never moving into industry. This links with the black hole literature, Maughan *et al.* (2013) between entrepreneurs and academia in research and also links with data analysis phase of research - immerse yourself in the data - good advice, then absorb the industry where you are trying to make an impact, technology is a facilitator of life and industry it has social and economy implications and thus when applied in an instrument such as an IA it needs to feed off the application domain to validate and test before release to market. This was evident in the interview with Vana and others when the AquaSmart network had issues with jargon and had to talk fishy language and eventually after nearly 1 year they found common ground. The immersion into the fish farm at a plenary was a fantastic facilitator. Equally students need immersion in industry to understand where they might work or how they might contribute to society or economy. This is a high level finding and worth discussion.

8.0 Concluding remarks

Now at the end of the DBA, the array of literature and a virtual box of tools and methods hold more than the sum of the parts. It has invigorated a deeper understanding of my professional practice that is aligned with my own personal baggage and my optimism. My own philosophical paradigm has advanced, I have adopting elements from Ghaye *et*

al. (2008); Ghaye (2010) in relation to his theory to ask positive questions which leads to developing conversation of positive regard. Thus, I endeavour to use the power of positive question to enhance human flourishing in my future collaboration activities, thus avoiding the deficit trap. I recognise the simplicity and complexity within reflective practice and my awareness hopefully aids my future decisions (Gibbs, 1988; Kolb and Kolb, 2005; Rolfe *et al.*, 2001). In addition, I empathise with Thompson (2008) in relation to the practitioner approach for a reflection on action moment where one encounters a difficult situation and can apply their 'head, heart, habit' framework. Awareness is key to recognition of habits and possible remedial action. My DBA is but a journey, a major one that I have shared with family, friends and colleagues and will continue to do so as I continue to learn and share my knowledge.

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