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Creating and Managing EU Funded Research Networks: An Exploratory Case

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Abstract: The collaborative European funded research and development landscape drives competitiveness among innovative organisations. Recently it has seen the rise of public private partnerships significantly impacting the dynamics of these networks. Thus, the complexity of managing research networks has intensified with the increased diversity of research network members. Additionally, the emergence of the academic entrepreneur has augmented the focus of educational institutions to include innovation and building start-up organisations. The impact of research is scalable if an optimum research network is created and managed effectively. This paper investigates network embeddedness; the nature of relationships, links and nodes within a research network, specifically their structure, configuration and quality. The contribution of this paper extends our understanding for establishing and maintaining effective collaborative research networks. The effects of network embeddedness are recognized in the literature as pertinent to innovation and the economy. Network theory literature claims that networks are essential to innovative clusters such as Silicon valley and innovation in high tech industries. The concept of embeddedness is what differentiates network theory from economic theory. This study adopts a qualitative approach and uncovers some of the challenges of multi-disciplinary research through case study insights. One challenge is competition between network members over ownership and sharing of data. The contribution of this paper recommends the establishment of scaffolding to accommodate cooperation in research networks, role appointment, and addressing contextual complexities early to avoid problem cultivation. Furthermore, it suggests recommendations in relation to network formation, incubation and operations. The network capability is enhanced by the recognition of 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 and subsequently on research output. The research concludes that the success of collaborative research is reliant upon establishing a common language and understanding between network members to realise their research objectives.

Keywords: research networks, structural embeddedness, network theory, case study.

1. Introduction

In 2018 the EU spent €295 billion on Research and development. This research investigates collaborative research across EU member states using a case study approach. It provides evidence in relation to setting up research networks and it presents barriers and opportunities that arise whilst conducting research across multi-disciplinary teams and distinct organisations.

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) postulated 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). However, there is little evidence within the EU funded research context, a unique landscape for networking and emergent innovation, product and service capability. Our society adopts community approaches to achieve progress across a myriad of initiatives, open source software development is one such example and collaborative research funded by the European Commission is another. This paper focusses on the latter whilst cognisant of the impact of both examples toward citizen empowerment and societal progression.

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). This research investigates structural embeddedness which 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, Behrens and Krackhardt, 2000). 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.

The aim of this paper is to investigate structural embeddedness within a multi-disciplinary research network, its formation, configuration and operations. This study adopted a qualitative case study method comprising 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 research network includes a diverse mix of researchers, and inter-disciplinary expertise. 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. The research illustrates the major impact that multi-disciplinary research has had on the industry and the visionary role of the research network. This paper contributes to the literature in relation to understanding network embeddedness in depth.

This 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. This study provides strong evidence to demonstrate the impact configuration and quality of inter-organisational relationships has on network operations. 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 research setting is within the complex collaborative European funded research and development landscape which has changed substantially in recent years. The European Commission places a large emphasis on its research programme to foster innovation and competitiveness through excellence in ICT research and development. The people (actors in the network) and the in-built structure of the network is critical to understanding the roles, enablers and barriers to successful research. This research shows that prior relationships are important, common ground rules need to be established and conflict is common due to the competitive nature of markets and economics.

The following sections discuss the pertinent literature followed by section 5 which details the research process and section 7 which presents the findings in relation to understanding how the structure of the network combatted the bottlenecks encountered and positively contributed to the success of the research network.

2. Research network composition; social side of early innovators and reciprocity.

This research leverages network theory and 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, Barabasi and Watts, 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 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, Trayner and de Laat, 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.

3. Application of network theory in social science.

Network, and particularly social network theory, is not without its critics. Mejias (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 explores 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).

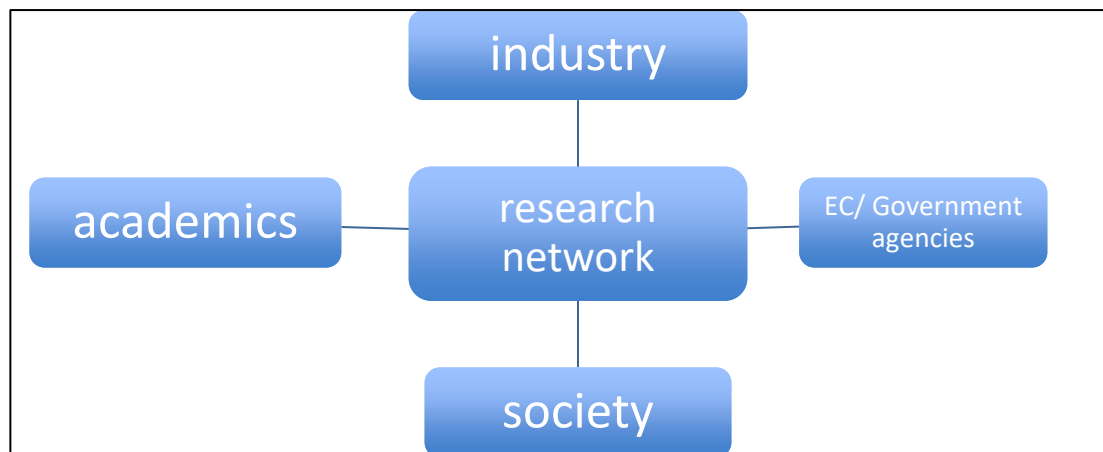


Figure 1: Network nodes

A research network enhances overall 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, 2014; Walter, Auer, & Ritter, 2006). This 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, 1995; 2000). 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, Jennings and Jennings, 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.

4. Structural embeddedness and collaboration in research networks.

Research networks provide a mechanism 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; (Gilsing *et al.*, 2008; Owen-Smith and Powell, 2004; Rowley, Behrens and Krackhardt, 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. Funding competitiveness, public private partnerships (PPP), open data policies and more poignant multi-disciplinary research means that networks of people involved in 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).

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 European Commission research 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). 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, Gassmann and Chesbrough, 2009; Chesbrough, 2003; Perkmann and Walsh, 2007). However, 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).

5. Research Methodology

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 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, Mehra and Dunn (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 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 (Freeman, 2004; Freeman, 2011; Scherngell and Barber, 2011; Scherngell and Lata, 2013; Wanzenböck, Scherngell and Lata, 2015; Herz, Peters and Truschkat, 2014; Carrington *et al.*, 2005; Scott and Carrington, 2011).

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 (Herz, Peters and Truschkat, 2014). Adopting an epistemological intermediary approach is appropriate for this study.

Furthermore, 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, Scherngell and Lata, 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. Additionally, 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, Trayner and de Laat, 2011).

This 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. Before selecting the case study explicit criteria (Table 1) was identified to increase the feasibility of the research implementation.

Table 1: Criteria for Organisational Participation in the 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	

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. 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 research participants Table 2 provides details of the interviews including the format and timing.

Table 2: Research Participants

Cod e	Participant Title	Organisation	Interview Completed	Intervie w Format	Intervie w 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	Website Blog Articles
C	Researcher at UNINOVA	UNINOVA	27/07/2017	Skype	0.50	Website Blog Articles
D	Technical Manager	Andromeda	17/08/2017	Skype	0.54	
E	Marketing and Business Development Manager	Grammos	03/08/2017	Skype	1.02	
F	Fish Farm Manager	Ardag	02/10/2017	Skype	0.53	
G	Managing Director	Q-Validus	11/10/2017	Phone	0.55	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

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. The source of this data was the individual participants 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. 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: Individual and Organisation Attributes for Case Study

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
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

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 included 3 academic partners, 3 end-user partners and 2 ICT partners. 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. A purposive sampling strategy of 10-targeted researchers was chosen. This non-probability sampling technique leverages the experience and judgement of the researcher.

The unit of analysis is the individual in the network (network node). 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).

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. 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).

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.

An iterative approach was adopted, the interview transcripts (A-E) 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 4.

Table 4: Documentation Register

<i>Document/Artefact Title</i>	<i>Relative importance to research</i>	<i>Level of accessibility</i>	<i>Comments/reflection</i>
Factsheet Website	Low	Public	Background information
	Medium	Public	Background information and event descriptions
Grant Agreement Project brochure Initial Dissemination plan	Medium	Confidential	Detail on project implementation
	Low	Public	Background information
	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 5 below identifies the documentation that was analysed and its usefulness to the research implementation.

Table 5: Summary of Documentation Analysis Deployed

<i>Document Type</i>	<i>Source</i>	<i>Inform Interview Questions</i>	<i>Augment Interview Data</i>	<i>Corroborate Interview Data</i>	<i>Provide Background</i>
Project Brochure	External	X			X
	Internal		X	X	
Initial Dissemination Plan	Internal	X	X	X	X
Project Plan	Internal		X	X	
Industrial and Business Showcase	Internal	X			X
Dissemination Materials	Internal	X			X
Dissemination Plan	Internal	X			X
Big Data CEN Standards Workshop Report	Internal		X	X	
Final Dissemination Plan	Internal		X	X	X
Web-Home Pages	External	X			X

Document Type	Source	Inform Interview Questions	Augment Interview Data	Corroborate Interview Data	Provide Background
Web-Blog Articles	External		X	X	
Organisational Chart	Internal				X

6. Research Context: AquaSmart

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. 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, Scherngell and Lata, 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 Strategy³. Furthermore, investment of €1.13 billion has been allocated to aquaculture research through the European Maritime and Fisheries Fund⁴ (EMFF) and other cross-cutting topics in H2020 during 20018 and 2019 include €170 million⁵ 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.

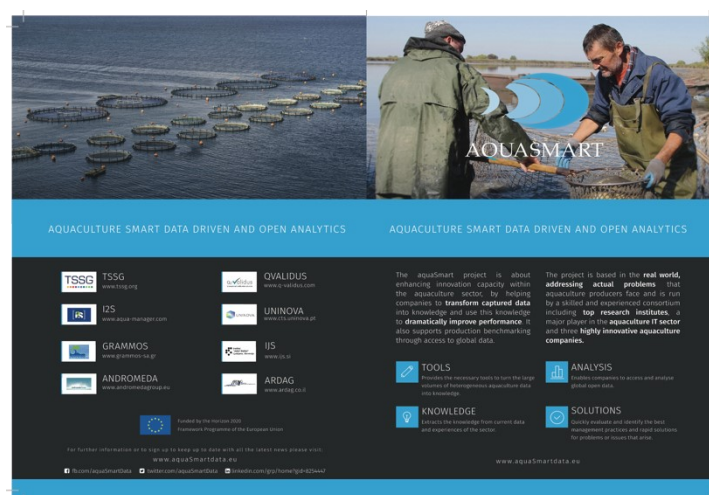


Figure 2:AquaSmart Context

The AquaSmart consortium comprises of 7 partners from 5 member states and 1 associated country. The AquaSmart network includes a diverse mix of researchers, fish farmers and ICT experts. The AquaSmart network includes participants from industry and academic organisations. The network consisted of 1 micro organisation,

¹ <http://www.AquaSmartdata.eu>

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

³ http://ec.europa.eu/maritimeaffairs/policy/blue_growth

⁴ https://ec.europa.eu/fisheries/cfp/aquaculture/funding_en

⁵ <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/dt-bg-04-2018-2019.html>

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. The following section (section 5) outlines the adopted research methodology.

7. Findings

This section presents the findings and provides evidence to illuminate stories and accounts of the network nodes (individuals active in the network) and their activities in collaborative research. The literature identifies difficulties in relation to creating and managing research networks; the empirical results provide insights to inform researchers toward their prevention and resolution (Lyall, Meagher and Bruce, 2015; Melese *et al.*, 2009; Mehlman *et al.*, 2010).

Table 6: Summary of key findings

<i>Finding</i>	<i>Description</i>	<i>Application</i>
<i>F1</i>	Network formation and network hopping. 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.	Impact of the research
<i>F2</i>	Diversity within research networks is conducive to a wide array of impact metrics. Optimising the creation of research networks (industry and academic collaboration) Incentivising mixed networks is essential for innovation. The network configuration for ICT EU research needs weak and strong ties to facilitate integration of technical and commercial expertise.	Network configuration
<i>F3</i>	Social aspects within the diverse network configurations assisted the prevention and resolution of issues. The findings presented evidence of the difficulties encountered building common understanding within multi-disciplinary research networks and between industry and academic networks.	Tensions within the network.
<i>F4</i>	Key roles as enablers to manage the research network (bridge, motivator, entrepreneur). The participants described cooperation and collaboration in the network. A network of diverse participants included incidents of reciprocity, exchange and regular cooperation and the challenges therein. The impact of these roles within the network included sustainability and progression of the network and its research output.	Impact of the research
<i>F5</i>	Difficulties encountered with managing research networks. Intra-network competition increases tensions and impact 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 evidence supported the importance of trust being central to behaviours in networks. Additionally, the research highlighted the funding differentiation impact of network relationships.	Barriers & resolutions. Role of the research funding agency to alleviate tensions.
<i>F6</i>	Tangible economic impact (e.g. skills and competency enhancement, new service offerings were critical). Research networks are encouraged under the EU Digital Agenda. This research presented the different new service offerings from its partner organisations.	Impact of the research
<i>F7</i>	This research found that the measurement of research network results and performance impact are collected and analysed too early to determine evaluation award.	Measurement of research impact beyond funding period.

7.1 F1 Network formation and network hopping

Formation of a new company from funded research goes beyond one network into another and is dependent on the drive of individuals with support of organisations. The formation of research networks is often not incubated as a new seed, its stems from previous growth and is cultivated. New research networks are formed from old alliances with the inclusion of new elements, new companies/spinouts emerge from research. The study highlighted that there is sometimes a lack of 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 research 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. 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 funded research/working groups has its advantages and disadvantages as you may be eliminating the positive innovative effect that 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 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 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 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. 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.

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 network in this study has identified the emergence of a new company as a real possibility. Interviewee A 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"*. The criteria for inclusion and exclusion of individuals or organisations is not evident.

7.2 F2 Network configuration

This paper discusses network configuration in detail and describes the nuances in the case study in relation to research network formation, management and sustainability. The network configuration for ICT research needs weak and strong ties to facilitate integration of technical and commercial expertise. In this case network centrality, idea generation and wide network knowledge were pivotal to network formation with specific roles emerging that impacted progress, opportunity management and problem resolution. The formation of the network is a crucial and time-consuming element of research initialisation and prior relationships was a significant factor for the creation of this research network. Specifically trust was identified as an enabler, the network formation stage depended on prior relationships to engage end-users.

Often, collaborative, funded research is multi-disciplinary connecting ICT with an application domain. The network configuration for ICT research needs weak and strong ties to facilitate integration of technical and commercial expertise. Diversity within the network is conducive to a wide array of impact metrics. While strong ties were apparent, in some cases weak ties and structural holes were considered significant advantages for this research network. Network diversity is critical to solving real-world problems and needs through multi-disciplinary research. The results from this research contributes directly to theory by providing rich insights in structural embeddedness. For example, the division between the type of network member; technical and business oriented. 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.

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 application domain. 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.

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. 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 following paragraphs provide some of the in-depth evidence that supports the insights in relation to formation and management of research networks.

7.2.1 Prior relationships Academia V Industry

The research network benefited in its incubation from the existence of prior relationships:
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".

There was an 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 this research, there were two individuals involved in the formation of the network. Participant A 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. When asked, *"how did you join the network?"* Participant I replied, *"I didn't join it, I created it"*. 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.

7.2.2 Challenges of convergence of multi-disciplinary expertise

Participant H 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 appears as a significant consideration for network formation. Participant G 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 describes how *"it took time to understand each other. Face to face meetings are crucial toward understanding different partners"*. Partner H 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".

Participant C 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 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 to join the network and Participant I encouraged the technical partners.

7.3 F3 Social aspects

Social aspects of diverse network configurations aid prevention and resolution of difficulties encountered e.g. toward building common understanding. The jargon used by the application domain 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. Eventually with careful intervention by the bridging partner and the coordinator the communication challenges between the diverse research participants were resolved. Following on, friendships were evident in this research network and facilitated enhancement of skills and competencies and enabled effective problem resolution. Additionally, trust, cooperation, reciprocity and exchange emerged as significant positive attributes. 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 joint exercise programs between participants.

Funding and costs (e.g. flights, meals) in relation to inter-organisational activity were cited as significant influencing factors on network progress, bridging the divide between the diverse network configurations. In addition, deep interpersonal relationships matured as participants referred to the network as family and akin to marriage.

Whilst collaborative research might allude to co-creation of knowledge, it was evident that some participants in the research network did not intend to pursue such objectives, this resulted in some isolation within the network.

7.4 F4 Enabling roles

The evidence from this research indicates that there were specific roles that individuals adopted to enhance the workings of the research network. This began with the formation of the network, through the management of the specific research and included the sustainability of the research toward commercialisation. Significantly, the depth of the relationships within the research network contributed to the effectiveness of these functions. For example, the participants highlighted a unique approach to motivation as a significant enabler. A specific individual within the research network adopted an explicit motivational role that featured at face to face meetings and conference calls. Furthermore, the research shows that this unique 'motivator' role had a positive effect in relation to problem resolution and work ethics, supported by an effective coordinator which resulted in high functioning collaboration and cooperation. This supports and extends the literature in relation to the need for inspiring leadership in research to motivate and support the researchers, the capacity building and investment in catalytic activities for active management is critical (Lyall, Meagher and Bruce, 2015) .

The structure of the network illustrated how one network member provided a bridge between ICT and the application domain. As the formation of the network and prior relationships already illustrated building bridges between network participants was critical and challenging,. 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. Participant D 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 role of a bridge was required as the gaps between perceptions and views were sufficiently sizeable that it affected the output and the performance of the network. The gaps in understanding were alleviated during social events and trust-building work activities. Participant A and Participant I cited culture and language as contributing factors *"different cultures and different work practices can have a significant impact on the network "*. Furthermore, Participant F identified location as a difficulty for collaboration, such as schedules for meetings and travelling for plenaries, which were identified as difficult but manageable.

7.5 F5 Difficulties encountered with managing research networks

Collaborative funded research involves individual and collective objectives and visions, it is inevitable that bringing inter-disciplinary researchers together can have difficulties and challenges. Within this research network it was clear from the outset that tensions were high between ICT organisations and the application area (aquaculture). Particularly, the research presents instances of anxiety in relation to sharing information and how this was resolved. Whilst the benefits of collaborative research networks are undisputed the fact that the network is conducting research does not override the requirement to protect trade secrets. This section details intra-network competition, tensions and trust issues triggered by initiatives such as EU open data policy.

It was clear from the empirical evidence that the open data policy and data sharing had conflicting priorities with competitiveness and that intra-network competition and the fear of sharing production data needed to be addressed and mechanisms employed to mitigate risk and alleviate tensions. Initially, open data compliance adversely effected the relationships within the network. Competitive production data tensions were difficult to resolve and complexity in relation to competition was evident particularly in relation to the end-users. However, techniques such as anonymisation facilitated the sharing of data among unfamiliar network parties. Thus, competition was initially a barrier but mechanisms were established to overcome this challenge and these can be recycled for further research management resolution.

Additionally, other barriers noted included a funding disparity among research networks, physical location of eligible partners and brevity of the funded network duration. 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. 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. 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.

The empirical evidence physical location of partners within the network is significant for managing face to face meetings and resolution of issues. Whilst a network has funds allocated for project meetings, the resources (cost, time, distance) can vary depending on the network. Investment in catalytic activities such as ideation workshops, meetings for conflict resolution might enhance the research management function. This study shows that face to face meetings and social interaction activities are integral to build trust within a research network. The high levels of trust between network members in this case study impacted competencies, problem resolution and 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. Interdisciplinary research encompasses social and natural science which needs a balanced rather than asymmetric contribution. Furthermore, the literature provides insights into the role of the funding agency and this research gives additional empirical evidence in relation to governance, disappointment and network bullying type obstructions and their resolution toward optimisation of network effectiveness (Lyall, Meagher and Bruce, 2015).

7.2.3 Building trust to alleviate research challenges and talk a common language

Trust is central to each and every inter-personal relationship and it affects behaviours of those in networks (Neves and Caetano, 2006). 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 initially mentioned one or two months to build up trust, but as we continued our discussion, it was recorded as significantly longer.

Participant A 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 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 believes it took about a year to build trust between the network participants. Furthermore, Participant A 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 network participants 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 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 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".

The network composition is a key factor to consider when a diverse network of researchers needs to understand each other's knowledge. Participant D 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 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.

It is clear that the jargon used 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.

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. Common understanding, ability to talk a common language and understand the requirements and capability of the research along with the collective know-how and technical implementation was key to realisation of the research achievements.

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.

7.6 F6 Tangible economic impact (e.g. upskilling, new service offerings)

The evidence from the case study reported pride in the quality of the research output, the results they were developing, and the depth to which friendships and interpersonal relationships had cultivated. New service offerings and the ability of partners to disseminate on a global level were emphasised. Commitment and trust impacted the research output and expectations of network participants.

Depth and wealth of industrial knowledge held by the end-users provided essential data while also it created challenges in relation to managing the research project. Each participant is an expert in their own area, collaborative research often aims to achieve multiple objectives, participants have individual and collective ambition and vision. 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. 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 the research network 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.

7.7 F7 Measurement of research network results and performance impact are collected and analysed too early to determine evaluation award.

EU funded research follows a rigorous evaluation process at proposal stage and is reviewed periodically 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 evident the study suggests explicit monitoring of output in relation to new company formation and provision of new service and product offerings. Thus, the funding duration and sustainability of the research network are important considerations and the provision of follow-on grants should be explored further.

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. It is clear that the role of the funding agency goes beyond the specific duration of any particular fund, and the sustainability, access to follow-on funds and nurturing of research networks holds potential. Currently, the funding agency provisions researchers with facilities toward formation techniques and there is opportunity to extend this and include network analysis functionality to give researchers a more resources to manage research networks.

8. Conclusion and recommendations

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 impact network optimisation. Social elements such as motivation, pride, friendships and trust play 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 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. This division in multi-disciplinary research where industry and academia collaborate can result in asymmetric contributions rather than balanced solutions. The richness of the research results will usually outweigh the barriers and obstacles encountered but the provision of mechanisms and planning for common issues can positively impact the level of achievements.

The empirical evidence from the research details anxiety in relation to understanding each other and the research information and how this was resolved. Specifically, the structure of the network illustrated how one network member provided a bridge between researchers.

Secondly, structural embeddedness has not previously been investigated in this area, it provides novel contextual insights. Technology progression strands society and its application areas are many, whilst this case study investigated ICT and Aquaculture, in the digital age technology is ubiquitous and many of the concepts encountered in this case study are pertinent.

The research describes the difficulties encountered by the research network 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. This unravelling of the complexities of managing research networks gives practitioners extensions to their toolbox to prepare for and react to barriers and obstacles that are inevitable in multi-disciplinary research networks. Network formation can be optimised and tailored for their own specific objectives in advance of the grant being awarded so that researchers can minimise disruption and focus on the research with a supportive research management function. It is evident that these insights provide a deeper understanding of managing research not achievable through quantitative methods.

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. Particularly the findings illustrate the necessity to actively address jargon within multi-disciplinary research networks especially relevant with the increase in multi-disciplinary research. 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. 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. As guardians of research and resource management of public finances in relation to a productive economy, health society and sustainable world the governance aspects need to extend to optimisation of research networks.

Disparity of funding among members of a research network highlights unbalanced support in collaborative environments which can be negative. The role of the policy makers goes beyond compliance and includes cocooning of researchers in a suitably provisioned environment, the ubiquitous nature of technology in our society and need for multi-disciplinary research networks is evident and needs to be fully addressed by policy makers.

Citizens and industry partners need support and representation toward accurate development of market requirements, product and service user scenarios and access to production data. 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. The funding agency acts as a gatekeeper for the knowledge economy, the wealth of expertise and knowledge that research networks encompass are not limited to network growth but quality and depth of relationships can enable further deep learning and technology advancements.

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Interrogating Business and Public Administration Research Attributes and Variables

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Abstract: Research proposal presentation or assessment panels and ethics assessment committees almost always ask us why we have included certain questions in our data or information collection instruments as well as why we think such questions will help us realise our research purpose. How can we answer these questions? First, let us step back. Numerous books have described what a conceptual framework is and why we need it. Further, there are several attempts to describe how we can conceptualise conceptual frameworks primarily through reviewing literature. One of the sets of literature that we should review is on attributes or variables, if not both, that are key to the research that we are pursuing. However, we find the discussion on how we should interrogate literature on attributes or variables not exhaustive to adequately guide a research student or a research novice on what they should do. Therefore, this paper proposes how we should explicitly identify, interrogate, and integrate literature on qualitative attributes or quantitative variables that are key to our business and public administration research. Apart from summoning basic systems thinking principles, the paper draws on reverse engineering comments compiled from examiners' reports¹ and consequent discussions with colleagues and students through devising seminars. We believe that the approach we have proposed in this paper will guide business and public administration research students and novices on how they should interrogate literature on attributes or variables that are key to the research that they are pursuing. If they get this right, it would contribute to robustness of their conceptual framework and, therefore, the research report. Before then, it will also empower us to answer the research proposal presentation or assessment panels and ethics assessment committees on why we have included certain questions in our data or information collection instruments and why we think such questions will allow us to achieve our research objectives.

Keywords: research conceptualisation, knowledge gap analysis, interpretive and theoretical frameworks, conceptual framework, research attributes and variables, research procedure and methods, research data and information collection instrument, discussing research findings

1. Background

More than ever, research proposal presentation or assessment panels and ethics assessment committees are asking 'why we have included certain questions in our data or information collection instruments' as well as 'why we think such questions will help us realise our research purpose'. This paper, therefore, proposes how we should explicitly identify, interrogate, link, and integrate qualitative attributes or quantitative variables that are key to the business and public administration research that we are pursuing. Our suggestions here may apply to any other research (most probably other social sciences and humanities) outside business and public administration. Our approach rests on basic systems thinking principles described in Gharajedaghi (2006) and builds on the work of Wotela (2016, 2017a). It also reverse-engineers comments of examiners' that assess our research student² reports as well as subsequent discussions with colleagues and research students through devising seminars. If successfully implemented, the proposals in this paper should lead to a contextualised, comprehensive, and critical write-up on qualitative attributes or quantitative variables that are key to the research that we are pursuing. In turn, this allows for confidently answering the research proposal presentation or assessment panels and ethics assessment committees.

To begin with, numerous books such as Ravitch and Riggan (2016) and journal articles such as Rocco and Plakhotnik (2009) and Imenda (2014) as well as conference proceedings such as Wotela (2017) have contributed to our understanding of conceptual frameworks. These source have described, debatably so, *what* conceptual frameworks are and *why* we need them in an academic research report, it be a thesis or dissertation. Further, they have attempted to describe *how* we can conceptualise conceptual frameworks. Wotela (2017) points out that literature review is the primary *process* of conceptualising conceptual frameworks. Conceptual frameworks comprise several subcomponents or sets of literature to review which vary in number from author to author. However, as we discuss in Section 3, we are convinced from the work of Badenhorst (2007) and to some extent

¹Examiner's reports of some WITS Graduate School of Governance and WITS Graduate School of Business Administration students.

² WITS Graduate School of Governance and WITS Business School

Ravitch and Riggan (2016) that any conceptual framework should (i.) interrogate literature on the research problem under study before moving onto (ii.) interrogating empirical literature that provides for exposing the theoretical knowledge gap. Thereafter, we should then (iii.) interrogate literature that discusses the attributes (qualitative) and variables (quantitative) that are key to the research under study. The three sets of literature should then provide for interrogating literature on the frameworks, theoretical or otherwise, that we can potentially use to interpret the anticipated empirical research results.

The focus of this paper is the subcomponent of conceptual frameworks that should supposedly focus on interrogating literature on either qualitative attributes or quantitative variables that are key to the research that we are pursuing—again primarily *what* this discussion is about and *why* we need it for our research to be comprehensive and critical. Discussing attributes and variables that are key to the research that we are pursuing is important three reasons. First of all, interrogating literature on either qualitative attributes or quantitative variables provides for conceptualising robust conceptual frameworks. Second, such a discussion provides for identifying appropriate frameworks, theoretical or otherwise, that we should use to interpret our empirical research results. Third, the discussion should ideally be the basis for populating the questions in the research data or information collection instruments that we ask our respondents. However, we fail to explicitly identify, interrogate, and integrate attributes and variables that are key to the research that they are pursuing. This shortcoming is exposed when research proposal presentation or assessment panels and ethics assessment committees asks us to substantiate why we have included certain questions in our research data or information collection instrument.

A quick search of literature shows that, other than research supervisor's or promoters notes³ whose access is limited, the discussion on identifying, interrogating, linking, and integrating attributes and variables that are key to the research that we are pursuing is lacking. Ravitch and Riggan (2016), Rocco and Plakhotnik (2009), Imenda (2014) as well as Wotela (2016) have, though not as explicitly, discussed attributes and variables and why we need this information when formulating our conceptual framework. Further, in this journal article, Wotela (2016) attempted to discuss *how* we should interrogate literature on attributes and variables that are key to the research that we are pursuing. However, the discussion omits *how* we should identify and integrate the discussion on attributes and variables. As a result, Wotela's (2016) discussion has proved to be insufficient and inadequate to successively guide research students and novices seeking to explicitly identify, interrogate, link, and integrate attributes and variables that are key to the research they are pursuing.

The paper begins with describing the qualitative research attributes and quantitative research variables in Section 2. We note that variables are but attributes that we can measure quantitatively. *Most discussions of attributes and variables are in the context of research data or information collection instruments. There is little emphasis for the need to interrogate and understand attributes and variables as part of our conceptual framework.* This is the problem that this paper speaks to. Section 3 sets the foundation through reviewing the six main components of a research report as well as the four processes in research. Like in our earlier work, we repeat this part not only because it is fundamental to our contribution but because we have continuously changed the way we think about the components and processes in research as we interact with students in various platforms on this subject. Further, we point out the seven subcomponents of the second component of research, that is, the conceptual framework where we also locate the subcomponent (fifth) that interrogates literature on attributes and variables that are key to the research that we are pursuing. Section 4 points out the 'golden threads' in researching and research reporting to emphasise the need to explicitly link the various research components and subcomponents as an avenue of attaining criticality. We then situate this paper in one of the four 'golden threads' as our point of departure.

In Section 5, we discuss with illustrations and examples how to pivot a business and public administration research through identifying, interrogating, and integrating qualitative attributes and quantitative variables that are key to the research that we are pursuing. First, we point out that we should use the research questions as well as where applicable the accompanying research hypotheses or research propositions to identify the attributes or variables, if not both, that are key to the research that we are pursuing. Second, during our 'theoretical' knowledge gap analysis that we undertake as part of literature review to determine additional attributes or variables, if not both, that are key to the research that we are pursuing. Third, we should then

³For example, those written and compiled by Amanda J. Rockinson-Szapkiw. <http://amandaszapkiw.com/artifacts/resources/tutorials/research-process/Step-7-Identifying-Labeling-and-Defining-Your-Variables.pdf>

discuss the identified attributes and variables within the broader context of the academic field-of-study that is appropriate to the research that we are pursuing. Fourth, we should use the interrogation of our selected attributes and variables to derive the questions that we should include in our empirical data or information collection instruments that we then use to interview our research respondents. Lastly, this discussion should also help us identify the appropriate frameworks, theoretical or otherwise, that we should use to interpret our empirical research results.

2. Describing research attributes and variables: The missing emphasis

Almost all research methodology textbooks—such as Neuman (2013), Bryman (2016), and Kumar (2018)—have defined, described, and discussed qualitative research attributes and quantitative research variables. Collectively, attributes and variables—as well as indicators and determinants—are changing or varying characteristics of a given phenomenon. First, this property allows for logically varying categories or characteristics or classifications of a given phenomenon. For example, sex has two categories or characteristics or classifications (girl or woman or female and boy or man or male) whilst classification of residence has three (rural, semi-urban, urban). Therefore, as Kaur (2013) points out, attributes and variables change from one person, organisation, institution, sub-region, region, country, and continent to the next or the other. This implies that not everyone in our research sample would have the same age, sex, height, weight, occupation, income, temperature as well as culture, language, religion, happiness, and anxiety. Second, the dynamic property of attributes and variables allows us to compare the relative positions (good or bad) of different persons, organisations, institutions, sub-regions, regions, countries, or continents on a given phenomenon that we are studying.

The distinction between attributes and variables is that the latter has *numerical* categories or characteristics or classifications which we can measure quantitatively. However, we can only manipulate the former qualitatively. This means that qualitative attributes become quantitative variables if we can quantitatively measure the change between their respective categories or characteristics or classifications. For example, attributes of public transport systems could be affordability, convenience, flow, and safety. The variables of such attributes could be transport costs, rate of private transport usage, travel timing, travel distance, travel speed, travel duration, and proportion of road accidents.

There are various types of attributes and more so variables such as independent versus dependent as well as extraneous. Kaur (2013) has also differentiated them on their scales of measurement—that is, nominal (attributes), ordinal (attributes with a specified numerical order), interval (numerical), and ratio (numerical). On an operational level, attributes and variables are what we ask our respondents or look for when collecting quantitative data (unorganised information) or qualitative information (organised data) so that we can answer our theoretical research questions or test our theoretical hypotheses or prove our theoretical propositions. This explains why most discussions of attributes and variables is almost always in the context of research data or information collection instruments.

There is no doubt that the foregoing description of attributes and variables is common and prominent in most research methodology textbooks—including but not limited to Neuman (2013), Bryman (2016), and Kumar (2018). However, as stated earlier, this description is in the context of research data or information collection instruments. Therefore, the focus is operationalisation of variables and sometimes, though not as explicit, attributes. There is little emphasis on the need to interrogate and understand attributes and variables—as part of our conceptual framework—before we include them in our research data or information collection instruments. The closest we get is Neuman (2013) who has described with examples how to source, summarise, and synthesis literature. However, even he does not explicitly discuss how we should do this for literature on attributes or variables that are key to the research that we are pursuing. The absence of this articulation is partly why we fail to answer the questions raised by the research proposal presentation or assessment panels and ethics assessment committees as to why we have included certain questions in our research data or information collection instruments as well as why we think such questions will help us realise our research purpose.

It is one thing to know what qualitative research attributes and quantitative research variables are and how they help us with formulating our data or information collection instruments. However, it is another thing to figure out the most appropriate attributes or variables that we should include in the instruments. Therefore, the gist of this paper is to identify, interrogate, and integrate the *theoretical foundation* underpinning the attributes and

variables that are key to the research that we are pursuing. This is certainly a useful discussion because whilst some attributes and variables as well as their categorisation or characterisation or classification are straightforward and established, the others are abstract and vague (Kaur, 2013). It is also most likely to help us to answer the questions, 'why we have included certain questions in our data or information collection instruments?' and 'what makes us think that such questions will help us to answer our research questions?'

3. Research components, subcomponents, and processes

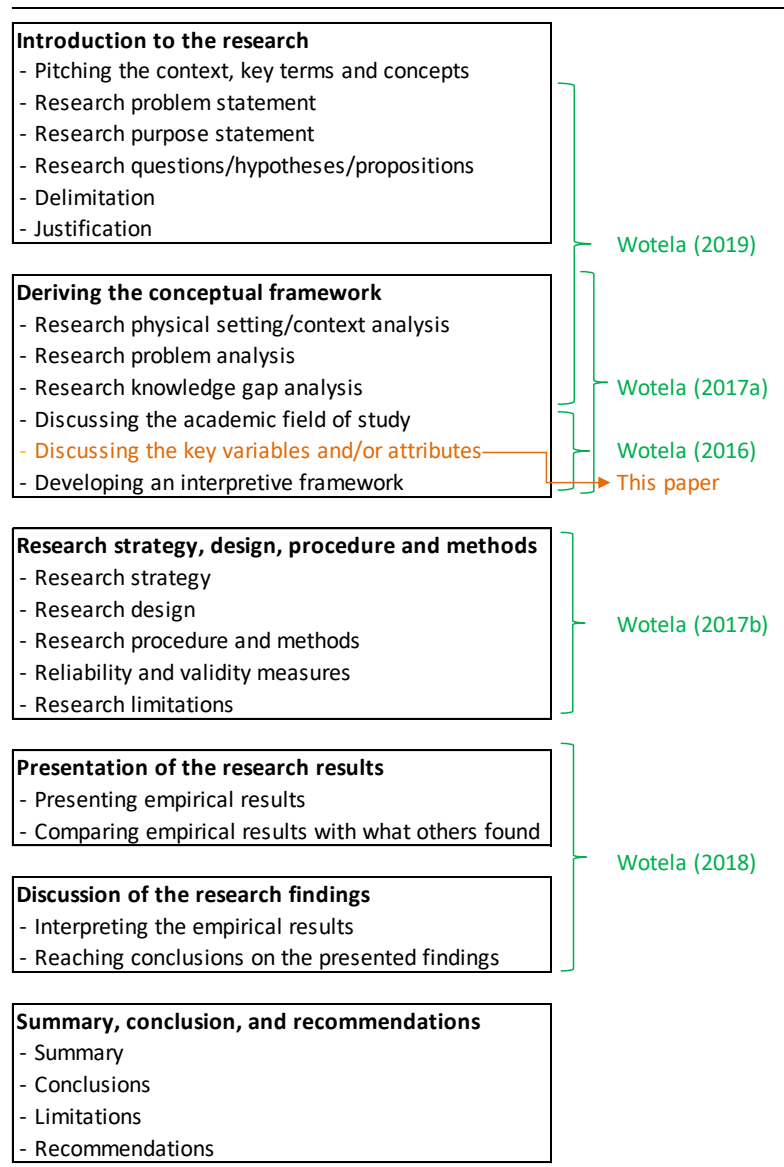
As we have argued earlier (Wotela, 2016), researching and research reporting is a complex undertaking. Therefore, to resolve this complexity, it helps to approach research from a systems thinking perspective. Identifying *components* (stock) and *processes* (flow) of complex phenomena, in this case research, is fundamental to systems thinking (Gharajedaghi's 2006). Using systems thinking approach detailed in Wotela (2016), we have identified and detailed six *components* of a business and public administration research report (Wotela, 2016, 2019) regardless of the number of chapters as presented in Figure 1, that is:

1. Introduction to the research to conceptualise the research
2. Reviewing literature to derive the conceptual framework
3. Research strategy, design, procedure and methods
4. Presentation of empirical research results
5. Discussion of research findings
6. Summary, conclusions, limitations, and recommendations

Relatedly and closely matching the six components, there are four *processes* in researching, that is, (i.) research conceptualisation, (ii.) theoretical interrogation, (iii.) empirical interrogation, and (iv.) empirical implementation as well as documentation. *Research conceptualisation* in business and public administration entails getting a research idea onto its researching trajectory. This involves intense reflection as well as iterative interrogation of the first component of a research report as well as the first three subcomponents of the second component (Wotela, 2019). The product of this process is spelling out explicitly and critically *what* the research is about and *why* we should bother to pursue it. The key products of this process are (i.) the research problem statement, (ii.) the research purpose (aim and objectives) statement, (iii.) the research questions as well as where applicable the accompanying research hypotheses or research propositions. The by-products of a thorough research conceptualisation process, which are also key to the entire research undertaking, are (i.) the research problem analysis within its physical context or space or setting and (ii.) the research theoretical knowledge gap analysis or empirical literature review.

Second, *theoretical interrogation*—which is primarily a structured and critical literature review resulting into a conceptual framework (second component)—provides for determining *how* we should undertake our research having already determined *what* research we should pursue and *why* during research conceptualisation. Among others, the key primary products of a theoretical interrogation process includes (i.) identification and interrogating the attributes or variables, if not both, that are key to the research that we are pursuing and (ii.) identification and interrogating the framework, theoretical or otherwise, that we should use to interpret our empirical research results (Wotela 2016). Eventually, the products arising from the research conceptualisation process and the theoretical interrogation process feed into conceptualising the conceptual framework for the research that we are pursuing.

Third, *empirical interrogation* is primarily reviewing research methods literature to detail our envisaged research strategy, design, procedure and methods (third component) proposed in our conceptual framework (second component). Lastly, *empirical implementation and its documentation* is the actual (and documentation of) collecting, collating, processing, and analysing empirical research data or information. We describe this process in the third component alongside the empirical interrogation. Thereafter, we present the empirical research results in the fourth component and—with the aid of the interpretive framework detailed in the second component—we discuss the research findings in the fifth component. In sum, we document the empirical implementation process in the third component and, thereafter, deposit the outputs (empirical research results) in the fourth component and the outcomes in the fifth component (discussion of research findings).



Source: Modified from Wotela (2019)

Figure 1: Showing the six components of a research report and their subcomponents

Apart from the fundamental six components and four processes of a business and public administration research report, Wotela (2016, 2017a, 2017b, 2018, and 2019) has also identified and detailed the first level subcomponents of the six components of research undertaking as presented Figure 1. For this paper, we highlight the subcomponents of the second component—that is, reviewing literature to derive the conceptual framework. He has argued that to derive a conceptual framework for the research that we are pursuing, we have to interrogate following sets of literature;

- 1. Research physical setting or context analysis
- 2. Research problem analysis
- 3. Research knowledge gap analysis
- 4. Establishing and discussing the academic context and its key components
- 5. Establishing and discussing the key research variables and/or attributes
- 6. Establishing and discussing the interpretive framework for the research

Eventually, summarising these six sets of literature provides for the seventh and final subcomponent of the conceptual framework (Wotela, 2016, 2019). Other than summarising the literature reviewed, the seventh component provides for proposing how we should carry out the empirical part of our research on the basis of the literature that we have interrogated. Therefore, as Wotela (2017a) has argued, a conceptual framework is an outline of how we should undertake the empirical part of our research—supported by, or engraved in, the

six sets of literature that we have interrogated. We should note that the focus of this paper is the fifth subcomponent of a conceptual framework—that is, establishing and discussing the key research attributes or variables, if not both.

Arnold and Wade (2015) state that as with most systems—in our case, the researching and research reporting system—systems thinking consists of three considerations, that is; a function or purpose, elements and components, and the interconnections between the elements and components. Implying from Arnold and Wade (2015), although not all systems have an obvious goal or objective, like systems thinking, a research should always have a defined aim and accompanying objectives. “The ... function or purpose [of a research is its] most crucial determinant ...” (Arnold and Wade, 2015, p3). Generally, this comprises its ‘research conceptualisation’ component and process (*what* research to pursue and *why*) as well as the accompanying conceptual framework component (*how* to pursue the research) arising from its ‘theoretical interrogation’ process. The second consideration is ‘elements and components’ that we detail in this Section. Lastly, it is the interconnections between the research elements and components that describes how they relate to and feed back into each other. We describe the interconnections of the elements and components of a researching and research reporting system in the next Section.

4. The four ‘golden threads’ in researching and research reporting

As provided for in systems thinking, the ability to link, and explicitly so, the various components and subcomponents of a research report provides for rigour and criticality. There could be more but we can claim at least four notable ‘golden threads’ in humanities and social science research in general and specifically business and public administration. First, (i.) the research title, (ii.) research problem statement, (iii.) research purpose statement, and (iv.) the research questions—as well as where applicable the accompanying research hypotheses or research propositions—should align. This is a fundamental red flag for most examiners as well as members of the research proposal presentation or assessment panels. More generally, they would like to see a harmonised content in the research title, the research problem statement, the research purpose statement, and the research questions. Specifically, between the research problem statement and the research purpose statement as well as between the research purposes statement and the research questions. Lastly, there as to be harmonisation between the research questions as well as where applicable the accompanying research hypotheses or research propositions.

Second, ‘the introduction to the research’ component should align with ‘the summary, conclusions, limitations, and recommendations’ component. The former provides for documenting the research conceptualisation—spelling out *what* the research is about and *why* we should pursue it. Having decoded the *how* to undertake the research and then moving on to actually implement the research in the subsequent components, it is important to document what the research has consequently realised in ultimate component—that is, ‘the summary, conclusions, limitations, and recommendations’ component. It is more critical if we deliberately mirror the primordial and ultimate components with the former showing ‘what we promised’ and the latter showing that ‘we have delivered what we promised’. This should be in context of what we actually did to get the empirical research results and reaching the conclusions as well as what these entail.

Third, the research questions and where applicable the accompanying research hypotheses or research propositions should align with the discussion on qualitative attributes or quantitative variables, if not both, that are key to the research that we are pursuing. In turn, the discussion on qualitative attributes or quantitative variables, if not both, should align with the questions in the research data or information collection instrument. Further, this discussion should also align with the frameworks, theoretical or otherwise, for interpreting empirical research results.

Lastly, the frameworks, theoretical or otherwise, for interpreting the empirical research results should align with the discussion of research findings. It is important to discuss relevant frameworks that are key to the research that we are pursuing. However, we should ensure that we actually use these frameworks when we interpret our empirical research results.

The focus of this paper is the third ‘golden thread’. In essence, we are pursuing the question, ‘how do we get to use the discussion on qualitative attributes or quantitative variables, if not both, to pivot our research so that it relates our (i.) research questions—as well as where applicable the accompanying research hypotheses or

research propositions—on one hand and on the other hand (ii.) the data or information collection instruments as well as (iii.) the frameworks, theoretical or otherwise, for interpreting empirical research results?’

5. Identifying, interrogating, and integrating literature on attributes and variables that are key to the research we are pursuing

To answer the questions, ‘why have we included certain questions in our data or information collection instruments?’ and ‘what makes us think that such questions will help us to answer our research questions?’ we should learn to explicitly identify, interrogate, and integrate literature on the attributes and variables that are key to the research that we are pursuing. This includes appreciating how these attributes and variables are related to each other (Kaur, 2013) and how they relate to our research questions as well as the frameworks, theoretical or otherwise, that we will eventually use to interpret the empirical research results. First off, as Wotela (2016, 2018) points out, the discussion on attributes or variables that are key to the research that we are pursuing is integral to the conceptual framework. This subcomponent should bridge the four research processes that we describe in Section 2. This means, as Figure 2 illustrates, we should deliberately pivot the discussion in this subcomponent by simultaneously and explicitly taking on board four related tasks of considerations.

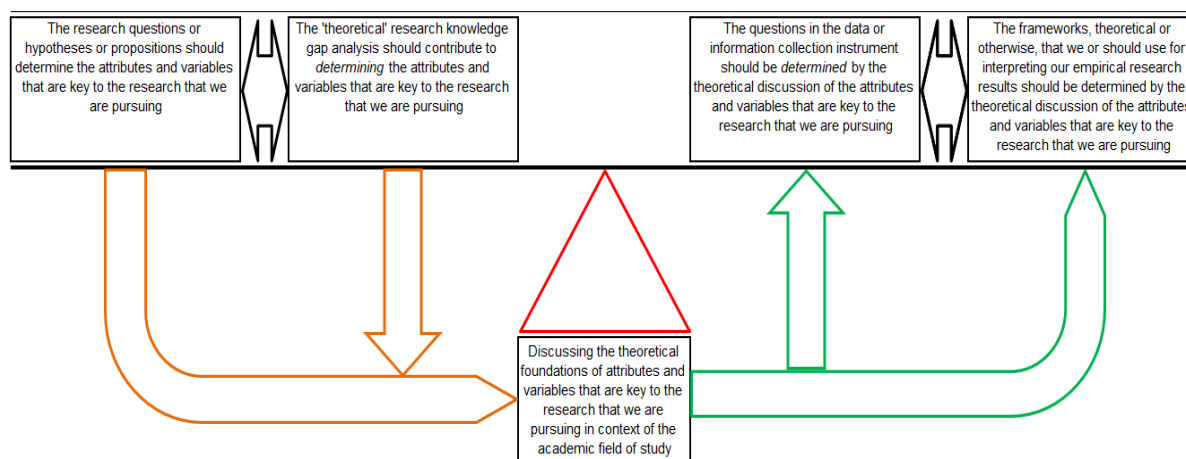


Figure 2: Showing how we should pivot the discussion of attributes and variables that are key to the research we are pursuing

First, (upper far left of Figure 2) the research questions—and where applicable the accompanying research hypotheses or research propositions—should *determine* the attributes or variables that are key to the research that we are pursuing⁴ (Connelly, 2015; Li & Ma, 2013). We should therefore begin with reviewing, reflecting, reconceptualising, and editing the research questions that we have posed and where applicable the accompanying research hypotheses or research proposition (Farrugia, *et. al.*, 2010). For example, Table 1 shows the research question (first row) and the accompanying null hypothesis (second row) and alternative hypothesis (third row) as well as the research proposition (fourth row). Interrogating this research question and its accompaniments suggests that ‘savings’, ‘traditional banking institutions’, and ‘income’ as well as qualifying what we mean by ‘people’ should be the attributes and variables that are key to this research. We should then subject these attributes and variables to literature interrogation so that we have a firm theoretical grounding on them and related factors. Doing so will also provide for identifying the other not so obvious aspects that can help us answer our research questions or test our research hypotheses or prove our research propositions. Inherently, such an undertaking provides for explicitly linking the research questions and where applicable their accompaniments (presented in the first component of the research report)⁵ to the discussion of attributes and variables that are key to the research that we are pursuing (presented in the second component of the research report)⁶.

⁴ In some cases, this could also be vice versa.

⁵ As we presented in Section 2, the first component of a research report—the introduction to the research—is dedicated to conceptualising ‘what’ research we are undertaking and ‘why’ we should bother to do so.

⁶ The second component of a research report—reviewing literature to derive a conceptual framework—is dedicated to interrogate literature so that we figure out ‘how’ we should undertake the research that we are pursuing.

Table 1: Showing the research questions and the accompanying research hypotheses and research propositions as well as the arising attributes and variables

Research questions and accompanying research hypotheses or research proposition	Identified research attributes and/or variables
What factors hinder people from saving in traditional banking institutions?	#People #Saving #Traditional banking institutions #Income
There is no difference between higher income earners and lower income earners in the proportion of money they save.	
The proportion of money saved by higher income earners is different from the proportion of money saved by lower income earners.	
If people had high incomes, they would save in traditional banking institutions.	

Second, (upper middle left of Figure 2) the ‘theoretical’ research knowledge gap analysis that we undertake as part of literature review should also contribute to *determining* the attributes or variables that are key to the research that we are pursuing (Zhao, Wu, and Liu, 2016). This is also called empirical literature review and involves reviewing past and current research that is similar to the one we are pursuing. The literature sources for this interrogation are primary or empirical research implying that the researchers or the authors actually collected, collated, processed, and analysed empirical research data or information whose results they consequently presented and discussed the findings. Obviously, they employed attributes or variables to collect, collate, process, and analyse empirical research data or information for their research. We can adopt as well as adapt some of their attributes and variables if they are key to the research that we are pursuing. For example, in addition to the four attributes and variables that we have identified in Table 1, reviewing past and current research can point to including consumption. These studies would argue that it is difficult to talk about savings without referring to income and consumption. Again, we should then subject the adopted and adapted attributes and variables to literature interrogation so that we have a firm theoretical grounding on them and other related factors. This undertaking provides for linking our (i.) research questions and where applicable their accompaniments (presented in the first component of the research report) to (ii.) the research knowledge gap analysis or empirical literature review as well as (iii.) the discussion of attributes and variables that are key to the research that we are pursuing (presented in the second component of the research report).

Third, (bottle middle part of Figure 2) after determining the attributes or variables that are key to the research that we are pursuing through (i.) the research questions as well as where applicable their accompaniments and (ii.) the ‘theoretical’ research knowledge gap analysis or empirical literature review, we should subject them to a literature interrogation. However, a theoretical discussion of the selected attributes and variables should be in the broader *context* of the academic field-of-study relevant to the research that we are pursuing. Indeed, to answer research questions or test research hypotheses or prove research propositions, we should collect the views and opinions of our research respondents through our data or information collection instruments. Regardless, the questions that we pose to our respondents in these instruments should have a firm theoretical and probably practical grounding. For example, unknowingly or otherwise, the issues that influence the respondents’ views and opinions on the services that learning institutions deliver sits in literature on education in general and specifically the education service delivery attributes and variables. Therefore we should, before anything else, have a theoretical understanding of education as the academic context and, thereafter, the education service delivery attributes and variables. In reference to Table 1, it is clear that the academic context would be economics. Therefore, we should interrogate literature to have a theoretical understanding of economics in general and then microeconomics (or macroeconomics) and, thereafter, the key attributes and variables in economics that are key to our research—that is; household income, consumption, savings as well as traditional banking institutions—all in the context of the ‘people’ that we are studying. This certainly provides us with a solid theoretical foundation on the variables that are key to our research on savings. We should also include a discussion of the various sources of data and information on these attributes and variables.

Further, our interrogation of attributes and variables should allow us to theoretically understand them individually and how they interlink or relate to each other as well as how they link in with the key aspects of the research that we are pursuing. Figures 3A and 3B show that it is helpful to map these relationships to bring out the causal-logical relationships between attributes or variables. Figure 3A shows that we can get to attributes or variables by breaking down the relevant field-of-study into components and further its components into components until we get to elements that we can collect data and information on. Furthermore, unlike Figure 3A, Figure 3B shows that the outcome may not always be pyramid or semi-pyramid shaped. In all cases, we should use literature to determine or support the identified components and subcomponents as well as the resulting attributes and variables. The literature should also determine or support the relationships between attributes and variables. Wotela (2016) has proposed how we should interrogate literature on the academic field-of-study, its components as well as its attributes and variables. Crossan and Apaydin's (2010) paper is another compelling example of what we should aim to achieve in this interrogation.

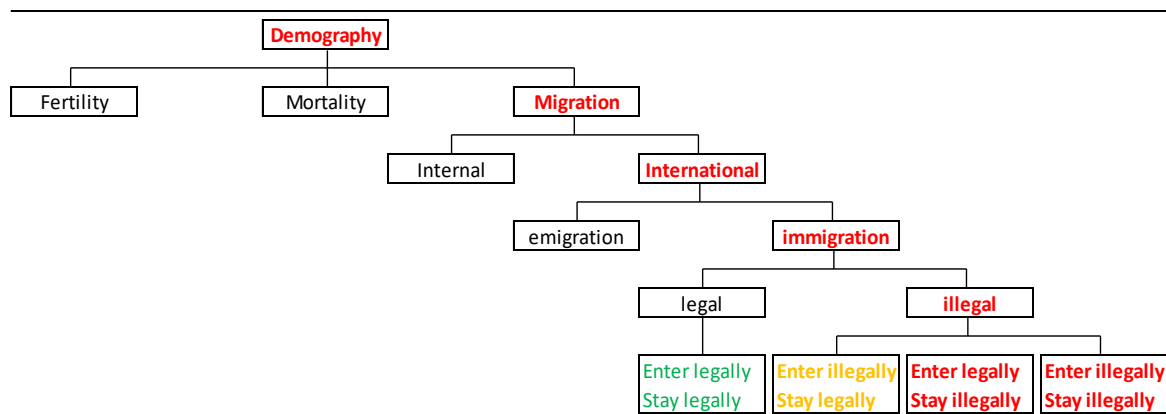


Figure 3A: Showing the academic field-of-study (demography), its key components at various levels, and the attributes or variables for studying illegal international migration (Letsiri & Wotela, 2015)

Fourth, (upper middle right of Figure 2) we should use the discussion of qualitative attributes and quantitative variables to determine the research strategy, design, procedure and methods (the third component of a research report) that we will employ for our research. More specifically, it should determine the questions that we field in our research data or information collection instrument (Pushpanjali, Piddennavar, and Mohan, 2011). Therefore, there should be a link, explicit for that matter, between the theoretical discussion of the attributes and variables that are key to the research that we are pursuing on one hand and on the other hand the questions that we should pose to our research respondents to elicit empirical research data or information from them. Inherently, this links our research questions (and where applicable the accompanying research hypotheses or research propositions) and the questions that we package in our data or information collection instruments. Further, this link is anchored by our theoretical understanding of the attributes or variables that we have selected.

To illustrate, Figure 4 shows what we have stated earlier that we should interrogate economics in general and then microeconomics (or macroeconomics) and thereafter its variables—household income, consumption, and savings to get a solid theoretical foundation on the variables that are key to our research on savings. We should obviously extend this theoretical interrogation to traditional banking institutions and context, that is, the ‘people’ that we are studying. This certainly provides us with a solid theoretical foundation on the variables that are key to our research on savings. Further, we should then use our selected and theoretically interrogated attributes and variables to derive the questions that we should ask our research respondents—in this case about their household income as well as their consumption and savings habits. Although the questions that we pose to our respondents are ‘ask-able’—that is, questions that non-specialists can actually comprehend and respond to—cumulatively, they help us answer our ‘theoretical’ research questions. For example, we cannot ask our respondents about their microeconomic status but we can ask them about their income, consumption, and savings. From their answers, we can then establish their micro-economic status using our theoretical and practical understanding of economics, its components, as well as its attributes and variables—more so how these variables are inter related.

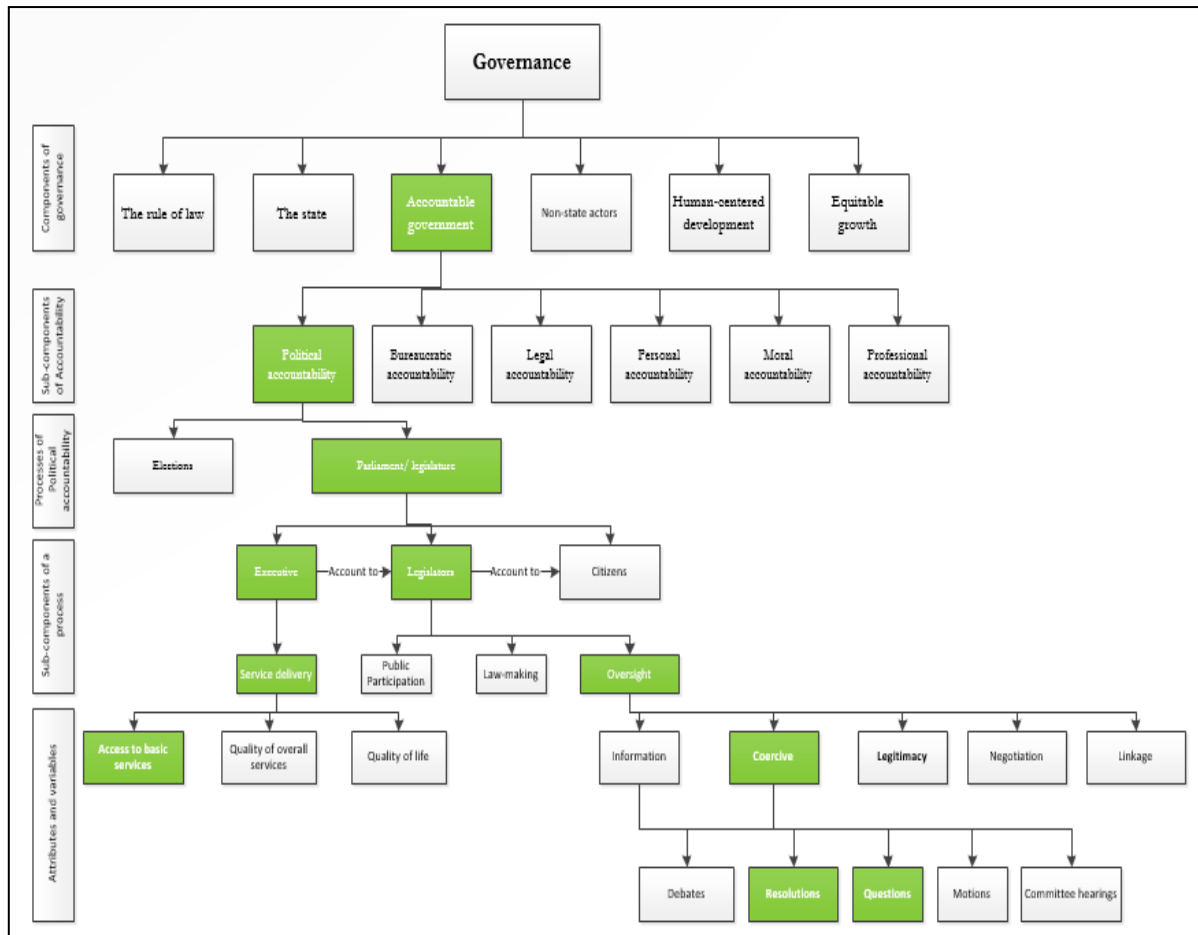


Figure 3B⁷: Showing the components, attributes, and variables of legislative oversight and service delivery within the governance academic field-of-study

Inherently, EVERY question in our data or information collection instrument should emanate from a thorough and explicit theoretical interrogation within an appropriate academic field-of-study. Therefore, as part of our conceptual framework, we are theoretically interrogating attributes and variables that are key to the research that we are pursuing to pivot our research. On one hand, our selected attributes and variables are linked to (i.) the research questions and where applicable the relevant accompaniments and (ii.) the ‘theoretical’ knowledge gap analysis or empirical literature review while, on the other hand, they are linked to the questions in our data or information collection instruments that we will use to collect data or information from our research respondents. Such a deliberate link will certainly provide for answering the questions, ‘why we have included certain questions in our data or information collection instrument?’ and ‘why we think such questions will help us realise our research purpose?’ Further and more generally, this interrogation may also provide valuable input into how we should collect, collate, process, and analyse empirical research data or information that we will collect using the questions in our research data or information collection instruments (Wotela, 2017b).

Lastly (upper far right of Figure 2) we should use (i.) the discussion of qualitative attributes and quantitative variables and (ii.) the questions that we populate in our empirical data or information collection instrument to *determine* the most appropriate frameworks, theoretical or otherwise, that we should consider for interpreting our empirical research results (Marzo-Navarro, Pedraja-Iglesias, and Vinzón, 2017). When interrogating literature on the attributes or variables that are key to the research that we are pursuing, we might encounter frameworks that are relevant to our selected attributes or variables, if not both. For example, we are likely to find a discussion on microeconomic theory when we are interrogating literature on income, consumption, and savings. The other way round is that literature on frameworks of interest, would also point to attributes and variables that maybe key to the research that we are pursuing. For example, literature on microeconomic theory

⁷ **Credit:** Mokibelo R. Ntshabeleng’s research on ‘Correlating effective legislative oversight and improved service delivery: A case of Gauteng Province’

might point to assertions—such as, ‘all things being equal, higher income leads a higher propensity to spend’—and, therefore, inherently pointing out income, consumption, and savings as important attributes or variables. Doing so will allow us to link (i.) the research questions and where applicable the accompanying research hypotheses or research propositions, (ii.) the attributes or variables, if not both, that are key to the research that we are pursuing, (iii.) the questions that we should ask our respondents to elicit empirical research data or information from them, and (iv.) the framework, theoretical or otherwise, that we should consider to interpret our empirical research results.

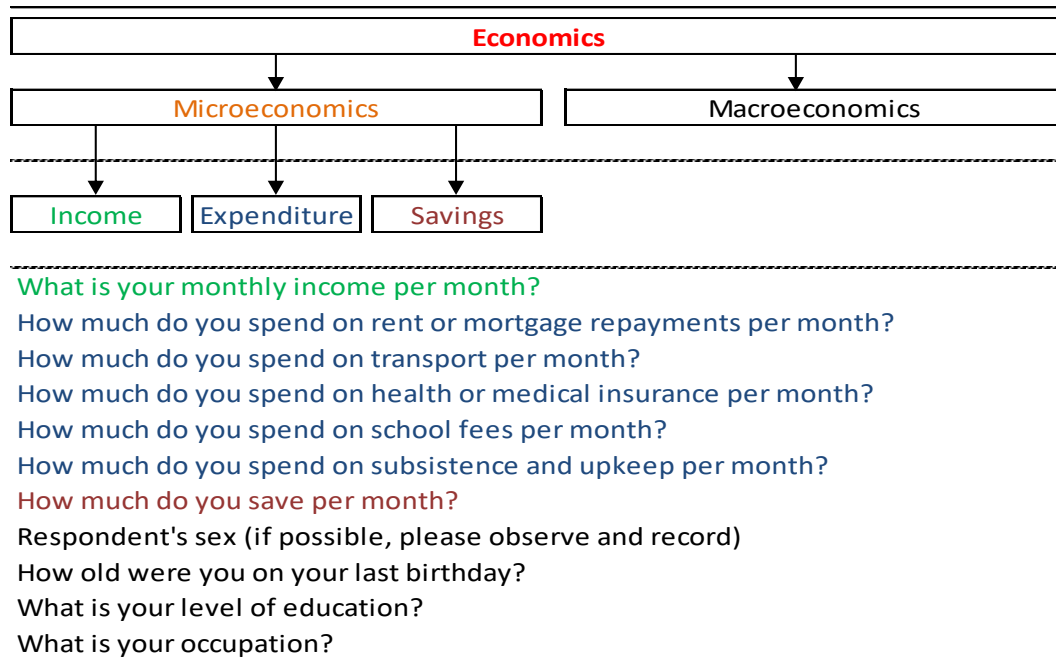


Figure 4: Showing the academic field-of-study (economics), its key components (microeconomics and macroeconomics), and its variables (income, expenditure, and savings) as well as questions for the data collection instrument

6. Summary and conclusions

The panels that assess research proposals and ethical considerations also review the accompanying data or information collection instruments. Among others, they are interested in why we have included certain questions in our instruments as well as why we think such questions will help us realise our research purpose. To answer these questions, we need to have a firm grip on how to explicitly identify, interrogate, link, and integrate qualitative attributes or quantitative variables that are key to the business and public administration research that we are pursuing. Therefore, in Section 5, this paper proposes five complimentary and overlapping tasks to explicitly identify, interrogate, and integrate attributes and variables that are key to the research that we are pursuing. First, we should use our research questions as well as where applicable the accompanying research hypotheses or research propositions to *identify* the qualitative attributes or quantitative variables, if not both, that are key to the research that we are pursuing. Second, we should *adopt* and *adapt* attributes and variables from research that is similar to the research that we are pursuing. Third, we should then use appropriate academic literature to *interrogate* the attributes and variables that we have identified, adopted and adapted within the academic field-of-study that is appropriate to the research that we are pursuing. Therefore, before interrogating these attributes and variables, we should initially interrogate the appropriate academic field-of-study and its components to provide an academic discourse or context. Academic contextualisation may provide for us to theoretically and, in some cases, practically understand our research attributes and variables. Fourth, we should then use our theoretical and practical understanding of our research attributes and variables to *decide* the questions that we should include in our data and information collection instruments. Fifth, we should also use our understanding of our research attributes and variables to *determine* the most appropriate frameworks, theoretical or otherwise, that we should use to interpret our empirical research results.

Before making the proposals that we share in the preceding paragraph, in Section 2, we interrogated attributes and variables in the context of research data or information collection instruments. We argue that there is

little emphasis, if present, on theoretical interrogation of attributes and variables and yet such an interrogation is key to the research that we are pursuing is an important subcomponent of the conceptual framework. Further, the theoretical discussion of attributes or variables should be explicit linked to the various components and subcomponents of our research proposal or report. It is important to do so and we have justified this assertion by pointing out the four 'golden threads' in researching and research reporting (Section 4).

To set the foundation of our paper, we have reviewed the six main components of a research report as well as the four processes in research (Section 3). We then zero in the seven subcomponents of the second component (the conceptual framework) of a research. More specifically, we locate the subcomponent in which we should interrogate literature on attributes and variables that are key to the research that we are pursuing. Ideally, it is in the fifth subcomponent of the conceptual framework—where we should discuss the attributes or variables that are key to the research that we are pursuing.

More generally, this paper argues that we should go beyond mere description of attributes and variables in the context of research data or information collection instruments. Instead, we should explicitly identify, interrogate, and integrate attributes and variables that are key to the research we are pursuing. This implies theoretically and practically understanding the attributes and variables that are key to the research that we are pursuing. Such a discussion will contribute to a rich conceptual framework of our research. Further, we should deliberately link the components, subcomponents, and elements of our research—a point that we argue for in Section 4. Therefore, in this paper, we provide for actualising the third of the four 'golden threads'. In essence, we should determine our research attributes and variables through interrogating (i.) the research questions and where applicable the accompanying research hypotheses or research propositions and (ii.) the 'theoretical' knowledge gap or empirical literature. Further, we should discuss our selected attributes and variables in (iii.) the context of the academic field-of-study that is appropriate to the research that we are pursuing. In turn, we should use our theoretical and practical understanding of our research attributes or variables to determine (iv.) the questions that we package in our data or information collection instruments and (v.) the frameworks, theoretical or otherwise, that we should use to interpret our empirical research results.

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I am grateful to our research students that took part in a series of *devising seminars* where we discussed conceptualising conceptual frameworks; establishing interpretive frameworks; and now identifying, interrogating, and integrating attributes and variables that are key to the research that we are pursuing. I am, however, most grateful to the students that applied these proposed approaches for providing feedback on what worked and worked really well as well as what did not work. Further, I would like to thank colleagues, notably Prof Pundy Pillay, for the helpful comments and encouraging remarks. Lastly, as always, the reviewers including my super niece Chilala Chicha for helping me fine-tune this article and reconcile my argument as well as perfect my write-up.

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The Role of Research Methodology in Enhancing Postgraduate Students Research Experience

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Abstract: Postgraduate student research experience is key to understanding the quality of postgraduate education. This article presents the critical factors that can enhance postgraduate students' research experience. The research explored postgraduate students' research experiences (n=116) at a research-intensive public university in New Zealand. The aim was to inform the development of a more personalised and scalable research methodology programme. The study identified several factors that can significantly enhance the postgraduate research experience, including the quality of supervision, institutional and department support, personal investment, and financial support. Also, the study found that courses on research methodology play an essential role in improving the postgraduate experience. In particular, providing research methodology education to students during candidacy enriches postgraduate research experience and contributes to the timely completion of postgraduate education. Despite the demonstrated significance of research methodology in postgraduate education, findings revealed that students are generally dissatisfied with the design and teaching of current courses on research methods. Students said courses on research methods are pedagogically monolithic, conceptual challenging, and inflexibly adaptive to individual future career trajectories. Findings also suggest that the way research methods are taught is disengaged from practical problems, with some teaching focused on the higher level of abstraction, with less opportunity to apply what is gained from research methods courses. This research contributes to the growing need to transform the way we design and teach courses on research methods, and the importance employing a research-led approach to inform the transformation.

Keywords: postgraduate research experience, research methodology, postgraduate education, supervisory support, institutional support

1. Introduction

Postgraduate students are becoming increasingly diverse, with different interests and goals for pursuing postgraduate education. Diversity is reflected in age, culture, ethnicity, nationality, prior research experience, and financial ability (Abiddin, Ismail and Ismail, 2011). The growing diversity in postgraduate students has created far-reaching challenges for institutions to provide adequate resources and individualised support to complete their studies on schedule and gain enriched research experience to obtain employment or further studies (Daniel, 2018; Spronken-Smith, Cameron and Quigg, 2017). Researchers have explored the notion of postgraduate research experience as a mechanism to understand the quality of postgraduate research programmes and supervision (Grant, Hackney and Edgar, 2014; Muraraneza, Mtshali, and Bvumbwe, 2020; Nachatar Singh, 2018).

Postgraduate research experience describes the student's collections of lived experiences, observations, events, knowledge, and skills acquired during their postgraduate programme. Such an experience is influenced and shaped by many factors, including the quality and nature of available research methodology. As a multidimensional construct, postgraduate research experience consists of students' episodic and perceived experiences during candidacy and the extent to which such experiences contribute to or shape the student's lifelong developmental growth after programme completion. Student completion rates and postgraduate research experience are intertwined phenomena critical to the quality of postgraduate education.

Though various studies have been conducted on factors that contribute to an enhanced postgraduate research experience (see, for example, Noori Hekmat, Rezaei, and Dehnavieh, 2016; Slight, 2017; Trigwell and Dunbar-Goddet, 2005; Wisker and Kiley, 2014; Wright and Cochrane, 2000), the role of research methodology training has been ignored. Courses on research methodology play a significant role in improving the postgraduate experience. In particular, providing research methodology education to students during candidacy enriches postgraduate research experience and contributes to the timely completion of postgraduate education.

This article reviews factors likely to enhance postgraduate students' research experience and examines the role of research methodology in contributing to the postgraduate research experience. The research aimed to develop a more personalised and scalable research methodology programme for postgraduate students.

2. Related research

Researching postgraduate student research experience is essential because it enables institutions to better address students' diverse learning needs, provide students with a meaningful pedagogical experience (Jancey and Burns, 2013), and widen future employability horizons. However, most studies in this area have focused on analysing students' understandings about their learning and supervisory experience (Burmeister, 2015; Phillips and Pugh, 2010).

Research has identified several factors that can contribute to an enhanced postgraduate students' research experience, including the nature of institutional support (Humphrey and McCarthey, 1999; Spronken-Smith, Cameron and Quigg, 2017); the quality of postgraduate supervision (Kaur, Kumar and Noman, 2021; Mohamed, Judi and Mohammad, 2017); financial challenges, family commitments, information and services offered to students by institutions (Abiddin, Ismail and Ismail, 2011). The quality of postgraduate student experience and completion rates are correlated (Spronken-Smith, Cameron and Quigg, 2017). However, the issue of postgraduate completion rates is debated elsewhere. For instance, Wright and Cochtane (2000) pointed out disciplinary differences in completion rates. They said that programmes in the Natural Sciences (e.g. Chemistry, Physics, etc.), by their nature, take longer for students to complete their degrees. Lessing and Schultz (2003) added other factors affecting student completion, including student-friendly environment, available administrative procedures and support, understanding scientific and academic requirements, understanding and balancing workload, supervisory support, time management and writing ability.

The quality of supervision remains critical to completion rates and postgraduate research experience. Over the years, several studies have pointed out the importance of postgraduate supervision and institutional support in enriching the postgraduate student experience (Franke and Arvidsson, 2011; Lange and Baillie, 2008; Lee, 2009; Kaur, Kumar and Noman, 2021; Styles and Radloff, 2001). In particular, Lessing and Schulze (2002) saw the research supervisor's task as ensuring that the topic on which a candidate embarks contributes to theory. Research has also reported that a research supervisor's role continually evolves in response to students' experiences (Wisker and Kiley, 2014). Subsequently, the supervisory role is becoming more challenging because most postgraduate students come from various ethnic, cultural, political, economic, linguistic and educational backgrounds. While their attraction and retention are paramount for educational institutions (Alam, Alam and Rasul, 2013), managing diversity dynamics is a significant challenge for institutions. Mohamed, Judi and Mohammad (2017) added that supervisory challenges are attributed to rising expectations in most postgraduate programmes and graduates' quality. There are also supervisory challenges associated with the marked differences between taught and postgraduate research degrees; Masters and Doctoral levels supervision.

Further, the postgraduate is also tasked with ensuring that students understand the research field and the study's context and gain the appropriate research methods needed to solve the identified problem (Daniel, Kumar and Omar, 2018). Factors such as similarity in the student research topic and supervisor's research interest and area of expertise, ability to establish collegial relationships, as well as providing emotional support are the essential determinants of student success in postgraduate education (Fraser and Mathews, 1999; Mouton, 2001; Styles and Radloff, 2000). It has also been pointed out that a positive relationship between a student and supervisor is the key to successful postgraduate programme completion (Peat, Taylor and Franklin, 2005).

A substantial body of research supports the quality of the supervision and institutional factors in contributing to enhancing postgraduate student research experience. However, this research does not acknowledge the role of research methodology in contributing to student success in graduate education. Understanding the relationship between different research methodologies and student experience, especially in a doctoral programme, can add to existing knowledge of enhancing the student research experience (Coronel Llamas and Boza, 2011).

The overarching purpose of this research was to explore factors likely to contribute to postgraduate students' enhanced research experience. The research also explored the role of research methodology programmes in enhancing students' postgraduate research experience as well as contributing to fulfilling students future research careers. The study also explored students' experiences and challenges of learning research methods courses. The central questions addressed in this research are:

- **RQ1.** What factors contribute to an enhanced postgraduate research experience?
- **RQ2.** What is the role of research methodology in influencing the postgraduate student research experience?

3. Research methods and procedures

The research was undertaken in a public research-intensive university in New Zealand. The context of the study was situated within an Australasian postgraduate education system, with predominantly research-based degree programmes. In the Australian postgraduate system, methodological research support is predominantly provided by student supervisors, with few exceptions in some programmes where instruction on research methodology is provided to all students regardless of their domain of study. Though there are limited required courses in research methodologies, in the Australasian postgraduate education system, during candidacy, students may often take short courses in skills development relating to research methods or take other programmes such as writing, engaging with the literature, etc.

The present study utilised an embedded mixed methods research design involving an online questionnaire. The questionnaire was adapted from (Trigwell and Dunbar-Goddet, 2005) and consisted of 17 structured questions measured on a 5 Likert scale (1=strongly disagree; 2 =disagree; 3 = neutral; 4 =agree; 5=strongly agree), and some open questions. Some items included open-ended questions intended to solicit data to explain participants' reactions and provide contextual insights into the quantitative data. Individual scores on the items in the questionnaire are shown in table 1. The instrument was tested for reliability, revealing an overall high Cronbach's Alpha ($\alpha = .936$; $N=17$).

3.1 Data analysis

SPSS was used to analyse the quantitative data. Respondents' demographic data were summarised using descriptive statistics (frequency tables and proportions, see Table 2). To extract the key factors that can explain an enhanced postgraduate research experience, exploratory factor analysis was used to describe variability among all observed correlated variables (see Table 1) and isolate those with high correlation measures. Responses to open-ended questions were analysed thematically, and selected quotes were used to provide more in-depth context to the factors extracted from the exploratory factor analysis.

Table 1: Descriptive Statistics

Variable	Mean	Std. Deviation
My supervisor/s have the skills and subject knowledge to support my research adequately	4.2	0.9
My supervisor/s make a real effort to understand any difficulties I face	4.1	1.2
My institution values and responds to feedback from research degree students	3.6	1.0
I understand the required standard for the thesis	4.1	0.8
Supervisory support and guidance	3.6	0.7
Supervisory support and guidance	5.6	1.6
There is adequate provision of library facilities	4.0	0.8
I understand the requirements and deadlines for formal monitoring of my progress	4.3	0.8
I understand the requirements of thesis examination	3.9	0.8
I understand my responsibilities as a postgraduate student	3.4	0.7
Access to appropriate facilities such as computer labs, software, and experimental rooms	5.0	1.5
Opportunities to develop a range of research skills	5.0	1.3
Opportunities to develop a range of transferable skills	5.0	1.4
There is appropriate financial support for research activities	3.2	1.3
I am encouraged to think about the range of career opportunities that are available to me.	3.7	1.1
Provision of guidance on institutional standards and expectations for your research degree programme	4.9	1.4
My postgraduate experience so far has improved my analytical skills	4.0	0.8
There are adequate opportunities available for me to develop my research skills further (e.g. independently carry out research)	4.0	1.0

Variable	Mean	Std. Deviation
My experience so far has helped me to develop a range of communication skills	4.0	0.7
My supervisor/s provide helpful feedback on my progress	4.2	1.0
The research interests in my department or faculty stimulate my work	3.5	1.1
My supervisor/s are available when I need them	4.2	1.0
My department provides a good workshops program for postgraduate students	3.6	1.0
My department provides opportunities for social contact with other research students	3.1	1.1
My department provides opportunities for me to become involved in the broader research culture	3.1	1.1
Opportunity to develop a range of research skills, e.g. data analysis, performing literature review	3.5	0.7
Opportunities to develop a range of transferable skills	3.3	0.8
Provision of guidance on institutional standards and expectations for your research degree program	4.3	0.8

3.2 Participants characteristics

One hundred sixteen participants filled in an online questionnaire. Sixty-nine identified as female, and 47(41%) identified as male. The median age range was between 31-35 years, constituting over a third of the total number of participants, 37(32%). The degree programmes in which participants were enrolled, were almost equally distributed; 61(53%) were enrolled in a PhD programme, and 55(47%) were enrolled on Masters Degrees. Further, participants were mainly pursuing their degree programmes on campus (or face-to-face), 101(87%), and 15(13%) were distance students (see Table 2 with all demographic information).

Table 2: Participants' demographic information

Variable	Frequency/Percent
Age range	
≤ 25 years	22(19)
26-30	24(21)
31-35	37(32)
36-40	16(14)
41-45	9(8)
46-50	4(3)
51-55	3(3)
≥ 56	1(1)
SEX	
Female	69(60)
Male	47(41)
Programme of study	
PhD	61(53)
Masters	55(47)
Mode of studies	
Primarily a face-to-face learner	101(87)
Primarily a distance learner	15(13)
Participant's discipline	
Health Sciences and related subjects	30(26)
Biological Sciences	28(24)
Engineering and Computer Sciences	23(20)
Arts and Humanities	15(13)
Biomedical and Veterinary Sciences	11(10)
Social Sciences	6(5)
Physical Sciences	3(3)

Though respondents reported diverse research experiences before joining postgraduate education, those with research experience upon completing undergraduate studies were proportional to those who said they gained research experience after completing postgraduate education (see Table 3).

Table 3: Research experience prior to postgraduate school

Experience	Frequency/Percent
Completed my postgraduate studies	30(26)
Completed my undergraduate studies	29(25)
Worked in a non-research role	16(14)
Worked in the same organisation that I currently work in	16(14)
Took a gap year	10(9)
Worked as a researcher	8(7)
Lecturer	4(4)
master student	1(1)
work at a private company based on my undergrad qualification	1(1)
worked as a professional	1(1)

Participants were in various stages of their study programme at the research time. Over two-thirds of the respondents, 71(61%), were in their second year's study programme, with a median year of 2 years in the programme. More than half, 55(47%) were writing their theses, and nearly half, 49(42%), indicated that they were either planning or collecting data for their research projects; 5(4%) said they submitted their thesis, and 5(4%) was waiting for viva 4(3%). There was only one participant who reported expecting to graduate.

3.3 Factor analysis

To determine the factors that are likely to influence postgraduate research experience, an exploratory factor analysis (EFA) was performed. Twenty-eight items were extracted using principle-component analysis (PCA) with Varimax (orthogonal) rotation technique. Kaiser-Meyer-Olkin measure of sampling adequacy was determined at a value of .815, above the recommended value of 0.6. Further, Bartlett's test of sphericity was significant at (χ^2 (378) = 2257.320; $p < 0.001$). The commonalities were all above 0.4 (see Table 4). Based on these tests, factor analysis was deemed suitable to proceed. From the EFA, seven factors were extracted, which explained 75% of the variance for the entire set of variables (Table 5). The factor loading was considered at $\geq .4$ as a cut-off value to help with better interpretation. Moreover, the statistical power was determined at .80 since the sample ($n = 116 > 100$) threshold value.

Seven items loaded into the first factor (see table 5). This factor was described as "supervisory support and feedback on student work", which explained 35.3 % of the variance. The second factor was extracted from 3 items and explained 10.3 % of the variance, and the factor was labelled "institutional support for students to develop research skills". The third factor was extracted from seven items, labelled "personal responsibility and accountability", and explained 8.1% of the variance. The fourth factor was named "institutional and supervisory support", explaining 7.252% of the variance. The fifth factor accounted for 5.430% of the variance and was labelled "departmental research support". The sixth factor explained 4.851% of the total variance, labelled as "culture of support for research methods skills development". Two items loaded into the seventh factor, referred to as the "financial support". This factor explained 3.912% of the total variance.

Table 4: Rotated Component Matrix

	Component							Commonality
	1	2	3	4	5	6	7	
My supervisor/s make a real effort to understand any difficulties I face	.90							.73
Supervisory support and guidance	.79							.90
My supervisor/s provide helpful feedback on my progress	.79							.83
My supervisor/s have the skills and subject knowledge to adequately support my research	.78							.77
My institution values and responds to feedback from research degree students	.65							.84
My supervisor/s are available when I need them	.63				.53			.69
Opportunities to develop a range of transferable skills		.83						.79
Opportunities to develop a range of research skills		.82						.62
Provision of guidance on institutional standards and expectations for your research degree program		.82						.80
Access to appropriate facilities such as computer labs, software, and experimental rooms		.77						.83

	Component							Commonality
	1	2	3	4	5	6	7	
I understand my responsibilities as a postgraduate student			.77					.83
I understand the required standard for the thesis			.76					.85
I understand the requirements of thesis examination			.69			.43		.73
There are adequate opportunities available for me to further develop my research skills (e.g. independently carry out research)	.45		.61					.84
I am encouraged to think about the range of career opportunities that are available to me.			.48		.42			.72
There is adequate provision of library facilities			.41					.79
I understand the requirements and deadlines for formal monitoring of my progress			.401					.75
Opportunity to develop a range of research skills, e.g. data analysis, performing literature review				.88				.86
Opportunities to develop a range of transferable skills				.85				.83
Provision of guidance on institutional standards and expectations for your research degree program				.80				.85
Supervisory support and guidance				.80				.72
My department provides opportunities for social contact with other research students					.76			.83
My department provides opportunities for me to become involved in the broader research culture					.76			.63
My department provides a good workshops program for postgraduate students					.72			.75
My postgraduate experience so far has improved my analytical skills						.85		.61
My experience so far has helped me to develop a range of communication skills						.66		.72
There is appropriate financial support for research activities							.78	.80
The research interests in my department or faculty stimulate my work						.45	.64	.77

4. Result

Postgraduate research experience is a critical phenomenon in postgraduate education. This study identified a wide range of factors likely to enhance the postgraduate student research experience (the relative influence of these factors is presented in Table 5, Table 6 and Figure 1).

Table 5: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cum %	Total	% of Variance	Cum %	Total	% of Variance	Cum %
1	9.874	35.265	35.265	9.874	35.265	35.265	4.678	16.706	16.706
2	2.869	10.245	45.510	2.869	10.245	45.510	3.480	12.429	29.135
3	2.271	8.110	53.621	2.271	8.110	53.621	3.150	11.249	40.383
4	2.031	7.252	60.873	2.031	7.252	60.873	3.054	10.908	51.291
5	1.520	5.430	66.303	1.520	5.430	66.303	2.936	10.487	61.778
6	1.358	4.851	71.153	1.358	4.851	71.153	2.032	7.255	69.033
7	1.095	3.912	75.066	1.095	3.912	75.066	1.689	6.033	75.066
8	.945	3.376	78.441						
9	.751	2.684	81.125						
10	.667	2.383	83.509						
11	.606	2.166	85.674						
12	.518	1.850	87.524						
13	.490	1.751	89.275						
14	.439	1.568	90.844						
15	.406	1.450	92.294						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cum %	Total	% of Variance	Cum %	Total	% of Variance	Cum %
16	.335	1.198	93.492						
17	.275	.983	94.475						
18	.253	.903	95.377						
19	.215	.769	96.146						
20	.188	.672	96.818						
21	.177	.632	97.450						
22	.153	.547	97.997						
23	.144	.514	98.510						
24	.122	.436	98.946						
25	.102	.363	99.309						
26	.073	.261	99.571						
27	.066	.236	99.807						
28	.054	.193	100.000						

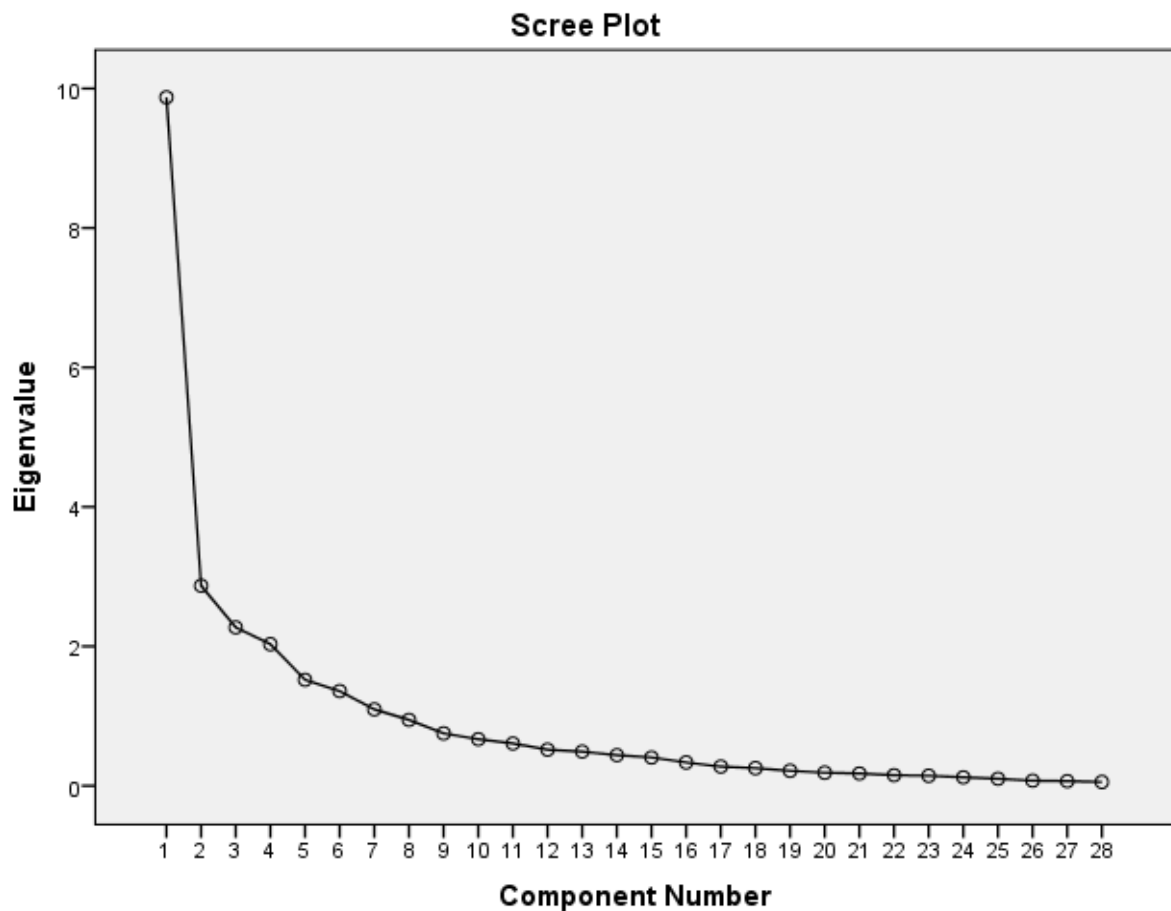


Figure 1: Scree Plot with extracted factors

The factors identified are the quality of supervisory support, institutional and departmental guidance and support, personal accountability and motivation, the culture of support for research methods, and financial assistance availability.

The supervisory factor involves providing guidance and support, timely feedback on the student work, and supervisors' availability when needed. Students expect an ideal supervisor to make every effort to understand the issues students face during their candidacy. They also anticipated supervisors to be knowledgeable in the respective research area and reasonably know research methodologies.

Institutional policies and expectations guide supervisors' interaction with students. In addition to the supervisory support, results in this study suggest that students expect their institutions to provide a learning environment where they can acquire a range of transferable domain and research skills. They stated that institutions need to provide appropriate research facilities and clear guidance on the research program's expectations and achievable standards.

Respondents said departmental support is also essential, especially, making social contact opportunities with other research students and academic staff. It was also clear that students appreciate the opportunity to research a research laboratory setting among shared research interests.

The study also found that being accountable and personal responsibility is critical ingredients of enhanced postgraduate research experience. Respondents said that students need to take advantage of the availability of the range of resources in their institutions and adhere to deadlines. Training on research methodology is another central element in enriching students' postgraduate experience. The data suggests that when students are offered opportunities to develop a range of research skills (e.g. data analysis, performing literature review) and acquire communication skills, they can widen their employability opportunities. Table 6 shows the degree of association between various critical factors the sense of an enhanced postgraduate research experience.

Table 6: Correlation of factors likely to influence enhanced research experience

	SS	IS	RMS	DS	FS	PA
SS						
IS	.741**					
RMS	.513**	.585**				
DS	.610**	.793**	.744**			
FS	.428**	.450**	.435**	.550**		
PA	.608**	.693**	.607**	.609**	.472**	

****Correlation is significant at the 0.01 level (2-tailed).**

Supervisory guidance (SS); institutional support (IS); research methodology support (RMS); department support (DS); financial support (FS); personal accountability (PA).

4.1 The supervisory factor

Supervisors are essential knowledge conduits between postgraduate students and the subject of their research and they can contribute to a fulfilled postgraduate research experience. Results in this study showed that having a knowledgeable and supportive supervisor remains an integral part of an enhanced postgraduate research experience as one respondent mentioned; *"Supervisory support is the most important part of postgraduate education, guidance and individual support are probably the most important things a supervisor can offer to their students."* The quality of supervision also determined a student's satisfactory completion of the degree. Respondents stated that supervisors are movers and inspirers in times when students are facing obstacles; *"if the student has a good and active supervisor, he will be able to complete the research on time."*

Respondents view research supervisors as a source of knowledge. It is vital to individuals who continually encourage students throughout the learning process, provide feedback, and mentor them during their programme's writing period. *"Supervisors are key through the writing process and providing timely feedback to ensure the quality of work."* *"Having the guidance of supervisors is paramount. While I do understand that doing a thesis is supposedly an independent act - having the 'expert' guidance of your supervisor in providing feedback is essential for me."*

However, supervising postgraduate students remains a complex form of teaching, requiring the supervisor to navigate a complicated relationship between student, institution, and department. According to the survey data, when conflicting expectations between the student and supervisor are not adequately stated and communicated in advance, challenges may prevail in the teaching environment, leading to dissatisfaction with the postgraduate program if not timely resolved. Respondents noted that being transparent about expectations and maintaining open communication in the supervisory process can help students to plan their academic programme and seek other sources of support when necessary; *"transparent and timely communication; advanced notice of supervisory absences to allow the student to plan around their schedule; improved career development support."*

Many postgraduate students who responded to the survey view supervisors as inspiring students, providing direction and general guidance during the research process, leading them to success and opportunities for better future career prospects. Fundamental to this expectation is that being supervised is a developmental process involving nurturing relationships between supervisors and students.

4.2 The department support factor

While the supervisory relationship is essential, the broader intellectual climate in a department helps students feel a sense of belonging to the department rather than isolated. Respondents said that a welcoming and supportive intellectual environment could enhance their research experience.

Respondents said a nurturing department climate needs to include facilitating social contact with other research students and staff. They also pointed out the need to provide a safe environment that cultivates and broadens the research culture. *"Opportunities to get to work on other research projects with other academics from the dept., so that I can learn how other academics conduct their research opportunities for teaching."*

Though lacking in many departments, some respondents stated that departments should offer formal training in research methods to enable students to gain the knowledge necessary to undertake their research and become career researchers. *"Departments should offer courses on research methods better to prepare their students for a fulfilled research career."*

The results of this study suggest that the research methods expertise of the student's supervisor also plays a role not only in setting the direction for student research but also contributes to the successful and timely completion of the postgraduate degree; *"acquiring the appropriate science in what you are doing is important. However, still, your adviser (or supervisory support) needs to guide you on how to appropriately use your knowledge in the process of doing your thesis"*.

4.3 Supervisors as teachers of research methodology

Many institutions consider supervision mainly as one aspect of teaching. Students are assigned to supervisors as a logical extension of existing teaching in a particular area purely based on their research interests, regardless of whether they are formally trained in the subject content. Students expect supervisors to have the skills and knowledge in the subject area and methods and procedures for undertaking research. The lack of a clear rationale for assigning students creates anxiety among supervisors. Early career supervisors, in particular, are concerned about their ability to successfully supervise a student to completion because students' success or failure reflects on the supervisor's competence and future reputation. Such concerns are equally shared among experienced supervisors, who are only knowledgeable in the single methodological area (Daniel, 2018).

Being knowledgeable in varied research methodologies is essential for enhancing postgraduate research experience. Respondents in the survey expected supervisors to be well versed in many research methodologies and avail that knowledge when needed. Some respondents stated that they learned research methods and techniques through their supervisors; *"one of my supervisors was a biostatistician, and she took it upon herself to make sure I was up to speed"*; others said they took formal instruction or methodological support programmes (e.g. workshops). Regardless, a significant number of students view supervisors as an additional means of learning research methods. *"I was also introduced to the various study 'types', as well as many of the biases and other factors one should look for when evaluating existing research"*.

4.4 The institutional and department support factor

Many institutions provide clear policies guiding the development and execution of postgraduate programmes; however, some are unaware of their learning environment's diverse growing students' expectations. Students expected institutions to work together with supervisors to provide adequate support for students, provide appropriate research training, and develop transferable research skills and knowledge vital to a career as a researcher.

Respondents said they expected institutions to offer students the opportunity to develop a range of research skills (e.g. data analysis, performing literature review) and an environment to create a range of transferable skills. They also expected that the institution and supervisors guide institutional standards and expectations for the quality of research. Further, students expect institutions to provide a conducive postgraduate student

research environment and an adequate infrastructure to support postgraduate study. *"I would like more institutional support and to have a lot more support from my supervisors, but that is not going to happen...."*

Students said they feel confident when they are provided with adequate supervisory and institutional support, as one participant remarked: *"I think that both institutional support and supervisory support play a major role in the development of confidence in me."*

Respondents also said they expect institutions to set standards and procedures for students and supervisors to interact during studies. Some said institutions need to be aware of personal circumstances, as any decision made by the majority may affect individual student completion of their programme. *"Research committees want to add more works, and they do not consider student capacity, money and time."* In situations where postgraduate students experience significant tension between student and institutional expectations, tension can impede on-time completion. The institutions may face a research funding shortfall (McCormack, 2004).

4.5 The personal accountability factor

Respondents said that while other factors play a critical role in determining enhanced postgraduate research experience, taking personal responsibility for setting the direction and duration of one's research programme is paramount to completing the program.

Some stated that taking personal responsibilities around planning and managing time helped them navigate the postgraduate program's complex trajectories. *"To complete my dissertation, it was.... necessary to ensure I managed my time well, particularly as I am a mother with two sons, aged 14 and 16, and was studying at a distance."*

Working independently is an essential quality for success in postgraduate education. To work independently, postgraduate students are expected to develop confidence, take personal initiative and accountability in their program, become self-regulated learners, and participate in setting the directions for their programme and exercise control over their learning. *"While the other factors are important, ultimately, I have to complete the work myself, and I have a reasonably strong belief that I can teach myself the basics of most concepts if needed."*

Respondents reported that confidence and ability to identify growth areas are important determinants of success in the postgraduate program and ultimately gain an enhanced postgraduate research experience; *"developing confidence and awareness of one's areas of weakness and strengths are important elements contributing to gaining important research experience."* Others stated that balancing postgraduate studies and family life is critical. *"My work, study and family balance will be the most crucial component to completing a thesis."*

4.6 The research methodology factor

Research methodology plays a vital role in postgraduate education and future career opportunities. Respondents share a recognition that research methodology is a critical factor in fostering enriched postgraduate research experience. They stated that research methods courses enable students to undertake their research projects successfully. *"Formally ensuring students are equipped with the necessary to complete project autonomously,"* Others stated that knowledge and skills in research methods help students to carry out better research projects, *"I think learning about research methodology can improve knowledge and skills in that field, just like any other subject such as math or writing'."*

In other areas of clinical research, respondents view knowledge of research methodology as key in fostering critical thinking skills in students interact with domain content: *"research methods in nursing research has helped me to critique articles in other subjects. "Also enables one to distinguish good research projects in the future."*

There was a shared belief among participants that the provisions of courses on methodology contribute to the timely completion of the postgraduate program; *"depending on the content or the course, and the relevance to research subject, a research methods course may help a student submit a thesis on time". "Receiving training in the necessary research methods is paramount to completing your research project in the allocated time. I feel like this is an area to which the institution should special attention should be paid."*

Respondents who received some form of training in research methods courses reported that research methodology improved the quality of their thesis and helped them gain a better grade: *"for me, understanding research methodology helped me gain the best grade I could for my dissertation..."* They also reported that courses on research methodology also helped them to transition from theory to practice: *"helpful foundation for thesis, and also helpful when translating research into clinical practice."* Others stress that methods courses also prepare them to become better researchers, improve their writing skills in other subjects, and produce a high-quality thesis.

Courses on research methods improve research literacy and provide students with the possibility of gaining essential theoretical and methodical skills to help them understand domain-specific knowledge and to be able to consume research produced in their respective areas effectively. They also mentioned that research knowledge helps them engage in knowledge translation and prepare them to become critical consumers of scholarly articles and thoroughly understand the knowledge to underpin research outcomes.

Some students emphasised that teaching research methods in non-course postgraduate programs is necessary to develop the skills needed to read and understand their subject domain. Others perceive methodology to produce new knowledge, advance science, and contribute to a future research career. *"I believe that further training in research methodology would be greatly beneficial for my future research endeavours....."*

4.7 Challenges in learning research methodology

Though the value of taking formal courses in research methods in postgraduate education is evident, many participants in this study reported significant challenges in learning research methodology. They said that learning methodology related to research design, data collection and analysis, writing, and concepts in quantitative research methods; *"I struggle to make sense with numbers, more specifically trying to understand what these numbers are telling me. I want to learn and know how to read those numbers."*

Students reported difficulties understanding theory and how to use it in their research projects. More specifically, many said the problem in effectively engaging with the literature, citing complexity in organising credible and critical literature reports and choosing an appropriate theoretical framework to guide their research; *"Getting myself to organise my research and to build up my theoretical framework"* and *"understanding the complicated jargon in the literature of research methods was a problem for me"*, as well as *"I am not sure whether I had chosen the right theory and how to relate it to my study."*

A growing interest in the use of mixed methods for researching students was identified in the data. However, many institutions are not offering formal training in mixed methods, and students said this is a problem in using mixed methods in their research. Some of the challenges mentioned in using mixed methods included challenges of research design and integrating various data into one study.

"It is impossible to learn everything about research in one or two semesters or a year! Lack of adequate time for learning research methodology was also identified as an additional challenge. Many institutions teach research methodology in a single semester, and however, students find it hard to absorb the content of research methodology in a single semester."

4.8 The financial factor

Availability of financial support in student assistantship, scholarships and awards was regarded as essential. Those who were self-funded and worked alongside their program faced significant challenges. *"It is hard trying to concentrate on your thesis when you are tired from working enough hours to pay your rent, let alone for food. Money is more than just rent and food, and it is peace of mind and time."*

Respondents stated that funding is necessary during data collection, *"I need funding to ensure I have the resources for data collection and to assist in transcribing information gained verbatim"*, and others stated, *"....writing a thesis and working is stressful."*

Surprising, not all respondents view funding as an essential factor in enhancing the postgraduate experience, *"although key in research, funding plays a secondary role in writing a meaningful research thesis"*, though many acknowledged that it is essential to have the scholarship to complete the postgraduate program on time. Others reported that students are more likely to complete their program on time if institutions are firm about

the expiration of scholarships. *"There is a strong incentive for me to finish on time (3 years) because my current scholarship funding will cease after that (my scholarship is payable for a maximum of 3 years of full-time study)." It is not uncommon for students to continue with their program even after their scholarships run out. One respondent stated that even when their scholarship ran out, they were still motivated to complete their program, "this is important, but it is possible without it. My scholarship ran out last year, and I am still managing to continue, so I do not believe funding is quite so as important as the support received from the people in my life."*

5. Discussion

There is a substantive body of literature on the importance of postgraduate student's research experience in contributing to increased completion rates, fulfilled research career and access to employment opportunities (see, for example, Drennan, 2008; Hodsdon and Buckley, 2011; Ginns et al., 2009; Lopatto, 2004). Postgraduate research experience describes student learning experience, the quality of supervision provided to them and the forms of support and resources available for them to access during their candidacy.

This research identified vital factors that contribute to enhanced postgraduate education: the quality of supervision, institutional and departmental support, personal responsibility and accountability, and financial support availability. The importance of the supervisory factor revealed in this research is consistent with previous research that suggests that postgraduate students who closely work with their supervisors gain a better research experience than those who left to work independently (Lyons, Scroggins and Rule, 1990; Yeoh and Doan, 2012).

The literature has shown that the quality of supervision and other institutional factors significantly improve postgraduate students' experience, ultimately leading to high student submission and completion rates (see, for example, Spronken-Smith, Cameron and Quigg, 2017; Wisker et al., 2003; Wisker, 2012). In the institution where this research was conducted, postgraduate supervisors are expected to meet with students for a minimum of an hour per week, and there is an ongoing debate on whether or not supervision is considered teaching or research. However, supervisors often come under increasing pressure to achieve minimum teaching hours, and they might not have time to provide adequate support needed for students to succeed in their postgraduate education. In some instances, where supervision is considered research, time dedicated to it might not be recognised. Another challenge is that supervisors might be assigned students or be obligated to take on students working on areas where they might not have expertise or interest, creating tension in the supervisor-student relationship. Furthermore, some supervisors might not be familiar with the research methods students might need to use.

In addition to institutional support, institutional transparency in policy dissemination can enhance the postgraduate experience and leads to timely programme completion. This finding also substantiates the view that possible tension exists between institutions' conceptions of research represented in policies and plans and individual postgraduate research students' understanding (McCormack, 2004); hence, precise communication and clarity on policy are essential to the success of postgraduate studies education.

Although the various body of previous research supports factors for enhancing postgraduate research experience identified in the present research (see Hodsdon and Buckley, 2011; Trigwell and Dunbar-Goddet, 2005), the role of research methodology in enhancing the postgraduate research experience and other factors pointed out in the literature. The current study revealed that courses on research methods play a significant role in enhancing the postgraduate student research experience. In particular, respondents collectively reported that access to courses on research methodology during their candidacy had enriched their postgraduate research experience and time contributed to the timely completion of postgraduate education. Further, results suggest that providing students with training on research methodology can significantly enhance postgraduate research experience, and such experience can live on beyond the period of candidature.

Students need to acquire knowledge in research methodology to cover many research processes, including research design, data collection and analysis, writing, and presentation. Therefore, providing postgraduate students with courses on research methods is essential since the postgraduate education model is predominately research-driven. Some students entering postgraduate programmes might not have prior research methods training necessary for undertaking research, especially at a doctoral level. Students lack

research training, and some thesis supervisory expertise in research methodology is critical, and formal training in methods is equally important.

Providing postgraduate students with courses on research methods is essential since the postgraduate education model is predominately research-driven. Consistent with recent research (see for example, (Daniel, 2018; Daniel, Kumar and Omar, 2018), results revealed that postgraduate students face significant challenges in learning research methods, yet there is relatively limited research into how research methods courses are designed and taught (Kilburn, Nind and Wiles, 2014). In the light of the challenges students face in learning research methodology, postgraduate supervisors need to demonstrate the ability to timely help students acquire required knowledge in various research methods and data analytical approaches during students' candidacy. Some students entering postgraduate programmes might not have prior research methods training necessary for undertaking research, especially at a doctoral level. Some postgraduate students' lack research training, thesis supervisory expertise in research methodology is critical, and formal training in methods is equally important.

6. Limitation and conclusion

Postgraduate student research experience is key to understanding the quality of postgraduate research programmes. Postgraduate student research experience describes student learning experience, supervision, resources, the research community, progress and assessment, access to vital research support resources and professional development during their candidacy. The study identified several factors that can significantly enhance a postgraduate research experience, including the quality of supervision, institutional and department support, personal investment, and financial support. The study found that courses on research methodology play a significant role in improving the postgraduate experience. In particular, providing research methodology education to students during candidacy enriches postgraduate research experience and contributes to the timely completion of postgraduate education.

This research contributes to the growing need to develop a substantial and sustainable pedagogical research culture in research methodology. The research presented in the article has some limitations. First, the data presented are based on the students' perceptions, and they may be limited to the respondents' experiences, shaped by the postgraduate program, where they were enrolled or completed during the survey. In addition, the survey carried out in the research presented in the current article was only limited to students and did not include supervisors' views regarding challenges they face supervising students and how they mentor students in research methods.

Though results presented in the article suggest that specific factors seem to have high loading, regression models would have been ideal for isolating definitive predictors of enhanced postgraduate research experience and associated factors such as completion rates employability. However, multicollinearity issues were identified, making it difficult to assess the effect of independent factors. Future work, therefore, needs to focus on further analysis of interactions of these factors (table 8) and possibly employment of alternative statistical approaches (e.g. causal models).

Finally, besides supporting the various factors contributing to student enhanced postgraduate experience, institutions need to consider offering discipline-specific methodological skills to equip students with the necessary training to gain broader employability and different research career trajectories.

Teaching research methodology requires imparting a combination of theoretical understanding, procedural knowledge, and skills competence. It requires individuals to develop in framing, designing, collecting and analysing data, presenting, interpreting, and communicating results. Further, the design and delivery of research methodology programs need to be organised in such a way to support students to become aware of the complexity of the subject and to learn how to become professional researchers (Coronel Llamas and Boza, 2011).

Students stated that learning research methodology during candidacy can significantly contribute to their timely completion and lead to many research opportunities and career trajectories. However, respondents reported dissatisfaction with the way current courses on research methods are taught. Students find courses on research methods pedagogically monolithic, conceptual challenging, and inflexible to individual future

career trajectories. Furthermore, students find the pedagogical modalities of many research methods courses disengaged from practical problems yet unattainable at a conceptual level.

This article contributes to the growing importance of researching the postgraduate research experience phenomenon, and it adds the role of research methodology in preparing students for research careers within and outside of academia. The article explores how higher education institutions can actively create positive and cohesive research cultures by teaching research methods for postgraduate researchers.

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Manipulating Common Method Variance via Experimental Conditions

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Abstract: Research data collected from single respondents may raise concerns regarding common method variance (CMV), which is believed to threaten the validity of findings. The primary concern is that CMV can inflate substantive relationships, such that they appear statistically significant when they are not. Thus, understanding the nature of CMV is critical, especially when one considers the popularity—and sometimes necessity—of using self-report data. Research examining CMV has found conflicting evidence about the impact of CMV. Researchers who believe CMV influences findings have proposed solutions to combat any real or perceived potential bias, including changing survey instructions and using marker variables, but few studies have examined the efficacy of these approaches. The purpose of this study is to examine the impact of these techniques and the nature of CMV using an experimental design. To conduct the experiment, multiple versions of a survey, which vary in their use of the remedial approaches, are utilized to collect data, which resulted in 1,069 usable responses. The experimental design was based on the faking literature and included instructions intended to induce or reduce the levels of CMV. Further, two different marker variables are used to determine the degree to which they create a psychological separation in substantive variables. Correlation analysis and measurement invariance are used to analyze the data. This study posits that, if CMV is a substantial concern for self-report data and these approaches are effective, then findings will differ in surveys that incorporate such approaches from surveys that do not. Results indicate few differences in experimental conditions, meaning that regardless of instructions or marker variable, substantive item correlations remained statistically similar. The results indicate this is likely due to the minimal impact of CMV, given that the proposed methods of correction did not significantly influence research findings. These findings have implications for researchers in that they do not support that CMV, or at least its proposed remedies, significantly alter findings. However, support for the null conclusions, in spite of appropriate statistical power, warrant future research examining the nature and impact of CMV.

Keywords: common method variance, experiment, same source research, marker variable, psychological separation

1. Introduction

Many social science researchers have concerns that common method variance (CMV) may create spurious inflation of covariances and observed correlations in same source perceptual data. CMV may derive from surveys in which respondents provide data for both independent and dependent variables in one time period, when the measurement method itself, rather than the actual relationships being investigated, influences findings. Scholars have called for more research on CMV and how it can be managed in self-reported data (Richardson, Simmering, and Sturman, 2009; Spector, et al., 2019). For decades, conflicting perspectives on the nature and likelihood of CMV have persisted (Richardson, et al., 2009), with some authors warning of its prevalence (e.g., Podsakoff, MacKenzie, Lee, and Podsakoff, 2003) and others arguing that its impact is overstated (e.g., Spector, 2006). Scholars have suggested procedural approaches to prevent or reduce CMV (Podsakoff, et al. 2003; Castille, Simmering, and Crawford, 2017) and introduced statistical techniques to detect or control for CMV. In this study, the authors aim to examine how survey design can influence CMV by introducing experimental manipulation into the data collection. The literature on faking in selection tests guides understanding of how one might detect systematic error in responses with the use of instructions to influence participants to respond in a particular way.

This study proposes an experimental approach to examining CMV, by manipulating a presumed cause of CMV to elucidate the nature of this error. Some prior experimentation on CMV exists, examining item priming and ordering (e.g., Johnson, Rosen, and Djurdevic, 2011; Schwarz, et al., 2017; Weijters, Geuens, and Schillewaert, 2009). In this study, the authors utilized a survey to examine implicit theories and illusory correlations, which

are common rater effects that may lead to CMV, but have not received much attention (Podsakoff, et al., 2003). Additionally, this study employs the Confirmatory Factor Analysis (CFA) Marker Technique using two different marker variables (Williams, Hartman, and Cavazotte, 2010) to detect CMV in data. While more research is needed, the finding that correlations among study variables did not differ significantly among experimental conditions supports the argument that procedural and statistical remedies to minimize CMV may be unnecessary or ineffective. The structure of the study is an overview of CMV and rater effects, hypotheses to be tested, the method, results, discussion of findings, conclusions and implications.

2. Literature Review

2.1 Manipulating Common Method Variance through Common Rater Effects

Common method variance (CMV) is defined as systematic error variance due to rater response styles, item characteristics, and aspects of measurement that threaten the validity of study findings when measures are collected using the same or similar methods through the inadvertent introduction of bias or variance that may be created by the measurement method itself (Podsakoff et al., 2003; Podsakoff, MacKenzie, & Podsakoff, 2012). CMV cannot be directly seen or measured, so its influence on research parameters must be inferred methodologically. Indeed, it is a source of error that may be unknown even to the respondent (Kline, Sulksky, and Rever-Moriyama, 2000; Moorman and Podsakoff, 1992). As some scholars believe the presence of CMV to be minimal or unbiased (Spector, 2006), at least in the presence of other types of error (e.g., unreliability of measures; Fuller, Simmering, Atinc, Ocal, and Babin, 2016; Lance, Dawson, and Birkleback, 2010) or within complex models (Siemsen, Roth, and Oliveira, 2010), assessing the efficacy of CMV detection techniques may be a challenge. Thus, following the literature on faking in selection tests, and recent research by Schwarz et al. (2017), the authors sought to increase the ability to detect CMV by introducing this error (or increasing it) in data through survey instructions.

2.2 Implicit Theories/Illusory Correlations

Common rater effects occur when responses to a survey are influenced by a single respondent answering all of the items on a survey, and implicit theories and illusory correlations are one way in which this effect can lead to CMV (Podsakoff, et al., 2003). Prior research has addressed other common rater effects (Simmering, Fuller, Richardson, Ocal, and Atinc, 2015; Castille, et al., 2017), but not implicit theories and illusory correlations (Schwarz, et al., 2017). While researchers can enact some degree of control over other potential sources of CMV, there are few means by which to avoid common rater effects when using same source data.

When using implicit theories and illusory correlations, respondents make logical connections among survey scales and therefore answer more consistently than distinct respondents would, thus potentially inflating substantive relationships (Baumgartner and Steenkamp, 2001; Meade, Watson, and Kroustalis, 2007; Salancik, 1984). This effect can create response bias when respondents distort their scores based on either the illusory correlations made due to the co-occurrence of scales in the study or implicit theories due to personal beliefs regarding construct interrelatedness (Berman and Kenny, 1976; Podsakoff, et al., 2003). Thus, responses to scale items may be based upon assumptions rather than the respondent's actual behaviors, feelings, or attitudes (Pace, 2010). While many researchers employ procedural efforts in an effort to reduce CMV (see Podsakoff, et al., 2003), such approaches cannot account for implicit theories or illusory correlations, thus leaving a gap in the literature.

An example of survey responses that are impacted by implicit theories would if respondents believe they are good employee and that good employees engage in organizational citizenship behaviors (OCBs), then respondents may report exhibiting OCBs whether they genuinely engage in them or not. Illusory correlations affect ratings by the rater imposing his/her beliefs of items/variables they expect to covary onto their responses (Podsakoff, et al., 2003; Pace, 2010). For example, if a measure of job satisfaction and a measure of OCB are in the same survey, respondents may assume that they are related and respond in a way that ensures the items are correlated. Studies have found that implicit theories and illusory correlations may influence ratings of leader behavior (Phillips and Lord, 1986), attributions of the causes of group performance (Staw, 1975), and perceptions about the relationship between employee satisfaction and performance (Smither, Collins, and Buda, 1989).

2.3 Experimental Manipulation

An experimental manipulation purports to influence specific sources of bias, which may then be observed in substantive relationships, in an approach similar to that of Schwarz et al. (2017). To manipulate CMV in survey responses, this research turned to the literature on faking in selection testing, where research is aimed at identifying job applicants who “fake” responses. Faking is providing false answers that indicate applicants have more desirable traits than they truly do (Kiefer and Benit, 2016), which reduces the validity of the test in predicting job performance. Faking experimental manipulations assign a random group of respondents taking a selection test (e.g., a personality survey) to either “fake good” or present their best selves in responses. In other words, respondents are given a cover story that may include a false purpose or incentive to fake (e.g., Robie, 2006) or obscure the purpose of the study (e.g., Birkeland, et al., 2006; Castille, et al., 2017; Ziegler, 2011). A comparable random set of respondents is asked to respond normally (e.g. Bing, et al., 2011; Schmit and Ryan, 1993; Paulhus, et al., 2003). Researchers can assess the influence of faking on personality test validity by comparing test scores from the two samples.

In the current study, rather than asking respondents to “fake good,” an instructional manipulation is aimed at increasing or decreasing the common rater effects of implicit theories or illusory correlations. Specifically, different experimental groups are given different instructions targeted to influence cognitive processes and biases, such as how to respond to survey items. If groups of respondents can be influenced to answer such that they use strong implicit theories/illusory correlations (inducing CMV), and other groups can be influenced against the use of implicit theories/illusory correlations (reducing CMV), then data from these groups can be compared to determine if there are differing levels of correlation among substantive variables between them.

Following Schwarz et al. (2017), measurement invariance (MI) tests were used to compare the groups of participants in each condition. MI indicates that an instrument measures the same construct in the same way across different groups. Demonstrating MI is necessary to support the validity of inferences made when testing multi-group data (Chen, 2008; Vandenberg and Lance, 2000). Failure to demonstrate MI indicates that participants can be induced to respond differently to survey items because of the instructional manipulation.

Hypothesis 1a: Correlations among substantive variables will be stronger in the CMV inducing conditions than in the CMV reducing conditions.

Hypothesis 1b: Measurement invariance will not be indicated in the comparison of the CMV inducing conditions and the CMV reducing conditions.

2.4 Marker Variables

Researchers have increasingly turned to post hoc detection methods to verify that CMV is not biasing their data (Simmering, et al., 2015). While these techniques cannot directly measure CMV, they may provide a means for estimating the amount of CMV that may be present or biasing to substantive relationships. The CFA Marker Variable technique (Williams, et al., 2010) has received attention as a promising means of detecting CMV in data, particularly when used with a suitable marker variable (Richardson, et al., 2009).

Marker variables were introduced by Lindell and Whitney (2001) as a proxy intended to capture CMV. While the correlational marker technique developed by these authors has been criticized for its lack of accuracy, the subsequently developed CFA Marker Technique has demonstrated empirical efficacy in a number of studies (Williams, et al., 2010; Williams and McGonagle, 2016). Researchers argue that “ideal” marker variables for this test are perceptual in nature (e.g., not objective, like age or tenure), measured in the same way as the substantive variables (e.g., on a Likert scale), and theoretically unrelated to the substantive variables in the study (Simmering, et al., 2015).

Marker variables may also be useful in preventing CMV by creating proximal separation when included in a survey in between substantive items as a “cognitive ‘speed bump’” (Podsakoff, et al., 2003: 884). Separation can make the respondent less likely to answer all survey items in a consistent fashion for two reasons. First, the introduction of so-called filler items can cause the respondent to forget their answers to prior substantive items, making it harder to make logical links between the substantive scales on a survey. Second, if the additional items seem different from the content in the substantive items, respondents may pay more attention to all of the items, both filler and substantive, when answering because the items seem unexpected.

This study examines the degree to which marker variables might create sufficient proximal separation to reduce CMV, arguing that the mere presence of a marker variable may reduce correlations among substantive variables. Moreover, this study asserts that ideal markers variables can be either “connecting” or “disconnecting,” such that the former allows a respondent to logically connect all variables (substantive and marker) in a meaningful way and the latter makes it more challenging for a respondent to find a logical connection among items. For example, a disconnecting maker placed between independent and dependent variables can create a stronger psychological separation because it is more difficult to come up with a logical reason that it might be a part of a larger theory. Thus, the introduction of a marker variable may be a procedural remedy for CMV in and of itself.

This use of marker variables creates a stimulus manipulation (McBride, 2012) which differs from the instructional manipulation previously introduced in this study. With stimulus manipulation, different experimental conditions use different stimuli. In this case, when the respondent encounters the different stimuli (e.g., presence or absence of a particular marker variable), then their behavior, interpretation, or response is posited to change accordingly.

Hypothesis 2a: Correlations among substantive variables will be stronger in conditions in which there is no marker variable than in conditions in which there is a marker variable.

Hypothesis 2b: MI will not be indicated in the comparison of the no marker variable condition and the marker variable condition

Hypothesis 2c: Correlations among substantive variables will be stronger in conditions in which there is a connecting marker variable than in conditions in which there is a disconnecting marker variable.

Hypothesis 2d: MI will not be indicated in the comparison of the connecting marker variable and the disconnecting marker variable condition.

2.5 Perceived Awareness of Research Hypothesis (PARH)

The PARH determines respondents’ perceptions of the survey purpose or what the researcher was attempting to find (Rubin, Paolini, and Crisp, 2010). The current study includes the PARH as a more direct measure of our manipulation of inducing CMV, in which respondents should report higher levels of awareness of the study hypotheses than in the reducing CMV condition. Additionally, responses to the PARH may also be influenced by the presence of the two different marker variables such that a connecting marker variable should be seen as less “different” than a disconnecting marker, so that the former can better fit into a mental model of substantive items.

Beyond the manipulation check, scores on the PARH scale should indicate participants’ reliance on implicit theories (Rubin, 2016). That is, if respondents feel confident that they know the relationships the researcher seeks to investigate, then they are more capable of mentally connecting those variables while answering items (i.e., implicit theories) in the way that they were instructed.

H3a: Subjects in the CMV inducing condition will report more awareness of research hypotheses than subjects in the CMV reducing condition.

H3b: Subjects exposed to the connecting marker will report more awareness of research hypotheses than subjects exposed to the disconnecting marker.

3. Method

3.1 Substantive Variables

This experiment required a model of previously studied same-source substantive variables to provide a context in which to assess the hypotheses, so the variables studied by Yang, Mossholder, and Peng (2009) were used. *Supervisory procedural justice (PJ)* is the employee’s perception of the supervisor’s fairness in determining outcomes (Leventhal, 1980). *Affective trust in one’s supervisor (Trust)* captures an “employee’s willingness to be vulnerable based on expectations that the intentions, words, or actions of their supervisor can be relied upon” (Poon, Rahid, and Othman, 2006). *Job satisfaction (JS)* is an individual’s overall feelings of happiness in the job (Hackman and Oldham, 1975). These variables were investigated by Simmering et al. (2015), who found there

was potential for CMV to inflate substantive relationships through implicit theories. These variables present a strong case for concern for CMV, in that each scale is perceptual, positively worded, transparent, and short enough to be easily remembered (i.e., easier to enact implicit theories). A subset of variables from Yang et al. (2009) was used to more strongly manipulate CMV, as a shorter survey provides greater opportunity for respondents to satisfice, which can increase common rater effects (Podsakoff, et al., 2012).

Notably, Yang et al. (2009) did not find CMV to be present at biasing levels in their data. However, they tested for bias using the correlational marker approach (Lindell and Whitney, 2001), which has a high error rate (Richardson, et al., 2009). A separate data set of these variables found possible CMV contamination with the CFA Marker approach (Simmering, et al., 2015).

3.2 Experimental Conditions and Manipulation Checks

Two experimental conditions based on CMV and three experimental conditions based on marker variables were developed to create three independent two-group randomized experiments, encompassing six separate experimental conditions, as seen in Table 1 below. These were enacted in an online survey.

Table 1: Sample Sizes in Experimental Conditions

CMV Manipulations	Marker Variable Manipulations	Sample Size
CMV Inducing	No Marker Variable	211
CMV Inducing	Creative Self-Efficacy as Marker	210
CMV Inducing	Attitudes towards the Color Blue as Marker	194
CMV Reducing	No Marker Variable	150
CMV Reducing	Creative Self-Efficacy as Marker	155
CMV Reducing	Attitudes towards the Color Blue as Marker	149
	Total	1,069

3.2.1 Common Method Variance

Two experimental conditions to manipulate CMV were created. The *CMV Inducing* condition intended to encourage respondents to answer items in the survey in a consistent manner, particularly by relying on implicit theories, even in the presence of seemingly unrelated items (e.g., marker variables). Instructions in this condition read, "In this survey, you will be asked to respond to several statements about your work and behaviors. The purpose of this study is to *verify the very strong relationships* among variables that have been found by various researchers." In the *CMV Reducing* condition instructions, intended to encourage respondents to consider each item as unrelated, read: "In this survey, you will be asked to respond to several statements about your work and behaviors. Several researchers have contributed items to this survey for separate purposes, *so questions should not be related to one another.*"

A factual manipulation check (FMC), which asks respondents questions as to the purpose and content of the survey (Kane and Barabas, 2019), was used to verify that the above instructions were understood by respondents. The FMC read, "Which of the following correctly describes the purpose of this study?" with choices that represented the *CMV Inducing* condition ("The purpose of this study is to *verify the strong relationships that exist among workplace behaviors*. As such, there is a clear purpose to this study.") and the *CMV Reducing* condition ("Separate researchers built the content of this survey for separate purposes *so the questions should not be related to one another*. As such, there is no clear purpose for this study."). Because the CMV manipulation was an integral part of the study, respondents who did not choose the correct answer (i.e., did not pass the manipulation check), were not allowed to continue with the survey. Thus, the FMC both reinforces the survey instruction and serves as an attention check.

3.2.2 Marker Variables

There were three experimental conditions related to the use of the marker variable. The *No Marker* condition had no marker variable included in the survey. Two ideal marker variables were used in the other conditions. *Creative Self-Efficacy (CSE)* was chosen as a connecting marker that one might find in a typical study of workplace attitudes. Creative self-efficacy refers to the belief that one can produce creative outcomes (Tierney & Farmer, 2002). *Attitudes towards the Color Blue (ATCB)* was chosen as a disconnecting marker that may seem randomly inserted. This is a scale intentionally developed for use as a marker variable to capture a seemingly neutral attitude regarding a color that could serve as a proxy for direct measurement of CMV (Miller & Chiodo, 2008).

3.3 Participants and Procedure

Survey participants were Amazon.com's Mechanical Turk (MTurk) workers. Participants were offered \$1 USD to participate and were told they had to currently work in the U.S. and have a supervisor. While 1,837 began the survey, 63 were dropped from the survey for failing to meet the conditions of working in the U.S., 90 were dropped for not having a supervisor, and 64 dropped out after completing the consent form. 1,620 respondents proceeded to the experiment.

Respondents read the study overview, gave consent, then were randomly assigned by Qualtrics online survey software to one of the six experimental conditions. Either CMV Inducing or CMV Reducing instructions were given, followed by the manipulation check item on the next page of the survey. Those who failed the FMC (488) were not allowed to continue, but the 1,132 who passed the check continued and were paid. Data from sixty-three participants were then removed due to failing an attention check question ("For this item, please answer STRONGLY DISAGREE."), resulting in a final usable sample of 1,069. This removal of approximately 30% of our respondents is consistent with prior manipulation check research, in which typical failure rates range from 3 to 46% (Maniaci and Rogge, 2014). Research has demonstrated that including those who fail manipulation checks greatly increase noise and reduce the ability to detect differences between experimental manipulations (Oppenheimer, Meyvis, and Davidenko, 2009), underscoring the importance of including such a check.

In each survey, the scales were presented in the same order: supervisory procedural justice, affective trust in supervisor, one attention check item, marker variable (in conditions where a marker was used), and job satisfaction. To better create proximal separation, markers were placed between exogenous and endogenous variables. After the substantive and marker scales, respondents were presented with the PAHR scale, one open-ended item to assess PAHR, then items to measure demographics.

3.4 Measures

All items were measured on a 5-point Likert Scale in which 1=strongly disagree and 5=strongly agree. PJ was measured with 7 items from Colquitt (2001), with $\alpha = .88$. Five items developed by Yang and Mossholder (2006) were used to measure Trust ($\alpha = .93$). Hackman and Oldham's (1975) three-item scale to measure JS had a reliability of $\alpha = .92$. Three positively worded items from Miller and Chiodo's (2008) ATCB scale ($\alpha = .77$) was the disconnecting marker. Tierney and Farmer's (2002) 3-item measure of CSE ($\alpha = .80$) was the connecting marker. The PARH four-item scale (Rubin, et al., 2010; $\alpha = .89$) was placed after the substantive items, as recommended by Rubin. Further, one open ended PARH item read, "In one or two sentences, please write what you think this research study was about," to capture the distinction between the true hypotheses in this study (which were obscure) and the substantive model presented.

4. Analyses

The usable sample was 54.3% male and had a mean age of 35 (min=18, max=80, SD=10.7). Most respondents (68.7%) were white/Caucasian. Respondent reported education levels were 43% with a 4-year college degree, 31.5% with some college, 14.4% with a masters degree, 7.7% with a high school diploma, and 2.9% with a doctorate or professional degree. As is common with MTurk, job categories varied widely. The mean number of years of work experience was 13.9 (min=1, max=59, SD=10.3). Control was enacted by random assignment to experimental design, and with no notable correlations among demographic variables and study variables, best practices were enacted (Carlson and Wu, 2012) by not using control variables.

Two sets of analyses were used to test hypotheses 1 and 2. First, 95% confidence intervals surrounding observed correlations in each condition were calculated and, the significance of the difference in correlations between conditions was calculated. Second, the more robust MI tests were conducted to determine the degree to which measurements of constructs were equivalent in different conditions. Demonstrating MI begins with an omnibus test of the equality of covariance matrices across the different groups of interest (Vandenberg and Lance, 2000). If covariance matrices differ across groups, an investigation into the source of the differences is necessary, testing a series of increasingly restrictive models against a baseline model (see Figure 1) to determine the level of invariance present (Vandenberg and Lance, 2000). There are three levels to investigate: (i) configural invariance (similar factor structure), (ii) metric invariance (similar factor loadings), and (iii) scalar invariance (similar item regression intercepts). Failing to establish invariance at any of the three levels indicates that the use of our manipulations regarding CMV (e.g., instructional manipulation and/or proximal separation in use of a marker variable) may have influenced responses. Hypothesis 3 was analyzed with t-tests.

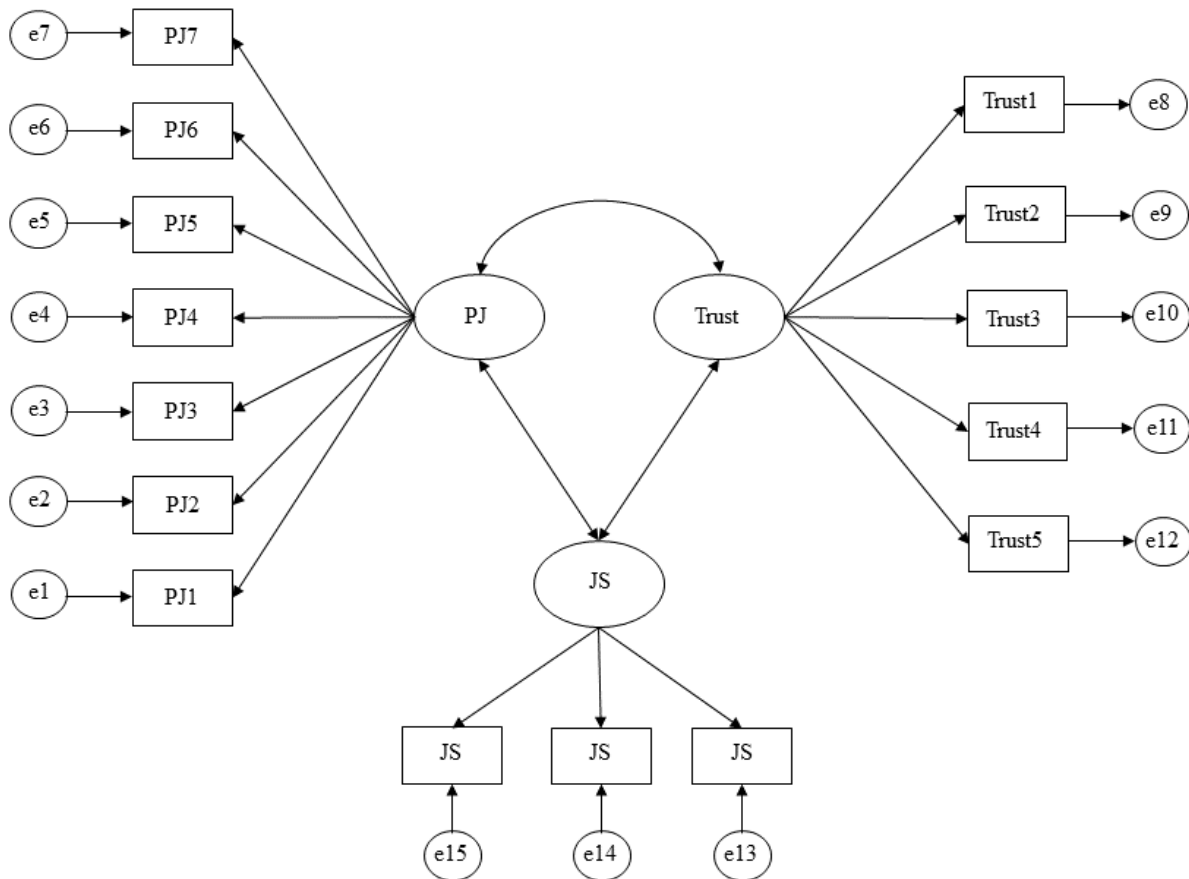


Figure 1: Configurational Model

The descriptive statistics, reliabilities, and correlations among the study variables in all conditions are in Table 2. Tables 3-5 contains Fisher z-score comparisons among correlations and the confidence intervals surrounding the correlations to test Hypotheses 1a, 2a and 2c.

Table 2: Descriptive Statistics, Reliabilities, and Zero-Order Correlations among Study Variables

Variable Name	Mean	SD	1	2	3	4	5
1. Procedural Justice	3.84	.71	(.88)				
2. Trust	3.74	.91	.81**	(.93)			
3. ATCB ^a	3.68	.82	.19**	.15**	(.77)		
4. CSE ^b	4.01	.70	.38**	.36**	-	(.80)	
5. Job Satisfaction	3.89	.91	.61**	.62**	.14**	.43**	(.92)
6. PARH	3.01	1.06	.15**	.19**	.11*	.15**	.21**

Note. ^a N = 343 for correlations with this variable. ^b N = 365 in correlations with this variable.

N = 1,069 for all other correlations. Coefficient alpha reliabilities appear in the in the diagonals. * $p < .05$, ** $p < .01$.

Hypothesis 1a predicted that correlations among substantive variables would be stronger in the CMV inducing versus the reducing conditions. However, as shown in Table 3, there were only two differences. The Trust-PJ correlation was higher in the connecting marker (CSE) condition when reducing instructions were given, opposite of predicted. Also unpredicted was the higher PJ-Trust correlation in the inducing condition when the disconnecting marker variable (ATCB) was used. Thus, H1a was not supported.

Table 3: Results of Test of Hypothesis 1a using Z-Score Comparison of Correlations

Hypothesis	Correlations	Conditions		Z-score	2-tail p
Hypothesis 1a		Inducing (95% CI)	Reducing (95% CI)		
No Marker		N = 210	N=149		
	PJ-Trust	.80** (.75 - .84)	.75** (.67 - .81)	1.16	.25
	PJ-JS	.56** (.46 - .65)	.63** (.52 - .72)	-1.00	.32
	Trust-JS	.55** (.45 - .64)	.53** (.40 - .64)	.26	.40
Connecting Marker		N=210	N=154		
	PJ-Trust	.83** (.78 - .86)	.77** (.70 - .83)	1.57	.12
	PJ-JS	.59** (.49 - .67)	.67** (.57 - .75)	-1.24	.22
	Trust-JS	.60** (.51 - .68)	.77** (.70 - .83)	-3.06**	.00
Disconnecting Marker		N=192	N=148		
	PJ-Trust	.87** (.83 - .90)	.77** (.70 - .83)	2.83**	.00
	PJ-JS	.60** (.50 - .68)	.67** (.57 - .75)	-1.07	.28
	Trust-JS	.60** (.50 - .68)	.70** (.70 - .83)	-1.58	.11
All Marker Conditions		N=402	N=302		
	PJ-Trust	.85** (.82 - .88)	.78** (.73 - .82)	2.76**	.01
	PJ-JS	.59** (.52 - .65)	.64** (.57 - .70)	-1.05	.29
	Trust-JS	.60** (.53 - .66)	.71** (.65 - .76)	-2.54**	.01

Note. * $p < .05$, ** $p < .01$.

Hypothesis 2a was not supported; only one of the substantive correlations indicated a statistically significant difference in the presence versus absence of a marker, and this was again opposite of predicted. The Trust-JS correlation was stronger when the marker variable was present (see Table 4). While the data do not indicate a reason for this opposite finding, it is possible that a marker could confuse a respondent and cause them to revert to patterned answers based on their own personal response tendencies. Hypothesis 2c compared observed correlations in the presence of a connecting versus disconnecting marker variable, and no statistically significant differences in correlations were present, leading to the rejection of this hypothesis, as shown in Table 5.

Table 4: Results of Test of Hypothesis 2a using Z-Score Comparison of Correlations

Hypothesis	Correlations	Conditions		Z-score	2-tail p
Hypothesis 2a		No Marker (95% CI)	Marker (95% CI)		
Inducing Condition		N = 210	N = 402		
	PJ-Trust	.80** (.75 - .84)	.85** (.82 - .88)	-1.84	.07
	PJ-JS	.56** (.46 - .65)	.59** (.52 - .65)	-0.52	.60
	Trust-JS	.55** (.45 - .64)	.60** (.53 - .66)	-0.87	.38
Reducing Condition		N=149	N=302		
	PJ-Trust	.75** (.67 - .81)	.78** (.73 - .82)	-0.72	.47
	PJ-JS	.63** (.52 - .72)	.64** (.57 - .70)	-0.17	.87
	Trust-JS	.53** (.40 - .64)	.71** (.65 - .76)	-2.94**	.00
Ind. and Red. Conditions		N=361	N=708		
	PJ-Trust	.78** (.74 - .82)	.82** (.79 - .84)	-1.72	.09
	PJ-JS	.59** (.52 - .65)	.61** (.56 - .65)	-0.48	.63
	Trust-JS	.55** (.47 - .62)	.65** (.61 - .69)	-2.42*	.02

Note. * $p < .05$, ** $p < .01$.

Table 5: Results of Test of Hypothesis 2c using Z-Score Comparison of Correlations

Hypothesis	Correlations	Conditions		Z-score	2-tail p
Hypothesis 2c		Connecting Marker	Disconnecting Marker		
Inducing Condition		N=210	N=192		
	PJ-Trust	.83** (.78 - .86)	.87** (.83 - .90)	-1.44	.15
	PJ-JS	.59** (.49 - .67)	.60** (.50 - .68)	-.15	.88
	Trust-JS	.60** (.51 - .68)	.60** (.50 - .68)	0.00	1.00
Reducing Condition		N=149	N=154		
	PJ-Trust	.77** (.70 - .83)	.77** (.70 - .83)	0.00	1.00
	PJ-JS	.67** (.57 - .75)	.67** (.57 - .75)	0.00	1.00
	Trust-JS	.77** (.70 - .83)	.70** (.70 - .83)	1.32	.19
Ind. and Red. Conditions		(N=365)	(N=343)		
	PJ-Trust	.80** (.76 - .83)	.84** (.81 - .87)	-1.62	.11
	PJ-JS	.63** (.56 - .69)	.60** (.53 - .66)	.64	.52
	Trust-JS	.65** (.59 - .71)	.65** (.58 - .71)	0.00	1.00

Note. * $p < .05$, ** $p < .01$.

Hypotheses 1b, 2b and 2d predicted that the different experimental conditions would not exhibit MI. Each of the experimental conditions (e.g., reducing vs. inducing condition) was tested for MI using AMOS 24. Results from the test of the equality of covariance matrices between experimental conditions appear in Table 6. Model fit was established using several common fit indices (Hair, et al., 2006; Hu and Bentler, 1995). As seen in Table 6 below, the models demonstrated reasonably good fit to the data across each of the experimental conditions which indicates MI. This lack of notable differences across the experimental conditions indicates no support for Hypotheses 1b, 2b, and 2d.

Table 6: Testing for Measurement Invariance across Groups

	χ^2	Df	P	CFI	TLI	SRMR	RMSEA
Reducing vs Inducing	672.17	177	.00	0.96	0.95	0.05	0.05
No Marker vs. Marker	681.93	177	.00	0.96	0.95	0.05	0.05
ATCB vs. CSE	543.56	177	.00	0.96	0.94	0.04	0.05

Hypothesis 3a posited that subjects in the CMV inducing condition would report higher levels of awareness of the research hypotheses than subjects in the CMV reducing condition. An independent samples t-test indicated support for this hypothesis, with a mean score on the PARH of 3.29 in the inducing condition and a mean score of 2.34 in the reducing condition ($t = -10.59$; $p < .00$). In addition, results indicated a significant change in the relationship between PJ and Trust, which were the first items responded to after the instructions. However, there was no statistically significant difference in mean PARH between the ATCB ($m = 2.92$) and CSE ($m = 3.00$) marker conditions ($t = -.96$, $p = .34$). Hypothesis 3b was rejected, but this does indicate that the selection of a marker variable does not matter, only that a disconnecting marker does not act as a procedural remedy for CMV.

In a post hoc analysis, possible differences in substantive correlations between the two most extreme conditions—*CMV Inducing* with no marker variable vs. *CMV Reducing* with ATCB—were examined. The former should produce higher correlations than the latter, but z-scores indicated only one statistically significant difference in the three substantive correlations: Trust-JS was lower in the *CMV Inducing*/no marker condition than in the *CMV Reducing*/ATCB condition ($r = .55$ vs. $r = .70$, $z = -2.30$, $p = .02$). This finding was in the opposite direction of expectations, and this could be due to unknown effects of the marker variable on response tendencies.

5. Discussion

This study examined experimental manipulations of CMV through instructions and the presence or absence of marker variables as a means to better perceive the threat to same source data that CMV may pose. While statistically meaningful differences in correlations in experimental conditions were anticipated, and MI was not expected, the hypotheses were not supported by the data. Specifically, there were few differences in correlations (some of which were opposite of predicted) and MI was found between experimental conditions.

Hypothesis 1 focused on the examination of the efficacy of the experimental manipulations to elicit different responses from the groups; however, the hypothesis was not supported, as there were not significant difference

among responses based on CMV inducing versus reducing conditions and measurement invariance was found. Hypothesis 2 focused on the use of marker variables to elicit different responses from the groups; however, none of the four hypotheses were supported, indicating that the neither the presence nor the type of marker variables utilized created a significant difference in the responses. Hypothesis 3 examined the differences between perceived awareness of the research hypothesis among the experimental groups and found support for increased awareness in the CMV inducing experimental group (3a), but not for the connecting/disconnecting marker variable (3b).

There could be varying reasons for this lack of support for most of the hypotheses. The experimental manipulations may have been weak, possibly resulting in respondent insufficient effort/careless responding in which items are answered without regard to instructions (Huang, Liu, and Bowling, 2015). However, the manipulation checks did not allow participants to continue the survey after failing, so remaining participants appeared to follow the manipulation instructions. Further, support for hypothesis 3a, in which participants in the inducing condition reported higher levels of PARH indicates that this manipulation was successful. As anticipated (Oppenheimer et al., 2009), this study had a high level of attrition (30%), yet this may be beneficial, as it increases the likelihood of surveying only those participants who accurately perceived the manipulation. If the majority of the respondents correctly answer the FMC, then null results are less likely related to the theory and are more likely related to the treatment being relatively imperceptible. Conversely, if more respondents answer the FMC correctly and no significant treatment is found, then results may be attributed to a fault in the theory or manipulation (Kane and Barabas, 2019). Here, however, the researchers believe the fault lies in the lack of impact of CMV, not with our manipulation—increasing evidence indicates that CMV is neither as pervasive nor as biasing as once believed (Fuller, et al., 2016; Lance, et al., 2010).

To seek meaning from answers to the qualitative item (Campbell, 2020), exploratory text-analysis was conducted using RapidMiner software, which identifies the most important terms used in the responses. Table 7 shows differences in experimental conditions. In the CMV *Inducing* conditions, “relationship” was the most important word, with “relationship with a supervisor” the second-most important term in two conditions. Conversely, in two of the three CMV *Reducing* conditions, “relationship” was either much lower on the list or absent from the top ten most important terms (yet, surprisingly, appearing as the top response when CSE was used as a marker). Finally, “color” was the fourth most frequent response in one of the ATCB conditions, indicating it was memorable and/or distinctive to respondents. These results provide additional evidence to support the effectiveness of manipulations and again points to the low influence of CMV.

Table 7: Top Ten Most Important Terms by Condition from Text Mining of Open-Ended Item Responses^a

Condition	No Marker	ATCB as Marker	CSE as Marker
CMV Reducing Conditions	job peopl feel employe work satisfact workplac attitud relationship_supervisor view_supervisor	work peopl feel color feel_supervisor studi think attitud survei research	relationship feel work feel_supervisor relationship_supervisor job attitud i_idea research studi
CMV Inducing Conditions	relationship relationship_supervisor work workplac feel job research behavior studi employe	relationship relationship_supervisor studi work research workplac think see job i_think	relationship work workplac job feel studi think i_think employe satisfact

Note. ^a The top 10 words (or stems) are listed in order of importance. Results that appear to be incomplete words are representative of a variety of words that might begin with a stem (e.g., “peopl” may represent “people,” “people’s”).

Previous research supports the finding that CMV is not pervasive and must be present at extreme levels to impact outcomes. Lance et al. (2010) found that imperfect scale reliabilities (like those in Table 2) can offset inflation in correlations due to CMV, and Fuller et al. (2016) showed that only very high CMV (i.e., 70%) biased correlations. The correlations (collapsed across conditions) among the current study variables are high (PJ-Trust = .81, PJ-JS = .61, Trust-JS = .62) compared to Yang et al.'s (2009) correlations (PJ-Trust = .71, PJ-JS = .25, and Trust-JS = .22). Simmering et al. (2015) reported stronger correlations than did Yang et al. (2009), but lower than correlations in this study (PJ-Trust = .74, PJ-JS = .51, and Trust-JS = .47). The current study manipulations likely impacted subjects' responses, but not in a way that differed among conditions. Thus, it is not known whether this data contains CMV, only that CMV does not differ between experimental conditions.

There were a number of limitations in the current study, each of which suggests future research directions. First, despite using manipulation checks, it may be too challenging for most respondents to answer in a CMV reducing manner, as doing so would require them to individually consider each item without making any judgments regarding surrounding items. Thus, researchers should continue to investigate different inducing and reducing CMV manipulations. Second, the different markers did not create a difference in correlations among substantive variables, which may indicate that markers may not influence responses. Yet, responses to the open-ended item indicates this doesn't negate their effectiveness—the presence of marker variables created variation, perhaps by creating “cognitive speedbumps,” but not to the extent of changing correlations or constructs. Third, respondents who failed the FMC regarding the study purpose were not allowed to continue. It could be fruitful to repeat the study and allow those who missed the manipulation to continue and compare responses. Finally, although this study indicates null findings, these were not predicted. The sample sizes of conditions provided appropriate statistical power for the stated hypotheses; however, future research positing null findings should be designed following best practices (e.g., Cashen and Geiger, 2004) to further explore potential null relationships.

6. Conclusions

The findings of this experiment are meaningful for researchers and reviewers as they provide more evidence to address the current debate regarding the nature and likelihood of CMV. In this study, procedural remedies were used that were previously purported to help control for CMV (Podsakoff, et al., 2012), but correlations among study variables did not differ significantly between experimental conditions.

Recent research (i.e., Spector, et al., 2019) has encouraged a more sophisticated understanding of method variance beyond the assumption that it is necessarily present and biasing. The current study provides more evidence of the elusive nature of CMV. The lack of significant findings in this study could indicate that either (a) the corrective measures do not actually correct for CMV or (b) CMV does not exist to biasing levels in survey methodology and does not need to be ameliorated. Further, while respondents noticed the marker variables, this did not create a meaningful impact on results. While more research is needed, these findings support the argument that procedural remedies to minimize CMV may be unnecessary or ineffective.

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Editorial by the Editor; Ann Brown

Invitation to our readers to send in their opinions and views by letter to the editor

We want to hear from you. We are always interested in well-argued points of view. All your letters will be read by the Associate Editors and selected ones will be published in a later issue.

The research papers in this issue address the following subjects:

- **Case based research – network embeddedness**
An exploratory qualitative case study investigating network embeddedness among public private research partnerships in the European Union. The case is a European Union funded research and development project (Dooley, Duane and O'Driscoll)
- **Quantitative Research Methods – the problem of Common Method Variance (CMV) bias**
An empirical paper using experimental methods to assess the success of current methods for managing this form of bias (Wall, Simmering, Fuller and Waterwall)
- **Teaching Research Methods**
Two papers – one empirical (Daniel), reporting on a survey of research student views on the factors most likely to enhance their research experience; one theoretical (Wotela) proposing a way to fill a missing step in the description of the research process in the research methods literature.

The papers

Case based research - Network Embeddedness

Dooley and co-authors apply qualitative case research methods using network theory to focus the direction of the investigation. Research projects in the EU often involve many different groups and institutions. This case, involving 7 partners and 5 member states, develops the insights of network theory in the analysis of such research networks. The findings identify a set of practical recommendations for network formation that would be valuable in the formation of a research network.

Quantitative Research Methods – the problem of Common Method Variance (CMV) bias

Many social science surveys make use of a single method of data collection as the only source for their research. This has troubled researchers in that it can encourage bias in the way that survey respondents handle the survey questions (CMV). Wall et al have designed and administered an experimental survey, to increase the chance of this error, in order to assess the efficacy of existing CMV detection techniques. The results seem indeterminate.

Teaching Research Methods

The survey of post graduate students views on their research experience, carried out by Daniel, identifies five main factors that they consider the most significant to their success. The results re-enforce much of current thinking on this issue – notably the importance of the role of the supervisor. In contrast Wotela's paper is largely theoretical. The issue it deals with was sparked by the question, frequently asked by research panels when presented with a research proposal – as to why the questions focused on data collection have been included. The paper makes the theoretical case for needing to include a step in the description of the research process, identifying the key attributes and variables for a research project. This is well illustrated by the example given in the paper of researching an individual's propensity to save.