



MONASH University

Knowledge Sharing Mechanisms in University–Organisational Collaborative Projects

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Doctor of Philosophy

A thesis submitted for the degree of Doctor of Philosophy at
Monash University in 2020

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Abstract

Universities knowledge shared with different stakeholders such as industry and non-government organisations (NGOs). These entities use knowledge for different outcomes: universities in part as a source of funding, industrial organisations as a tool for economic development and NGOs as a tool to effect change. The ways these stakeholders produce knowledge varies due to differences in their objectives, functions and responsibilities. Collaboration between universities and stakeholders such as industry/NGOs can play a major role in the field of knowledge sharing. Currently, knowledge is not being shared effectively between universities and industry/NGOs, and the level of collaboration between researchers and industry/NGOs in Australia is low compared to international benchmarks.

A growing number of researchers stress such collaboration. However, little attention is paid to comparative studies of how knowledge is shared in university–industry/NGO collaborative projects. The aim of this research is to explore how knowledge is shared in university–industry/NGO collaborations using ongoing collaborative projects in an IT faculty in Australia. This study adopts Nonaka’s theory of knowledge creation and views knowledge as a continuum of tacit to explicit knowledge. It focuses on the role of shared collaborative spaces (SCSs) for knowledge sharing using industry and NGO projects as case studies, adopting the interpretive paradigm. Exploratory investigations were undertaken to categorise different types of university–industry/NGO partnerships. The Higher Education Research Data Collection (HERDC) was utilised as a criterion for case selection.

The first, ProjectNGO, was a 5-year collaborative project between a university and international NGO with branches in Australia and Bangladesh. It was a participatory action research (PAR) project that investigated the adoption of new technologies. The second case study, ProjectIndustry, was a 4-year collaborative project that aimed to develop a prototype for semi-automatic plant-layout design in an independent Australian oil and gas company. The participants were recruited through their direct involvement in collaboration and communication throughout the project. Interviews with academics, industry and NGO representatives were conducted, transcribed and then coded and analysed using thematic analysis. This revealed six knowledge sharing mechanisms and 22 associated practices in various SCSs, all of which led to knowledge sharing and creation. The mechanisms were exchange, articulation, modification, accumulation, feedback and transfer.

Using the thematic findings and mapping onto Nonaka’s knowledge creation theory, the study proposes a conceptual framework. It is unique in the area of knowledge sharing mechanisms in defining the mechanisms, relationships among mechanisms, relationships of each SCS and mechanism, practices, and channels and tools for knowledge sharing. Investigating interorganisational knowledge sharing mechanisms in this manner can assist organisations to understand how these mechanisms differ in order to provide strategies for governing knowledge sharing practices. In addition, this study examines the central issues in sharing knowledge, along with the basic conditions for creating SCSs in which knowledge can be shared.

Based on the proposed mechanisms, universities, industry and NGOs can discover new opportunities to facilitate knowledge sharing. This should improve and increase collaboration between university and industry/NGOs, and help the latter with their endeavours. The study opens up new reflections on collaboration by exploring knowledge sharing mechanisms. At the same time, it acknowledges the need for further studies of other organisations and contexts.

Keywords: Ba, information technology faculty, knowledge creation theory, knowledge sharing, shared collaborative spaces (SCSs), university–industry collaboration, university–NGO collaboration

Declaration

This thesis is an original work of my research and contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Mozhdeh Dehghani

13 December 2020

Publications during enrolment

Conference proceedings

Dehghani, Mozhdeh, (2019). " Knowledge sharing mechanisms in a socio-technical collaborative project in it-related faculties: preliminary findings". In Proceedings of the 27th European Conference on Information Systems (ECIS), Stockholm & Uppsala, Sweden, June 8-14, 2019. ISBN 978-1-7336325-0-8 Research Papers.

Dehghani, M., Denison, T., Stillman, L. (2018) "Shared collaborative spaces challenges in inter- organisational collaborative projects". PACIS 2018 Proceedings. 199.

Presentation

Dehghani. (2017, Dec). Knowledge sharing mechanisms in university-industry collaborative projects in IT-related faculties in Australia. Proposal presented at ACIS Doctoral consortium, Hobart.

Acknowledgements

Writing this dissertation would not have been possible without the help and support of some wonderful people who I need to acknowledge here.

First of all, I would like to express my sincere and deep appreciation to my supervisors: Dr Tom Denison, Dr Steven Wright and Dr Larry Stillman, for their encouragement, advice and guidance throughout my PhD journey. I truly believe that without their support and insights, I would have not been able to complete my study. My deepest appreciation goes to Dr Tom Denison. Tom, your advice and support on both the PhD to keep the research and thesis on track as well as on my personal life have been invaluable.

In writing this thesis, I have turned to a number of people for advice and assistance. I extend warm thanks to Monash University academic staff: Professor Frada Burstein and Associate Professor Henry Linger, who offered feedback during my candidature and helped me to shape my research.

Special thanks to the Faculty of Information Technology's Research Communication and Academic Language Specialist, Julie Holden, for constructive feedback during my study in the choice of words and English expressions to communicate my ideas more clearly. Your support and guidance are very much valued.

Many thanks to the staff of the Monash Graduate Research Office and the Caulfield School of IT (especially to Helen Cridland, Allison Mitchell and Ammie Juile), who supported and guided me in delivery of administrative issues.

Many thanks also to all my study participants who shared their experiences, stories and perspectives freely, which enabled me to conduct this study.

Additionally, I would like to acknowledge accredited professional editor Mary-Jo O'Rourke AE, who provided copyediting and proofreading services according to the national university-endorsed 'Guidelines for thesis editing' (Institute of Professional Editors, 2019).

I would also like to thank Monash University in offering a scholarship for my PhD course and various educational and other support services that provided me with wonderful learning opportunities to expand my research skills and knowledge in the field. I gratefully acknowledge the funding received close to my thesis submission and during COVID-19 from the Monash University Graduate Research Completion Award.

A special thanks goes to my deceased grandfather, who passed away during my PhD and I was not able to see him again. He had a great role in my life. He stressed the importance of education and I know that this respect for education has shaped my values and made me the person that I am today. My prayers are always with him.

I would like to thank my parents: my father, Asghar, and my stepmother, Farah, who always encourage me on my long journey of education. I will never forget their kindness and efforts to develop my life skills and qualifications. I thank also my siblings and parents-in-law for their patience and support while we were away from home during the study.

Special acknowledgement goes to my beloved husband, Mohsen, who is my best friend and has supported me in all stages of my PhD. Mohsen, many thanks not only for taking care of me during this period, but also for being a wonderful dad and for your constant and unwavering support. Without your support, encouragement and help, this endeavour would have never been possible.

Last but not least, I have to thank many times my cute little son, Aren, for being a good kid with his dad when I was studying. Aren, sorry for being even grumpier than normal while I wrote this thesis!

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CHAPTER 1: INTRODUCTION

As Francis Bacon said, “knowledge is power” (Baggaley et al., 2013, p. 898). Today we can find a needle in a haystack with knowledge. Beyond the haystack, in reality we can also find knowledge in different places and from different stakeholders. In this context, universities are a major cornerstone of knowledge creation as they produce knowledge that is shared with different stakeholders such as industry and non-government organisations (NGOs). The ways in which these stakeholders produce knowledge varies due to differences in their objectives, functions and responsibilities. Because of the role of knowledge in different situations and the power it can hold, it has become a main strategic resource.

1-1. Problem Statement

One of the greatest and most strategic assets of an organisation is its knowledge and knowledge sharing activity (Panahi, 2014). Knowledge sharing as a two-way exchange of information, skills, opinions and ideas, along with its interpretation, is also a strategic issue. As will be discussed in Chapter 2, there are a number of ways of classifying knowledge, but the within this study, knowledge will be categorised as either tacit or explicit (Nonaka & Takeuchi, 1995). Explicit knowledge is documented or codified knowledge, while tacit knowledge is informal or non-codified knowledge that resides in an individual’s mind in different forms, namely, mental modes, personal experience, know-how, insight and paradigms (Nonaka & Takeuchi, 1995; Panahi, 2014).

Depending on an individual’s knowledge and experience, time and shared context, identifying whether shared knowledge between two people is tacit or explicit can be difficult. In fact, “the distinction between tacit and explicit knowledge is not as clear in reality as in the theoretical definitions” (Panahi, 2014, p. 10) because an individual’s knowledge and experience, expert knowledge, time and the characteristics of shared context affect the nature and level of tacitness (Panahi, 2014). For this reason, the current research is consistent with the tacit–explicit continuum (Nonaka & Takeuchi, 1995) that is still used as a common practical classification of knowledge in the literature (Panahi, 2014).

These two types of knowledge are found among both individuals and organisations, and need context for creation and sharing. The context supports knowledge creation and use (Wei Choo & Correa Drummond de Alvarenga Neto, 2010) because the knowledge-creation process is necessarily context-specific in terms of who participates and how they participate (Nonaka, Toyama, & Konno, 2000, p. 14).

Knowledge sharing, which comprises capturing, disseminating, transferring and applying useful knowledge, is a strategic issue for universities, as it can be a source of funding, and for industrial organisations as a policy tool for economic development (Nemati-Anaraki & Heidari, 2014). Commercialisation and academic engagement can result from collaboration and partnerships between universities and industry, and so play an important role in the field of knowledge sharing (Parekh, 2009). Commercialisation, or technology transfer, is divided into patenting, licensing of inventions and academic entrepreneurship. It may occur in technology transfer offices (TTOs), science parks and incubators. Academic engagement represents interorganisational collaboration and includes collaborative research, contract research, consulting and other forms of knowledge exchange in collaborations between universities and industry (Perkmann et al., 2013). This range of knowledge transfer activities represent channels or mechanisms through which knowledge is transferred between partners. Different kinds of knowledge are shared via each mechanism based on the individual needs within the mechanism and the characteristics of the mechanism.

Through commercialisation, with the help of academic researchers industries can access new knowledge and ideas, and identify the latest research about design and development of their products in a competitive market (Guimón, 2013; Jones, 2004). Through such collaboration, universities can create jobs and economic sustainability. For example, this can advance public health via medical products and services. Interest and investment in research in turn lead to improvements in research funding (Caulfield & Ogbogu, 2015). NGOs' use of the knowledge produced in collaboration with academics can improve their practices, help to reduce poverty and satisfy donors (Hayman et al., 2016) and universities, through collaboration with NGOs, can access skills, competencies and capabilities in practice (Yaziji & Doh, 2009)

The focus of this study is on how universities engage in knowledge sharing activities, and in particular with industry and NGOs. NGOs are organisations that are not part of state structures. They are self-governing and possess different objectives, with value-based motivations based on voluntary contributions. They are not primarily motivated by commercial considerations (Corry, 2010; Walsh & Lannon, 2018). In contrast, an industry is defined as “any general business activity or commercial enterprise” that produces goods and services (“industry,” 2019). Different entities use knowledge for different outcomes: universities as a source of funding, industrial organisations as a policy tool for economic development (Nemati-Anaraki & Heidari, 2014) and NGOs as a tool to combine their strengths and capabilities in order to effect change (Walsh & Lannon, 2018).

Sharing different types of knowledge in a specific context in university–industry and university–NGO collaboration is a topic of both managerial and academic interest because university–industry collaboration may result in commercialisation or other benefits, and university–NGO collaboration is a means of social action and policy practice through generation of different solutions to community problems and concerns (Strier, 2011).

This study explores knowledge sharing via one form of academic engagement, collaborative projects.

1-1-1. The importance of knowledge sharing in university–industry engagement

One of the main objectives of university–industry collaboration (UIC) is to ensure the relevance of academic research. In other words, this type of engagement has emerged in response to the requirement that publicly funded research should be relevant to industrial, social and economic problems (Department of Industry and Innovation, 2014, p. 8). Knowledge sharing plays an important role in improving relevance. Knowledge created in universities takes various paths before reaching industries. Through these paths, knowledge is captured, disseminated, transferred and applied (Nemati-Anaraki & Heidari, 2014).

Parekh (2009) defined knowledge sharing “as an activity through which knowledge (i.e. information, skills, or expertise) is exchanged among people, friends, or members of a family, a community, an organisation or collaborative parties” (p. 147). In UIC, the active actors (Jiang, 2008) in knowledge sharing are researchers and industry representatives, whose knowledge is produced in codified forms (explicit) or resides in their minds (tacit). Sharing different kinds of knowledge can be complicated. Relationships between people to create shared contexts can emerge in a shared space, namely, physical, virtual or mental spaces, or any combination of these (Nonaka, Toyama, & Konno, 2000). This shared space acts as a platform for individual or collective knowledge processes.

Others have also suggested that the flow of knowledge towards industry in this type of collaboration is not efficient because of “unnecessarily complex, grandiloquent language, a somewhat impractical vision of the research, relative ignorance of business practice, and the perception of a low level of reliability” (Pineda et al.,

2009, p. 137). Limited sharing of different kinds of knowledge can undermine researchers' ability to build effective collaboration and highlights the need for effective knowledge sharing.

1-1-2. The desire of NGOs to improve their understanding and use of knowledge in their activities

The Organisation for Economic Co-operation and Development (OECD) defined an NGO as “any non-profit entity organised on a local, national or international level to pursue shared objectives and ideals, without significant government controlled participation or representation” (OECD, 2018, p. 2). NGOs can be classified based on their primary objectives and functions. Ebrahim (2003) divided NGOs, based on objectives and functions, into two categories: service and membership NGOs. The focus of service NGOs is on providing a range of services to their clients and members (the public). Donations and grants are their main sources of funding, whereas membership NGOs' focus is on the benefits of their members, such as employment associations and sports clubs. Their funding comes from activities such as membership fees and sales.

NGOs are diverse in their goals, target groups, strategies, resources, tools, effectiveness, impact, sustainability, etc. (Berezko & Zhezhnych, 2017). NGOs have a major role in global economic and social life (Ulleberg, 2009). In playing their roles, NGOs face several challenges. Their credibility and legitimacy have been questioned in social development (Appe & Barragán, 2017).

In order to make significant contributions to diverse areas and find sustainability in social development, they need to find ways to manage their actions with better knowledge and collaboration with different stakeholders. One of the main stakeholders that NGOs desire to collaborate with is universities. Through collaboration with universities, NGOs want to solve community problems, regain legitimacy, promote organisational sustainability and strengthen their contribution to society (Appe & Barragán, 2017), as well as playing a role in knowledge production (Hayman et al., 2016). Because of their different objectives and motivations, NGOs produce and implement knowledge differently (Walsh & Lannon, 2018).

Despite the use of expert and participatory knowledge in decision-making (Green, 2012), NGOs face challenges in knowledge management (KM) (Walsh & Lannon, 2018). Therefore, they need to learn how to manage produced knowledge. Since there is little research on KM within NGOs' and how they communicate with academics during collaboration, this thesis exploring knowledge sharing mechanisms in university–NGO collaboration, which may lead to improved KM, an area in which NGOs face challenges.

A growing number of researchers have stressed the importance of collaboration with NGOs and industry and the ways each entity shares knowledge. However, little attention has been paid to comparative studies of how knowledge is shared in university–industry/NGO collaborative projects. This research applies Nonaka's theory of knowledge creation, specifically Ba (Nonaka, 1994; Nonaka & Konno, 1998; Nonaka & Nishiguchi, 2001; Nonaka & Nishihara, 2018; Nonaka & Toyama, 2005; Nonaka et al., 2008), to highlight knowledge sharing mechanisms within university–organisational collaborative projects with industry and NGOs from the perspectives of active actors (academics and industry/NGO representatives). Nonaka's theory of knowledge creation will be explained in detail in Chapter 3.

The previous studies have largely investigated knowledge flows and types of knowledge transferred between actors. In contrast, this research explores knowledge sharing by using Nonaka's knowledge creation model with a focus on SCSs to map university–organisational collaborative projects, using one industry-based and one NGO-based case study.

1-1-3. The need for effective university–industry collaboration in Australia

The level of collaboration between Australian researchers and industry is low when compared to international benchmarks. “Australia ranks 29th and 30th out of 30 OECD countries in the proportion of large businesses and SMEs collaborating with higher education and public research institutions on innovation” (Department of Education and Training, 2014, p. 3). Furthermore, effective use of knowledge is limited in socioeconomic development and national innovation in Australia due to a lack of project management and collaboration skills, limited motivation of researchers to engage in collaborative knowledge-exchange processes, poor policy and inadequate practice (Cuthill et al., 2014, p. 36). Consequently, Australian performance has never been strong in UIC (Brown, 2015). Australia needs to improve in translating and commercialising its strong research base (Innovation and Science Australia, 2016). Governments, research organisations and businesses are increasingly looking to facilitate relationships and collaboration. Australia, like other countries, has attempted to face these issues and has developed a number of strategies to increase knowledge transfer from universities to industry (Brown, 2015). Australia’s strategic measures can be divided into two categories:

- 1) Enhancing the flow of knowledge across sectors via improving incentives for collaboration between research and industry (Department of Education and Training, 2016); publishing science and research priorities (Australian Government, 2015); allocating Research Block Grant (RBG) funds in a simpler and more transparent manner (2016); providing competitive grants through the Australian Research Council (ARC) and National Health and Medical Research Council (NHMRC) (2015) and so on
- 2) Establishing specialised structures to support university–industry engagement such as Collaborative Research Network (CRN)¹ projects (2009); Academic–Industry Linkage Projects (2015); Excellence in Research for Australia (ERA); Cooperative Research Centres (CRC);² and so on.

As can be seen, Australia has implemented strategies to increase knowledge transfer between university and industry because it is there that Australia’s performance is poorest. However, the literature addressing issues relating to the academic community in interorganisational networks and knowledge sharing in university–industry research partnerships in Australia is limited (Harman, 2001; Zubielqui et al., 2015). The current research addresses this high-level need by exploring knowledge sharing mechanisms in collaborative research projects and looking at the ways in which researchers and industry/NGO representatives within these partnerships share information and knowledge. Finding effective knowledge sharing mechanisms from the perspectives of active actors (researchers and industry representatives) may lead to increased effective collaboration.

A growing number of researchers have stressed the importance of collaboration with NGOs and industry and the ways each entity shares knowledge. However, little attention has been paid to comparative studies of how knowledge is shared in university–industry/NGO collaborative projects. This research applies Nonaka’s theory of knowledge creation, specifically Ba (Nonaka, 1994; Nonaka & Konno, 1998; Nonaka & Nishiguchi, 2001; Nonaka & Nishihara, 2018; Nonaka & Toyama, 2005; Nonaka et al., 2008), to highlight knowledge sharing mechanisms within university–organisational collaborative projects with industry and NGOs from the perspectives of active actors (academics and industry/NGO representatives).

The previous studies have largely investigated knowledge flows and types of knowledge transferred between actors in exploring the mechanisms. In contrast, this research explores knowledge sharing mechanisms by

¹ The CRN program was announced in the 2009–10 Budget. A total of \$81.1 million of CRN funding was committed to 15 projects through two competitive selection rounds. The program has ceased. www.education.gov.au/collaborative-research-networks-crn

² . The CRC Programme is a competitive, merit-based grant program that supports industry-led and outcome-focused collaborative research partnerships between industry, researchers and the community. www.business.gov.au/assistance/cooperative-research-centres-programme

mapping the knowledge creation model with a focus on SCSs in the context of university–organisational collaborative projects using ProjectNGO and ProjectIndustry as case studies.

1-2. Research Objectives

The overall aim of this study is to identify and investigate knowledge sharing mechanisms in university–organisational collaborative projects in the IT faculty from active actors’ perspectives in the Australian context. The specific objectives are as follows:

- To explore knowledge sharing mechanisms in university–organisational collaborative projects in Australia
- To explore drivers and barriers in the knowledge sharing processes of university–organisational collaborative projects from participants’ perspectives in Australia
- To explore the different kinds of knowledge shared in university–organisational collaborative projects from participants’ perspectives in Australia
- To explore different shared collaborative spaces in supporting knowledge sharing processes in university–organisational collaborative projects from participants’ perspectives in Australia
- To explore the strengths and limitations of the concept of Ba for understanding the process of knowledge sharing and creation

1-3. Research Questions

Research questions defined in relation to the research gap have been identified based on the case studies in the IT faculty. In the context of the two detailed case studies, the research questions are formulated as follows:

1. How is knowledge shared in university–organisational collaborative projects?

Sub-questions:

- What are the drivers and barriers in the knowledge sharing processes of university–organisational collaborative projects from participants’ perspectives in Australia?

2. How do participants create shared collaborative spaces (SCSs) for knowledge sharing in university–organisational collaborative projects?

Sub-questions:

- What kind of knowledge is shared in SCSs in university–organisational collaborative projects?
- What kinds of SCSs support knowledge sharing in university–organisational collaborative projects?
- What are the conditions required to develop SCSs between participants in university–organisational collaborative projects?

3. What are the strengths and limitations of the concept of Ba for understanding the process of knowledge sharing and creation?

1-4. Research Scope

1-4-1. Types of knowledge sharing

Knowledge sharing as a complex activity not only has been a fundamental part of any KM initiative but it has been the most researched topic in KM. Its characteristics depend on in which particular situation might take place (Edwards, 2017).

There are two approaches to UIC knowledge sharing. In the first approach, knowledge is divided into untargeted knowledge and targeted knowledge. In untargeted knowledge transfer, knowledge transfer occurs from the university to industry in a one-way engagement via publication, conference proceedings and patents, resulting in codified knowledge, while in targeted knowledge transfer, knowledge transfer occurs between the university and one (or more) specific private partners. This transfer happens via different channels such as consulting, collaborative projects and exclusive licenses. This form of knowledge transfer allows the sharing of explicit and tacit knowledge simultaneously (Hermans & Castiaux, 2007).

The second approach considers how a firm's knowledge is captured, stored and shared. This approach is categorised into formalised knowledge sharing and informal knowledge sharing. The first category considers knowledge to be collectable, storable and retrievable artefacts, in other words, codified or explicit knowledge. The second category highlights organisational knowledge as tacit, socially constructed and collectively held (Zahra et al., 2007).

For the purposes of the current study, knowledge sharing in targeted knowledge transfer and informal knowledge sharing approaches has been adopted because the outcomes of previous research demonstrated that in order to improve KM in organisations, both formal and informal knowledge sharing practices are needed (Zahra et al., 2007). By adopting these approaches, this study explores the types of tacit and explicit knowledge that university researchers and industry/NGO representatives acquire personally or as a group in shared collaborative spaces within collaborative projects.

1-4-2. ICT characteristics in the Australian context

For understanding knowledge sharing mechanism and what actually happens during the processes, I undertook a case study methodology. Because the nature of research projects varies widely between different disciplines and a study of this kind requires in-depth analysis, it was necessary to limit the number of case studies. I decided to focus on collaborative projects within ICT faculties.

In defining the information and communication technology (ICT) sector, the Australian Bureau of Statistics (ABS) has accepted the OECD definition of ICT industries. Further, this definition considers the following issues according to their context (OECD, 2011):

- Specialisation ratio (the proportion of businesses in an industry that have ICT activity)
- The fact that ICT products are also produced by enterprises that are not classified as ICT sector industries; and
- The overlap of the ICT sector with content industries.

It should be noted that “the OECD ICT industries definition includes a wider range of goods and services produced than the Australian definition and, consequentially, industries involved in ICT activity” (Australian Bureau of Statistics, 2008). The definition of the ICT sector in the current research is restricted to the Australian interpretation of the OECD ICT industry definition in ICT industries survey conducted by the ABS in 2006–07 (Australian Bureau of Statistics, 2008).

Given that the current research focused on collaborative projects between information technology (IT) faculties and industry/NGOs in the Australian context, reviewing the existing literature in this area (the ICT industry) has provided a sense of the nature of the ICT industry in Australia. Reviewing the literature which is available from the OECD, ABS and Australian Computer Society (ACS), and some other literature, has in turn helped to inform the choice of research sites and participants in order to situate the research in terms of the industry and NGOs.

Australia's ICT industry forms a significant part of the economy. ICTs are used across industries in Australia. In 2008, the services sectors including ICT rescued Australia from the global financial crisis according to an Australian Treasury Paper and the ABS (Australian Computer Society Inc, 2015). In 2010, the ICT sector contributed nearly 8 per cent of Australian GDP. It should be added that contribution to GDP is one of the key economic measures (Australian Computer Society Inc, 2015).

According to the Global Information Technology Report 2015, Australia obtained an excellent ranking for ICT usage such as online service offerings and e-participation tools. Australia also took 4th place in mobile telephone subscriptions of the third generation or above. However, it took 25th place in ICT uptake by businesses. Consequently, there is a need to improve the level of ICT uptake by government and businesses (Baller et al., 2016; Dutta et al., 2015) because "the Australian economy is largely dependent on commodity exports and is not particularly innovative" (Dutta et al., 2015, p. 23). The mining industry remains a significant part of the economy (Baller et al., 2016) but, as stated earlier, the services sector including the ICT industry rescued Australia from the global financial crisis, not the mining sector (Australian Computer Society Inc, 2015).

1-5. Overview of the Research Design

My research is exploratory within an interpretive paradigm. To capture in-depth knowledge sharing mechanisms in SCSs, I have used participants' opinions and perspectives about how they created SCSs in collaborative projects. Since my study looks at participants' viewpoints and experiences in regards to knowledge sharing, it is qualitative in nature. Among the different ways to conduct qualitative studies, this research uses in-depth case studies. A case study is a suitable research strategy for studying a phenomenon in its context and provides more advantages when the theoretical refinement of a concept such as knowledge creation theory is applied as the lens of analysis (Yin, 1994). In the context of exploratory research, studying a small number of cases in depth is sufficient to explore the relationships between different elements of a theoretical framework (e.g. in my research, SECI, Ba and knowledge assets) and to clarify the applicability of the framework.

1-6. Theoretical Frameworks

My research has used Nonaka's theory of knowledge creation as a theoretical frame to explore SCSs in collaborative projects. This theory consists of three elements: (i) the SECI process (four modes of knowledge conversion including socialisation, externalisation, combination and internalisation); (ii) Ba, a shared context in which knowledge is shared; and (iii) knowledge assets (Nonaka, 1994; Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000). These three elements act dynamically together. But each element illustrates a different process of knowledge creation and, potentially, knowledge sharing. The SECI process forms the basis of how knowledge is shared and created, Ba forms the basis of where and when (space and time) knowledge is shared and created and the knowledge assets are the basis of what knowledge is shared and created.

While my study focuses primarily on the concept of Ba, it cannot be examined independently of the other two elements. It identifies how knowledge is shared and created between individuals not only in intra-organisational contexts, but additionally in interorganisational contexts such as family businesses (Brännback et al., 2008).

1-7. Contribution to Knowledge

By analysing how researchers and industry/NGO representatives created shared spaces and which shared spaces they preferred for knowledge sharing in collaborative projects, my research explores how the knowledge creation model can be used to explicate effective knowledge sharing mechanisms in the context of university–organisational collaborative projects and reflecting academics’ and industry/NGOs’ perspectives.

I have identified six key knowledge sharing mechanisms, namely, exchange, articulation, modification, accumulation, transfer and feedback. These mechanisms are original contributions to a dynamic approach to knowledge sharing in the context of university–organisational collaborative projects. These mechanisms will help industry/NGOs and universities to discover new opportunities to facilitate knowledge sharing among actors.

1-8. Thesis Structure

The thesis is organised into eight chapters as follows:

Chapter 1: Introduction – the current chapter has provided the background to the study and the rationale for the study by pointing to its significance.

Chapter 2: Literature review – this chapter presents a more detailed review of the relevant literature on the topic and the context, framework and scope of the research. It starts by defining UIC, university–NGO collaboration and relevant studies in the context of university–industry/NGO collaboration. Then it continues with presentation and discussion of concepts of knowledge, defining different kinds of knowledge, knowledge sharing, knowledge sharing challenges and knowledge sharing mechanisms. It ends by introducing the knowledge creation model and relevant models.

Chapter 3: Research Design – this provides the justification and explanation of the strategies and methods that have been adopted in the research. It provides the rationale for the choice of paradigm, methods, theoretical framework, research techniques and data analysis method (thematic analysis) in order to explore the research questions.

Chapter 4 and 5: Reports of Case Studies – these present the findings of the case studies. They start by applying the SECI process for knowledge conversion within NGO/industry projects and continue by applying the shared context (Ba) for knowledge sharing and creation within them. They end by applying knowledge assets for knowledge sharing and creation within both projects.

Chapter 6: Findings, Identification of Context-Specific Knowledge Sharing – this discusses the identification of context-specific knowledge sharing mechanisms. In this chapter, the data is examined, coded and reviewed using a thematic analysis approach to answer the main research questions.

Chapter 7: Discussion – this provides reflections on the two case studies, and discusses and compares the findings of the research to the existing literature. It also revisits the research questions and provides answers to each question. It ends by proposing guidelines for effective knowledge sharing within collaborative projects.

Chapter 8: Conclusions – this chapter concludes the thesis by providing the summary of the research. It presents the limitations and contributions of the study. It ends with recommendations for future research.

1-9. Chapter Summary

This chapter has described the background and problem statement of the research. The chapter has presented the research objectives and questions, and brief descriptions of the research methodology, framework and contributions. The next chapter will provide a review of the relevant literature.

CHAPTER 2: LITERATURE REVIEW

2-1. Chapter Preview

The previous chapter introduced the problem statements and the overall structure of this study. The purpose of this chapter is to review the related literature on knowledge, knowledge sharing mechanisms and associated challenges in relation to university–industry and university–NGO collaboration. First, the chapter provides a general background to the concepts, discusses their key areas and reviews the associated studies, and then concludes with the approach taken in this study. Second, the chapter presents the background theory (knowledge creation theory) and reviews the studies that have used this theory in the university–industry/NGO context that provides a comprehensive understanding, which is then used as an analytical framework and will be presented in Chapter 3. Examining the literature in those broad areas relevant to my research topic has enabled me to identify a gap in the literature, in relation to what further research would be useful, and to refine my research questions.

This chapter begins with a review of the definitions of university–industry collaboration (Section 2-2) and university–NGO collaboration (Section 2-3) and relevant studies in the context of university–industry/NGO collaboration (Section 2-4). Then it continues with presentation and discussion of concepts of knowledge (Section 2-5), defining different kinds of knowledge (Section 2-6), knowledge sharing (Section 2-7), knowledge sharing challenges (Section 2-8), and knowledge sharing mechanisms (Section 2-9). It ends by introducing the knowledge creation model and other relevant models (Section 2-10) and providing the chapter summary (Section 2-11).

2-2. University–Industry Collaboration

Nowadays, organisations are working in new ways and structures compared to several decades ago (Almeida & Soares, 2015). One of the flexible structures that organisations now deploy is collaborative projects (Blindenbach-Driessen & Van Den Ende, 2006; Thiry & Deguire, 2007). Through these collaborative projects, the knowledge, capabilities and resources of the organisations evolve and are built up (Boh, 2007). What is learned through each project helps to improve organisational performance not only because of the valuable experience gained through previous projects which could be applied in similar future projects, but also because of newly produced knowledge which could lead to new business opportunities (Almeida & Soares, 2015).

This section presents the specifics of collaborative settings, specifically those concerned with university–industry/NGO collaborative projects. The literature on university–industry collaboration (Section 2-2) and university–NGO collaboration (Section 2-3) is treated separately; however, some issues overlap. Consequently, some studies are reported in both sections.

The Organisation for Economic Co-operation and Development (OECD) defined collaboration as “active participation in joint innovation projects with other organisations” (OECD Publishing, 2017, p. 134). In other words, when two or more people or organisations work cooperatively towards the same purpose, they interact together. This interactive process is called collaboration (Okane, 2008). Although universities have collaborated with industry partners in various forms since the nineteenth century, collaborative activities have grown in order to increase productivity and economic growth (Jones, 2004). In the literature, this concept is described in six ways: channels of university–industry interaction (Bekkers & Freitas, 2008; Fernández-Esquinas et al., 2015), patterns of knowledge flow (Bekkers & Freitas 2008), knowledge transfer channels (Polt et al., 2001), university–industry cooperation or interaction (Davey et al., 2011; Fernández-Esquinas et

al., 2015; Schartinger et al., 2001; Turpin et al., 1996) and university–industry engagement (Perkmann et al., 2011). The following paragraphs discuss the discrepancies in terminology.

In the university–industry interaction category, the university interacts with industry in order to support technology transfer and cooperative research (Santoro, 2000). Schartinger et al. (2001) defined four types of interactions between universities and the business sector: joint research projects, contract research, joint supervision of PhD and Master's theses by university and firm members, and the mobility of university researchers into private firms. Santoro (2000) emphasised technology transfer, while Schibany and colleagues (2001) focused more on research interaction.

There are different factors that motivate academics to collaborate with industry (Debackere & Veugelers, 2005). These include academic evaluation based on contributions to university–industry collaboration, funding for future research, increasing practical knowledge, applying theory in practice and feeling a sense of accomplishment through collaboration with industry. At the institutional level, royalty payments, university support for business, good publicity for the university, financial support for university research and job opportunities for graduates are identified as motivating factors for university to collaborate with industry (Decter et al., 2007; Rohrbeck & Arnold, 2006). Access to new ideas, reduction in their own research and development (R&D) costs, recruitment and retention of staff, and access to university facilities are discussed as drivers for organisations in collaborating with universities (Decter et al., 2007; Dooley & Kirk, 2007).

Attia (2015) grouped the drivers of university–industry collaboration into two main categories: relationship drivers and business drivers. Relationship drivers include mutual trust, mutual commitment, having shared goals, understanding of common interests by different stakeholders, prior relationships with the business partner and cooperation to address societal challenges. Business drivers include the commercial orientation of the university, access to funding opportunities via working with business, flexibility of the business partner, interest of the business in accessing scientific knowledge, access to business-sector R&D facilities, employment and short geographical distance of the university from the business partner.

Ghobadi (2015) categorised the drivers of knowledge sharing in software development teams into four major categories and seven specific subcategories. The major categories are people-related, structure-related, task-related and technology-related. The subcategories are: 1) diversity-related drivers such as skills-related, geographical and time-related drivers; 2) capability-related drivers such as team members' knowledge, skills, experience and backgrounds; 3) team perceptions drivers such as the perceptions, attitudes and values of team members; 4) team organisation drivers such as team organisation and the conduct of the project; 5) organisational practices drivers such as existing organisational norms, communication networks and practices; 6) task-related drivers such as contextual and task-related issues; and 7) technology-related drivers such as templates, tools and methodologies.

In the patterns of knowledge flow between universities and firms, contract research and knowledge transfer are identified as means of university–industry interaction (Bekkers & Freitas, 2008). The purpose of contract research is to support the adoption of interdependent knowledge, whereas the adoption of systematic knowledge based on patents and licensing is mentioned as an outcome of knowledge transfer. While the current research acknowledges the importance of contract research for university–industry collaboration, patents and licensing are best understood as methods of technology transfer rather than knowledge transfer.

With regards to knowledge-transfer channels, channels of knowledge transfer between universities and industry can be categorised into: collaborative research, contract research and technology-related consulting, staff mobility between firms and public science institutions, cooperation in the education of postgraduate students, vocational training for employees, use of intellectual property rights (IPR) by public scientific

organisations, spin-offs, and informal contacts and personal networks (Khan, 2015; Polt et al., 2001). Bekkers and Freitas (2008) grouped these channels into three categories, namely, knowledge-transfer channels related to industry sector, knowledge-transfer channels related to scientific discipline and knowledge-transfer channels related to organisational features. The current research accepts the Bekkers and Freitas (2008) groupings of the different channels because they consider different channels according to their purpose and function.

Davey et al. (2011), in discussing university–industry cooperation and means of cooperation among European universities, identified curriculum development and delivery, lifelong learning, student mobility, academic mobility, commercialisation of R&D results, collaboration in R&D, entrepreneurship and governance (Davey et al., 2011). Turpin et al. (1996) classified university and industry cooperation in Australia into three different levels of organisational arrangement according to project time spans, individual engagement in projects and the structure of institutional arrangements.

In the university–industry interaction category, collaborative research projects, patents, spin-off creation, consultancy and specialised training, and informal relationships are mentioned as means of how firms interact with the university (Fernández-Esquinas et al., 2015).

In the university–industry engagement category, Perkmann et al. (2013) defined two concepts of commercialisation and academic engagement as a consequence of university–industry relations. Commercialisation or technology transfer exploits a patented invention (p.424) and can occur via patenting, licensing of inventions or academic entrepreneurship. Academic engagement represents interorganisational collaboration (p.424) and occurs via collaborative research, contract research, consulting or other forms of knowledge exchange. Person-to-person interactions are the basis of this collaboration.

The above studies suggest that patenting and licensing are the best methods of technology transfer and collaborative projects are the best way to encourage knowledge transfer. Following these definitions and classifications, my research is consistent with those types of university–industry collaboration that are defined as academic engagement because the objective of the research is to explore knowledge sharing mechanisms in university–industry collaboration from the perspectives of researchers and industry representatives. My research also focuses on collaborative projects as one form of academic engagement that emerges as a result of person-to-person interaction.

2-3. University–NGO Collaboration

In defining university–NGO collaboration, different search terms such as “university–NGO collaboration”, “university–community partnership”, “academy–community partnership”, “university engagement with community-based organisation”, “university and community collaboration” and “university–third sector collaboration” were researched in the literature.

University–NGO collaborations are relationships between NGOs and their practitioners and academics and academic units based on shared objectives and interests. University–NGO collaboration has been described as “a win–win situation in which NGOs provide access to empirical experience and evidence, and the academic partner brings theoretical framing and methodological expertise” (Aniekwe et al., 2012, p. 4).

Aniekwe et al. (2012) described the purposes of university–NGO collaboration as follows:

- helping to expose and frame research questions
- allowing interaction throughout the research process
- supporting data collection and analysis
- providing outlets for sharing, feedback and dissemination.

Roper (2002, p. 341) identified five different types of university–NGO collaboration. In this classification, the focus is on the scope of the collaboration and the way in which each party defines the collaboration:

1. The expert-consultant model: the academic expert comes in and analyses a problem and makes recommendations, and the organisation is a consumer of the product.
2. The expert-trainer model: the academic helps the NGO develop organisational skills to deal with a particular set of problems.
3. The joint-learning model: research regarding a particular problem is used as a platform for developing skills in conscious or critical inquiry.
4. The best practice model: the researcher documents organisational practice for the purpose of sharing that experience more broadly in order to improve development practice.
5. The theory-development model: the research is meant to contribute to the development of the theoretical literature and may be part of a broader intellectual undertaking.

The concept of university–community partnership relates to engagement between faculty, students and the community (Bryer et al., 2020) and emerges as a response to teaching, research and practice needs (Soska & Butterfield, 2013). It fosters innovative planning solutions for communities (Jackson & Marques, 2019). Fisher et al. (2004) categorise university–community engagement primarily into four types: 1) service learning and student engagement projects, in which students are involved in service-oriented internships, class projects and other opportunities in which they can learn and contribute to the community; 2) local economic development, in which institutions are engaged in community development by sponsoring activities or creating entities in communities such as bookstores, restaurants, schools and childcare centres; 3) community-based research or participatory action research, in which faculty members help communities to solve problems through research; and 4) social work initiatives, which embody all of the previously mentioned types of engagement and focus on individual and professional issues such as licensing, democratic processes and community ownership. Jacob et al. (2015) defined university–community engagement in terms of sustainable networks, partnerships, communication media and activities between higher educations and local, national, regional and international communities. These activities include establishing relationships, collaboration initiatives, business ventures, co-sponsored meetings, conferences, sports events and research projects.

In the context of university partnership research with communities, NGOs need professional competencies in analysis and project planning to support implementation, assessment and post-project monitoring, as well as staying up to date with relevant new theories and applications (Zolezzi, 2014). These were identified as drivers for NGOs in Italy when collaborating with universities, providing opportunities for Italian universities to validate/revise their theoretical or modelling approaches based on real case studies via access to NGOs' field experience. Similarly, Chernikova (2016) explained the mutual benefits of collaboration between universities and civil society organisations (CSO) in Canada: CSOs in Canada accessed different kinds of knowledge such as theoretical expertise, research skills and integration of contemporary technology, and gained the ability to evaluate their work and access networks and human resources in short supply. Universities via collaboration with CSOs in Canada increased and enhanced academic researchers' knowledge about global issues, provided complementary expertise and experience, enriched students' training, increased the international expertise of professors, strengthened their practical work, enhanced the overall internationalisation of the university and access to communities, which in turn led to higher quality field-based projects and provided opportunities for future projects, enhanced students' education and provided direction and opportunities for students' future careers. Chernikova also emphasised the leadership of integrators, availability of spaces where the synergy of ideas occurs and the priorities of funding agencies as enabling factors for university–CSO collaboration.

Among various typologies such as those developed by (Fisher et al., 2004; Jacob et al., 2015; Roper, 2002), the NGO case study in my research fits under the theory-development model (Roper, 2002) or community-

based research (Fisher et al., 2004). Since there is a need in the literature to bridge the gaps between academics and NGO practitioners and to improve communication between them (Aniekwe et al., 2012), my research focuses on exploring knowledge sharing mechanisms in collaborations based on shared objectives and interests.

2-4. University–Industry/NGO Collaboration Studies

Recent studies of university–industry/NGO collaboration have paid growing attention to identifying different channels/models and developing a typology of the characteristics of collaboration (Fisher et al., 2004; John et al., 2015; Melink et al., 2014; Perkmann & Walsh, 2008; Roper, 2002). Some of this literature focuses on the implications of national policy approaches and national (or regional) innovation systems in collaboration, drivers and barriers in establishing collaboration, and the impact of faculty quality on engagement in technology transfer (Ankrah et al., 2013; Brohman et al., 2003; Kalar & Antoncic, 2015; Melink et al., 2014; Olivier et al., 2016).

Another part of the literature highlights industry/NGO characteristics (such as size, absorptive capacity and technology openness), peer effects in collaboration, open-data partnerships, factors that influence the formation of linkages between universities and firms, cultural characteristics in shaping university–industry/NGO and the forms and objectives of university–industry/NGO collaboration (Callaert et al., 2015; Chernikova, 2016; Freitas et al., 2013; Giuliani & Arza, 2009; Zolezzi, 2014).

Other studies examine university–industry collaboration from the perspectives of: social capital (Thune, 2007); spin-off processes and characteristics (Soetanto & Jack, 2016); the process of learning in university technology transfer offices (TTOs) (Weckowska, 2015); the nature and outcomes of university–industry relationships (González-Pernía et al., 2015); collaboration and modes of innovation (Lakatos et al., 2015); and characteristics of university–industry collaboration by econometric models (Fontana et al., 2006).

Finally, a number of studies explore: the impact of affiliation in knowledge exchange in the university–industry collaboration context (Boardman, 2008); the role of different types of intermediaries involved in knowledge transfer (Wright et al., 2008); knowledge sharing processes in family and small and medium-sized enterprises (SMEs) (Brännback et al., 2008); and specific aspects of managing knowledge through collaboration (Numprasertchai & Igel, 2005).

As will be discussed later, although a number of studies have discussed knowledge sharing mechanisms and shared spaces in an intra-organizational context, there has been little research into how knowledge is shared within the types of university–industry/NGO collaborative projects and shared spaces (Hansson, 2007; Niccolini et al., 2018) that form the focus of this thesis, or comparing two different contexts (industry and NGO projects). There is a need to explore the impact of shared spaces, either physical or mental, in knowledge sharing mechanisms and to further investigate the relationships between mechanisms, practices and tools in the specific context of such collaborative projects.

2-5. Defining Knowledge

In the knowledge management (KM) context, knowledge is an economic resource that affects every aspect of human life. The meaning of knowledge has been defined in various ways in the literature. Plato defined knowledge as “justified true belief” (Nonaka & Takeuchi, 1995, p. 21). Nonaka (1994) agrees with this definition in his knowledge creation theory, adding that “truthfulness” (p.15) and “personal belief” (p.15) are important parts of the traditional definition of knowledge, reinforcing the importance of “justification of knowledge” (p.15). The traditional view considers knowledge static, but his new definition considers

knowledge “a dynamic human process of justifying personal beliefs as part of an aspiration for the truth” (Nonaka, 1994, p. 15) to create a new definition of knowledge that can effectively drive the creation of new ideas and concepts.

Beyond epistemological definitions of knowledge, there are other explanations of knowledge in the IT literature. One such explanation is called the hierarchical view of data, information and knowledge (Alavi & Leidner, 2001). While data and information can be defined as raw numbers and facts, and processed data respectively, knowledge is defined as authenticated information. Knowledge can be explained as information embedded in the minds of individuals and interpreted with their own personal skills, experiences and capabilities. In this view, information is converted into knowledge after processing by the individual’s mind and knowledge becomes information when it is presented in the form of text, graphics or other symbols. With respect to knowledge categories based on information, Buckland (1991) provides another classification. They categorise information as process, knowledge and thing. Information-as-process means becoming informed. What a person knows changes according to the time they are informed. On the other hand, information-as-knowledge concerns what is perceived in information-as-process. Knowledge which is acquired in this process is intangible. There is no way to measure or touch it. Knowledge-as-thing concerns objects such as data and documents. They are tangible. Measuring and touching and seeing them is easy and accessible because they are manifested in a physical form (such as on a printout, on a computer screen, even via audio). In order to use information-as-knowledge, it needs to be described or represented via physical ways such as text, signals or symbols. In other words, it becomes information-as-thing. In information-as-thing, a tacit form of knowledge is converted into an explicit form.

Furthermore, wisdom is often added to this hierarchy in the KM literature (Davenport & Prusak, 1998). Wisdom at the highest level refers to the accumulated knowledge in people’s minds that provides practical insights (Panahi, 2014). In the hierarchical view of knowledge, data indicates know-nothing information and knowledge dealing with know-that or know-how, but wisdom is about know-why (Zeleny, 1987). In this hierarchy, wisdom refers to the insights of people that can be captured and leads to the effective application of knowledge in life. Since wisdom is the highest level of abstraction, capturing and studying this kind of knowledge is difficult.

Knowledge has also been defined as information plus the combination of skills, experience and personal capability (Baker et al., 1997). Since people interpret information using their own personal skills, experiences and capabilities, knowledge may be created as a result. This is in line with the widely accepted definition in the KM literature provided by Davenport and Prusak (Panahi, 2014). They described knowledge as a “fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information” (Davenport & Prusak, 1998, p. 5).

Knowledge can be further viewed from an objective or subjective point of view. From an objective point of view, knowledge can be seen as a thing that is independent of the original context and applicable to any similar situation such as best practices, documentation, etc. (Roberta et al., 2011). It can be explicitly stored and transferred without individual perceptions independently of the individuals who produce it (Becerra-Fernandez & Sabherwal, 2014). From the subjective point of view, knowledge is dependent upon the original context and people who produce it, being created by the interaction between the individual and the context such as the daily practice of work. In this view, individuals give meaning to a situation through interpretation (Roberta et al., 2011). It can be concluded that “knowledge cannot exist without individuals and contexts that surround humans” (Nonaka & Toyama, 2005, p. 421). The meaning of knowledge always depends on the context or the individual’s interpretation and can be either explicit or implicit (Roberta et al., 2011).

Alavi and Leidner (2001, p. 109) considered knowledge from several other perspectives: namely, as “a state of mind”, “an object”, “a process”, “access to information” and “a capability”. Becerra-Fernandez and Sabherwal (2014) categorised “an object”, “access to information” and “a capability” as belonging to the objective point of view. They placed the two other perspectives under the subjective umbrella. From this perspective, knowledge is considered a state of an individual’s mind, or as a practice or process (Alavi & Leidner, 2001). According to these authors, knowledge as a state of mind is defined as the beliefs of individuals with different experiences and backgrounds, while knowledge is defined as a practice which does not reside just in an individual’s mind but is brought into practice (Alavi & Leidner, 2001; Becerra-Fernandez & Sabherwal, 2014). The subjective view aligns with Nonaka’s new definition of knowledge because in this view knowledge is produced by the interaction of individuals in different shared contexts. For knowledge sharing that happens via the interaction of different departments, groups and divisions, a subjective view of knowledge can explain these processes more effectively. Consequently, for the purpose of my research, I have adopted the subjective view of knowledge.

2-6. Different Kinds of Knowledge

Numerous ways of classifying knowledge have been proposed in the literature.

Tacit and explicit knowledge are important classifications (Nonaka, 1994; Polanyi, 1967). Tacit knowledge is difficult to express and therefore difficult to share. It includes “insights”, “intuitions” and “hunches” (Becerra-Fernandez & Sabherwal, 2014). In contrast, explicit knowledge can be expressed in a variety of forms such as data, manuals, patents and computer programs, and can be shared. Explicit knowledge can also be converted into tacit knowledge and vice versa. However, codifying and sharing tacit knowledge is more difficult than with explicit knowledge because of the elusive nature of tacit knowledge. This classification is still used as a common practical classification of knowledge in the literature (Panahi, 2014). Experiential knowledge, a subcategory of tacit knowledge, is gained through lived experience (Faulkner, 2017) and is built through shared hands-on experience among the members of an organisation and between the members of an organisation and other stakeholders (Nonaka, Toyama, & Konno, 2000; Rai, 2011). It is a job-specific form of knowledge and skills, such as tips, rules of thumb, know-how, new ideas, perspectives, etc. (Panahi, 2014).

Looking at organisation behaviour in seeking, creating and using information, Choo (1998) proposed tacit, explicit and cultural knowledge in the intra-organisational context, emphasising the structure and dynamics of how information is used within organisations. These categories are used in the knowledge-acquisition process. They focus more on information flow. However, there is a gap when they explore different categories of knowledge and full flows of knowledge in the knowledge sharing process. Similarly, Blackler (1995) proposed five types of knowledge within organisation studies. He used the terms “embodied”, “embedded”, “embrained”, “encultured” and “encoded” knowledge. To explore these categories in the literature, he focused on organisational learning.

Other categories similar to tacit and explicit knowledge were proposed by Bhatt (2001). He argued that organisational knowledge is created as a result of interactions between technologies, techniques and people. Organisational history and culture are the main platform for this interaction, which he expressed in terms of foreground and background knowledge. The first refers to knowledge that is easy to capture and codify, while the latter is more like tacit knowledge, which is difficult to capture. Bhatt argued that the emergence of these kinds of knowledge depends on organisational history and the conditions of interaction.

There are yet other ways of classifying knowledge. Lundvall and Johnson (1994) categorised knowledge into four groupings, namely, know-what, know-why, know-who (when and where) and know-how within an

organisation. They wanted to find the relationships between different kinds of knowledge and fundamental economic concepts. They defined know-how as practical skills or expertise. A

Some studies classify knowledge based on the flow of information. Anderson (1989), on the other hand, focused more on the flow of information, describing such general flows in terms of declarative, procedural and working memory. Declarative memory includes factual knowledge which can be used in any situation. Information from the environment can be deposited as factual knowledge in human memory. It represents know-about. In contrast, with procedural memory, knowledge is encoded in a use-specific way. It represents learning by doing. People are able to acquire knowledge in a procedural form, while working memory is the place that all the information from the environment comes into at first. Working memory includes the portion of knowledge that is actively used. As Lundvall and Johnson (1994) pointed out, declarative knowledge may be characterised as “Know-what” and procedural knowledge may be viewed as “Know-how” (Becerra-Fernandez & Sabherwal, 2014).

One final classification of knowledge is that of general knowledge and specific knowledge (Sabherwal & Becerra-Fernandez, 2005), which focuses on how knowledge is possessed. General knowledge is possessed by a large number of individuals, while specific knowledge is possessed by a very limited number of individuals. General knowledge can be shared and transferred easily, but specific knowledge is difficult to share.

From the several typologies of knowledge discussed above, the classification that best fits with the focus of my research is the tacit/explicit classification, as it is used as a practical classification of knowledge in the literature and can apply in different contexts such as intra-organisational and interorganisational contexts. Furthermore, knowledge sharing starts at the individual level and occurs through the interaction between explicit and tacit knowledge (Nonaka & Takeuchi, 1995). In the context of university–industry/NGO collaborative projects, it would appear more effective as a classification for analysing knowledge sharing processes in which individuals interact in everyday discussions, face-to-face/online, formal/informal meetings, and use reports, new products, textbooks, journals, guidelines and electronic databases for knowledge sharing. In addition to these different types of knowledge (tacit and explicit), experiential knowledge as a subset of tacit knowledge will also be picked up later through application of the knowledge creation model within the case studies.

2-7. Knowledge Sharing and Knowledge Transfer

“Knowledge transfer” and “knowledge sharing” are common terms in the literature and sometimes used interchangeably. My research makes a distinction between knowledge sharing and the concept of knowledge transfer.

Knowledge transfer has been defined as “the movement from its point of generation or codified form to the point of use” (Grover & Davenport, 2001, p. 8) within a specific context such as learning that happens in midwifery or butchery through face-to-face practice (Bosua & Scheepers, 2007). Bolisani (2008, p. 112) defined knowledge transfer as the process through which a “piece of knowledge” is passed via medium or channels from somebody to somebody else. In the majority of studies, knowledge transfer is defined as the process in an organisation through which different departments, groups and divisions interact and are affected by the experience of others (Argote & Ingram, 2000) and learn from that experience (Easterby-Smith et al., 2008). Easterby-Smith et al. (2008) and Argote and Ingram (2000) focused on interactive dynamics between organisations, units and departments as the main source of knowledge transfer in the KM process. In these contexts, knowledge transfer can be referred to in terms of legal structures such as strategic alliances and networks which include R&D coalitions, franchising, co-production agreements, licensing and joint ventures

(Easterby-Smith et al., 2008) and collaborative projects through which knowledge transfer takes place and stakeholders learn from each other's experience. In university–industry/NGO collaboration, different structures are used as a context for knowledge transfer including collaborative research projects, contract research, joint supervision of PhDs and community-based research.

Opposed to this, knowledge sharing can be defined as “activities of transferring or disseminating knowledge from one person, group or organization to another” (Lee, 2001, p. 324). Knowledge sharing is considered a process or activity leads to both individual and organizational learning (Andrews & Delahaye, 2000; Nidumolu et al., 2001). It implies a process of mutual or collective learning through ongoing interaction (Bolisani & Bratianu, 2017). The definition of knowledge sharing is not limited only to organisations (Law, 2009; Nemati-Anaraki & Heidari, 2014; Parekh, 2009). For example, Parekh (2009) considered knowledge sharing as activities through which information, skills and expertise are exchanged among individuals, a community, an organisation or collaborative parties, while Law (2009) defined knowledge sharing as transferring “meaningful information, along with interpretation” between individuals, groups or organisations. Others have defined knowledge sharing as a dual process of not only acquiring knowledge but also contributing to knowledge production through activities such as “learning-by-observation, listening and asking, sharing ideas, and giving advice” (Bosua & Scheepers, 2007, p. 95). In a similar vein, Bartol and Srivastava (2002) defined knowledge sharing as sharing information, skills, opinions and ideas between individuals at an organisational level. All of these authors emphasised interaction between individuals.

In this thesis, the term “knowledge sharing” is used to describe a two-way exchange of information, skills, opinions and ideas along with interpretation among different entities such as individuals or organisations. As Nonaka (1994) showed, knowledge sharing is rooted in the context in which it occurs, my research project looks at collaborative projects to explore knowledge sharing mechanisms within one broad knowledge transfer mechanism.

2-8. Knowledge Sharing Challenges

The nature of the barriers to knowledge sharing in collaborative projects has been well studied. Van Wijk et al. (2008) explored the factors affecting knowledge transfer in interorganisational collaboration after reviewing and analysing 75 papers. Factors impacting on knowledge transfer included absorptive capacity, ambiguity, cultural differences, differences in goals, trust and tie-strength. Absorptive capacity is defined as the ability of a firm to identify the value of new knowledge and use it in daily routines (Cohen & Levinthal, 1990). Knowledge ambiguity is one of the most important barriers to knowledge sharing (Simonin, 1999; Szulanski, 1996) and refers to “the inherent and irreducible uncertainty as to precisely what the underlying knowledge components and sources are and how they interact” (Van Wijk et al., 2008, p. 833).

Pineda et al. (2009) explored the manner in which the particular characteristics of the university and industry and their socio-cultural contexts prove to be significant impediments to collaboration. They found that universities use complex language such that businesses subsequently ignore research because of its perceived impracticality, along with differences in organisational cultures and innovation-assimilation capacities.

Van Wijk et al. (2008), based on previous studies, divided social context into three dimensions: structural, relational and cognitive. The structural dimension indicates patterns of relationships and linkages among firms. Being connected via a large number of relationships to other organisations and units increases relevant knowledge access, and the frequency of interaction and communication increases the strength of those relationships. The cognitive dimension refers to the “resources within relationships that provide shared representations, interpretations and system of meanings” (p.835), for example, shared vision and values. The cognitive dimension promotes mutual understanding. It is in this context that cultural differences can occur.

These are related to different ways of working in different countries and organisations. These impede interaction and can cause conflicts between members (Krishna et al., 2004).

Attia (2015) and Bruneel et al. (2010) categorised the important barriers that affect university–industry collaboration into two groups: orientation-related and transaction-related barriers. The orientation-related barriers refer to the main motivations and concerns of academics in doing collaboration. For example, academics might delay or even not publish the results of collaborative projects due to commercial considerations or the confidentiality of the industry research. Transactional barriers refer to the “factors that can create noteworthy transactional costs to collaboration to industry” (Attia, 2015, p. 17), for example, a lack of skills among university staff that can produce long delays in the collaboration process or conflicts over IP and university administration (Bruneel et al., 2010).

Brohman et al. (2003, p. 98) studied a partnership between two universities and an NGO in Mexico. They divided university–NGO partnership issues into three categories, namely, “structural constraints rooted in the relationship between partners and the principal funder; structural constraints based in the internal constitution and procedures of the two universities; and differential needs and interests between the universities and NGO”. Furthermore, they mentioned distance, language and culture as additional barriers.

Olivier et al. (2016) organised NGO–researcher partnerships challenges based on the literature into four categories (p.447): 1) asymmetrical power relations linked to perceptions of unequal knowledge, competence and resources – for example, NGOs have less methodological knowledge concerning study design compared to academics; 2) divergent goals and approaches linked to the priorities of the partners – the priorities of academic researchers are increasing knowledge and communicating their findings through scientific publications, while the priority of NGO staff is achieving behavioural or policy change in a specific community (Rathgeber 2009, pp. 16–18, cited in Olivier et al. (2016). Divergent goals and approaches bring tensions in collaboration because of the different expectations that researchers and NGOs may have regarding the results of research; 3) lack of recognition for the contributions made by each partner linked to partners’ quality in doing research – academic researchers are more aware of the standards of methodological and scientific rigour, while NGO members have pragmatic considerations in doing research; and 4) impediments to respect within partnerships linked to impediments in establishing a collaborative environment for partners to pursue their goals within the partnership.

2-9. Knowledge Sharing Mechanisms

The process of knowledge sharing has been approached in a variety of way in the literature. For example, Hansen et al. (1999) introduced two different knowledge management strategies after studying knowledge management in companies in several industries: codification strategies and personalisation strategies. In codification strategies, knowledge is codified and stored in databases and accessed and used by anyone in the company while in personalisation strategies, knowledge is shared through direct person-to-person contact.

Building on this approach, Boh (2007) proposed a framework for knowledge sharing mechanisms in a project-based organisation (PBO), defining a knowledge sharing mechanism as “a mechanism for accumulating, storing, interpreting, retrieving, and applying know-what, know-how, and know-why that is relevant to the performance of the organization and its members” (Boh, 2003, p. 795). He identified two knowledge sharing mechanisms, namely, personalisation and codification. The personalised mechanism is related to more ad hoc and informal knowledge sharing (tacit). The codified mechanism relates to formal knowledge sharing (explicit) and involves the use of electronic databases. These two mechanisms occur on two different levels, individual and institutional. The personalised knowledge sharing mechanism at the individual level occurs as part of person-to-person informal interactions between individuals e.g., social networks. At the institutional level, it

occurs in an informal way within the routines and structures of organisations e.g., mentoring programs (Bell et al., 2016). Codified knowledge sharing mechanisms at the individual level occur in an informal and ad hoc manner: e.g., informal documentation. At the institutional level, they occur within the routines and structures of the organisation and are documented in a formal KM system such as a document repository (Bell et al., 2016). It is via these knowledge sharing mechanisms that individuals can access formal and informal practices, not only from other actors, but also from organisational memory (Boh, 2003).

Lilleoere and Hansen (2011) identified three context-specific knowledge sharing practices in a pharmaceutical company in Denmark: reactive, routine and transfer. The routine and transfer practices took place as a part of daily work, while reactive practices took place outside the department, but within the organisation. They used the Socialisation, Externalisation, Combination, and Internalisation (SECI) concept (Nonaka, 1994) as a theoretical framework in exploring these practices. A detailed explanation of practices will be discussed in Section 2-10.

Others have described knowledge sharing mechanisms or practices using a variety of approaches. Hund et al. (2019) identified six key mechanisms in the digital innovation lab (DIL) for KM and innovation: liaison employees, workshops, aggregating of cross-functional knowledge (CFK), small teams, rotation and exploration. They used these mechanisms to uncover how DILs facilitate KM and recombination in three different industries and show how knowledge enters the DIL, how knowledge is applied and recombined, and how knowledge is shared across organisational units. Kuusinen et al. (2017) identified sharing informally, in meetings and through email as the top three knowledge sharing practices in large agile organisations. The identified practices were based on interaction within teams and with customers or company colleagues. They claimed that knowledge sharing is easier within agile teams across the organisation. Finally, for managing alliance know-how knowledge, Kale and Singh (1999) used the term knowledge articulation, knowledge codification, knowledge sharing and knowledge internalisation as organisational processes. Knowledge articulation is defined in the alliance as a process of converting the tacit knowledge of the individual into articulated knowledge in the form of spoken or written words.

While the above examined knowledge sharing mechanisms in an intra-organisational context, there have also been some studies that look at knowledge sharing between organisations. For example, Appleyard (1996) categorised interfirm knowledge sharing mechanisms in the semiconductor industry into public and private mechanisms. With public mechanisms, knowledge can be accessed through public channels such as patents, reverse engineering, newsletters, the popular press, trade journals and conference presentations, while in private mechanisms knowledge can be shared through private channels such as email, the telephone, face-to-face meetings, visits to other companies' fabrication plants, consortia or benchmarking studies. When training members of the recipient firm, planned socialising activities, transferring experienced personnel and providing documents, blueprints or hardware are named as different forms of existing mechanisms for transferring knowledge from one firm to another (Easterby-Smith et al., 2008). Mason and Leek (2008) also suggested two types of interfirm knowledge-transfer mechanisms: knowledge articulation and knowledge codification. They considered conferences and interfirm reviews as knowledge articulation, while contracts, documents, review procedures and decision-support systems are considered knowledge codification.

Hermans and Castiaux (2017) applied structuration theory (Giddens, 1984) to explore knowledge transfers specifically inside university–industry collaborative research. They investigated the four forms of knowledge: know-what, know-why, know-how and know-who. Codified and public instruments such as patents, scientific journals, conference proceedings and databases are categorised under know-what and know-why, while know-how and know-who are shared through practice and interactive learning. They suggested a new typology based on the nature of the project and the type of knowledge transferred between projects. They used the typology of discovery, exploration or exploitation. In fact, they provided a new lens for looking at university–industry

projects through examining knowledge flows between partners. However, they did not look at the creation of the spaces for sharing knowledge between individuals within the projects.

Jin and Yaqi (2011) developed a research framework called K-space, which is short for “knowledge space”, by reference to Boisot (1995)’s information space in the Chinese university–industry context. They suggested seven certain stages of knowledge creation, namely: demand codification, knowledge gain, knowledge digestion, knowledge sharing, knowledge propagation, knowledge spillover and knowledge degeneration. Different knowledge forms were identified based on the K-space framework. Then they compared their proposed framework to the SECI model for analysing the knowledge conversion processes in the Chinese university–industry context in order to generate knowledge. The comparison will be discussed in Section 2-10.

Finally, two studies that examined the situation within franchises were identified. Gorovaia and Windsperger (2010) divided knowledge-transfer mechanisms in franchising into two categories. The first category, with a high degree of information richness, includes training, conferences, meetings, the telephone and visits to outlets and the second category, with a low degree of information richness, includes fax, intra- and internets and other electronic transfer mechanisms. Perrigot et al. (2017) took a different approach, analysing franchisees’ perceptions of know-how transfer in franchise networks. Their research aimed to provide a franchisee-centred model of how knowledge is created and disseminated in networks. Findings showed that there are formalised sets of documents that capture the codified know-how mechanisms. They called these documents “operations manuals” that were used as a source of guidelines. Operations manuals contain explicit information. They use authorize the different ways to transmit know-how within networks. Such authorized ways include as emails and internet, initial training sessions, discovery sessions, ongoing training, regional meetings, committees, informal personal contacts and in-field consultants.

Most of the studies mentioned have explored knowledge sharing mechanisms in an intra-organisational context, and the terms knowledge sharing mechanisms and practices are used interchangeably. The studies considered organisational processes and knowledge flows relevant to the performance of the organization and its members, rather than the creation of spaces for sharing knowledge between individuals within projects. For this project, a distinction is made between mechanisms and practices so as to investigate how knowledge sharing occurs in relation to the creation of shared collaborative spaces and the knowledge sharing mechanisms which are established, in an interorganisational context. This should help in better understanding how the different stakeholders’ specific situations influence knowledge sharing behaviour.

In my research, then, the term knowledge sharing mechanism is used to describe a process or an activity of exchanging and sharing individually held knowledge in tacit and explicit forms with other project members within a collaborative project structure, or the exchange and sharing of knowledge produced by the project with the primary organisations and parties involved in establishing the project, as well as a wider audience.

Knowledge sharing practices are not the same as mechanisms, but a component thereof, and apply to a specific activity or piece of software through which individuals in shared collaborative spaces are acting to share knowledge.

2-10. Knowledge Creation Model

Dalkir (2011) describes, compares and contrasts a number of models used within the discipline of KM including the studies of Choo (1998), Weick (2001), Nonaka and Takeuchi (1995), Wiig (1993), von Krogh and Roos (1995), Boisot (1998), Beer (1984) and Bennet and Bennet (2004). These KM models address KM from a holistic and comprehensive perspective (Dalkir, 2011).

The model that best fits with the focus of my research, however, is the knowledge creation model presented by Nonaka and Takeuchi (1995) because in this model, knowledge sharing and use occur through the interaction between explicit and tacit knowledge, “starting at the individual level and moving up through expanding communities of interaction crosses sectional, departmental, divisional and organizational boundaries” (Nonaka & Takeuchi, 1995, p. 72). This model has been used in other KM conceptual models such as Choo’s sense-making model and Wiig’s model (Ezell, 2017). The model is reviewed and discussed extensively in the KM literature, has been implemented and field tested with respect to reliability and validity, and considers people, process, organisation and technology dimensions (Dalkir, 2011).

The knowledge creation model explains the phenomenon of organisational knowledge creation (Nonaka, 1994; Nonaka & Takeuchi, 1995). Nonaka and Konno (1998); (Nonaka & Toyama, 2003) revisited it and added some components to modify it. It contains the three elements of SECI, Ba (physical, virtual and mental space) and Knowledge assets (see Figure 2-1). Each of these three elements will be discussed in detail in Chapter 3 Section 3-6.

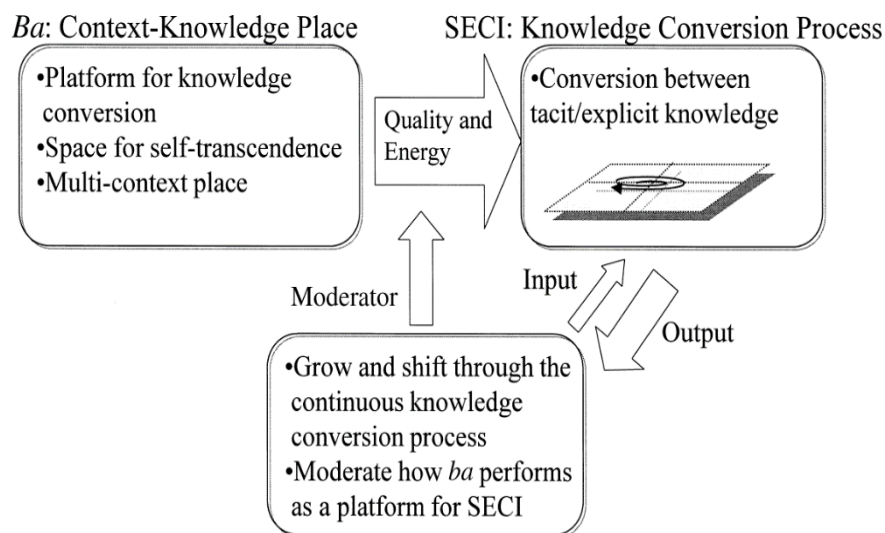


Figure 2- 1.The three elements of the knowledge creation process

Source: Nonaka, Toyama & Konno, 2000

The knowledge creation model has been criticised by some authors who argued that the model does not sufficiently explain aspects such as the conditions of knowledge creation (McLean, 2004). Although it focuses on the conversion of tacit and explicit knowledge, it does not address issues of how decision-making takes place using both forms of knowledge (Dalkir, 2011). Gourlay (2006) argues that some of the processes and examples of knowledge conversion mentioned in the model are not supported by sufficient evidence and it omits inherently tacit knowledge. Knowledge reusability has not been considered during knowledge conversion, although reusable knowledge is a fact of organisational life (Harsh, 2009). Despite these criticisms, this model has been one of the more used and robust models in the KM (Dalkir, 2011; Panahi, 2014) and information system (IS) literature (Panahi, 2014) and it continues to be applied in a variety of settings such as interorganisational and intra-organisational contexts.

The modified model consists of three components: SECI, Ba and Knowledge assets. These components act dynamically together, but each component focuses on a different process of knowledge sharing and creation. The SECI process forms the basis of how knowledge is shared and created; Ba forms the basis of where and when (space and time) knowledge is shared and created; and the Knowledge asset is the basis of what knowledge is shared and created (Nonaka, 1994; Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000).

The interpretations of this theory have changed considerably based on different contexts. For example, Hautala (2011) studied academic knowledge creation in international research groups. She applied the theory of Ba in humanist (H-group), technical (T-group) and scientific (S-group) research groups. Her research showed that abstract concepts and philosophical discussion are created through social and conceptual closeness in the H-group. Technical knowledge is created in a project in the T-group. Scientific knowledge is created in the S-group as a part of the global scientific community. Informal face-to-face interaction and dynamic mutual understanding are fundamental for knowledge creation in H-groups. Trusting each other's know-how and technical knowledge provide better conditions for knowledge creation in the T-group. Knowledge is created more in informal personal meetings in the S-group because the S-group is formed based on autonomous researchers who share common interests. So face-to-face communication is essential for knowledge creation in all case groups. But the role of the physical Ba is different in each case. Generally, in all cases Ba is formed in relation to the type of knowledge created, the characteristics of group members and structural factors.

Lilleoere and Hansen (2011) identified three context-specific knowledge sharing practices in a pharmaceutical company in Denmark. The reactive practices appeared in response to critical episodes. The routine knowledge sharing practices occurred as a part of the individual work routines in the department. These practices can be divided into internal and external meetings. The internal meetings were held by members of a project group. These meetings could be formal or informal. The formal meetings were scheduled on a weekly basis, whereas the informal meetings occurred at different times and in various places at lunch, during coffee breaks, at the office or in the laboratories. The external meetings were held monthly with other project stakeholders outside the department. In the reactive practices, tacit knowledge was catalysed through face-to-face interactions at formal, scheduled meetings such as brainstorming meetings. The transfer practices included tacit and explicit knowledge. These practices could occur through individual-to-individual or individual-to-group interactions. Together, these three practices (routine, reactive and transfer) led to knowledge creation. In this project, SECI was useful as a theoretical framework for exploring knowledge sharing practices, but it was not suitable for exploring individuals' actions and their purposes for knowledge sharing.

A few studies in the context of university–industry collaboration applied all elements of the knowledge creation model as an analytical lens (Vijayan et al., 2018). They proposed a unified model of dynamic knowledge creation using the theory of SECI modes, Ba and Knowledge assets to develop the education system in learning factory settings. Their research findings showed the importance of the knowledge creation model in the learning factory setting and discussed the importance of the role of management. Socialisation and externalisation modes were explored as the key knowledge creation processes, and combination and internalisation as the knowledge sharing processes. They considered the learning factory as Ba (physical place), where the actual work takes place, while the library system, information management system, email and other technology are considered virtual places for storing and sharing information. They mostly focused on the SECI part and did not explore Ba in depth.

In the context of university–industry/NGO partnerships, current studies have typically focused on only one part of knowledge creation theory, either SECI (Alluri & Balasubramanian, 2012; Hermans & Castiaux, 2007; Lilleoere & Hansen, 2011; Prasasti et al., 2018) or Ba (Brännback, 2003; Brännback et al., 2008; Hautala, 2011; Huhtelin & Nenonen, 2015; Niccolini et al., 2018) as a theoretical framework for exploring knowledge creation practices. Consequently, there is ample room for interesting reflection on the application of all elements of Nonaka's theory and evolution of the collaborative shared spaces dedicated to knowledge sharing and creation in the context of university–industry/NGO collaborative projects.

In my research, the focus is on using Nonaka's knowledge creation model to study shared collaborative spaces (SCSs) within university-organisational collaborative projects are shared spaces representing the specific space and time that individuals established in order to share and create knowledge. Such SCSs are not just a physical

space such as a room, they may also be a mental space or an interaction space in which individuals are acting to share knowledge.

2-11. Chapter Summary

This review of the relevant research has identified some important gaps in the literature.

First, reviewing the literature on knowledge creation has revealed that knowledge sharing is an important but complex process in university–industry/NGO engagement (Alavi & Leidner, 2001; Brohman et al., 2003; Olivier et al., 2016; Pineda et al., 2009). From a knowledge-generation perspective, current knowledge sharing in university–industry/NGO engagement can be problematic for three main reasons:

- a) Characteristics of the university: researchers in universities use complex language and businesses and NGOs subsequently ignore them because of the perceived impracticality of the research
- b) Characteristics of the industries/NGOs, which have different organisational cultures and innovation-assimilation capacities
- c) Socio-cultural differences between universities and industry/NGOs including discrepancies as to the nature of research, different work styles, different approaches to the development of the research, discrepancies in IPR and different values.

As a result, several challenges to the effective sharing of knowledge between universities and industry/NGOs have been identified. In response to these challenges, the current research explores how knowledge is shared within collaborative projects from the perspectives of the active actors (researchers and industry/NGO representatives) in an ongoing collaborative project in IT-related faculties in Australia.

Second, there is well-developed research on knowledge-transfer such as patenting behaviour and publications (D'Este & Patel, 2007; Hermans & Castiaux, 2007). The review of the literature has shown that knowledge transfer is the legal form in which the knowledge transfer takes place, for example, strategic alliances, joint ventures and collaborative projects. As knowledge transfer occurs within collaborative projects, the current research explores knowledge sharing mechanisms between individuals, groups and organisations within collaborative projects. Therefore, in my research knowledge sharing is defined as either a process of exchanging and sharing individually held knowledge in tacit and explicit forms with other project members within a collaborative project structure, or exchanging and sharing knowledge produced by the project with the main organisations and parties who were involved in establishing the project and relevant wider audiences.

Third, although challenges in university–industry/NGO partnerships and knowledge sharing processes are identified in previous studies as mentioned in Section 2-8 above, the review of the literature has shown that the barriers and drivers identified in university–industry/NGO partnership are mostly linked to establishment of the collaboration and partnership, and not just the knowledge sharing mechanisms at the individual level as one form of knowledge-transfer activity. Therefore, there is a need to investigate the surrounding factors which impact on knowledge sharing success in one form of knowledge-transfer activity at an individual level from participant perspectives and compare it in two different contexts (university–industry and university–NGO).

Fourth, since little is known about the impact of shared spaces, either physical or mental, on knowledge sharing mechanisms, there is ample room for developing new insight and reflections on Nonaka's theory, specifically, evolution of the collaborative shared spaces dedicated to knowledge sharing in the context of university–industry/NGO collaborative projects and revisiting the relationships between the components of the model in new contexts.

This chapter has reviewed the relevant literature and defined the relevant concepts to my study such as university–industry/NGO collaboration, and associated challenges and drivers of knowledge and knowledge sharing mechanisms, then it has explained the knowledge creation model. In doing so, the gaps in the literature have been identified. On the basis of this literature review, the next chapter (Chapter 3) presents the research methodology and the conceptual model that has been adopted to explain the key mechanisms of knowledge sharing and the factors which facilitate or inhibit knowledge sharing success in university–industry/NGO collaboration in the Australian context.

CHAPTER 3: RESEARCH DESIGN

3-1. Chapter Preview

The overall aim of this study is to identify and investigate knowledge sharing mechanisms in collaborative projects between universities and industry/NGO from the perspectives of active actors (researchers and industry representatives). Ethical approval with project number 9895 was acquired from Monash University Human Research Ethics Committee on 20/07/2017. Research questions are outlined in Section 3-2. This chapter discusses the research paradigm (Section 3-3), research purpose (Section 3-4), research methods (Section 3-5), theoretical framework (Section 3-6), research techniques (Section 3-7), data analysis (Section 3-8) and data collection (Section 3-9).

3-2. Research Questions

In order to address the research objectives, in the context of IT-related projects, this thesis aims to answer the following research questions (RQ):

RQ1. How is knowledge shared in university–organisational collaborative projects?

Sub-question:

RQ1-1 What are the drivers and barriers in the knowledge sharing processes of university–organisational collaborative projects from participants’ perspective in Australia?

RQ2. How do participants create shared collaborative spaces (SCSs) for knowledge sharing in university–organisational collaborative projects?

Sub-questions:

RQ2-1 What kind of knowledge is shared in SCSs in university–organisational collaborative projects?

RQ2-2 What kind of SCSs support knowledge sharing in university–organisational collaborative projects?

RQ2-3 What are the conditions required to develop SCSs between participants in university–organisational collaborative projects?

RQ3. What are the strengths and limitations of the concept of Ba for understanding the process of knowledge sharing and creation?

3-3. Research Paradigm

A research paradigm builds the foundation for a study and creates knowledge about the subject (K. Williamson, 2013b). Three common categories of philosophical paradigms in information systems (IS) are positivist, interpretive and critical (Myers & Avison, 2002; Orlikowski & Baroudi, 1991). In the positivist approach, knowledge can be created based only on “what can be objectively observed and experienced” (Williamson et al., 2002, p. 27). Positivist researchers seek to discover reality or truth. In order to discover reality, measurement and objectivity are their main tools (K. Williamson, 2013b). In contrast, in the interpretive approach reality is dependent on people’s thoughts and experiences, and reality can be discovered through “social constructions such as language, consciousness and shared meanings” (Myers & Avison, 2002, p. 7). In interpretivist research, “researchers emphasise the meaning made by people as they interpret their world” (Williamson et al., 2002, p. 25). The critical approach has some similarity to interpretivism, but critical theory is particularly concerned with the social, cultural and political factors that can limit people’s ability in the production and reproduction of reality, as well

as ways to overcome them (Myers & Avison, 2002). Critical researchers seek to explore “oppositions, conflicts and contradictions” in the status quo of contemporary society (Myers & Avison, 2002, p. 7).

In order to capture knowledge sharing mechanisms in explicit and tacit forms, previous researchers have adopted positivist (Hermans & Castiaux, 2007) or interpretivist approaches (Panahi, 2014). The current study fits within the interpretivist paradigm and is consistent with previous studies in the interpretive research paradigm, because it explores knowledge sharing mechanisms including explicit and tacit knowledge. To fully capture these mechanisms, it uses participants’ opinions and perspectives about how knowledge is shared in collaborative projects.

3-4. Research Purpose

Based on researchers’ purposes, that they want to “explore a new topic”, “describe a phenomenon” or explain “why something occurs”, research can be categorised as exploratory, descriptive or explanatory (Babbie, 2011; Neuman, 2012, p. 16).

In exploratory research, research is conducted to create a general picture of conditions. Researchers formulate questions for future studies after examining their research (Neuman, 2012). In other words, in order to respond to the “researchers’ desire for better understanding” (Babbie, 2011, p. 95), to determine the “feasibility of conducting research”, and to develop methods or techniques for measuring in future research, exploratory studies have usually been adequate (Neuman, 2012, p. 16). Exploratory studies are also based on qualitative data and address the what and how questions (Neuman, 2012).

Descriptive research delineates the phenomena in more depth than the basic information available. It presents “a systematic picture with specific details” of the available condition such as activities or relationships (Neuman, 2012, p. 17). Researchers observe situations or events and then describe what was observed. They provide a detailed and accurate picture of phenomena to report on the background of a situation (Babbie, 2011; Neuman, 2012). This type of research seeks to answer who, what, when or where questions about the status quo (Tanner, 2000, p. 73). Explanatory research links issues or topics with a general principle (Neuman, 2012) and addresses questions of how and why to “explore interrelationships of variables” (Babbie, 2011; Tanner, 2000, p. 79).

The current study is best defined as exploratory research because it creates a general picture of knowledge sharing mechanisms in collaborative projects. It answers how and what questions in order to explore knowledge sharing mechanisms in collaborative projects that will be used in the future.

3-5. Research Methods

Research methods can be quantitative, qualitative or mixed-methods in nature (Cecez-Kecmanovic & Kennan, 2013; Creswell, 2009). These methods provide direction during research.

Quantitative studies seek to measure and analyse causal relationships between variables (Denzin & Lincoln, 2005). They follow a linear research path (Neuman, 2012). Quantitative researchers have a positivist approach in doing research and want to measure variables and test hypotheses. Generally, they do not focus on processes (Denzin & Lincoln, 2005). Such research seeks to answer what, who, how many, how much, where and when questions “which can be measured at a particular point in time” (Williamson et al., 2002, p. 34). Surveys and experimental research are two ways to conduct quantitative studies (Creswell, 2009).

In contrast, qualitative researchers have an interpretive or critical approach in doing research. Researchers try to explore detailed information about phenomena from participants' perspectives (Creswell, 2009). Since qualitative research follows a nonlinear research path, it responds to complex questions which involve why and how questions (Neuman, 2012; Williamson et al., 2002). Ethnography, grounded theory, case studies, phenomenological research and narrative research are examples of qualitative research methods (Creswell, 2009).

In mixed-methods research, qualitative methods are used in combination with quantitative methods, seeking to examine multiple research approaches (Creswell, 2009; Denzin & Lincoln, 2005). Qualitative and quantitative methods are employed in response to research questions.

This study is concerned with processes, looking at participants' viewpoints and experiences in regards to knowledge sharing mechanisms in collaborative projects to discover "how is knowledge shared in collaborative projects", so it is qualitative in nature. Among the different ways to conduct qualitative studies, the current study has used case studies because this research is concerned with the question of how knowledge is shared in one type of university-external party engagement, collaborative projects. It explores knowledge sharing mechanisms in collaborative projects in depth via two data collection methods, including interviews and project documentation, over a sustained period of time.

3-5-1. Case Study

The current study is exploratory research within the interpretivist paradigm. A case study provides a means to understand social phenomena in their natural settings. In other words, this method studies a phenomenon within the context in which it happens and it cannot be explored outside of context (Darke & Shanks, 2002). In the words of Yin (2003), "the boundaries between phenomenon and context are not clearly evident" (p.13). It is a comprehensive research strategy comprising the logic of design, data collection techniques and specific approaches to data analysis (Yin, 2003). Yin suggested six sources of data collection in conducting case studies: documents, archival records, interviews, direct observation, participant-observation and physical artefacts (Yin, 2003, p. 83). The case study approach is the most common qualitative research method within the IS discipline (Shanks & Bekmamedova, 2013), because it investigates a contemporary phenomenon using multiple source of evidence (Yin, 2003) and helps to understand the nature and complexity of existing processes (Benbasat et al., 1987).

Case studies seek to analyse qualitative data based on the experience of the stakeholders involved (Shanks & Bekmamedova, 2013). To capture in-depth knowledge sharing mechanisms in SCSs, I have used participants' opinions and perspectives on how they create SCSs in collaborative projects. Since my study looks at participants' viewpoints and experiences in regards to knowledge sharing, it is qualitative in nature. Since a case study is a suitable research strategy for studying the phenomenon in its context and it also provides more advantages when the theoretical refinement of a concept such as the knowledge creation model is applied as a lens of analysis (Yin, 1994), this research has used an in-depth case study.

Case studies can involve single or multiple cases (Shanks & Bekmamedova, 2013). A single case study investigates a phenomenon in depth in one setting, while a multiple case study investigates a phenomenon in depth in diverse settings (Shanks & Bekmamedova, 2013). The multiple case study provides a means to understand "similar outcomes across cases with similar contexts" (Shanks & Bekmamedova, 2013, p. 180).

I decided to use multiple case studies. Based on exploratory investigations undertaken during the primary data collection phase to categorise different types of university-industry partnerships, I realised that a large number of case studies, would not allow for in-depth analysis of individual cases or the detailed mapping of the knowledge creation model. Given that, in the context of exploratory research, studying a small number of cases in-depth is considered sufficient to explore the relationships between different elements of a theoretical framework (for example, in my research SECI, Ba and Knowledge assets) and clarify its applicability, I decided to limit the number of cases. This still allows for a level of cross-case comparison and provides results that may be generalisable, subject to qualification (Shanks & Bekmamedova, 2013). I decided limit the study to two cases (collaborative projects) after identifying potential cases during the initial exploratory investigations because the two most likely cases stood out significantly from the others in terms of being considered successful projects by their faculty, they contained a number of significant differences in the nature of the projects, and I wanted to be able to present a sufficiently in-depth analysis. Although there are advantages in studying more than two cases, and a third case could have been added, those available would not obviously have helped in the comparison of the two cases under consideration, and may have limited the depth of the analysis overall. Figure 3-1 shows research design of the current study.

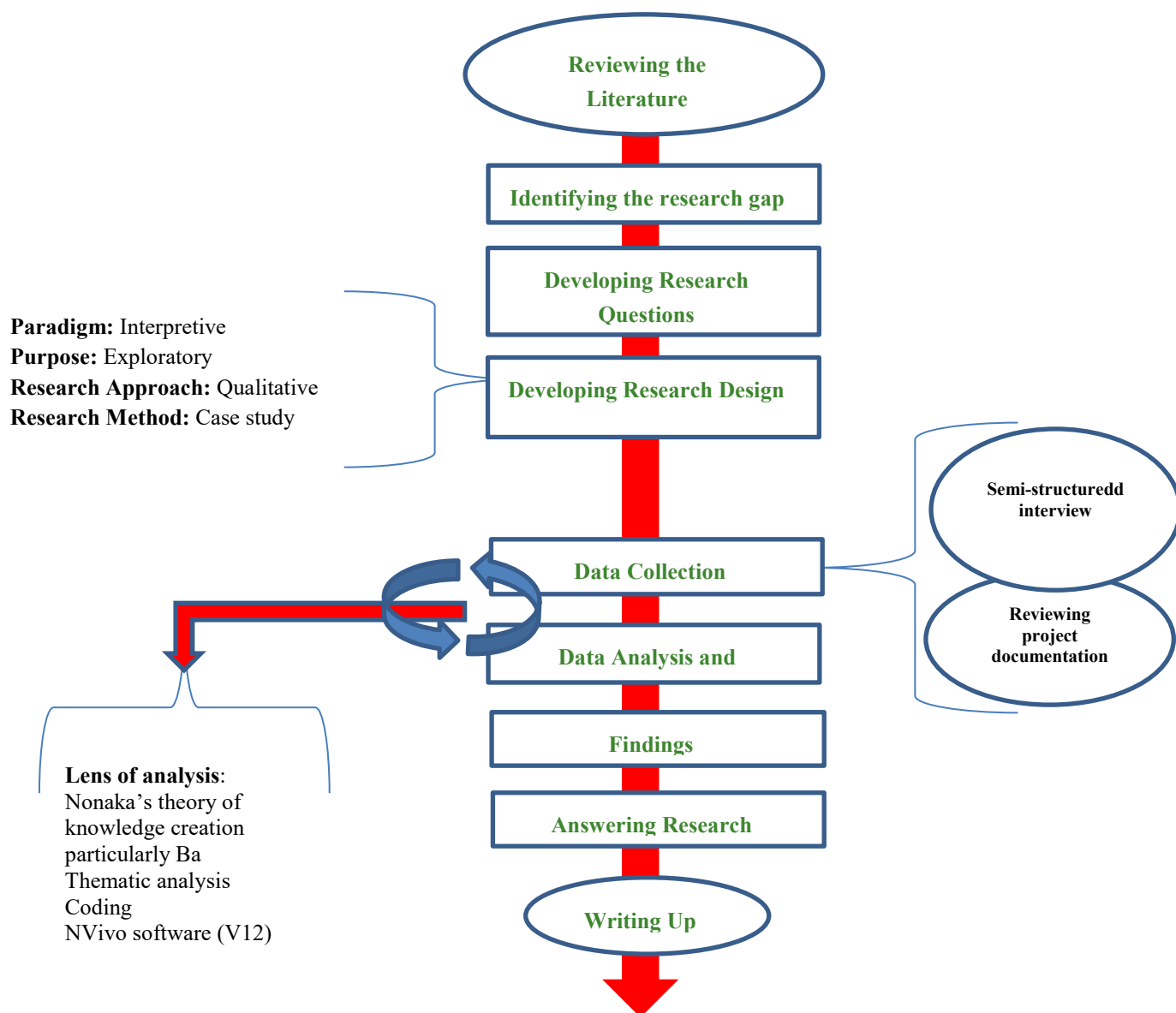


Figure 3-1. Research design

3-5-2. Case Studies and Participant Selection

The unit of analysis for this study is the project – specifically a project where a university department or faculty partner with an external organisation to conduct the project. For selection of the case studies, exploratory investigations were undertaken during the primary data collection phase to categorise different types of university–industry/NGO partnerships; for example, exploring information on ACS-accredited courses in different universities across Victoria based on their websites and consulting with the key stakeholders, such as the Faculty Research Service Managers, Faculty Business Development Managers and Faculty Industry Portfolio Managers, explained in detail in the following Sections 3-5-2-1 and 3-5-2-2.

3-5-2-1. Initial Data-Gathering (Exploratory Investigation) Part A

ICT in Australia can be applied within large, complex and diverse contexts such as government, business and education. I focused on higher education because I was interested in knowledge sharing mechanisms in university–industry/NGO collaborative projects. I wanted to explore knowledge sharing mechanisms to aid in

the design of knowledge creating places and assist university researchers and industry/NGO representatives in more collaboration.

The majority of Australian universities are grouped into four consortia: The Group of Eight, Australian Technology Network (ATN), Innovative Research Universities (IRU) and Regional Universities Network.

Table 3- 1. Groupings of Australian universities based on www.australianuniversities.com.au

No	Australian University Category	Members
1	Group of Eight	➤ The University of Adelaide ➤ The Australian National University ➤ The University of Melbourne ➤ Monash University ➤ The University of New South Wales ➤ The University of Queensland ➤ The University of Sydney ➤ The University of Western Australia
2	Australian Technology Network (ATN)	➤ Curtin University of Technology ➤ University of South Australia ➤ RMIT University ➤ University of Technology Sydney ➤ Queensland University of Technology
3	Innovative Research Universities (IRU)	➤ Flinders University ➤ Griffith University ➤ La Trobe University ➤ Murdoch University ➤ James Cook University ➤ Charles Darwin University
4	Regional Universities Network	➤ Central Queensland University ➤ Southern Cross University ➤ University of Ballarat ➤ University of New England ➤ University of Southern Queensland ➤ University of the Sunshine Coast

In order to identify suitable case studies, the current study started by considering the potential for university and industry/NGOs collaborative projects in IT-related faculties from each grouping of Australian universities. It is acknowledged that ICT research can occur in other faculties, such as medicine, law and business, and other enterprises that are not classified as ICT sector industries. Looking at all faculties was not possible because it would make it much more difficult to identify projects. In the projects that were identified, it might be difficult to determine the extent to which ICT was important in a consistent way.

For the purposes of the current research and in order to select research sites, IT-related faculties were selected based on Australian ICT tertiary education courses which are accredited by the Australian Computer Society (ACS).³ All of the ACS-accredited courses, which include groupings of Australian universities in Victoria, were considered as research sites (Table 3-3). The use of ACS-accredited courses can be a good choice for limiting scope. But it should be added that this is actually a guide to teaching practices, not research. The ACS does not accredit research, only teaching. Consequently, limiting the scope to ACS-accredited courses remained a surrogate for identifying where research may occur.

³ www.acs.org.au/cpd-education/accredited-courses.html

The current research considered Victoria as a geographical location in selecting universities because in Victoria there were universities from each grouping. Easy access to collaborative projects was another criterion for selecting Victoria as the geographical location because I needed to regularly contact the collaborative projects in order to do interviews.

Table 3- 2. Research sites based on ACS-accredited courses based on available information from 2016.

No	Name of University	Australian universities categories	ACS accredited courses			
			Faculty	School	Department	College
1	Deakin University	—	Business and Law	Business	Information Systems and Business Analytics	—
			Science, Engineering and Built Environment	Information Technology	—	—
2	Federation University Australia	—	Science and Technology	Engineering and Information Technology	—	—
3	La Trobe University	Innovative Research Universities (IRU)	—	Engineering and Mathematical Sciences	Computer Sciences and Computer Engineering	—
				Business	Management	—
4	Monash University	Group of Eight	Information Technology	—	—	—
5	RMIT University	Australian Technology Network (ATN)	—	Business and Information Technology	—	—
				Computer Science and Information Technology	—	—
6	Swinburne University of Technology	—	Information and Communication Technologies	—	—	—
7	University of Melbourne	Group of Eight	Engineering	Computing and Information Systems	Computer Science and Software Engineering	—
8	Victoria University	—	—	—	—	Business
						Engineering and Science

Since the nature of ICT is so diverse, care was needed in selecting specific projects as case studies. Some exploratory investigations were undertaken during the primary data collection phase to categorise different types of university–industry/NGO partnerships, for example, exploring information on ACS-accredited courses in different universities across Australia based on their websites and consulting with the key stakeholders such as the Faculty Research Service Manager, the Faculty Business Development Manager and the Faculty Industry Portfolio Manager at Monash, Melbourne, Federation and Victoria universities.

The findings of the exploratory investigations demonstrated that each faculty was using different ways to categorise university–industry/NGO partnerships. Methods used included the Australian and New Zealand Standard Research Classification (ANZSRC), funding type and kind of partnership. It seemed that there was

no unique method across faculties. Finding an appropriate sample from these categories was difficult because, based on the key stakeholders' interviews, the interpretation provided in each category could be substantially different.

There are two popular methods for data collection in Australian university research which are common across Australia: 1. Excellence in Research for Australia (ERA) and 2. Higher Education Research Data Collection (HERDC):

1. The ERA is Australia's national research evaluation framework. The Australian Research Council (ARC) is responsible for administering the ERA. In this method, the quality of Australian university research is measured by comparing it against national and international benchmarks. Information about research publications, research application, commercialisation and collaboration are collected in this method within each discipline at each university. Data are collected by four-digit Field of Research (FoR) code by the university. In fact, disciplines are defined as two-digit and four-digit FoR codes as identified in the Australian and New Zealand Standard Research Classification (Australian Research Council, 2017).
2. The HERDC is the annual collection of research output and income from Australian universities. Data in this method is submitted by universities each year. The Department of Education and Training is responsible for administering HERDC (Department of Education and Training, 2017b). In this method, data is collected based on research publications, as well as research income across a number of categories (Department of Education and Training, 2017a). It should be added that the HERDC method identifies where the research funding is coming from. The four categories of HERDC are:

- **Category 1: Australian competitive grants:** This category includes collection of research output and income from funding bodies for research schemes and programs which registered on the Australian Competitive Grants register (ACGR)⁴ (Department of Education and Training, 2017a). It concerns the income that higher education providers receive from the Australian Government's Research Block Grants (RBG). Schemes and programs such as the ARC, Discovery Projects and Linkage Projects are important examples on the ACGR list.
- **Category 2: Other public sector research income:** This category includes any other collection of research income from the Australian government that is not eligible for inclusion in Category 1. It comprises programs, grants or contracts that are supported by state or territory governments, local governments and government business enterprises (Department of Education and Training, 2017a).
- **Category 3: Industry and other research income:** Any other research income and industry funding must be collected in this category. This category is divided into different subcategories (Department of Education and Training, 2017a):
 - **Australian**
 - **International A: Competitive, peer-reviewed research grant income**
 - **International B: Other income**
 - **International C: HDR fees for international students**
- **Category 4: Cooperative Research Centre (CRC) research income:** This category includes the research income for higher education providers which is granted by the CRC. The CRC program was

⁴ The ACGR is available at: www.education.gov.au/australian-competitive-grants-register

established in 1990. Its aim is to connect researchers in the public and private sectors with end users. Through this program, researchers and end users can interact closely (Cooperative Research Centers Association, 2016). It supports industry-led and outcome-focused collaborative research partnerships between industry, researchers and the community (Department of Industry Innovation and Science, 2017). This category comprises the following subcategories:

- **Research income derived from Australian government grants to CRCs**
- **Research income derived from non-higher education providers members of CRCs**
- **Research income derived from external parties contributing to CRCs.**

Since university–industry/NGO collaboration can occur in all of the mentioned categories, the HERDC could be considered a criterion for my research case selection. However, taking samples from each category could have been problematic because achieving saturation was difficult. Limiting the scope to one category could be a solution. Since I am looking for examples of best practice, the most successful collaborative projects according to the key stakeholders' interviews were mentioned under Category 3. The case studies were selected from this category. It should be added that this category is classified under different subcategories, as mentioned above. The Australian subcategory was selected for the purpose of my research and includes contracts, grants and donations, bequests and foundations.

Each collaborative project which was classified under the Australian subcategory of Category 3 of the HERDC system was considered a suitable case study. It could include projects where the funding comes from Australian industry and business, syndicated R&D arrangements, Australian NGOs and Australian individual or other grants.

All successful collaborative projects named by the key stakeholders in the interviews which were listed under Category 3 were considered as potential case studies.

3-5-2-2. Initial Data-Gathering (Exploratory Investigation) Part B

The information provided in this section is based on consultation with the key stakeholders such as the Faculty Research Service Manager, the Faculty Business Development Manager and the Faculty Industry Portfolio Manager at Monash, Melbourne, Federation and Victoria universities. The aim was to interview and consult with all the universities mentioned in Table 3-3; however, of the eight universities I was able to interview four of them.

Research collaboration is formed between universities and industry/NGO for three main reasons.

To gain funding opportunities (income): In traditional research environments, most of the research projects are funded by government grants. The amount of money available for that has been significantly reduced in the last ten years and so researchers are looking more to non-traditional sources of funding to be able to carry out their research. Industry partners and end users are interested in funding research projects because they get the benefits of project outcomes.

To gain access to datasets: Companies in industry and NGOs have huge datasets and much information. Universities want to access that data via research collaboration.

To have impact on end users: Collaborative research projects that aim to solve societal problems can have positive impacts on end users.

There were no standard definitions of research partnerships in the universities consulted. The written definition is about their procedures and guidelines about how organisations should work together. They followed the government definition of research in the HERDC guideline.

There was no unique categorisation which could enable the identification of research collaborative projects. Faculties followed the government reporting requirements in the categorisation of their research projects. Consequently, based on the key stakeholders' advice, I selected the HERDC categories to limit my case selection, as explained in detail in Section 3-5-2-1.

I was looking for projects generally considered successful by the main stakeholders, and they determined these by factors including the amount of the money coming to the university, the impact of the project on industry practice and society and how the outcome of the project changed industry practice and real-world problems, and research on which the company or external party continues to collaborate. They said that finding a new partnership and starting from scratch was very difficult. Therefore, in longer term collaboration, where universities have a long-term relationship with a particular company as a kind of built-up relationship over many years was considered another factor in measuring the success of collaborative projects.

The most successful collaborative projects according to the key stakeholders' interviews were those under Category 3. Therefore, I selected case studies from this category. From the potential case studies, I decided to select one national case and another international case for comparison.

I chose projects from research universities due to ready access to projects and pre-established connections with project members that gave me a specific opportunity to be able to negotiate, schedule interviews and access project resources. There were two collaborative projects in research universities under Category 3 in the IT faculties at that time.

First, the NGO project was a 5-year collaborative project between a university and an international NGO with branches in Australia and Bangladesh. It was a participatory action research (PAR) project about investigating IS design and socio-technical questions related to the adoption and adaptation of new technologies. Second, the industry project was a 4-year collaborative project commencing in 2016. The aims were to develop a model (solution) for semi-automatic plant layout design to solve a 3D pipe-routing problem and a visual interface to display the model that allowed engineers to comment and guide on the proposed prototype and the processes. I approached the project leaders of each project and both of them were happy to collaborate with my research. Then I selected potential participants from all project partners who were involved directly in collaboration and communication. Since I chose them based on their role and involvement in projects, I called them active actors. Jiang (2008) used this term in a scientific collaboration community to find the location of the principal scientists. Since different scientists perform different roles in collaboration, the active scientists often undertake important roles in these projects.

3-6. Theoretical Framework

A theoretical framework explains the research process (Williamson et al., 2002). It is used as an analytical lens for directing research. In this research, I build on Nonaka's theory of knowledge creation, which consists of three elements: (i) the SECI process; (ii) Ba; and (iii) Knowledge assets (Nonaka, 1994; Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000). These elements will be discussed in Section 3-6-1. While the study focuses more on the Ba aspect, the concept of Ba cannot be examined independently of the other two elements.

The Japanese concept of Ba, which translates into English as "place", was introduced by Nonaka and Konno (1998) in order to address the fundamental condition for knowledge creation. In the knowledge-creation process, they define Ba as a shared context in which knowledge is shared, created and utilised (Nonaka, Toyama, & Konno, 2000). It is a suitable framework for analysing knowledge-creation processes not only in intra-organisational contexts, but also in interorganisational contexts such as families and businesses

(Brännback et al., 2008), science parks (Hansson, 2007) and sustainable management of rivers (Niccolini et al., 2018). Ba is not a fixed structure, but offers a flexible structure for knowledge creation and, according to the Ba concept, not only can different forms of knowledge be created but individuals can also share time and space in business structures at the same time (Nonaka, Toyama, & Konno, 2000).

My study seeks to explore knowledge sharing mechanisms in collaborative projects. This kind of collaboration occurs in interorganisational contexts. Different shared contexts can emerge within collaborative projects based on participants who have different experiences, ideas, skills, passions and tensions. These relationships are not fixed, they are flexible and depend on context. Because the outcome of this research is to explore knowledge sharing mechanisms in the university–industry/NGO collaborative project context, the knowledge creation model developed by (Nonaka, 1994; Nonaka & Takeuchi, 1995), and especially the concept of Ba, are considered a suitable framework. Understanding the different characteristics of Ba in collaborative projects and how active actors interact with each other in each Ba can facilitate the development of new insights into knowledge sharing.

3-6-1. Knowledge Creation Model

The knowledge creation model has three elements: SECI, Ba and Knowledge assets. The following paragraphs describe each of these three elements of the knowledge-creation process.

3-6-1-1. The SECI Process: Four Modes of Knowledge Conversion

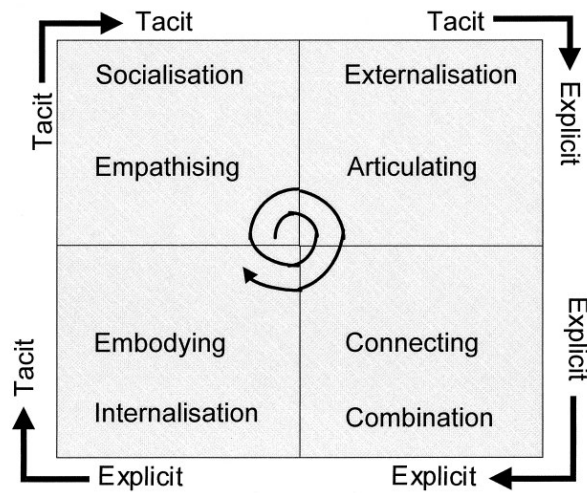
The interaction between explicit knowledge and tacit knowledge leads to knowledge creation. It is a continuous process. Nonaka, Toyama and Konno called this interaction “knowledge conversion” (Nonaka, Toyama, & Konno, 2000, p. 9). There are four modes of knowledge conversion, namely, socialisation, externalisation, combination and internalisation (SECI). These are key activities through which knowledge emerges. The spiral in Fig. 3-3 indicates a continuous process of knowledge sharing and conversion from explicit knowledge into tacit knowledge and vice versa.

Socialisation (from tacit knowledge to tacit knowledge): Since tacit knowledge such as world views, mental models and mutual trust is often created and shared in social meetings outside of workplaces, socialisation is defined as a process of converting new tacit knowledge from shared experiences such as spending time together or living in the same environment.

Externalisation (from tacit knowledge to explicit knowledge): Externalisation lead to the basis of new knowledge. It describes how knowledge is crystallised and show the process of articulating tacit knowledge into explicit knowledge. Concept creation in new products and quality control circles are examples of this mode.

Combination (from explicit knowledge to explicit knowledge): This is specified as the process of converting explicit knowledge into other complex and systematised explicit knowledge. Breaking down of concepts is another part of this mode, such as converting a corporate vision into operationalised business or product concepts.

Internalisation (from explicit knowledge to tacit knowledge): Learning by doing is the basis of this mode. It is defined as a process of converting explicit knowledge into tacit knowledge. In fact, individuals can capture shared explicit knowledge such as explicit materials, product concepts and manufacturing procedures in organisations and convert them into tacit knowledge through action and practice. When knowledge is embodied in individual tacit knowledge, it becomes valuable because accumulated tacit knowledge at the individual level is a new spiral of knowledge creation when individual starts to share their knowledge with others via socialisation.



The SECI process

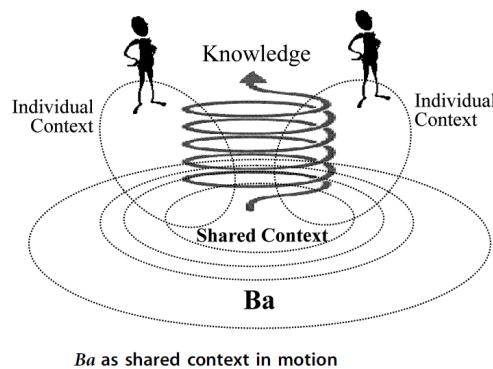
Figure 3- 2. The SECI process

Source: Nonaka, Toyama & Konno, 2000

3-6-1-2. Ba: Shared Context for Knowledge Creation

The SECI processes are supplemented with the concept of Ba (Nonaka & Konno, 1998; Nonaka & Toyama, 2003; Nonaka, Toyama, & Konno, 2000). The design of an appropriate Ba in each mode can support and nurture evaluation of knowledge conversion (Nonaka & Nishiguchi, 2001).

Since the “knowledge creating process is necessarily context-specific in terms of who participates and how they participate, knowledge needs a context to be created” (Nonaka, Toyama, & Konno, 2000, p. 14), Ba can be considered a shared space in which individuals interact (see Figure 3-4). This space can be “physical (e.g., office, dispersed business space); virtual (e.g. email, teleconference); mental (e.g., shared experiences, ideas, ideals); or any combination of them” (Nonaka & Konno, 1998, p. 40).



Ba as a shared context in motion

Source: Nonaka, Toyama & Konno, 2000

Ba acts as a platform for individual or collective knowledge processes. It can be said that knowledge appears in shared contexts, “where it is then acquired through one’s own experience or reflections on the experiences of others” (Nonaka & Konno, 1998, p. 40).

In order to participate in a Ba, individuals can involve and transcend their own limited perspectives or boundaries. When a Ba is considered a framework, knowledge can be regarded as a resource for creation. This knowledge might be used at a specific time in a specific place because it is intangible, boundaryless and dynamic; otherwise it has no value. Therefore, in order to use knowledge, an accumulation of knowledge at a certain space and time is needed. Consequently, Ba can be defined as a platform for the “resource concentration” of an organisation’s knowledge assets (Nonaka & Konno, 1998, p.41).

In knowledge creation, individuals are affected by social, cultural and historical contexts and they cannot be free from those contexts, which prepare the foundation for individuals to interpret information in order to create meanings. Real-time knowledge creation emerges by means of self-transcendence.

There are four types of Ba which emerge during modes of knowledge creation. Each Ba speeds up the knowledge-creation process by supporting a specific conversion process.

- 1) **Originating Ba:** This is the primary Ba in which the knowledge creation process begins and offers context for socialisation. Feelings, emotions, experiences and mental models are shared in this Ba (Nonaka & Nishiguchi, 2001). In order to convert and transfer tacit knowledge to tacit knowledge (socialisation mode), physical and face-to-face experiences are fundamental. Organisational issues such as knowledge vision and culture are related to this Ba. From originating care, love, trust, commitment, freedom and safety appear which are the basis for knowledge conversion among individuals (Nonaka & Konno, 1998; Nonaka & Nishiguchi, 2001; Nonaka, Toyama, & Konno, 2000).
- 2) **Interacting/dialoguing Ba:** This represents the externalisation mode of the SECI model. In this phase, tacit knowledge is converted into explicit knowledge. Since dialogue is key to this phase, an individual’s mental models and skills must be converted into common terms and articulated as a concept through dialogue. Individuals are involved in the creation of meaning and value (Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000).
- 3) **Cyber Ba/systemising:** This represents the combination phase of SECI models. Collective and virtual interactions are characteristic. In this phase, explicit knowledge can be converted into other explicit knowledge and disseminated to groups of people. Information artefacts such as online networks, groupware, documentation and databanks provide an opportunity for the creation of this Ba (Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000).
- 4) **Exercising Ba:** This offers a context for internalisation. It helps the conversion of explicit knowledge into tacit knowledge. The basic elements in this Ba are individuals and virtual interactions. Individuals absorb explicit knowledge via virtual media such as written manuals, teleconferences or simulations and then convert it into tacit knowledge. At first, transcendence and explicit knowledge are synthesised and then they are internalised in individuals as tacit knowledge through action (Nonaka, Toyama, & Konno, 2000).

The knowledge foundation of an organisation emerges through the knowledge generated from each type of Ba, but it should be noted that the accumulation of different materials or information is not enough for an organisation’s Ba. Organisations need to create new knowledge continually through the spiral cycle of “converting tacit knowledge into explicit knowledge and then reconverting it into tacit knowledge” (Nonaka & Konno, 1998, p. 47).

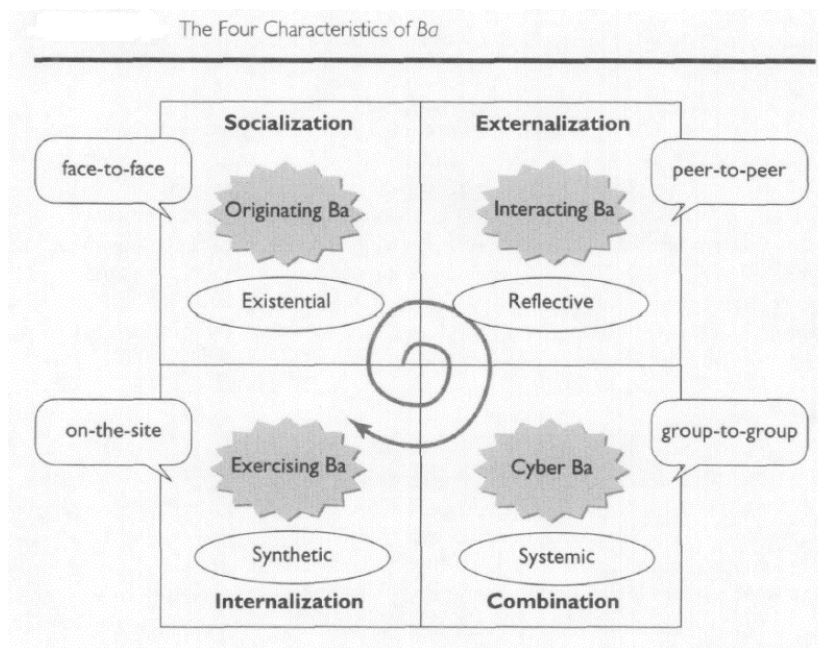


Figure 3- 4. The four characteristics of Ba

Source: Nonaka & Konno (1998)

3-6-1-3. Knowledge Assets

Both the inputs and outputs of an organisation's knowledge creating processes can be considered as knowledge assets. Nonaka, Toyama & Konno (2000) defined "knowledge assets as firm-specific resources that are indispensable to create values for the firm. Knowledge assets are the inputs, outputs and moderating factors of the knowledge creating process" (p.20).

Due to the tacit nature of knowledge and dynamic nature of Knowledge assets, it is difficult to measure the value of Knowledge assets. In order to understand how Knowledge assets are created, acquired and exploited, Nonaka, Toyama and Konno (2000) proposed four types of Knowledge assets (see Figure 3-6):

- 1) Experiential Knowledge assets
- 2) Conceptual Knowledge assets
- 3) Systemic Knowledge assets
- 4) Routine Knowledge assets

Experiential Knowledge Assets Tacit knowledge shared through common experiences • Skills and know-how of individuals • Care, love, trust, and security • Energy, passion, and tension	Conceptual Knowledge Assets Explicit knowledge articulated through images, symbols, and language • Product concepts • Design • Brand equity
Routine Knowledge Assets Tacit knowledge routinised and embedded in actions and practices • Know-how in daily operations • Organisational routines • Organisational culture	Systemic Knowledge Assets Systemised and packaged explicit knowledge • Documents, specifications, manuals • Database • Patents and licenses

Figure 3- 5. Categories of Knowledge assets

Source: Nonaka, Toyama & Konno, 2000

3-7. Research Techniques

As discussed in Section 3-5, this study adopts an interpretive paradigm and a qualitative approach using in-depth case study. Data collection techniques in this method include interviews, observation, questionnaires, and document and text analysis (Darke & Shanks, 2002). For the purposes of this study, interviewing, in particular semi-structured interviewing, participant observation and reviewing the relevant documents were appropriate for the data collection. I had freer access to information about the ProjectNGO than the ProjectIndustry because of the stricter confidentiality provisions of the industry project. Furthermore, some participants in ProjectNGO were located in a different country, and the ProjectIndustry had limitations on access to people and meetings because of issues of confidentiality. Consequently, I was not able to observe these participants during their collaboration and daily work.

3-7-1. Project Documentation

In the process of qualitative research, the researcher may collect documents such as minutes of meetings, official reports, personal journals, diaries, letters and emails (Creswell, 2009). This material is useful for understanding the contexts and exploring the process of knowledge sharing and kinds of knowledge that are shared through collaborative projects. Documents included research project proposal, research data, project reports, workshops proposals and reports, implementation plan, the minutes of the meetings and publications for ProjectNGO and research project proposal, general reports, and publications for ProjectIndustry. Background information for this study comprises available published literature in the fields of knowledge management, knowledge sharing and university–industry/NGO collaboration.

3-7-2. Participant Observation

Participant observation gives an opportunity to a researcher to capture useful information from different sources (McKechnie, 2008). In this technique, the researcher records participants' behaviours and activities at the research site (Creswell, 2009). The researcher's role can be as a complete observer, a participant-as-observer or an observer-as-participant in order to collect data (McKechnie, 2008). Since the purpose of this research is to gain a deep understanding of knowledge sharing mechanisms from individuals who live and experience it, the researcher's role was supposed to be as a complete observer who recorded information and process as they occurred in order to explore the relationship between what participants said and what they actually did. However, as I have explained, I could only attend some meetings and seminars of the ProjectNGO

that took place online, in the university and in the NGO's branch in Australia. The ProjectIndustry did not provide access to attend meetings.

3-7-3. Semi-structured Interviews

This technique is mostly used for qualitative data collection and is often used in case studies (Williamson, 2002). There are three types of interviews, namely, structured, unstructured and semi-structured. Since this research paradigm is interpretivist with an exploratory purpose, I wanted to explore detailed information about knowledge sharing mechanisms from the participants' perspectives. In other words, knowledge sharing mechanisms in collaborative projects are explored with the support of direct quotations from participants. In addition, capturing tacit knowledge is part of fully understanding complex knowledge sharing mechanisms.

Unstructured interviews could have advantages when exploring in-depth issues such as tacit knowledge and the detail of each case study, including allowing the interviewees to identify what they considered important and the reduction of any bias on the part of the interviewer. However, they are also potentially more demanding on participants in terms of time, and this was a significant issue, particularly for the industry case. After considering the options, I decided to use semi-structured interviews. The broad agenda was already set before each interview, which helped with time management. A semi-structured interview has a standard list of questions, in this case drawing on the literature and the research questions, and may introduce some bias. However, the interviewer is aware of this, and can follow up participants' comments for each of the questions involved (K. Williamson, 2013a), making it an open and flexible technique for data collection, to understand people and topics from their own points of view. This type of interview is appropriate in an interpretivist approach with an exploratory purpose (Williamson, 2002).

3-8. Data Analysis

After each interview was conducted, I analysed the transcript before conducting the next interview. Following this process helps a researcher when doing fieldwork to go back and forward between existing data and collecting new data. This not only helps to generate new strategies, but also provides an opportunity to modify the previous one (Miles & Huberman, 1994).

The general process for analysing data according to Creswell (2013) has three stages: preparing and organising the data for analysis; interpreting data through a process of coding and emerging of themes; and representing the data in an understandable format (e.g., figures, tables or discussion). From different data analysis approaches for qualitative research, I selected thematic analysis because it can be used within most theoretical frameworks. In other words, it is a theoretically independent and flexible approach and it suits the potential for an experiential or critical orientation to qualitative research (Terry et al., 2017).

Thematic analysis is a common exploratory approach for analysing qualitative data from interviews and unstructured observations (Williamson et al., 2013). In this approach, sections of a text, for example, transcripts, field notes and documents, are coded in order to create themes according to whether they appear in the context (Schwandt, 2007). Based on my research design and methodology, thematic analysis is an appropriate analysis method because it seeks to explore and identify emerging concepts in regards to the research questions. The collected data was analysed to identify knowledge sharing mechanisms in collaborative projects according to the researcher's and industry/NGO representatives' experiences and perspectives.

There are two basic approaches to conducting thematic analysis. One approach is that themes are determined in advance by existing theory and are reflected in the interview questions (theory-driven) (Terry et al., 2017); the other approach is a flexible approach to coding and theme development. The codes emerge from the data (data-driven) and exact words used by participants (Nvivo codes) (Creswell, 2013; Terry et al., 2017).

In coding, I primarily used the data-driven approach to see what emerged from the data. This means that I initially coded with the exact words used by participants, rather than pre-existing codes. However, the original list of questions that was developed from the literature acted as a form of guide to the discussion. I was aware that this may have introduced a level of bias, both during the interview and the analysis of the transcripts. In coding the terms provided by the participants was used and tried to be guided by their ideas not any preconceived ideas obtained from the literature. After the initial coding, I reviewed the codes to determine whether the codes were still relevant to the transcripts. Therefore, irrelevant codes were deleted, some codes were merged with other codes, some codes were modified, some codes were moved to new places and some overlaps were removed.

For the next level of coding, I consulted the literature, the conceptual framework and the research questions to improve the level of robustness. Therefore, the codes and themes were determined by a mix of a data-driven approach, based on familiarisation with the data, and a theory-driven approach, based on the literature, conceptual framework and research questions. An example of the interview coding is attached in Appendix B.

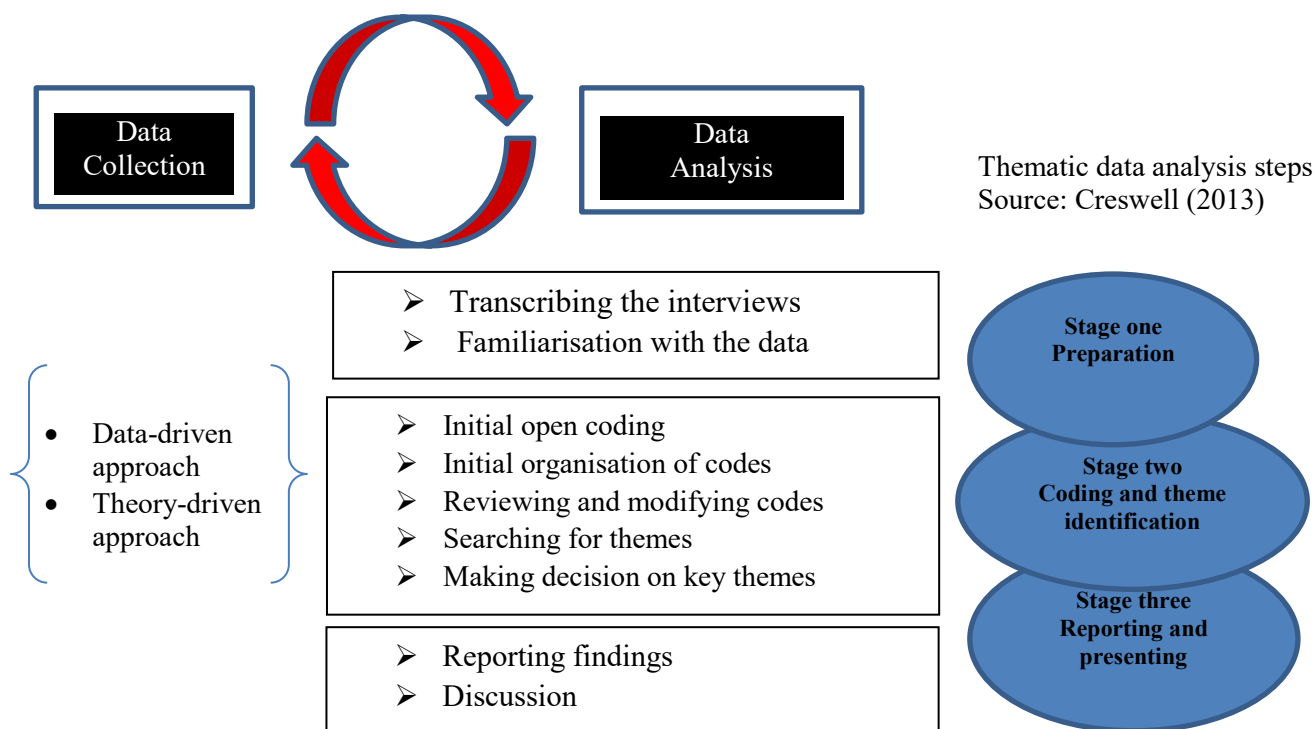


Figure 3- 6. Data collection and analysis steps

3-9. Data Collection

Two case studies were conducted. In total, there were 20 interviews including 15 with ProjectNGO members and 5 with ProjectIndustry members (see Chapters 4 and 5). I conducted interviews with academics in face-to-face meetings at their offices, while interviewing industry and NGO representatives was done via Skype, Zoom and phone. The duration of interviews ranged from 40 minutes to 80 minutes. All interviews were recorded and transcribed verbatim. I attended NGO meetings, seminars and workshops, and I had access to NGO documents. Based on the initial analysis, I also undertook a second round of interviews with ProjectNGO members. However, ProjectIndustry members, both academics and industry representatives, were found to be very busy people. Arranging the interviews with them took more time and requesting a second round of interviews was rejected. For modification of these processes, I communicated with the project leader on the academic side. Again, the email communication processes after the first round of interviews took time; for example, in some cases I only received a response one month later or more.

3-9-1. Limitation of Data Collection

The study has had limitations in terms of access to people, project documents and observation. The main issue was related to scheduling time for interviews with industry and NGO representatives. They were very busy people. The process of recruiting them was quite time-consuming and the appointments for interviews needed to be re-arranged several times. The ProjectIndustry did not provide access to meeting minutes or give permission to attend meetings because of the confidentiality of the context.

3.10. Chapter Summary

This chapter has explained the design of the research which included the paradigm, purpose and methods, the reasons for selecting the theoretical framework and description of the elements, research techniques, data collection and analysis, and selection of case studies and participants. Therefore, the current research is exploratory research within the interpretivist paradigm. It is qualitative in nature because it looks at participants' viewpoints and experiences in regards to knowledge sharing. An in-depth case study method

applying the knowledge creation model as the lens of analysis is used to explore knowledge sharing mechanisms and the relationships between different elements of the theoretical framework and to clarify its applicability. Semi-structured interviews and project documentation were adopted as data collection methods and thematic analysis was selected as the data analysis method.

CHAPTER 4: REPORT ON PROJECTNGO

4-1. Chapter Preview

This chapter begins by considering the NGO case study and introduces the context, the demographic information on the participants and an overview of the coding information. It then presents the application of the knowledge creation model within ProjectNGO, structured in three main sections. Section 4-5 describes the SECI process; Section 4-6 presents the different SCSs within ProjectNGO; and Section 4-7 shows the different knowledge assets within ProjectNGO.

4-2. Case Study Context (ProjectNGO)

ProjectNGO was a 5-year collaborative project between a university and an international NGO with branches in Australia and Bangladesh. It was launched on 7 June 2015. This project investigated information system (IS) design and socio-technical questions related to the adoption and adaptation of new technologies. It was a participatory action research (PAR) project and the outcomes were expected to include recommendations on managing PAR projects and documentation on developing information management systems for resilient farming in Bangladesh. It was not conceived of as a single project but, rather, as a group of related sub-projects including PhD research, research on Facebook and research on information literacy. All sub-projects ran in parallel.

For the core project, 100 smartphones and phone credit were given to women farmers in each of three villages in Bangladesh. The women farmers were trained in the use of smartphone applications. This provided benefits for the women in a number of ways. The women were trained to access agricultural and fishery information related to crops, rice cultivation, fisheries, livestock, poultry and general horticulture via their smartphones. This information was provided through a commercial telecommunications company via an app which also incorporated information relevant to the local community. Women could call back for free if they needed further information and advice.

The project research team was split between Australia and Bangladesh. The university, located in Melbourne, Australia, was responsible for the governance of the project and designing and undertaking the research. A researcher from Rome was also engaged on the project. The Australian branch of the NGO was responsible for the administrative aspects of the project, including contract management. The Bangladesh branch of the NGO was responsible for field implementation. It managed and gave direction to the implementation of the project in Bangladesh. In particular, it worked with a number of partners, including local NGOs, a commercial telecommunications company and a number of Bangladeshi universities. However, the primary focus of this case study is the interaction between the university and the NGO and the other partners were only introduced into the study where they had an impact on that relationship and the ways in which knowledge sharing occurs.

The project aims can be divided into three categories:

- 1) **Strengthening livelihoods and life opportunities:** In general, this project aimed to build the capacity of the women in the villages to use mobile phones and information to improve their livelihoods.
- 2) **Developing research methodology:** This collaborative project considered women farmers' opinions about the usefulness of the information and the technology. Based on the findings of the

project and the processes undertaken in its management, both the university and the NGO hoped to identify new ways of working with communities, increasing participation and local empowerment.

- 3) Developing new strategies on university–NGO collaboration:** This collaborative project had complex structures. It can be considered a test of how organisations with different structures work together on innovation to assist with the running of future projects.

4-2-1. Project Partners and Their Roles

University: was responsible for governance of the project, including receiving money from donors and distributing the funding as needed, and designing the research. It was primarily interested in research applications and developing research theories in the project. The project was started by two academic researchers; however, the team grew to include one additional academic, two postdoctoral researchers and five doctoral students.

NGO (Australian branch): was responsible for the administrative parts of the project such as government arrangements, contracts and money. Two staff were involved. One was a portfolio manager for Bangladesh and the other had contract responsibilities.

NGO (Bangladesh branch): was responsible for field implementation. This branch did not actually work in the field. It managed, supervised, distributed funding and gave direction in the implementation of the project to local NGOs. Three staff were involved in managing the project and other partners in the implementation of the project in Bangladesh. These other partners included:

- **Local NGOs:** There were three local NGO organisations that worked in the field, one in each village. Each organisation employed one or two staff in the field who worked directly with the women.
- **Commercial telecommunications company:** There was one IT company with four individuals engaged and a total of eight individuals working on content development, the technical backend and the call centre.
- **Local Bangladeshi universities:** There were five universities involved that undertook small research projects. These were side projects and their management was not included in this study.

Associate researcher: This partner was an associate professor at an Italian university. He had particular expertise in social psychology and quantitative research design.

Table 4-1. Numbers of project members.

Partners	University			
Position	Academics		Postdoc	PhD students
Number	3		2	5
Partners	NGO (Australian branch)			
Position	Country manager for Bangladesh		Administrative person	
number	1		1	
Partners	NGO (Bangladesh branch)			
Position	Staff	Three NGOs	Telecommunications company	Local Bangladeshi universities
Numbers	3	6	8	5
Partners	Individual researchers			
Numbers	1			

4-2-2. Outputs of ProjectNGO

A range of project outputs were identified:

Practical outputs:

- Benefit to women farmers. This project provided an opportunity for women in villages to learn and use technology and find useful information in order to increase their own livelihood outcomes (such as food production).
- Management of university–NGO collaboration. This project brought about an opportunity for the university and NGO to learn how to manage and run this kind of complex collaborative project.
- An agricultural information system, based on smartphone apps and an SMS messaging service, and tailored for local conditions.
- A Facebook page that advertised the project to the community. The women who learned how to use smartphones and Facebook were subscribers to this page and shared information via this page.
- The identification of options for future projects.

Academic outputs:

- One of the key outputs was gaining theoretical knowledge on researching PAR methodologies based on documenting the women's opinions about the usefulness of the information and the technology in real life (Sarrica et al., 2017) . In other words, the project aimed to gain knowledge about how a community domesticates and adapts technology in order to improve its capabilities.
- Sharing knowledge:
 - Publishing academic articles
 - Presenting at different conferences
 - Publishing reports that described the project and its outcomes. These reports were published by the NGO in Bangladesh and were useful for public consumption, internal consumption and the organisation.
 - Publishing newsletters

4-3. Participants

Different groups were involved during this project, as outlined in Section 4-2-1. I did not interview the local NGOs, the local universities or the telecommunications company because the focus of this research is the relationship between the NGO and the university. Therefore, I interviewed the project members who had direct communication throughout the project and who were directly engaged in collaboration. In total, 16 out of 35 participants were interviewed between November 2017 and August 2019. Since most of the project members had only just joined the project in 2017, they needed time to gain experience in the project. I interviewed participants twice. After the first round of interviews, I analysed the interviews based on the model and gained understanding about which areas needed more clarification. I then attended meetings (face to face and via video) and examined related documents. That in turn enabled me to better understand the project context.

Table 4-2. Demographic information on the participants

No.	Participant Organisation	Participant Role	Code
1	University	Main researcher	U1
2	University	Project leader: leadership of academic side	U2
3	University	Research program manager	U3
4	University	Chair of the steering committee	U4
5	University	Research program manager	U5
6	University	Doctoral student	U6
7	University	Doctoral student	U7
8	University	Doctoral student	U8
9	University	Doctoral student	U9
10	Associate researcher/Italian university	Scientific collaborator	R
11	NGO (Bangladesh branch)	Project manager	NB1
12	NGO (Bangladesh branch)	Program director	NB2
13	NGO (Bangladesh branch)	Economic Justice and Resilience Program Manager	NB3
14	NGO (Bangladesh branch)	Country director for NGO in Bangladesh	NB4
15	NGO (Australia branch)	Portfolio manager	NA1
16	NGO (Australia branch)	Portfolio manager	NA2

Participants were asked about what sort of knowledge they shared, how they shared knowledge, how they created SCSs, which spaces and tools they preferred for knowledge sharing, limitations/difficulties in sharing knowledge and the barriers and drivers to knowledge sharing. Semi-structured interviews were used as one of the data collection techniques. The questions were revised and modified after conducting the first interview to ensure the relevance and clarity of the questions. The interview questions are attached in Appendix A. A summary of what each question measures and its purpose is found in a table in Appendix C.

Four interviews were conducted over Skype and Zoom and recorded using a voice recorder, one via phone and 12 interviews were conducted at the university during normal working hours. The duration of interviews ranged from 35 to 80 minutes. The recorded interviews were transcribed verbatim and then entered into the qualitative data analysis software NVivo 12. In this chapter, participants are identified by codes: e.g. U1=University researcher 1; NA=NGO (Australia); NB=NGO (Bangladesh).

In conducting the project, the interactions between different parties occurred in different ways. A series of field visits and many online discussions took place. Academics went to Bangladesh two or three times a year and some of the Bangladeshi staff came to Australia for face-to-face meetings when possible. There were two regular pre-arranged meetings. One was of the steering committee that was run about once a month with senior members of the project team. It was conducted online. The other meeting was of the governance committee that was held every six months. Senior project members and external faculty and NGO managers attended. Its purpose was project oversight.

As an international collaboration, there were many online meetings between partners formally and informally. Communications were frequent through email and Skype. Cross-cultural, telecommunications, language and other barriers were apparent in this collaboration. These will be discussed in Chapters 6 and 7 in detail.

In the next sections, each component of the knowledge creation model is applied within ProjectNGO separately. However, in practice these components act dynamically together. Section 4-5 describes the SECI process that formed the basis of how knowledge was shared; Section 4-6 presents the different SCSs that formed the basis of where and when (space and time) knowledge was shared; and Section 4-7 presents the knowledge assets that were the basis of what kind of knowledge was shared throughout the project.

4-4. Applying SECI Processes for Knowledge Conversion within ProjectNGO

The interaction between explicit knowledge and tacit knowledge leads to knowledge creation. It is a continuous process. Nonaka, Toyama and Konno called this interaction “knowledge conversion” (Nonaka, Toyama, & Konno, 2000, p. 9). There are four modes of knowledge conversion, namely, socialisation, externalisation, combination and internalisation (SECI). These are key activities through which knowledge emerges. Each knowledge process of the SECI model is described in terms of how it fit into ProjectNGO.

Socialisation (from tacit knowledge to tacit knowledge): Socialisation is defined as a process of sharing tacit knowledge and building new tacit knowledge from shared experiences or empathising reality through actual experiences (Nonaka & Nishihara, 2018; Nonaka, Toyama, & Konno, 2000). Socialisation occurs via spending time together, living in the same environment or informal social meetings outside of the workplace. Within ProjectNGO, socialisation was an ongoing process. It was

intense at the beginning of the project, with staff replacements and introducing new aspects of the project. This occurred between academics and NGO representatives when they started to talk about their theoretical knowledge or when they tried to implement this knowledge in the field. It happened when they shared their personal knowledge about their organisational context or cultural and social knowledge of Bangladesh. Project members gained tacit knowledge of the characteristics and requirements of the project, fieldwork, data collection and theoretical background. Through socialisation, for example in the steering committee, they talked about general things that needed to be done, like different procedures to obtain accurate data.

The following interview responses from one academic and the associate academic researcher illustrate how they considered related issues as part of the socialisation process.

We discuss the problems with the NGO people at meetings, to say, what's going to work? How can we get better data? Because they know the situation on the ground. They know how much time people are already putting into it and things like that. They know what's possible and what might be culturally or socially acceptable. They can say, "Okay, you can try this, or you can try that." So, we're learning from them about how to do ... to get more accurate data to meet our needs. And of course, that's a two-way discussion (U1).

We talked about participatory action research, that was the starting point of the project. For example, already discussing about this core knowledge, what is participatory, what is action, puts into question my assumption about this concept (R).

Through socialisation, academics and NGO representatives learned from each other by converting new tacit knowledge from shared experiences. In Nonaka's model, socialisation typically occurs in a traditional apprenticeship and mentorship in an organisation or beyond organisational boundaries (Nonaka, Toyama, & Konno, 2000). In contrast, the ProjectNGO members socialised through formal and informal meetings, workshops and seminars in physical or virtual collaborative spaces and via field observation.

Externalisation (from tacit knowledge to explicit knowledge): The externalisation process leads to new explicit knowledge. It describes how tacit knowledge is formed into concepts, for example, creating a concept when developing a new product or making improvements to a manufacturing process in a quality control circle (Nonaka & Nishihara, 2018; Nonaka, Toyama, & Konno, 2000).

Within ProjectNGO, project members, after talking about theoretical, social and cultural knowledge, during conversation and exchange of knowledge in the socialisation mode, started to write proposals or articulate the process of implementation in the field. Alternatively, it could be the case that academics after analysing the data realised that something was missing. In order to understand the context around the data and interpret the results, they talked with the NGO staff and asked questions related to cultural and social situations. These kinds of communications mostly happened through direct discussion (phone, Skype) to articulate the best answers. This led to documenting project objectives, designing data collection tools such as surveys and questionnaires, developing theoretical frameworks and capturing community requirements and characteristics for the first time, to be refined during later processes. These were required by the management of the project in order to help to conduct the project in practice. In addition, this led to development of academic articles and reports to disseminate the outcomes of the project with wider audiences. Running workshops with project associates was mentioned as another way of externalising the knowledge that project members gained from the project. For example, a participant stated:

I think having workshops with the NGO and partners is a way of sharing the knowledge that you have gained from the project or all experience from the project (U5).

Externalisation in ProjectNGO occurred through written and verbal articulation in peer-to-peer interaction. In common with Nonaka's model, dialogues strongly support this process and peer-to-peer interaction is the basis of articulating knowledge into common terms in this mode.

Combination (from explicit knowledge to explicit knowledge): This is specified as a process of converting explicit knowledge into other complex and systematised explicit knowledge. It can be done through breaking down concepts or combining separate explicit knowledge (Nonaka, Toyama, & Konno, 2000). In ProjectNGO, the combination mode happened through ongoing discussion to make sure that project members were talking about the same concept. For example, in drafting the surveys to find out what was happening, they had to discuss and clarify the questions and the terms that were used in those questions to make sure that both the researchers and their NGO partners understood the same things in both English and the Bengali language. As one of the academics mentioned:

[Concepts are negotiated and renegotiated] through discussion, it's continuous discussion, to make sure we're talking about the same thing. So that happens always on an ongoing basis; that's not a once-off thing, there's a couple of times when it becomes more explicit. So for instance when we design the surveys to find out the baseline data, and you know, a year later to find out what else was happening, we have to discuss the questions and we have to discuss the terms that are used in those questions, and we have to make sure that we both understand the same things; because obviously we need to, so that we interpret the same starting point for interpreting the data; but also because we ourselves are not actually doing the interviews (U1).

When the project members collected information and put it together in a context to create a survey, that survey was new explicit knowledge. Knowledge was combined from many different sources and processed to form new knowledge in one context (surveys).

In an organisational context, explicit knowledge is combined after being collected from inside or outside the organisation and then the new explicit knowledge is disseminated among the organisational members through presentations or meetings via computerised communication networks and large-scale databases (Nonaka & Nishiguchi, 2001). During ProjectNGO, different versions of data collection tools such as surveys, questionnaires and reports were created based on the first draft which emerged in the externalisation mode and was shared between project members via email, Google Drive and Zoom. Different versions of academic articles were created in order to share project experiences with wider audiences, articles which were more systemised explicit knowledge. The combination mode was an ongoing process throughout ProjectNGO and led to the creation of more systemised explicit knowledge. In this project, computerised communications also played an important role in the sharing of the new explicit knowledge within the project, while journal articles were used as a medium for sharing the produced knowledge outside of the project.

Internalisation (from explicit knowledge to tacit knowledge): This step defines a process of converting explicit knowledge into tacit knowledge (Nonaka, Toyama, & Konno, 2000), for example, creating value in the form of technology, products, services and experiences, and software (Nonaka & Nishihara, 2018). In ProjectNGO, explicit knowledge created previously (data collection tools such as surveys, questionnaires and reports, and PAR methods) was shared throughout project and converted

into tacit knowledge by individuals. Explicit knowledge such as survey questions had to be internalised in individuals' minds through being implemented in the field and practice. For example, project members understood the PAR methods by reading documents about PAR and implementing the PAR methods in the field. Project members internalised the written explicit knowledge to increase their tacit knowledge base. Through the internalisation mode, not only explicit knowledge such as data collection tools like surveys, questionnaires, academic articles and theoretical frameworks, but also tacit knowledge such as experience of university processes, how to work in the field and how to work with NGO were internalised in project members' minds.

Based on these processes, they gained experience and turned into tacit knowledge what had happened and what had worked or not worked. These processes were constantly iterated and internalised in people's minds. Ongoing discussion and reflection led to internalisation of the explicit and tacit knowledge in individuals' minds and created a database for new steps in the project. The training of local organisations based on the explicit available knowledge about the theories and methods is another example of internalisation.

In an organisational contexts, actions and practices are fundamental in this mode (Nonaka & Nishiguchi, 2001). There are many formal and informal rules and practices for internalising and people need to follow those rules. However, in ProjectNGO discussion and reflection led to internalisation and people needed to concentrate on building relationships with others that in turn provided opportunities for internalising knowledge. One of the academics stated that:

I think in a project like this, [what] I'd say is that in talking about how you interact within a team, you can try and make things too explicit. You can try and set too many rules. I think sometimes that doesn't work. And depending on the project, and depending on the people, you may get better results by focusing on the relationships between the people, rather than focusing on the rules (U1).

In an organisational context, internalised knowledge can broaden, extend and reframe organisational members' tacit knowledge (Nonaka & Nishiguchi, 2001). It can be shared throughout the organisation. In ProjectNGO, the internalised knowledge not only could be used as a new database for each partner (the university and the NGO), but could also act as a trigger for other projects and communities. For example, workshops were held for local organisations in Bangladesh. They were trained in what PAR is and how they could apply it in projects; how to do surveys; how to do interviews. As one of the Bangladeshi members mentioned:

We will have a sustainability workshop and then we will design how we can spread out this content to develop to the wider community (NB1).

The knowledge that local organisations members learned and gained in conducting the research could then be used and applied in other similar research projects and other similar communities. The internalised tacit knowledge at the individual level throughout the project could then start a new spiral of knowledge creation when it was shared with others through socialisation.

The interactions throughout the project were shaped by shifts between different modes (SECI) because "knowledge creation is a continuous process of dynamic interactions between tacit and explicit knowledge" (Nonaka, Toyama, & Konno, 2000, p. 12).

4-5. Applying Ba/SCSs for Knowledge Creation within ProjectNGO

Ba can be considered a shared space in which individuals interact (Nonaka & Konno, 1998, p. 40). As discussed previously in Chapter 3, there are four types of Ba which emerge during modes of knowledge creation: originating Ba, interacting/dialoguing Ba, cyber Ba/systemising and exercising Ba. “Each Ba offers a context for a specific step in the knowledge creating process. However, the respective relationships between each single Ba and conversion modes are by no means exclusive” (Nonaka, Toyama, & Konno, 2000, p. 16). The knowledge-creation process begins from originating Ba and is associated with the socialisation mode, dialoguing Ba is associated with the externalisation mode in which tacit knowledge is made explicit, systemising Ba is associated with the combination mode in which new explicit knowledge is combined with existing information and knowledge, and exercising Ba is associated with the internalisation mode in which explicit knowledge is converted into tacit knowledge (Nonaka et al., 2001).

4-5-1. SCSs within ProjectNGO

Within ProjectNGO, academics and NGO representatives needed to create SCSs to share and create their knowledge. These SCSs can be considered Ba. Shared spaces can be built intentionally or spontaneously (Nonaka, Toyama, & Konno, 2000). The following section outlines the participants’ responses to illustrate how this project utilised various SCSs. In Nonaka’s model, different emphasis is given to various spaces. Therefore, the discussion reflects this weighting. Because the nature of the project was PAR, project members had more interactions in the tacit-to-tacit form, which in turn resulted in more originating SCS compared to other spaces.

4-5-1-1. Originating SCS

Within ProjectNGO, this can be seen as the primary space in which academics and NGO representatives began to share and create knowledge. In ProjectNGO, in this space project members started to generate ideas. Physical and face-to-face meetings were important for members of the project. The best work was done when the partners met each other face-to-face, based on participants point of view. Although the structure of the project was complex and it was difficult for them to have physical meetings, they preferred to socialise in a physical place at the first stage. However, they also used Skype and Zoom for socialisation. Ongoing information and knowledge sharing mostly happened in the design stage of the project, such as designing a new survey instrument or new set of questions. Knowledge sharing was relatively straightforward on the university side between the academics. However, they also tried to have regular meetings with the associate academic researcher in Italy and the NGO representatives in Bangladesh, and this became logistically more complex.

In the originating SCS within this project, care, trust and commitment, openness and autonomy as emotional knowledge appeared which correspond to the elements that the literature identifies as important for originating Ba.

Care: This is defined as “serious attention or thought in doing something properly” (Barber, 2005). To care for someone is to help them to learn, increase their awareness of important events and their consequences, and nurture their personal knowledge creation while sharing their insights. In the organisational context, care encourages members to “voice their opinions or give feedback as part of a process to help others” (Von Krogh, 1998, p. 138). In this project, care as a helpful relationship was reinforced by the two academics, who commented on the importance of care.

When the situation arises, we have to be careful and go through the documents, do lots of drafts; make sure everybody is getting what they need (U1).

And a large part of it is creating documents like some survey questions, some interview questions and going to drafts to make sure everybody is happy (U2).

In order to share knowledge in ProjectNGO, it was important for project members to create space in which all members felt safe to share knowledge and to make sure that all participants were getting what they hoped out of the project.

Trust: Trust has many possible definitions and it is an important element of successful KM processes (Bukowitz & Williams, 2000; Ford, 2004; Rolland, 2000). Trust can be defined as “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” (Mayer et al., 1995, p. 712).

Trust has three dimensions in social psychology, namely, cognitive (rational), affective (emotional) and behavioural (Lewis & Weigert, 1985). In the cognitive dimension, people engaging in relationships “cognitively choose whom they will trust in which respects and under which circumstances” (p.970). This trust is related to rational decision-making based on available information (Höglund et al., 2019). Trust is influenced by past experiences and chances of future interactions within organisations (Bijlsma & Koopman, 2003). Affective trust is related to “an emotional bond among all those who participate in the relationship” (Lewis & Weigert, 1985, p. 971). Behavioural trust is the undertaking of action based on the confident expectation of action by all the individuals involved in the action. This is reciprocally related to cognitive and emotional dimensions (Lewis & Weigert, 1985).

There are also different targets of trust, namely, organisational trust, interpersonal trust (relational trust), group trust, institutional trust (Ford, 2004) and trust in technology (Lankton et al., 2015). In an organisational context, the trust required for knowledge creation is organisational trust. For example, employees trust organisation rules, policies and norms, and act accordingly, or employees trust their supervisors to follow the policies. This is not relational trust. It depends on employees’ ability to predict and understand their supervisors’ behaviours through the rules and policies of the organisation. Relational trust is between individuals and depends on an individual’s perception and willingness to trust. The “willingness of one person to increase his/her vulnerability to the actions of a group of people” is defined as group trust and “a feeling of confidence and security in institutions” is defined as institutional trust (Ford, 2004, p. 557). Trust in technology is considered and examined when users have experience with the technology. There are two approaches to trust in technology: human-like trust and system-like trust. In human-like trust, integrity, ability, competence and benevolence are considered the four main beliefs, while reliability, functionality and helpfulness are the system-like trust beliefs (Lankton et al., 2015).

Interpersonal trust can be developed through the sharing of information and knowledge between individuals. As a result, it can be said that the knowledge sharing and generation which occur through organisational trust and interpersonal trust will make these processes more successful. Interpersonal trust may develop as a result of knowledge sharing and it may not be required for starting the knowledge sharing (Ford, 2004).

Knowledge generation within ProjectNGO may not have required interpersonal trust at the beginning of the collaboration because the partners trusted each other's knowledge due to the standing of the organisations, levels of expertise and knowledge, and previous experience. As two NGO members mentioned:

I would also say that I think we trust a lot of knowledge that comes from university, based on their reputation. So, there is a certain amount of trust when you go into a partnership with an organisation, yes, we have to – there is certain assumptions that are made, and one of the assumptions is that university is a trusted university that produces a high level of academic achievement and so therefore, knowledge they provide there's a certain amount of trust, based on their reputation. So, it is not an online university that we've never heard of, it's not, it is an established university (NA2).

I mean, I know that in terms of trusting other members' knowledge, we have as a – for all of the other members, I guess, awareness of their own expertise and their engagement at the field level. So, the things that they share I know are based on a certain level of expertise and knowledge and previous experience, that is one. But number two, probably more importantly, is about looking at what are the documented results on this. So, where we're making claims, where is the information that backs this up, where is the analysis that backs that up? (NA1)

Individuals within ProjectNGO trusted the other members to share their information and knowledge because they were working towards a predefined objective. For example, an academic stated that:

The first is you trust that the intention of team members are all for the benefit of the – for the objective. I think the first – the main thing, is that all members believe that, um, like, they work towards the same goal, they work towards the same objective, yeah. From there, I think the trust will work itself out, because you know you are working towards the same goal (U3).

The level of interpersonal trust increased with time between individuals. At first, there was no need to build trust. They trusted each other because they relied on their partner's knowledge. However, when they continued to work and interact within a project, trust evolved over time based on ongoing observations and interactions. As one of the academics observed the development of trust throughout the collaboration:

Yeah, degree of acceptance of what people say I think changes with time. So, if you haven't worked with people before or you haven't interacted with them a lot, you can have a conversation and think, okay, that sounds interesting. But you are not – you won't fully think oh, wow, it's – this person has said XYZ therefore I, you know, I believe that, I trust their insight. But once you know them and you've worked with them and you've just interacted with them in lots of different settings, formal and informal, you develop a degree of trust, or not (U4).

Interpersonal trust is important in the process of tacit knowledge sharing. Project members trusted each other through the processes even though the results were not necessarily in line with their expectations because of different organisational cultures. In the university academics had more independence of action, while in the NGO there were set procedures to conduct research or a project. So NGO representatives needed to follow these procedures and academics needed to respect them. One of the academics stressed that:

In the project, we trust them to do certain things but the results are not necessarily what I wanted or expected. The limitation is there, I cannot enter their private space as organisation to say I do not think you did the wrong/right thing because my trust, their trust depends on our respect. Respect what they are doing (U2).

Based on my observation and reviewing related documents, it can be said that project members were willing to share knowledge. They trusted that their knowledge would not be stolen and used by other members. Project members found it easy to establish trust during collaboration. Since it was PAR and project members needed to discuss processes and outcomes, strong interpersonal trust was required. The presence of interpersonal trust increased the success of knowledge sharing and generation within this project.

Commitment: The concept of organisational commitment is derived from social psychology and sociology (Camelo-Ordaz et al., 2011). It occurs when organisation members “feel identified with, and involved in, the organisation and its goal” (Camelo-Ordaz et al., 2011, p. 1443). So it can be defined as an individual’s willingness to work towards organisation goals and values (Reichers, 1985). In an organisational context, training and its reward system are mentioned as two main factors to enable organisational member commitment. Training courses help members to acquire the necessary knowledge and a reward system can strength organisation performance and increase members’ commitment (Garrido-Moreno et al., 2014). In ProjectNGO, project members talked about “we”. This shows their commitment to each other and the project. Academics and the associate academic researcher were socially close to each other, which indicates their mutual understanding of the phenomena under research. The following examples show how academics showed their commitment to the project and project members.

We work on it together. We sit down here and say what information we want from them we want because [the NGO] has some information that he wants. We have some information that we want. So, there is the baseline survey. We both contributed to that. So, we talk to people in [NGO] Bangladesh to get social, cultural knowledge from them (U1).

We are very collaborative, I think we’ve got a good friendship circle. It has been developed over many years (U2).

In the collaborative project context, for NGO members acquiring new information and knowledge and connecting with large academic communities were mentioned as enabling members’ commitment. As one NGO member stated:

Collecting data which could be useful for NGO to integrate in other projects. So, they are supervising the PhD students who are focusing on our program or our project. I think those are the major roles and, also, another thing I also see, connecting us with large academic communities. The university has a wider academic network here, so they connect us with different other universities in Bangladesh and outside Bangladesh (NB3).

For academic members of the project, research interests, acquiring new insights in their area of expertise and publications were mentioned as factors enabling commitment. The following are interview extracts that show academic viewpoints in regards to enabling factors of commitment:

So, from my perspective, I suppose, my view reflects my research interests, so that would be the knowledge produced that would be important for me and that I'd hope to see

produced from this project, that would be insight into the ways in which people were in a certain culture in a very sort of prescribed circumstances, so rural women in Bangladesh. The ways in which they interact with information technologies. So that insight (U4).

The output, for us [as] researchers, there will be some publications. I mean, as a researcher myself, producing a publication is one thing, but for us, for our work to be able to have meaningful use by someone or some organisation like [the NGO], I think that's – that's, that's one of the goals, for me (U3).

Openness: This can be considered the way in which individuals accept the different perspectives and knowledge of other group members and are willing to freely express their own views, ideas and knowledge (Mitchell et al., 2009). Openness can be blocked through a lack of trust in the organisational context (Redlich et al., 2014). However, in ProjectNGO due to strong pre-established trust members were open to sharing and accepting new ideas and insights during collaboration. For example, participants stated that:

Shortly after the distribution of smartphones, religious leaders were already getting participants to upload different apps and things like that. I thought that was really interesting. Otherwise I'd say that – I'm really waiting for the new ideas and insights, I really would like to see the reports and analysis that we have coming out (NA1).

I can share my knowledge but I have also to accept that, but maybe this is something that I learn in this project, that my knowledge will be irrelevant to this specific context because of so many cultural distances, power issues that are not evident, that only a local knows. So in this sense I had to trust. We go back to the issue of trust. I have to trust because otherwise it will be a top-down approach, which could be negative (R).

Despite cultural distances and differences, there was a strong willingness among project members to freely express their own views, ideas and knowledge because there was strong trust among project members about the reputations of the organisations and levels of partners' expertise, knowledge and experience. They knew that project members were inspired and committed to project goals and partners' expertise, and what was shared and proposed by others was aligned with project goals. For knowledge (especially tacit knowledge) to be shared, there should be a space in which people feel safe to express their ideas and accept new ideas.

Autonomy: The concept of autonomy can be applied at different levels, namely, at the individual, group and organisational levels (Nonaka, 1994; Nonaka & Nishiguchi, 2001). It can be defined as the amount of freedom of an individual to act autonomously in carrying out assigned tasks (Hackman, 1983). It also refers to "the capability of groups to self-regulate on relatively whole tasks" (Molina & Llorens-Montes, 2006, p. 266).

In ProjectNGO, defining different independent topics and having separate PhD topics allowed academic members to act autonomously. In turn, this led to finding new information and knowledge based on new topics that were defined under ProjectNGO. In the organisational context, autonomy leads to finding unexpected knowledge for organisations by increasing organisational members' motivation to create new knowledge (Nonaka & Nishiguchi, 2001). Two of the academics in ProjectNGO explained the autonomous behaviour in the project as follows:

We organised a workshop with the village women, so we were supposed to go to the village, but because of the security situation, we were not able to; so the women came to Dhaka. Six from ... six from ..., that we put together, and we gave them some activities to do about evaluating information, and recognising good-quality information, and different games that they play. My research was added on top of that and was looking at the evaluation they did afterwards, of what they found more interesting in the workshop and what information they wanted to keep from the workshop. So if you are giving them the choice at the end of the workshop, "What information do you want to keep, about what specific topic and in which format?" because I'm looking at it from the record point of view, if they wanted a handout, if they wanted to take their own notes or a video recording, audio recording and so on. What I was particularly interested is knowing that women in villages sometimes have started using notebooks and to see what they write in those notebooks (U5).

There is one PhD student, she is part of this collaborative project and she is doing ... her research is within the project, but of course her topic is her own. She is given specific topics on areas to research. Given the specific research question within the project, we have a number of research question we are exploring and we said to her this is a research project, you have to explore. Or you are going to explore. But as a PhD she has to make sure it's her own work. As she is looking at the question of empowerment of women, her findings could potentially feedback probably not into this project because it will be stopped by then, but her findings could fit in similar projects (U1).

Autonomous behaviour appeared in two ways. One was in developing new projects and new ideas related to the main project. For example, doctoral students and the research fellow were autonomous in selecting the topics of the research and the ways of conducting the research. In addition, autonomous behaviour appeared in practice through the many discussions about what they needed to do in the field to collect data effectively. An instance of this is the manner in which academics trained NGO people on how to collect related data. However, the Bangladeshi workers were relatively autonomous and did not always follow instructions.

4-5-1-2. Dialoguing SCS

The externalisation mode of the SECI model occurs in this space. Within ProjectNGO, in this space academics and NGO representatives preferred to discuss their mental models and skills, knowledge of the theoretical framework, knowledge of PAR, and social and cultural knowledge of Bangladesh. They then converted their tacit knowledge into an explicit form through writing either reports or academic articles, documenting project objectives or designing data collection tools such as surveys and questionnaires. They grouped tasks based on members' specific knowledge and capabilities for making knowledge explicit. NGO representatives were involved in developing the concepts and writing academic articles. This space is constructed consciously compared to originating SCS. For example, one of the academics stressed that:

We can talk about the article we are writing with [X] and [Y]. It varies from article to article. [X] and [Y] were taking a big role in this article. They had decided on the theoretical approach we would take. And then had written the first draft of the article. So, they provided all the insights and what I am doing is going to say critiquing the article and saying I do not understand what they had written. Some things need

clarification and some information is not consistent. You have not written properly. And this makes reorganising a little bit better. So, when we write the article, we generally spread out the roles between us. And that what is happening in this article. With the previous article, I wrote the first draft or most of the first draft of the article and the others brought more theoretical insights which we discussed which we were reorganised all together (U1).

Like the organisational context, an individual's mental models and skills are converted into common terms through dialogue via peer-to-peer interaction. Interactions in this space occurred through face-to-face meetings or online media such as email, Skype, Box and Google Drive, which are described in the systemising SCS section to avoid repetition because they were also used in that space. In addition, workshops were used as a place for externalisation in ProjectNGO.

4-5-1-3. Systemising SCS

The combination phase of the SECI model occurs in this space. New explicit knowledge which is created in the dialoguing SCS can be combined with other existing knowledge in this place. Information artefacts such as online networks, groupware, documentation and databanks provide an opportunity for the creation of this space in an organisational context (Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000). Within ProjectNGO, virtual SCSs played an important role. Because of the scattered structure of the project and distances, project members used Skype for regular meetings and email for sharing documents and files. Different versions of data collection tools such as surveys and questionnaires, drafts of academic articles and reports were shared which were created in the dialoguing SCS in this space and then converted into new explicit knowledge. The new explicit knowledge was different from the first draft because it was combined with other existing knowledge, either explicit or tacit. It can be said that the new explicit form of knowledge was shared and created sequentially in this space during collaboration. It could occur at a group level throughout the whole project during collaboration. Collective and virtual interactions such as discussion of the organisational context are characteristic in this space.

The applications were used in creating Systemising SCS include Skype, Email, Box, Google Drive and Social media.

Skype: This is a telecommunications application which was used for sharing tacit and explicit knowledge. It provides video chat and voice calls over the internet. Because of the scattered structure of the project and distances, project members used Skype for regular meetings.

Email: This was used as a tool for sharing explicit knowledge and information throughout the project. An NGO member mentioned email for sharing explicit knowledge when he explained the existing methods of knowledge sharing based on his own opinion:

[For sharing knowledge with other project members] there was two methods actually. One is verbal sharing, second is written sharing. In this written sharing, we share documents, we have one learning platform that contained learning from the project. Those are web based. Another is sometimes we have direct emails we can send to another and the verbal communication. We attended the meetings, we have sharing of our learning in oral communication and papers. From this I mean in part of written

communication we are trying to have published our writings both in peer-reviewed journal or editorial section (NB1).

Box: This was a specific online space to record explicit knowledge of the project such as minutes, documents of official processes and all the related data about the project. It was a cloud-based service called Box. The Australian branch of the NGO provided this service. Project members used Box for storing data and archiving official versions of the meeting minutes and datasets. All of the project members had access to it. An NGO member described this space as follows:

From our side [NGO], we basically store things, the specific things, in our Box. Some have other things, like Dropbox. The products we have for project, those are kept in Box, like the project documents and the learning documents and other project documents. So, we keep it in a single space and it is accessed obviously by NGO and sometimes non-NGO people can also access that (NB3).

Academics had issues in using Box because of the organisational culture and requirements. The university had its own rules and regulations in regards to the ethics of recording research data. Academics needed to make sure that the NGO agreed with university requirements in regards to access, intellectual property and administration. They could keep related data in this space. Since the NGO needed to store its own official records based on its own need, the university was not able to manage the official records for the NGO. Therefore, it seems that because of the needs of each organisation to store official records in a different manner, the academics were not willing to use Box. In the early stages they used this space, but as the project went forward the academics preferred to use their own space in Google Drive among themselves to share research-related documents because of the abovementioned issues and difficulty in getting permission from the university IT department. So, academic members used Box just for storing official documents that were common to both organisations such as minutes of meetings between the NGO and the university. One of the academics explained the issues raised when using Box as follows:

We have thought about Box as one of the spaces that we have issues with. These would come back to organisation requirements as well. So for instance, we get the data collected. We have our ethics and explanatory statement. We have to prepare them and ask where we are storing all the data, who has access to it and so on. If we use Box [the NGO] can control it. We have to make sure that they are going to agree to our requirements and our ethics requirements and our intellectual property issues. We got an agreement to this, so there are administrative aspects to that, administrating that particular space, that are important and they need to be agreed to before we can agree to keep things there (U1).

Google Drive: Academics created a shared space in Google Drive to record research data, reports and key documents that only the academics had access to. This space is a file-storage service developed by Google and the university had an agreement to use it. This drive allowed the academics to store files on university servers and to synchronise and share files across devices. One of the academics explained how and why they created this space.

We also try to have a shared space between us, about the research matters within the project. Last time, I built the Google Drive sharing space and then created the structure for [recording data there], so it's all – it's shared by the team [academics] (U3).

Social media: Project members did not use social media for their communication during collaboration. However, they used social media for communication with the communities, especially Facebook. This can be considered another form of Systemising SCS with the community, not project members. There were two formal Facebook pages. One was a page which was set up by the NGO Bangladesh in order to promote the project and the other one was a Facebook page for women in which women from the community were contributors to this page and they shared their information through this page. Knowledge sharing through Facebook during this project for community members was important. For example, in cold weather women were able to show photographs of their plants or animals to the community and ask their opinion about what was going wrong.

The academics used Facebook individually and they used it as one way of communicating what the project was doing with everyone outside of the project. As one of the academic members mentioned:

Facebook. It is not used by the project at [the NGO] that is supposed to be in charge of it, but by my own page on my Facebook space. I share knowledge with everyone by usually general comments and sometimes on the pages of the project page or the blogs (U2).

One of the NGO representatives used Facebook Messenger for communicating with the community because they found that Facebook Messenger was more reliable than other talking apps in Bangladesh.

We prefer Facebook Messenger. This is quotation by the community that the Facebook Messenger is good and better than other talking apps (NB1).

Another academic believed that the Facebook page assisted to publicise the project but was not an effective way of sharing knowledge among project members.

I think it helps in publicity, having said that I do not think – our Facebook page does not jump out very well. I do not think it is a good example. It is there but it is not very effective. Because nobody uses them (U1).

Finding sufficient time to use social media was mentioned by the academics as one of the major barriers to engaging effectively in sharing knowledge through social media.

I do not want to waste my time. Wasting time on Facebook, I do not want to waste my time on Twitter or Instagram or anything or anything else at all, because you get consumed by Facebook. Because I heard and want to check, but Facebook, for example if I do something, I can put a movie on Facebook (U2).

Twitter was mentioned as a medium for knowledge sharing outside of the project, for example:

I use Twitter as well. But not for this project, so I use Twitter as a Facebook workroom. But I do not actually use it for this project because the others use other apps (U1).

4-5-1-4. Exercising SCS

This space offers a context for internalisation. It helps with the conversion of explicit knowledge into tacit knowledge (Nonaka, Toyama, & Konno, 2000). Within ProjectNGO, it occurred through shared spaces such as workshops or through reading and discussing an academic article or recording and taking notes. Project members discussed data collection tools such as surveys and questionnaires, academic articles, theoretical frameworks and the methodology process that they created. Members' reflections and feedback on the explicitly created knowledge led to new contextual experiences related to real-life situations and building up relationships based on experience for future actions or projects. These were mentioned as fundamental ways of internalising explicit knowledge in this space. As the associate academic researcher stated:

For example, it's reorienting some of the research themes that I have for example, or even though it was not successful, last year I submitted a project for some EU funds with another party working in the same area. So, the knowledge coming from this project, let's say theoretical exchanges, but also the direct experience in the field, I'm using this knowledge already in order to think about new projects (R).

Training through workshops was mentioned as a way of internalising explicit knowledge for NGO members in the field. To hold a workshop such as on PAR, they needed to hire another organisation to come and train the people in the field because of the language barriers. As one of the academics mentioned:

We realised that everybody was new to [PAR]. The local people, the local NGO, they are not doing very well. So, at that point we said, okay obviously everybody needs more training, what can we do? So we found another person who works for the Research Institute of Bangladesh and who specialises in PAR and we got them to have workshops for everybody in the Bangladeshi language in PAR methods (U1).

Table 4-3 summarises the differences discussed about how different SCSs operated within ProjectNGO.

Table 4-3. Categorisation of shared collaborative spaces within ProjectNGO.

SCSs=Ba	Originating	Interacting/ Dialoguing	Cyber / Systemising	Exercising
Knowledge conversion	Tacit–Tacit	Tacit–Explicit	Explicit–Explicit	Explicit–Tacit
Level of members’ engagement	Individual	Individual/ Group	Group/Project	Project/Individual
Characteristics	• Care • Trust • Commitment • Openness • Autonomy	• Task-based • Grouped individuals based on specific knowledge	• Using more ICT applications • Creating systemised know-what knowledge	• Discussion • Reflection • Feedback • Training
Tools	• Face-to-face meeting • Virtual face-to-face meeting (Skype)	• Face-to-face meeting • Virtual face-to-face meeting (Skype) • Email • Report • Document (Word format) • Workshop • Google Drive • Memo • Whiteboard	• Virtual face-to-face meeting (Skype) • Email • Report • Document (Word format) • Talk • Google Drive • Box • Memo • Social media just for community and publicising	• Face-to-face meeting • Virtual face-to-face meeting (Skype) • Workshop • Note-taking

4-5-2. ProjectNGO SCSs Compared to Nonaka’s Model (Ba)

This section presents an analysis of ProjectNGO when mapped to Nonaka’s model (Ba). Mapping to the model showed that knowledge was shared and created in the SCSs. However, in some spaces the characteristics of the SCS were different from the original model.

In the originating SCS, face-to-face interaction, either physical or virtual, was the bedrock for ProjectNGO. It was a space where tacit knowledge was shared and new ideas generated. Generation of new ideas was supposed to be via face-to face meetings. However, because of the geographical spread of the project, the originating SCS needed to be supported by virtual face-to-face or informal and formal meetings. Technology was a necessary tool for creating this space. Knowledge sharing mechanisms were best supported by this space, where individuals shared their experiences and tacit knowledge. The results of sharing knowledge in this space contributed to idea generation and new sets of questions. Another important difference with the original model is that there was no trust formation in this space because trust had already developed before starting the project. In a similar vein to the original model, emotional knowledge such as care, trust, autonomy, commitment and openness appeared in this space because of the nature of the project that needed more discussion. People needed to spend more time together.

In the dialoguing SCS, tacit knowledge was converted into explicit forms. Tasks were divided based on an individual’s conscious knowledge because people were already socialised and knew each other.

Explicit knowledge creation occurred peer to peer and face to face in either physical or virtual ways. IT was a necessary tool for creating this space. The level of interpersonal trust was increased through this peer-to-peer interaction.

In the systemising SCS, explicit knowledge was created sequentially. Co-creation of explicit knowledge continued until reaching the confirmed final version. Co-creation of explicit knowledge could occur in peer-to-peer or group-to-group meetings, either face to face or virtually. IT and peer-to-peer / group-to-group interaction were necessary tools for creating this space.

In the exercising SCS, produced explicit knowledge was internalised in individuals' minds as tacit knowledge. It could occur individually when the individual embodied explicit knowledge that was communicated in data collection tools such as surveys and questionnaires, academic articles, theoretical frameworks and methodology processes or training through workshops where project members learned how to conduct research in practice. IT was a necessary tool for creating this space.

It can be concluded that the concept of Ba is a useful tool for understanding the knowledge sharing processes within ProjectNGO. Applying this theory to explaining the knowledge sharing activities helped to identify knowledge sharing took place with diverse stakeholders engaging in university–NGO collaboration. Ba is also a strong theory for explaining the different modes of knowledge conversion and it supports the knowledge sharing activities in the context of the university–NGO collaboration.

However, there are some differences with the original model: an important difference is the use of virtual platforms and ICT applications in all of the spaces. These tools enhanced creation of each space and consequently could be considered essential elements for creating SCSs. In Nonaka's original model, ICT is essential within the cyber Ba and considered an accessory tool for other Ba. In the original model, trust formation starts in the originating Ba and is considered an output of this space. However, in the context of the university–NGO project there was well-established organisational trust due to prior collaboration experiences and the reputations of the organisations. Therefore, trust could be considered an input to the originating SCS. Figure 4-1 shows the different spaces and their characteristics in the context of the university–NGO collaboration.

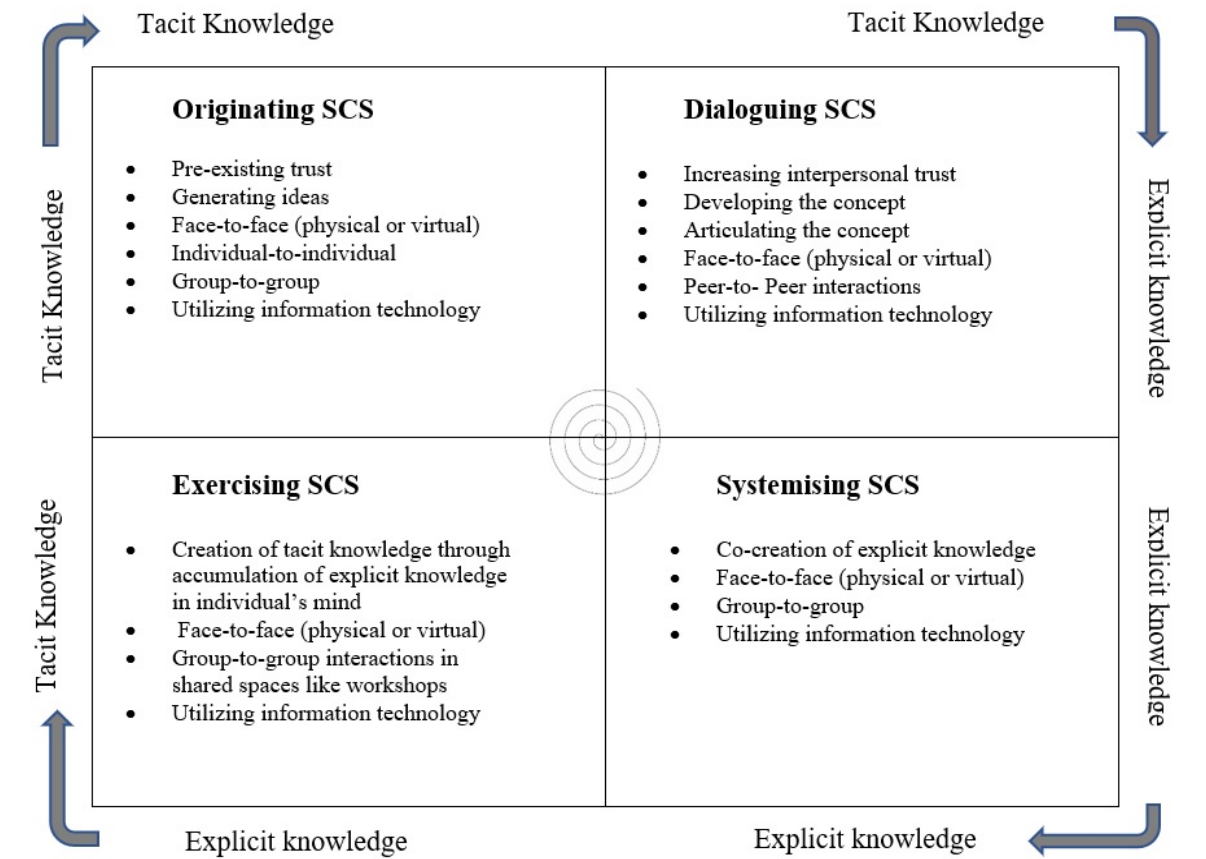


Figure 4-1. Different SCSs within the university–NGO collaboration and their characteristics.

For the university–ProjectNGO collaboration, in practice project members created mostly online SCSs because of the scattered nature of the project such that partners were located in different geographical places. However, they preferred to have face-to-face meetings because of the participatory nature of the project required significant ongoing discussion. Therefore, face-to-face meetings mostly in the originating SCS were the most effective space in supporting knowledge sharing in ProjectNGO. Trust was a precondition in establishing SCSs. In addition, time, resources, common goals, clear timelines and clear objectives were mentioned as necessary conditions to develop collaborative spaces from participants' perspectives.

4-6. Knowledge Assets for Knowledge Creation within ProjectNGO

The kinds of knowledge that an organisation possesses can be considered knowledge assets (Nonaka, Toyama, & Konno, 2000; Nonaka, Toyama, & Nagata, 2000). Knowledge assets are dynamic and constantly evolving. There are inputs, outputs and moderating factors of the knowledge creating process (Nonaka, Toyama, & Konno, 2000). Nonaka and his colleagues did not specify which type of knowledge asset facilitates which kind of knowledge creating process (SECI) (Chou & He, 2004). Chou and He (2004) in their research specified the relationship between knowledge assets and SECI, and concluded that people employ different type of knowledge assets based on the type of task they are performing.

There are four types of knowledge assets according to the knowledge creation model:

- Experiential knowledge assets
- Conceptual knowledge assets
- Systemic knowledge assets
- Routine knowledge assets

Within ProjectNGO, each knowledge asset is described as follows:

Experiential knowledge assets: The shared tacit knowledge which is built through shared, hands-on experiences among organisational members is considered experiential knowledge such as skills and know-how (Nonaka, Toyama, & Nagata, 2000). Experiential knowledge assets are difficult to elucidate because their contents are tacit (Chou & He, 2004). Within ProjectNGO, the experiential knowledge that individuals brought to the project was shared through the exchange of experience among academics in the university, between academics, NGO representatives and researchers, and between the NGO and its community. This facilitated knowledge creation processes which can be categorised into skills and know-how that were acquired by academics through their experiences with different organisations and different research projects or by NGO representatives through their experiences with the community in the field or even new experiential knowledge created as a result of the project. Through their lives and what the women were doing in the field with technology, experiential knowledge was created based on the women's activities and, in turn, not only influenced the specifics of the project but also contributed to a program on mobile phone information and action in Bangladesh. Within ProjectNGO, these assets were primary inputs, outputs and moderators of the socialisation mode in the originating SCS. The following quote from an NGO member shows what kind of experiential knowledge members shared in this project. More examples of experiential knowledge assets are given in Figure 4-2.

I've given examples of how – this project fits within the [NGO] Bangladesh country strategy, as well as the [NGO] Asian Regional Strategy. So probably more on strategic issues. I've shared opinions on possible business development opportunities. Also, earlier on in the project, I shared a lot of opinions with regards to doing things related to sustainability and exit strategy, and shared knowledge around my previous experience working in the ICT development field and also with other ICT development projects in Bangladesh that I was aware of it (NA1).

Emotional knowledge as a subset of experiential knowledge assets such as trust, care, commitment, autonomy and openness also appeared within ProjectNGO in the same way as an organisational context, but trust can be considered an input because the project members trusted each other's knowledge because of the reputations of the partners. They trusted each other because they relied on partners' knowledge, while in organisational contexts trust is created as an output of the knowledge creating processes (Nonaka, Toyama, & Konno, 2000).

Conceptual knowledge assets: These assets consist of the explicit knowledge articulated through images, symbols and languages (Nonaka, Toyama, & Konno, 2000). They are concepts or designs perceived by the members of the organisation (Chou & He, 2004), discussed and then expressed in explicit form. Within ProjectNGO, the tacit knowledge of the project members was articulated in theoretical and methodological concepts and in the content of academic articles. Conceptual knowledge assets were inputs and outputs of the externalisation mode in the interacting SCS. The following interview response outlines a good example of conceptual knowledge assets.

I think that an important knowledge that has been generated for NGO is about the role of research in reframing the goals of NGO, of a big NGO and of a small NGO. This question, how

can we question our role, what will be the importance of technologies, how can we reorient, say, our goals in order to include other ways of doing international cooperation rather than providing just material goods.

So methodological knowledge and also political knowledge. Political in the sense of understanding a goal and objective, a vision of an NGO. For us, at least for me, knowledge has to do with, for example, what does it mean doing participatory research, what does it mean doing research in the field in areas that are so different from the Western part of the world? So, for example, how to deal with problems with data or how to mediate between scientific goals and needs of the communities (R).

A large banner was used as one way of explaining the project to the community. This visually explained the experience in the field and what the women were doing. The poster was designed by a local artist to express the project in a Bengali way to the community. Drawing the diagrams to show research and theory processes in formal and informal meetings also explored a way of sharing conceptual knowledge.

Systemic knowledge assets: In the organisational context, these assets consist of systematised and packaged explicit knowledge such as licences, patents, product specifications, manuals and documented and packaged information about customers and suppliers (Chou & He, 2004; Nonaka, Toyama, & Konno, 2000). Within ProjectNGO, meeting minutes, reports, manual on PAR, data collection tools such as surveys and questionnaires, project proposal, research agenda, academic articles, memos and comments could be considered systemic knowledge assets. They could be shared easily because they were mostly know-what knowledge. They were inputs and outputs of knowledge conversion in the interacting, cyber and exercising SCSs.

Routine knowledge assets: These are practical assets in tacit form that are routinised and embedded in the actions and practices of organisations. They include know-how, organisational culture and organisational routines for doing the daily business of the organisation (Nonaka, Toyama, & Konno, 2000). Within ProjectNGO, through different kinds of workshops, discussions and reflections in the NGO office or university, certain patterns of information and knowledge were shared and created among project members such as about how to do PAR, how to do an interview, how to do surveys with interaction of both sides face to face or virtually. This knowledge was shared and created early in the project has become routine at the end or in later stages of the project. Routine knowledge assets were inputs and outputs of the internalisation mode in the exercising SCS.

Knowledge assets provide the opportunity to identify critical knowledge areas. Figure 4-1 shows the classification of knowledge assets in ProjectNGO.

There were also other relevant information and knowledge in the NGO outside of this project. This information and knowledge were produced by other sections of the NGO. Members did not know about the existence of this relevant information because of the lack of organising and storing it in a systemic way. One of the NGO members in the first round of the interviews mentioned that they were thinking about the management of this information and knowledge.

We yet want to find out what we are thinking about sustainability of our knowledge generated in different projects. Because we were not able to find information we have. We have stored with our systems as different data. We stored content in our laptop and our IT partner, they actually are keeping this all the data on call centre information on the server. Recently we got

permission in [university] system to keep some files in university storage and those are things. We also use the Dropbox (NB1).

The second round of interviews after one and a half years of the project showed that they claimed that there was a clear policy in the NGO in this regard.

From our side [NGO], we basically store things, the specific things, in our Box. Some projects have its own box, like Dropbox. Nowadays, the products we have for second project, those are kept in Box, like the project documents and the learning documents and other project documents. So we keep it in a single space and it is accessed obviously by the NGO and sometimes non-NGO people can also access that [NB2].

It seems that both of the organisations had problems in managing and documenting the knowledge produced by not only this project but also other relevant and similar projects. For example, in the NGO there were other similar projects in different countries and ProjectNGO members were not aware of those or their findings or outcomes.

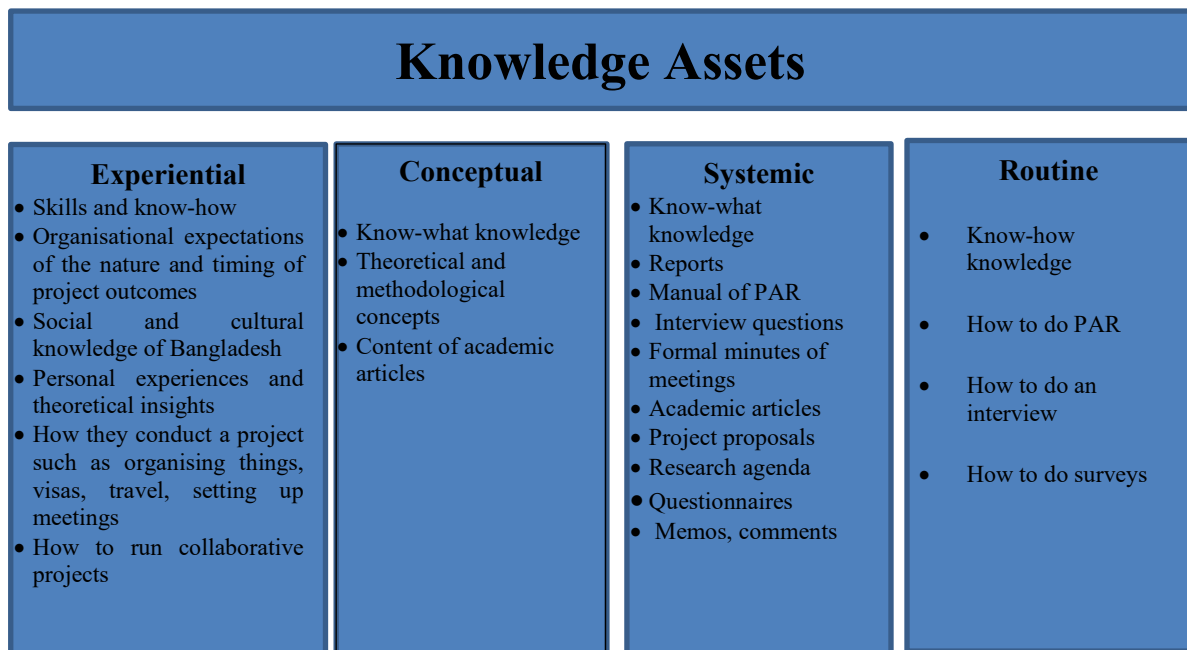


Figure 4-2. Knowledge assets classification in ProjectNGO.

4-7. Chapter Summary

In this chapter, I have applied the knowledge creation model within ProjectNGO. This has shown how knowledge was shared and created through SECI, in which spaces and time (SCSs) and what kinds of knowledge were shared and created (knowledge assets).

Applying the knowledge creation model within ProjectNGO helps to identify knowledge sharing processes. The knowledge creation model consisting of three elements: SECI, Ba and knowledge assets, is a useful tool for understanding knowledge sharing processes. ProjectNGO members socialised through formal and informal meetings, workshops and seminars in physical or virtual SCSs.

Externalisation in ProjectNGO occurred through written and verbal articulation in peer-to-peer interactions. The combination mode was an ongoing process throughout ProjectNGO and led to the creation of more systemised explicit knowledge. Action and practice as the intra-organisational context were fundamental in the internalisation mode within ProjectNGO and discussion and reflection were facilitated by this mode.

ProjectNGO members utilised four types of SCSs during collaboration. Because of the scattered nature of the project, virtual platforms and ICT applications were essential elements for creating SCSs. Care, trust, commitment, openness and autonomy were explored as necessary conditions for developing the originating SCS. Trust was considered an input for the originating SCS because there was well-established organisational trust due to prior collaboration experiences and the reputations of the organisations. However, time, resources, common goals, clear timelines and clear objectives were mentioned as necessary conditions to develop all SCSs from participants' perspectives.

Different types of knowledge assets were shared and created in different modes of knowledge creation (SECI) based on the characteristics of the tasks involved in each mode. Experiential knowledge assets were primarily associated with the socialisation mode in the originating SCS, conceptual knowledge assets were associated with the externalisation mode in the interacting SCS, systemic knowledge assets were inputs and outputs of knowledge conversion in the interacting, cyber and exercising SCSs, and routine knowledge assets were inputs and outputs of the internalisation mode in the exercising SCS.

Chapter 5 applies the knowledge creation model within ProjectIndustry. In Chapter 6, the mechanisms under each process will be identified and the challenges and drivers associated with each process will also be explored.

CHAPTER 5: REPORT ON PROJECTINDUSTRY

5-1. Chapter Preview

This chapter begins by considering the industry case study and introduces the context, the demographic information on the participants and an overview of the coding information. It then presents the application of the knowledge creation model within ProjectIndustry, structured in three main sections. Section 5-4 describes the SECI process; Section 5-5 presents the different SCSs within ProjectIndustry; and Section 5-6 shows the different knowledge assets within ProjectNGO.

5-2. Case Study Context (ProjectIndustry)

Dinoco,⁵ an independent Australian oil and gas company, and the research university established a long-term research partnership to support Australia's low-carbon energy transition. The partnership aims to develop innovative responses to real-world challenges to the energy sector via expertise in both engineering research and design, and IT. This partnership started with opening the FutureLab and Innovation Centre in the research university in 2016. For continuation of the partnership, both partners intend to have more projects and invest jointly.

As part of this partnership, Dinoco provided a considerable donation to the research university. The research university categorised the allocated money according to three related pillars, namely, engineering, additive manufacturing and data science.

The ProjectIndustry that is studied in the current research is a collaborative research project between the research university and Dinoco under the data science pillar. This specific project was not directly funded by and was not a precondition of the donation. After receiving the donation, the research university nominated projects based on Dinoco's needs. One of Dinoco's issues was optimising the layout of the equipment and connecting pipes that form a chemical plant. This process was still being solved manually, taking multiple engineers several years to complete. Dinoco was interested in this project because the aim was to minimise the total cost of the plant while ensuring its safety and correct operation.

This four-year collaborative project started in 2016. The aims of this project were first, developing a method for semi-automatic plant layout design to solve the 3D pipe-routing problem and second, developing a visual interface to display the method that allowed engineers to comment on and guide the proposed prototype⁶ and the processes. In the beginning, a solution was provided for one of the units in Dinoco, delivering a complete prototype to the Dinoco Board in 2017. Then, to make the result more realistic, scalable and interactive, it was improved throughout the collaboration to provide an alternative layout for an entire plant. The next stages of the project considerably extended the 2017 optimisation methods and visualisation tools by adding more stages based on the needs of Dinoco and evaluation of the methods in practice.

⁵ The pseudonym for the industry partner.

⁶ The first draft of the formal specification of a problem is the model and the algorithms that give one or more solutions to the model are the solver.

Dinoco agreed to provide detailed information on the problem and provided permission to the academics to publish. This specific collaboration did not have commercial-in-confidence issues in the beginning. However, my research shows that the commercial nature of Dinoco had an impact on how information could be exchanged during collaboration and how project members had limited interaction during collaboration. In contrast to ProjectNGO, Dinoco was interested more in the end product to solve its own problem, not the process of finding the solution. In ProjectNGO, NGO representatives were interested not only in the end product but also the whole process and conduct of the project were important for them.

The outcome of this project will help to reduce the footprint of the plant and piping costs, the amount of time required to manually design it and the amount of downtime required for maintenance. The research university was responsible for developing a prototype in order to design the layout and developing an interactive 3D visualisation tool to display the proposed methods virtually. The prototype, which included a model⁷ and solver, was developed based on the practical information which was provided by Dinoco. The research university provided computational, visualisation and optimisation input, while Dinoco provided financial support and chemical engineering input such as scope and all the knowledge of the plant. Dinoco was not interested to look at the algorithms and numbers, it only looked at 3D versions of the prototype that were designed by the visualisation team.

Communication between Dinoco and the research university occurred through weekly video progress meetings, bimonthly in-person meetings at the research university and in-person meetings on the Dinoco site as needed that the academic leader attended. The academic leader was responsible for all communication with Dinoco.

5-2-1. Project partners and their roles

In total seven participants from the research university, including two academics from the optimisation area, one academic from the visualisation area and four research fellows, two from optimisation and two from visualisation, and two industry representatives from Dinoco were engaged in this project including a project supervisor and downstream team lead.

The academics involved in this project were drawn from two different disciplines in the research university, namely, optimisation and visualisation. The optimisation team figured out and extracted the real positions of the equipment, plant and pipes based on the information that was provided by Dinoco. The visualisation team used that extracted data to visualise the 3D model.

Academics and research fellows from the optimisation area were responsible for formulating optimisation problem models, applying model transformations to improve model efficiency and developing and using profiling methods to speed up optimisation programs. Academics and research fellows from the visualisation area were responsible for the visualisation of solutions, designing the graphical specifications of constraints in 3D that allowed them to be understood clearly and designing a web-based interface for remote discussion and collaboration.

⁷ There is a distinction between a problem model and a particular model instance. The problem model is the formal specification of a problem where the input data is described in terms of parameters, while a particular model is where the values of the parameters are added to the model. In this context, the focus is a problem model.

The ProjectIndustry supervisor was the main point of contact between Dinoco and the research university. He provided all the guidance that needed to be supplied to the research university and the downstream team leader provided subject matter expertise and practical information on Dinoco's design requirements for existing and future plants. He was also involved in evaluating the outcomes of the visualisation works. The project supervisor and downstream team leader worked closely with the academic leader.

Table 5- 1. Number of project members

Partners	Research University			
Position	Academic		Research fellow	
	Optimisation	Visualisation	Optimisation	Visualisation
Number	2	1	2	2
Partners	Dinoco			
Position	Dinoco representatives			
	Downstream team lead		Project supervisor	
Numbers	1		1	

5-2-2. Outputs of the Collaborative Project

There were different types of outputs for this project:

Practical outputs:

- Development of an interactive 3D visualisation tool (web-based 3D viewer) for remote discussion and collaboration
- Development of optimisation and visualisation software
- Descriptions of structures and processes for existing plant layouts (with which to validate the proposed methods)
- Empirical experiments testing the efficiency and effectiveness of the prototype implementations
- Conference presentations
- Commercialisation of the system (solvers and tools)

Academic outputs:

- Developing a solver to solve the 3D pipe-routing problem in the Dinoco workspace (prototype)
- Publishing academic journal articles: They published two articles and were planning to publish more

5-3. Participants

In total, seven participants from the research university, including three academics from the optimisation and visualisation areas and four research fellows, and two industry representatives from Dinoco, were engaged in this project. The PhD researcher aimed to interview all project members but, because of the unavailability of some members, only a total of five participants were interviewed: four from the research university, including the project leader with expertise in formulating complex optimisation problems who contributed both to the optimisation and visualisation areas of the project, two research fellows from optimisation, one research fellow from visualisation and one participant from Dinoco who was the project supervisor.

Two interviews were conducted over Zoom and recorded using a software recorder. Three interviews were conducted at the research university during normal working hours. The duration of interviews ranged from 25 to 70 minutes. The recorded interviews were transcribed verbatim and then entered into the qualitative data analysis software NVivo 12. In this chapter, participants are identified by codes: e.g. RU1=Research university researcher 1; X=Dinoco. Table 5-2 shows the institutional information of the participants with their assigned codes.

Table 5-2. Institutional information on the participants in ProjectIndustry.

No	Participant Organisation	Participant Role	Code
1	Research university	Project leader: leadership of academic side	RU1
2	Research university	Research fellow	RU2
3	Research university	Research fellow	RU3
4	Research university	Research fellow	RU4
5	Dinoco	Project supervisor	X

5-4. Applying the SECI Process for Knowledge Conversion within ProjectIndustry

As with the ProjectNGO case study, the following sections apply the SECI, Ba and knowledge assets components of Nonaka's frameworks within ProjectIndustry.

Socialisation (from tacit knowledge to tacit knowledge):

In this mode, the communications between the research university and Dinoco when negotiating the project were mostly via the leader from the academic side and both industry representatives. The academic leader was responsible for all the communications and played an important role in the early stage. At the beginning of the collaboration, she visited the Dinoco site in order to obtain an overview of workplace practices, and from then on visited again as needed. This stage was fairly limited and building tacit knowledge occurred between academic leader and industry representatives when they started to talk about procedures in the two organisations, ways of working, and expectations from the collaborative project, and how to use or interpret the manuals related to the problem.

Later in the project, academics socialised with industry representatives in regular meetings, and there was renewed socialisation but this time between more members of both groups, as will be discussed in Section 5-5. The purpose of these meetings was to discuss the application of the new prototype and how it could be used in practice. In Nonaka's model, socialisation typically occurs in traditional apprenticeship and mentorship in an organisation. In contrast, in ProjectIndustry, all academics did not socialise directly with the industry representatives in the initial stage of the project; instead communication occurred by the project leader through a face-to-face visit to the Dinoco site or online meetings.

Externalisation (from tacit knowledge to explicit knowledge):

There was almost no conversion of tacit knowledge to explicit knowledge in the early stages between industry representatives and academics in this mode, as the first real involvement of most academics came with their examination of the documents supplied by Dinoco. However, as the project progressed, after the development of the first tool was shared with the industry representatives and they started using it, academics were able to build on the process of finding different possibilities for the optimal solution, articulating their new knowledge in academic articles in journals or conferences. This could represent a new cycle in the SECI process.

Combination (from explicit knowledge to explicit knowledge):

After receiving detailed information in an explicit form about the design of a new plant and clarifying questions about parts of the layout, the academics started to read and understand the context and problem. Then they discussed the problem among themselves. Based on a precise understanding of the complexity of the plant, the academics started to convert the existing information about the problem into a mathematical programming language and develop a strategy to find the optimal solution to the problem. Through discussion and reflection, the academics used the explicit knowledge provided by Dinoco and combined it with their existing knowledge from their own areas of expertise. The academics' new knowledge was crystallised into an explicit form such as algorithms and mathematical equations for pipe routing, resulting in the initial prototype.

The outputs of the combination mode were consequently a prototype, journal articles and an interactive 3D visualisation tool that will be explained in Section 5-5. The prototype needed to be shared with Dinoco representatives for discussion and evaluation. One of the academics described the process of creating the prototype and outlined that the first version of the tool or optimal solution was created among the academics, then the results were shared with the Dinoco representatives.

We have to create [solution], basically [based on the problem they provide us]. [Creating the solution] has four parts. So, based on the data, we develop a model which can be fed into the optimisation. So, the model basically describes the equipment and certain required information like, for example, safety distances between equipment. Or particular areas which need to be kept empty for maintenance, stuff like that, and that is fed into our input data, or it's actually a case file, the first part.

The second part is the optimisation. It basically tries to get the best possible positions for the equipment. To minimise an object function. And an object function has three parts. It is the overall footprint. So basically the length and the width, and best case you want to get it as small as possible. Length of pipes, if you have a shorter pipe, you need less material, makes it cheaper. And the third part is basically creating a 3D model. Basically, a visualisation of the data. And the fourth part is a viewer which we use to discuss the results with [Dinoco] (RU4).

Discussion and dialogue among academics supported formulation of the plant layout design problem in mathematical programming language. In common with Nonaka's model, peer-to-peer interaction was the basis of articulating knowledge into common terms among the academics. Apart from the development of the specification or description of the problem, there was little interaction with Dinoco before creating the tool and no interaction when creating the prototype.

The interaction with the Dinoco representatives began after creating the first version of the prototype in this mode. During this mode, different versions of the prototype were created based on the initial design. The prototype created by the academics was shared with the Dinoco representatives through regular meetings via computerised communication networks, as will be explained in Section 5-5. In this mode, the Dinoco representatives started to provide feedback based on their expertise, experiential and routine knowledge in regards to the applicability of the prototype in practice. The prototype was modified sequentially based on the Dinoco representatives' feedback. The project supervisor of Dinoco explained what they provided to modify it:

You could say we [Dinoco representatives] provide the information as per our discipline, we're providing the guidance on – at a high level – whereas the [university] guys are taking that guidance and applying it [to modify the tool] (X).

The scientific results of this project which were articulated in academic articles were sequentially modified via academic interactions in this mode. The advice and guidance provided by the Dinoco representatives related to the prototype helped the academics to modify the first drafts of the academic articles. The Dinoco representatives did not have direct interaction in the articulation of the scientific results. The scientific results which were produced by the academics were published in international conferences and journals of either the optimisation or visualisation communities. Conferences and journals were used as the mediums for sharing the scientific results of the project with wider communities outside of the project.

Internalisation (from explicit knowledge to tacit knowledge):

In this mode, explicit knowledge such as the final version of the prototype was delivered and tested in practice in the Dinoco workspace. After testing the prototype in practice (at the Dinoco site), Dinoco learned how to explore and evaluate alternative layouts for realistic pipe-routing scenarios. As a result, it could design a better plant in less time. Practising the prototype in the Dinoco workspace helped Dinoco to understand what was needed and to learn how to employ the resulting system for future products. The feedback provided by the Dinoco representatives after testing in practice assisted the academics in improving and modifying their results.

In addition, a Dinoco representative highlighted that both partners (Dinoco and the research university), as a result of this project, also learned more about university–industry collaboration (UIC):

By doing this collaboration, we've worked out how to work and integrate and engage with the university and what works well and what doesn't work well, and I'm sure they [research university] have had the same experience as well on their side. They have a better understanding of how to work with Dinoco, based off their experience – experiences to date (X).

Based on this collaboration, as processes were internalised in project members' minds, project members gained experience and turned it into tacit knowledge with respect to managing collaborative projects.

5-5. Applying Ba/Shared Collaborative Spaces for Knowledge Creation within ProjectIndustry

The following section illustrates how ProjectIndustry members created various SCSs, namely, originating, interacting/dialoguing, cyber/systemising and exercising spaces, in order to share knowledge.

5-5-1. Originating SCS

Communications in this project started through a visit to the Dinoco site by the leader from the academic side to gain an overview on what was going on in practice and discussion about the project expectations. Tacit-to-tacit knowledge conversion occurred between the academic leader and industry representatives, and included knowledge about the procedures in the two organisations, ways of working, and expectations from the collaborative project, and how to use or interpret the manuals related to the problem. Then communications continued through regular meetings, including face-to-face and online with the academic leader. At the start of the collaboration, there was little interaction between academic members and Dinoco representatives. Most interaction at this stage occurred via the academic leader. It can be said that the other project members did not have the need to create a shared space for interaction because all the required information was transferred by the academic leader at the initial stage.

In addition, data and explicit information about the plant, specific aspects of the plant such as piping, corrosion and maintenance, and the construction of the plant were made available in the originating SCS. In the beginning of the project, this information came mostly in an explicit form such as manuals, specifications, guidelines and books from different stakeholders who were engaged in the actual work at Dinoco. These stakeholders included engineers, specialists, managers at various levels, and the people involved in the construction of the plant itself. As the academic leader commented:

Three kinds of information were primarily shared in this project. The first one is actual data about plant. This information is written. The second one is data about how plant is built already. That is written, talked that is a little bit question marked, questions, and the third one is the objective what is actually we are hoping for. It is reduction cost of the pipe. It is a reduction cost of the support. It is a reduction in the in the foot-print and this has changed through the project and plus terminology about most position of decision part (RU1).

Face-to-face meetings and online media such as Zoom and email were the primary spaces for sharing tacit knowledge, and making available data and explicit information between the academic leader and Dinoco representatives in this project. So tacit knowledge was shared in the originating SCS, but explicit information in the form of documents was also first made available. Email and Zoom will be described in the systemising SCS to avoid repetition. The documents containing explicit information was shared mostly via email because it was easy to share and email was considered a formal channel to track and record shared information within ProjectIndustry. Although the documents were shared at this stage, the explicit knowledge contained within them was not used until the academic researchers started to use them.

5-5-2. Interacting/dialoguing SCS

This is the space for the externalisation mode of the SECI model. As discussed, very little happened in the externalisation mode initially and the conversion of knowledge gained into academic articles after the creation of the final versions of the tools involved only the academics. What did happen in this space was that the academics discussed optimisation and visualisation processes. As noted, the researchers were part of either the optimisation team or the visualisation team. As a consequence, the tasks were divided based on members' specific knowledge and expertise. In the interacting SCS, the academics articulated concepts that could be used in their joint efforts to provide the first prototype and tool. Once the project got underway, the academics moved quickly to the Cyber/systemising SCS, as the focus turned to the combination mode and the development of the first prototype.

Communications and interactions among each team started in this space occurred frequently during a working day. It was spontaneous. However, between the two academic teams interaction also took place weekly through Zoom. One of the academics highlighted how they interacted during this project in the research university as follows:

We at [the research university] use basically Google Drive for pretty much everything. And we have a mailing list. So any communication between the members, even if it is just between two members, goes mostly via that mailing list so everyone knows what's going on. And then we have a shared Google Drive folder where we put all the documents and everything. All our software is web-based, so everyone can access it [RU4].

Interaction among the academics in this space occurred through face-to-face meetings and online media such as email, Zoom, Slack, and Google Drive, which will be described below. Email and Zoom will be described in the systemising SCS to avoid repetition because they were also used in that space.

Slack: This is a cloud-based instant messaging platform developed by Slack Technologies. It is a chat room for communication and sharing information and files among a specific group in one place. Chat rooms can be organised by topic, private groups and direct messaging. The academics used this platform internally to communicate among themselves. The following quote shows how the academics used this platform.

So that is easy for us internally, like our team, like optimisation and the visualisation guys, to create a room for a particular issue and then we all chat about that issue. We [can] create multiple groups with different topics. So once this topic is over, then you go out (RU3).

Google Drive: This space is a file-storage service used internally by the academics to share all the related documents to the project. It was developed by Google and the university had an agreement to use it.

5-5-3. Cyber/systemising SCS

This represents the combination phase of the SECI model. Collective and virtual interactions are characteristic here. In this space, the academics developed the first version of the prototype and visualisation tool, and only later involved Dinoco representatives for them to look at it, suggest refinements discuss its applicability in practice.

One of the academics explained the process of the exchange of explicit information as follows:

A partner will give us the problem, describing the problem in detail. They're also giving us details about the equipment, details about the process, how they come in, not in detail but adequate detail that is required for us to come up with the layout. So, they are mainly explaining the problem in detail and associated constraints and all that. For example, when you have two pieces of equipment, they cannot be really close, they have to be at least this number of metres apart or they have to be within this area, something like that (RU3).

As discussed, routine knowledge of the industry in the form of documents had been provided by Dinoco representatives. As the academic leader explained:

[Dinoco] provides the all the knowledge of the plant, all the data is given by them, and all structure of what part of the plant cannot be optimised at the same time. It is too big. So, we started with the small part. Determining which part, I wanted which equipment? All the equipment; which constraints, what they want there is a very strong component for visualisation of the solutions; what interfaces; what solutions; all that comes from them. Our role is to figure out the algorithms that capable of doing what they want in a reasonable amount of time. And with the quality that they applied (RU1).

The routine knowledge of the industry in practice was shared by Dinoco representatives. It was chemical engineering input for ProjectIndustry.

When they were first trying to kick it off, the information [we] shared was quite simple. It was like a challenge statement. So this is what we as [Dinoco] wanted to achieve and we'd pass that over to [research university] and it was a very high level there and just sort of said, you know, we want to reduce the footprint of our facilities, by reducing the pipe lengths and the equipment layout and it was as simple as that, and then the [research university] guys and [academic leader] picked it up, as something that they could interpret via optimisation. So it was probably the information they shared in the beginning was quite basic, and then from then it's increased. Once that there was interest or once there was interest there it went. It increased to how – how complex the information was being shared [X].

Based on the information supplied and their existing knowledge, the academics articulated the concepts that were to be applied in the development of the first prototype. In this space, after the development of the initial prototype, the academics and Dinoco representatives started to discuss refinements to the prototype and its applicability in practice. Dinoco representatives mostly shared their experiential knowledge verbally through Zoom. As a Dinoco participant said:

To be honest, most of [the knowledge] was in verbal format during our videoconferences and I'd say very little of it was shared via email. So predominantly it was shared verbally via videoconference.

Because of the type of information, which was about working practices and organizational routines for carrying out day-to-day business on the site and experiential knowledge of individuals, verbal sharing was considered a suitable method by the Dinoco representatives.

Based on the functions of the prototype in the virtual interface and the feedback from Dinoco representatives, a different version of the prototype was created. Zoom, email, Gitlab and an interactive 3D visualisation tool were used as shared spaces for interaction that will be described as follows:

Zoom: This virtual shared collaborative space played an important role. Because of the distance, project members preferred to use Zoom for regular meetings. One of the participants highlighted why they used Zoom more.

Our collaborators are not here in [City A], they're in [City B] and the visualisation team is in [another campus]. So the three teams get together through Zoom, which enables us to have video chats and share our computer screens, which is more effective in showing our work and sharing how we did it and why we did it, and then that enables other parties to understand why we did it and suggest more ideas (RU3).

Project members used Zoom in regular weekly meetings to discuss the prototype and any related problems.

Email: They used email for sharing documents and files and anything that was not addressed in the meetings. A Dinoco representative stressed that:

Most communications will be sent via email, whether they be updates or reports or response to questions that didn't get answered at the videoconference, they will be sent via email and the occasional phone conversation (X).

The majority of the project members did not discuss the usefulness of email. However, two of them thought that email was not best way for knowledge sharing.

Sometimes information I think takes a long time to come and the reason why sometimes it is interrupted from the [Campus A] to [Campus B] is because we do not collaborate as much and not face-to-face, it is always by email. And email is awful. It is not a fantastic way of collaborating, particularly between two people that have different cultures (RU1).

Within ProjectIndustry, cultural differences led to misinterpretation of information that was shared by email.

When sharing virtually the – the hardest part is being able to convey what you're talking about, because what you write is read verbatim. You have to think about how it's being interpreted on the other side. So I guess that's one consideration (X).

Despite the usefulness of email which was stated by a minority of the participants, the interview data shows that email was mostly used for sharing data and information in collaboration between the research university and Dinoco partly because of the type of information, which was suitable to share via email, and partly because of the strict policy of Dinoco towards Google products. The academics at the research university used Google products like Google Drive for sharing documents and information. However, Dinoco staff were not allowed to use Google products. So the Dinoco representatives did not have access to shared Google Drive. As a result of that, they decided to share information via email.

GitLab: This is an open-source DevOps platform. It is mostly used by teams who collaborate and build software in order to share codes. It also provides remote access to Git repositories that in turn have more features in order to help in the management of the software development lifecycle. The academics used it internally because the research university subscribed to it. One of the academics stated that:

There is a global GitLab, which is GitLab.com. But Research University has its own site with GitLab. So, all of the GitLab service is to be used because if Research University said it, it's confidential and so on. So that is just a code versioning system. Well, Git is the code versioning system. But GitLab is a host or a service which provides that and more, like continuous integration (RU2).

Interactive 3D visualisation tool: This interface was one of the outputs of this project. It was a specific web-based interface for remote discussion and collaboration, and allowed all the people who were involved in this project to communicate about the design of a new plant, question parts of the layout and provide feedback on further iterations of the plant design. It played an important role in the systemised SCS. Through this interface, people could connect and view the 3D model. Everyone could rotate and zoom the prototype via linked views and navigation. Any connected user could control the interface. The characteristics of this web-based interface such as labelled mouse pointers for each user, means of highlighting and selection allowed each individual to drive conversations and suggest changes within the prototype based on their own areas of expertise. One of the academics explained this interface as follows:

There is an interface that the guys are creating. It actually enables a shared view, a shared, three-dimensional view of the layout. So people on different, actually, on different sides of the internet can look at the same model, in the same view angle, and can together move, rotate and so on. And so collaboratively explore a single module. That's the tool which is being developed as part of this project (RU2).

A web-based interface was one of the main outputs of this collaboration and used as a main shared space to demonstrate the prototype between Dinoco and the research university in order to provide feedback and discuss its applicability in practice.

Social media: Project members did not use social media for communication because it was a confidential project. The type of information shared was suitable for video, verbal or email communication. However, the academics internally used Slack, GitLab and Google Drive for communication as explained in discussion of the previous space.

Dinoco had its own infrastructure. For example, the staff were not able to use Google products because of the strict policy of Dinoco in order to use and share files. They used Zoom for communication. But they were not able to access any other products for communication because of the commercial nature of Dinoco. Most of the information created by this project was shared via email, as a Dinoco representative stated:

It's all [documentation] managed on the [research university] side of the project. We have access to some of the information. Most of the information, if it's sort of like minutes of meetings and things like that, are created by [the research university] and they share that with us via email. We do record minutes of meetings here on the [Dinoco] side

as well and we keep them internally and unless requested by [the research university] we don't share them with them (X).

In this project, social media as a shared space was not used because of the type of the project and the Dinoco policy that restricted access to other products.

5-5-4. Exercising SCS

Internalisation of SECI occurs in this space, wherein the produced explicit knowledge of the project is internalised in an individual's mind. The academics absorbed the produced explicit knowledge such as algorithms, mathematical formulae and codes via application in developing the prototype and interactive 3D visualisation tool. The Dinoco representatives learned and internalised prototype via testing in practice. It can be said that this was akin to learning-by-doing. Testing the prototype in practice happened on the Dinoco site. Interaction between the academics took place in the research university via face-to-face meetings or online meetings. That is, the members of both partner organisations created their own spaces in each site, either the university or Dinoco, in order to internalise the produced knowledge. The interactive 3D visualisation tool was a shared space between the academics and Dinoco representatives after testing the prototype in practice. If the prototype did not work in practice, Dinoco representatives provided their own insight and feedback through this space.

Trust, commitment and openness were explored as characteristics of all SCSs in ProjectIndustry. Trust was established from the beginning of the project and was developed during the collaboration. Commitment and openness between Dinoco representatives and academics appeared after the actual start of interaction between Dinoco and university members in the systemising SCSs.

Trust: Various types of trust were discussed in the ProjectNGO case study. Within ProjectIndustry, there was strong organisational trust. The academics trusted the Dinoco representatives' information and knowledge because they relied on their knowledge in practice. As one of the academics stated:

I trust their knowledge a lot. In terms of partners, I believe they are experts in their field about how the process plant works, how they build or they design it, so I have to trust them [RU3].

The Dinoco representatives trusted the academics' knowledge because they had past collaborative experience. According to past experience, they built trust based on academic justifications of what, how and why they were doing particular things for specific topics.

I guess we – what we've done in the past is we've – when we've decided, and we've had the university team make a decision on a certain part of the project, we've gotten them to describe to us what – why they landed on that decision and what the alternatives were that they considered. So at least that way we've become informed of what they've done and why, and that's how I guess we've built up trust that we – they're making the correct decisions and vice versa, just through their justifications of what they're doing and why (X).

Interpersonal trust was also developed in this project from the academic viewpoint. One of the academics reinforced about why they trusted the Dinoco representatives.

I guess, if the software we are developing works, then I can trust that the information that the notes have given was correct. So that is how I can [trust them] (RU4).

Based on the applicability of the results of the first stage of the project in practice, the academics concluded that the Dinoco representatives were expert in their own field and provided reliable information and knowledge during this collaboration.

Commitment: Project members talked about “we”, which reflects their commitment to each other and the project. Commitment shows the dedication of the members to doing their assigned tasks related to the project and other members. One participant said that:

We always have several algorithms in our head, then we discuss them. Then some come to us and could [change them]. By that time, you see the same things. Then you [examine] them and then change them (RU1).

The creation of joint publications, software tools and different platforms were mentioned as factors enabling commitment by academic members to the project, and to each other. One of the academics described how they felt involved in the project through achieving specific outcomes.

We had two papers. Two papers about the optimisation part, and we have established a workflow which consists of four parts. Which are several software tools, different platforms, different languages, which we will now deploy to [Dinoco]. So there's two papers, which is basically good for us. As well as the software which will be deployed to [Dinoco] (RU5).

In addition to the publication as per university expectations, for academics being involving in developing a tool which helps industry in performing its own tasks can be considered a factor enabling member commitment. As one of the academics stated:

Through this project, we have created some publications which have already been accepted and published last year and we are also planning on submitting a new paper out of this collaboration. If you don't know, this is a state-of-the-art tool. I don't think there's a better tool than this at the moment in the world. So we get research output in terms of the university expectations. So that is the tool that is needed for industry and this is going to be used. That's the key. This is not just a research output. This is a tool that is a research output as a result of developing it as the last tool that will be used and which will be used to save a lot of time and money for the industry when they start using it (RU4).

Openness: In ProjectIndustry, members were open to sharing and accepting new ideas and changing the directions and methods during collaboration. For example, participants stated that:

One of the learnings that [Mr X] and I picked up from, through, I guess, our regular catchups with [the research university] was regarding a product that we already used internally. For our own engineering work, we were getting the [research university] guys to see whether they could adapt our own tool to the project's needs, at which point they became quite highly skilled in that program and they were able to then teach us a little bit about it as well at the same time [X].

Research is constantly sharing knowledge. Every time they did something, you learned something. For example, while routing the pipes we found out the path for the pipe at the same time. And it was too expensive so we routed it individually, phase one. That was set. The next

phase, that was not set. [Dinoco] was not happy with that, because obviously that one was not optimum. The first decision phase passes to the second decision and you can change it because it was better, so that's what we did So we had the belief that we wanted to figure out how far from the optimum we were. So we figured out the way, we decided to lay each pipe individually without anything else [RU1].

In order to find the solution to an existing problem, the project members accepted new insights and ideas proposed by other project members and made changes to processes as needed. However, in sharing and implementing those ideas in practice, the Dinoco representatives needed to consider their employer's direction and policy.

Table 5-3 summarises the differences discussed about how the different SCSs operated within ProjectIndustry.

Table 5-3: Categorisation of shared collaborative spaces within ProjectIndustry.

SCSs=Ba	Originating	Interacting/ Dialoguing	Cyber / Systemising	Exercising
Knowledge conversion	Tacit–Tacit	Tacit–Explicit	Explicit–Explicit	Explicit–Tacit
Level of members' engagement	Individual	Individual/Group	Group/Project	Project/Individual/ Organisation
Characteristics	- Well-established trust - Limited interactions - Exchange of explicit information - Using ICT applications	- Task-based - Grouped individuals based on specific knowledge - Using more ICT applications	- Using more ICT applications - Creation and co-creation of the knowledge - Commitment - Openness	- Action - Reflection - Feedback - Commitment - Openness
Tools	- Face-to-face meeting - Virtual face-to-face meeting (Zoom) - Email	- Face-to-face meeting - Virtual face-to-face meeting (Zoom) - Email - Google Drive - Slack	- Virtual face-to-face meeting (Zoom) - Email - Google Drive - Interactive 3D visualisation tool (web-based interface) - Slack - GitLab	- Face-to-face meeting - Virtual face-to-face meeting (Zoom) - Interactive 3D visualisation tool (web-based interface)

5-5-5. ProjectIndustry SCSs compared to Nonaka's model (Ba)

The following narrative presents what happened in ProjectIndustry when mapped to Nonaka's model (Ba). Mapping to the model shows that knowledge was shared and created in the SCSs. However, in some spaces the characteristics of each SCS were different from the original model.

In the originating SCS, although the academic leader made some visits to the Dinoco site, virtual interactions were important for ProjectIndustry in this space. There was limited socialisation and tacit knowledge conversion between academic leader and industry representatives, however for most academics there was no initial involvement in socialisation. Since there was a predefined problem to be solved, documents containing explicit information associated with the problem were made available in the originating SCS but only tacit information about the nature of the documents was exchanged at that point. The originating Ba in original model, mainly offers a context for socialisation and building tacit knowledge (Nonaka, Toyama, & Konno, 2000). However, in the ProjectIndustry, originating SCS could be a space for providing access to explicit information, partly because it was needed for the project to continue and partly to assist in exchanging tacit information about the nature of the documents. There was no explicit to tacit knowledge conversion in this space, and the academics only accessed the content of the documents in other SCSs. They used email for exchanging information. Technology was a necessary tool for creating this space. Another important difference with the original model is that trust was already developed before starting the project. In comparison to the original model, experiential knowledge did not exist as output and input for this space, due to the less direct interaction in this space between the academics and Dinoco representatives.

In the dialoguing SCS, the tacit knowledge of the academics was converted into an explicit form, but this was primarily between the members of the two academic teams to discuss their respective areas of knowledge in order to commence work on the development of the prototype, which occurred in the systemising SCS. Dinoco representatives did not have a direct role in conceptualisation either in the dialoguing SCS or the systemising SCS. Tacit-to-explicit knowledge creation occurred peer-to-peer and face-to-face either physically or virtually among academics. Because of the technical nature of the project, IT was a necessary tool for creating this space.

In the systemising SCS, interactions between academics, using the documentation previously supplied by Dinoco and the application of their disciplinary knowledge, the academics created a prototype and an interactive 3D visualisation tool. After developing the prototype, the Dinoco representatives and more academics started to interact directly. Then the prototype was modified sequentially. The further development of explicit knowledge (the prototype) reached a confirmed final version with the direct interaction of the Dinoco representatives. The interactive 3D visualisation tool was used for testing the prototype in the virtual space. IT was a necessary tool for creating this space. Experiential knowledge (commitment and openness) between the Dinoco representatives and academics was important in this space.

In the exercising SCS, the produced explicit knowledge (the final prototype) was delivered to Dinoco and tested in practice. The produced knowledge was internalised in the academics' minds as tacit knowledge through developing the algorithms, mathematical formulae and codes. Dinoco representatives internalised the final developed model via testing in practice and consecutively improving the Dinoco routines. The interactive 3D visualisation tool was used in this space after testing the prototype in practice. If the prototype did not work in practice, the 3D visualisation tool was used for interaction to get feedback. IT was a necessary tool for creating this space.

The application of Ba helped to explain the knowledge sharing process within IndustryProject and to understand the processes involved. Ba is a strong theory and supports the knowledge sharing activities in the context of the UIC. However, there are some differences between the original model and my findings.

The most important difference is the use of virtual platforms and ICT applications in all of the spaces. Trust was an input for creating the SCSs. However, in the original Ba model trust is considered an output of this space. More direct interactions between the academics and Dinoco representatives started in the Systemising SCS after developing the prototype. The experiential knowledge of the Dinoco representatives was added into the Systemising SCS.

Figure 5-1 shows the different spaces and their characteristics in the context of the UIC. As shown in Figure 5-1, in the ProjectIndustry originating, dialoguing, systemising, exercising SCSs were created during collaboration for knowledge sharing. Compared with ProjectNGO, originating SCS was limited for socialisation and it was also a space for making available explicit information for use later in the project. The role of the dialoguing SCS was also limited in this case, as it was used by academics only, to create some initial conditions and concepts to assist the two teams in working together. Consequently, Dinoco representatives were not involved in the dialoguing space.

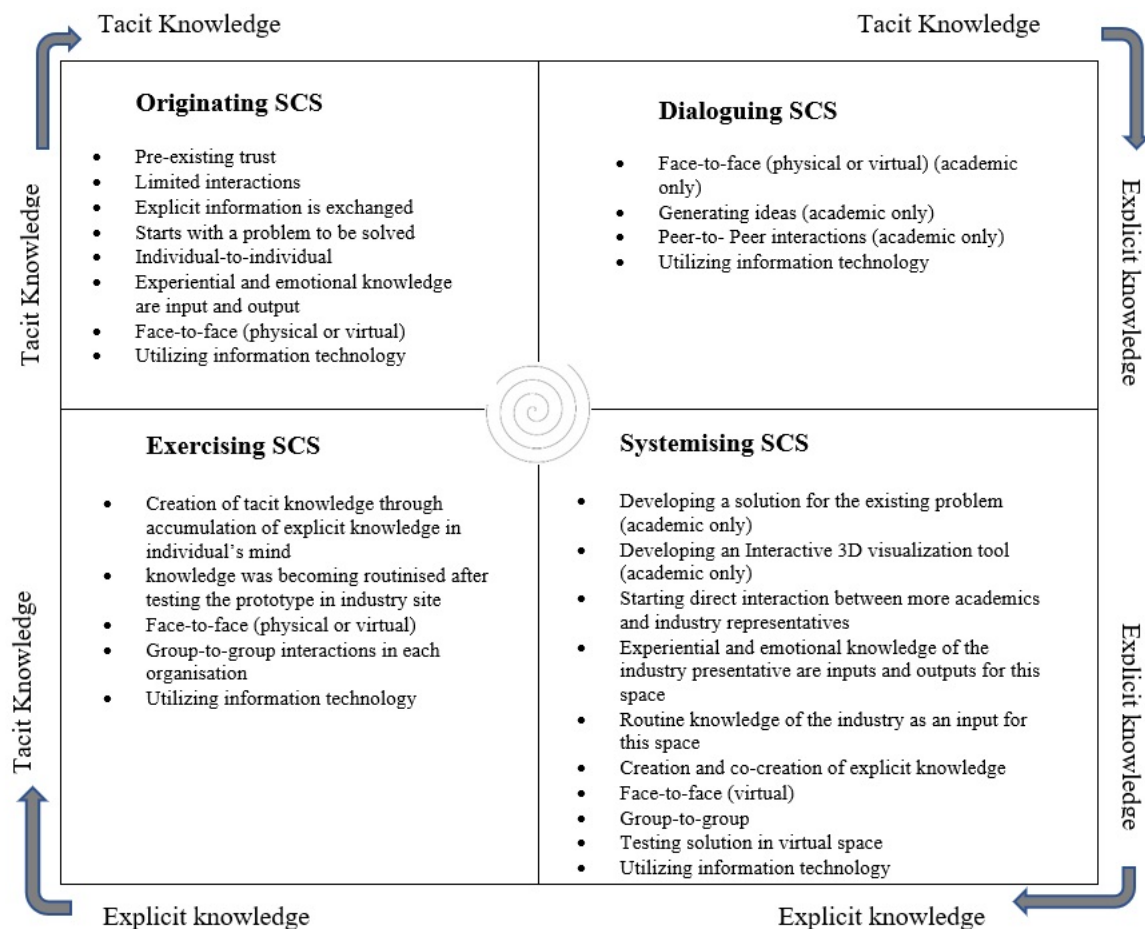


Figure 5-1. Shared spaces and their characteristics in ProjectIndustry.

For ProjectIndustry, although project members mentioned that they preferred to have face-to-face meetings, in practice they created mostly online SCSs because of the nature of this project and the characteristics of the web-based interface used. Since the topic under discussion in the project was technical, project members preferred to share technical and mathematical information via specific communication tools such as Slack and Gitlab. In addition, partners were located in different geographical places, therefore they needed to have virtual meetings. The characteristics of the interactive 3D visualisation tool also allowed each individual to drive conversations and suggest changes within the prototype based on their own areas of expertise. As a result, it can be concluded that online SCSs were the most effective spaces in supporting knowledge sharing in ProjectIndustry.

Based on the characteristics of the spaces as described above, trust is a precondition for establishing SCSs. Trust can be considered an input for the academics. They trusted the Dinoco knowledge and relied on it because Dinoco was giving them knowledge about its practices and needs, while Dinoco representatives needed to build trust based on past collaborative experience. Trust was created as an output of the knowledge creation process for ProjectIndustry.

In addition, having a clear understanding of the project scope and methodology, common topic, understandable scope and specific room for discussion were mentioned as necessary conditions to develop SCSs from participants' perspectives. Having specific room for discussion even for virtual meetings was also mentioned as a condition of establishing SCSs.

5-6. Knowledge Assets for Knowledge Creation within ProjectIndustry

As with the ProjectNGO case study, within ProjectIndustry the four types of knowledge assets explored according to the knowledge creation model are experiential, conceptual, systemic and routine. The various types of knowledge assets were discussed in the ProjectNGO case study. The knowledge assets within ProjectIndustry are described in the following section.

Experiential knowledge assets: These can be categorised into skills and know-how knowledge. In ProjectIndustry, these assets were inputs, outputs and moderators of the socialisation, combination, and internalisation modes in the originating, the systemising, and the exercising SCSs. Within ProjectIndustry, shared tacit knowledge emerged through the exchange of experience among the academics within the research university, among the industry representatives in Dinoco, and between the academics and industry representatives. For the Dinoco representatives, these assets were acquired through their experience with other partners, past collaborative experiences and actions on site through involving other focal points like engineers. The academics acquired experiential knowledge through their experience with different organisations and different research projects.

In the socialisation mode, the experiential knowledge of the Dinoco representatives was about how to use data, manuals and guidelines in regards to specification of the pipes and equipment. One of the academics explained what kind of information they got through collaboration before developing the prototype.

They provide us with data to develop the model. So, for example, they give us information about the equipment, size of equipment. They give us information about how that equipment is connected. So you have Equipment A and Equipment B and there is a pipe between Equipment A and B, and we get all the necessary information to do the optimisation and visualisation (RU4).

In the combination mode, after the initial prototype had been developed, the Dinoco representatives' skills, which were know-how knowledge about how they worked in practice, were shared with the academics. The Dinoco representatives talked about the discipline (chemical or process engineering), skills and know-how knowledge which they gained during work. However, they needed to add and share their personal opinions to the project. A Dinoco representative said that they could probably share their personal experience with other project members to some extent:

[They] would come through in some of the discussion, personal opinions and the like, as an influence on what and how the project moves. Most of the opinions and [know-how knowledge] are shared based on Dinoco direction. Personal opinions are probably added as required (X).

The academics shared tacit knowledge of the application of optimisation technologies, design and evaluation of visualisation tools, and formulated complex optimisation problems among themselves in the externalisation mode before they developed the prototype and interactive 3D visualisation tool. Furthermore, through this project both of the partners learned how they could collaborate and work with external stakeholders.

Conceptual knowledge assets: Within ProjectIndustry, conceptual knowledge assets were inputs and outputs of the externalisation and combination modes in the dialoguing and systemising SCSs. The Dinoco representatives did not have any role in creating or sharing these assets, other than to supply the base data required by the project. The academics' tacit knowledge, including that which developed during the project and their own scientific knowledge was articulated into the content of academic articles, the prototype and other new technology. The following interview response shows how the academics generated conceptual knowledge in this project.

[This project] was used to generate a solution to the problem that [Dinoco] has. [This project] generates a tool that allowed [Dinoco] to do something that before it could not do in the process, helping them, we think [about the reason that Dinoco asked us]; why does [Dinoco] want? how does [Dinoco] want it and how to design it, and it is also in the process helping us to test limits of our technology and figure out what is missing and how we can fix it. And that why we produce papers and so it is generating knowledge in different ways (RU1).

Systemic knowledge assets: Within ProjectIndustry, these assets were inputs and outputs and were primarily used in the combination modes in the systemising SCS. Actual data about the plant and constraints in written form, as manuals, mathematical formulae, terminology, algorithms, the prototype, academic articles, meeting minutes and reports, are considered systemic knowledge in this project. They are explicit know-what knowledge, so they were shared easily during this collaboration.

Routine knowledge assets: Within ProjectIndustry, these practical assets were inputs to the combination mode in the systemising SCS. These assets were know-how knowledge that was routinised in action for Dinoco when it tested the prototype in a web-based interface in the systemising SCS and applied the prototype in practice. This was Dinoco's existing routine knowledge about the pipework. Industry representatives shared this base level pipe knowledge when the testing the prototype in web-based interface. Furthermore, after practice the prototype in the site, knowledge about how to improve the layout of the pipe was shared and created, and was becoming routinised. As a result of the project, Dinoco learned how to reduce the costs of piping.

Figure 5-1 shows the classification of knowledge assets in ProjectIndustry. In ProjectIndustry, experiential knowledge can be considered tacit knowledge and conceptual, routine and systematic knowledge can be considered explicit knowledge.

Knowledge Assets			
Experiential	Conceptual	Systemic	Routine
Skills and know-how	Know-what knowledge	Know-what knowledge	Know-how knowledge
- Skills and know-how that are retained by industry representatives from their working experiences - Knowledge about how to work and engage with the partners (industry and university) - Personal experiences and theoretical insights (mostly academics) - Tacit knowledge of application of optimisation technologies, design and evaluation of visualisation tools (university) - University learned the processes of industry daily practices	- Methodological concepts in developing new technology and prototype - Content of the academic papers	- Actual data about plant and constraints in written form - Manuals - Mathematical formulae, terminology - Computer programs - Prototype - Academic articles - Reports - Meeting minutes	Existing routine knowledge about the pipework

Figure 5- 2. Knowledge assets classification in ProjectIndustry

5-7. Chapter Summary

In this chapter, I have applied the knowledge creation model within ProjectIndustry. This has shown how knowledge was shared and created through SECI, in which spaces and time (SCSs), and what kinds of knowledge were shared and created (knowledge assets). As with the ProjectNGO case study, applying the knowledge creation model within ProjectIndustry helps to identify knowledge sharing processes. SECI, Ba and knowledge assets are useful tools for understanding the knowledge sharing processes.

To summarise, in the beginning of the project, the communications between the research university and Dinoco occurred mostly via the leader from the academic side and both industry representatives. The academic leader was responsible for all the communications and played an important role in transferring explicit information about the design of the new plant and questioning parts of the layout. Little knowledge was exchanged in the externalisation mode, and what was exchanged was primarily between the academic teams in preparation for the development of the prototype and other outputs in the combination mode. Industry representatives did not have a direct role in the conceptualisation or tool development, and the direct interaction between the Dinoco representatives and academics began after the first version of the prototype was created in the combination mode. Dinoco representatives provided feedback about the applicability of the prototype in practice based on their expertise, experiential and routine knowledge.

In the internalisation mode of the SECI, the final version of the prototype was delivered and tested in practice in the Dinoco workspace. Testing the prototype in practice provided opportunities for Dinoco to learn how to explore and evaluate alternative layouts for realistic pipe-routing scenarios. Dinoco learned by doing in practice.

ProjectIndustry members utilised four types of SCSs during collaboration. Because of the technical nature of the project, virtual platforms and ICT applications were essential elements for creating SCSs. Trust was explored as a necessary condition for developing the SCSs. Trust was considered an input for the originating SCS because there was well-established organisational trust due to prior collaboration experience. Commitment and openness were explored after the actual start of interaction between Dinoco and more university members in the systemising SCSs. However, having a clear understanding of the project scope and methodology, common topic, understandable scope and specific room for discussion were mentioned as necessary conditions for developing SCSs from participants' perspectives.

Different types of knowledge assets were shared and created in the different SCSs based on the characteristics of the tasks involved in each space. Experiential knowledge assets were primarily shared in the originating SCS. In addition, these were shared in the systemising and the exercising SCS as the project progressed. Conceptual knowledge assets were inputs to the externalisation mode in the interacting SCS and outputs of the combination mode. Systemic knowledge assets were inputs and outputs of the externalisation and combination modes in the interacting and systemising SCSs. Existing routine knowledge assets were shared in the combination mode in the systemising SCS.

Chapter 6 discusses and identifies the mechanism under each process for both projects, with Dinoco and the NGO. It also explores the challenges and drivers associated with each process.

CHAPTER 6: FINDINGS, IDENTIFICATION OF CONTEXT-SPECIFIC KNOWLEDGE SHARING MECHANISMS

6-1. Chapter Preview

The previous Chapters 4 and 5 presented the mapping of the knowledge creation model to the NGO and industry projects. It was shown that project members derived knowledge from the project and from each other through knowledge conversion modes in shared collaborative spaces (SCSs). After mapping to the model in Chapters 4 and 5, in this chapter the data is examined, coded and reviewed using the thematic analysis approach that was presented in Chapter 3 to answer the following research questions:

RQ1. How is knowledge shared in university–organisational collaborative projects?

RQ1-1. What are the drivers and barriers in the knowledge sharing processes of university–organisational collaborative projects from participants' perspective in Australia?

For theme identification, codes were grouped together to develop themes according to their content similarity, theoretical links and frequency of occurrence. The extracted themes reflect active actors' perspectives and experiences of how knowledge was shared. The themes are named according to their content and knowledge creation process within the NGO and the industry projects that were presented in Chapters 4 and 5 and within the literature. I have considered the extracted themes as mechanisms of knowledge sharing. Each mechanism has relevant codes/sub-themes and the important codes associated with each theme are called practices for knowledge sharing. The extracted practices are supported by relevant statement from the interviews. Note that where people (liaison person) and things (email) are described as practices, it is not so much those people and things that represent the practice, rather the activities associated with them and how they are managed.

The final analysis revealed six themes/mechanisms:

- **Exchange:** This mechanism occurred throughout the socialisation process in the originating SCS of Nonaka's knowledge creation model, that is, after the project was defined in the initial stages of the collaboration. For ProjectNGO, this involved sharing direct experience and building tacit knowledge to generate ideas. For ProjectIndustry, there was limited tacit knowledge exchange and a number of documents were made available. The exchange mechanism for both projects occurred throughout the project. However, it was intense in the beginning of the project. Characteristics of this mechanism are: tacit-to-tacit knowledge conversion through exchange of direct experience and reaction for ProjectNGO and ProjectIndustry; and the provision of documentation or explicit knowledge about the routine actions of Dinoco.
- **Articulation:** This mechanism occurred throughout the externalisation process of Nonaka's model in the dialoguing SCS for ProjectNGO and ProjectIndustry and in the early stage of combination mode in the systemising SCS for ProjectIndustry. In this mechanism, the tacit knowledge of the individuals was first turned into explicit knowledge which could be refined during later processes. For ProjectNGO, writing academic articles, documenting project objectives and designing data collection tools such as surveys and questionnaires were means for converting individuals' tacit knowledge into an explicit form. For ProjectIndustry, writing academic articles, developing prototypes and algorithms for pipe routing and developing an interactive 3D visualisation tool also involved converting tacit knowledge into an explicit form in the initial stages of those tasks. In the

articulation mechanism, project members were divided based on their expertise in specific tasks. Characteristics of this mechanism are: crystallising and articulating tacit knowledge into explicit form by writing for ProjectNGO; and writing and developing initial concepts for prototypes and tools for ProjectIndustry through peer-to-peer interaction.

- **Modification:** This mechanism occurred through the combination process in the systemising SCS of Nonaka's model. In this mechanism, an explicit form of knowledge for use by the project was created and shared sequentially based on the first version of the concepts developed in the articulation mechanism. For ProjectNGO, different versions of explicit knowledge such as data collection tools like surveys and questionnaires, and academic articles based on discussion and revision could emerge sequentially from each of the project's members through group-to-group interaction. For ProjectIndustry, different versions of the prototype and algorithms were developed through group-to-group interaction (between Dinoco representatives and academics) in a web-based interface. Dinoco representatives provided their insights and opinions about the first version based on their experiences in practice. All of the team members become involved in sharing and creating new versions of explicit knowledge that were previously created in the articulation mechanism. Therefore, creating different versions of explicit knowledge through group-to-group interaction is the main characteristic of this mechanism.
- **Accumulation:** This mechanism represents the internalisation process of Nonaka's model in the exercising SCS. In this mechanism, finalised/created explicit knowledge was absorbed by individuals (project members) and accumulated as tacit knowledge in their minds. In other words, this mechanism represents the creation of new tacit knowledge based on the learning and use of the explicit knowledge shared through the previous mechanisms. In ProjectNGO, the explicit knowledge was accumulated in individual minds after reading, writing, discussion and reflection in the exercising SCS in the university and the NGO site. In ProjectIndustry, explicit knowledge developed by the project became tacit knowledge in individuals' minds as they used and became familiar with the prototype on the Dinoco site, without the interaction of the academics, and writing and discussion on the university side, without the interaction of the Dinoco representatives. Learning and practising are the main characteristics of this mechanism.
- **Feedback:** In this mechanism, ongoing findings and information about the processes and context can be shared. This included comments and suggestions made by project members about processes and contexts that were already developed. The obtained feedback helped project members to refine their thinking, select methods and develop new insights in doing assigned tasks. This mechanism has some similarities with the modification mechanism, but it is also different because the modification mechanism focuses on explicit forms of knowledge that were already created by project members. However, the feedback mechanism is about project processes or routine activities, either explicit or tacit. It can be constant or in written format. For ProjectIndustry, this mechanism occurred throughout the project in SECI. Feedback was constant between the academic participants. However, feedback only occurred between the academics and Dinoco representatives at a certain point, in the combination and internalisation modes of SECI, after developing the prototype and testing the tool in practice (Figure 6-10). For ProjectNGO, this mechanism occurred throughout the project in SECI via monthly interviews with a smaller group of people, email and doctoral students' presentations.

- **Transfer:** In this mechanism, finalised knowledge, progress reports and actual prototypes and tools (intuitive knowledge) were transferred from the project to the organisation (Dinoco/NGO and university) or from Dinoco/NGO to the university. For both projects, this could happen throughout the project in any of the originating, dialoguing, cyber and exercising SCSs that are the basis of SECI. In addition, early know-how/know-what knowledge and finalised knowledge of the project were transferred from the project to wider audiences. For ProjectIndustry, early know-how/know-what knowledge could be transferred via an academic article format to share early stages of the developing prototype with wider audiences. Transferring outcomes for both projects in written format and developed prototypes for ProjectIndustry are the main characteristics of this mechanism.

This chapter details the identification of the six context-specific knowledge sharing mechanisms (RQ1). After identifying the mechanisms, the related challenges and drivers associated with each mechanism are then identified, based on the active actors' perspectives. The discussion of the challenges faced in each mechanism will be noted at the end of the discussion of that mechanism and then discussed in detail in Section 6.3 (RQ1-1).

6-2. Knowledge Sharing Mechanisms

6-2-1. Knowledge sharing through exchange mechanism

For ProjectNGO, academics and the NGO representatives learned from each other and reacted through the exchange of experience and information. As in Nonaka's model, sharing direct experience and building tacit knowledge occurred through observation and discussion in physical or virtual collaborative spaces in ProjectNGO (Figure 6-1). In Nonaka's model, socialisation typically occurs in a traditional apprenticeship, a mentorship or in on-the-job training, or via participating in informal social meetings and discussions within an organisation (Nonaka, 1994; Nonaka & Takeuchi, 1995). In an organisational context, members learn from each other through shared hands-on experience and physical proximity (Nonaka, 1994; Nonaka & Takeuchi, 1995). The ProjectNGO members socialised in regular meetings (formal and informal). Face-to-face interactions were especially important for the ProjectNGO members. However, they mostly socialised virtually because of the geographical spread of the project. They communicated and exchanged experiences, ideas and beliefs via regular meetings, conversations and discussions about project-related problems and issues. Project members learned from each other and reacted through talking.

For ProjectIndustry, sharing direct experience and building tacit knowledge (empathising) was initially limited to interactions between the academic leader and industry representatives, as was discussed in 5-5-1. However, additional information was made available in the form of documentation using this mechanism. This was because tacit knowledge relating to how to use or interpret the documents needed to be exchanged so as to assist with later stages of the project. This was mostly a one-way transfer of information and data. As one of the academics commented:

We are not engineers. At [Dinoco], they're all engineers. So, there's lots of knowledge coming from their side, which we just don't have any idea about. So how the whole process they are running and how that works, we have no idea about. So basically, every little detail which we need to do, the optimisation and the visualisation, is knowledge we get from them. Because we just don't know anything about it. It is not our domain, it is not our expertise (RU4).

The important practices associated with the theme of exchange in ProjectNGO included talking and discussion, face-to-face interaction, holding regular meetings and using email.

Talking and discussion: This was the most common way of socialising in ProjectNGO. Sharing knowledge was a social process in the university–NGO project. As a PAR project, members needed to discuss processes and outcomes. Most discussions and talk appeared in the originating SCS. Project members, in particular the leader of the academic side, made regular visits to Bangladesh. Project members talked about their theoretical knowledge, knowledge in the field, organisational, cultural and social knowledge about Bangladesh, characteristics and requirements of the project. Talking and discussion mostly occurred face to face or virtually face to face in the design stage of the project including proposing a research topic and designing data collection tools such as surveys and questionnaires. This continued in regular visits to Bangladesh throughout the project and in the other shared spaces where and when members wanted to modify or add to the research design based on the achieved outcomes so far and existing conditions. Discussion among the academics ranged from theoretically related discussions to chatting about administrative work such as organising visas. As one of the academics and individual researchers stressed:

Actually, so much of that is administration, we have talked about that, but let's say half the work or more is just management of information. Just to do things you got the structure, so if you are asking academic questions, most of my time is just being on paperwork or just organising things, organising visas, organising travel, setting up meetings and sorts of thing like that, so that is not high-level academic knowledge (U2).

We have a number of in-person meetings, for example, when I was there but also going in the field in Bangladesh or when colleagues are here in Italy. For example, in October I organised a meeting in Rome on ICT for development. So it was, let's say, broader than just talking about ... but it was also an opportunity to meet and discuss the advancement of the project (R).

As illustrated in the above examples, most of the discussions among project members involved a tacit form of knowledge. There were ongoing conversations and discussions happening among project members to help the project evolve. They also shared their experiential and discipline knowledge. Face-to-face discussions also provided an opportunity for tacit knowledge sharing. Their discussions may have involved the sharing of explicit information in the form of documents, for example, books about the Bangladeshi context, when they talked about the established culture of Bangladesh and existing conditions. However, they mostly discussed their tacit knowledge. As the associate researcher stated:

I think the first time that we went to Dhaka, for example, we were not allowed to move outside the city because of security reasons. So we had this problem, in order to have a meeting with the villages. The project was about to start and so we decided to do a participatory mapping exercise which meant the villagers came to Dhaka, because the problems were only for us, not for the locals. It's a matter of power, but they came to Dhaka and we asked them to do a group exercise and to draw maps of their villages together, describing while they were creating the map that way. I think this exercise came from the experience that I had, using visual data in small communities, because I'd just finished another project which used a similar way of data (R).

Face-to-face communications: In ProjectNGO, physical and face-to-face meetings were important and effective in knowledge sharing because they needed to discuss and conceptualise tacit knowledge. As a lot of tacit knowledge was being exchanged, face-to-face meetings would normally be an important and effective way of doing this, but due to the scattered nature of the project, the opportunities for face-to-face meetings, particularly between academics and NGO members of the team, were limited. Face-to-face communications happened formally and informally. Project members through face-to-face interactions could understand and react to topics under discussion because of the direct engagement. Academics met each other informally every day during working hours. However, the academics and NGO members mostly met each other formally through two set meetings and regular visits of academics to the field in Bangladesh. The following interview quotes from two academics show the importance of face-to-face communication.

Talk and writing. A lot of talk. I think because it is an international project with Bangladesh and the English is good, but the body language issue is important in everything. I think face-to-face is the most effective way and they always expect us to take a leadership role all the time. a), Because I think a little bit that they don't like doing it, and b), because they think that we're the experts and authority. So probably just being there is very important. So, I think the face-to-face communication on Skype, if it works, is very important (U2).

In terms of designing projects, I think you have to add links always and different tools would have various structures and weaknesses, but I think face-to-face meetings are always important (U1).

Regular meetings: There were also two set meetings that occurred throughout the project These meetings were the place for the exchange of tacit knowledge. One was the steering committee meeting that was run about once a month with senior members of the project team. It was conducted through Skype. Its purpose was oversight. The other meeting was the governance committee meeting that was held every six months. Senior project members and external faculty and NGO managers attended. These two pre-established meetings led to considerable efforts regarding facilitating collaboration and managing time and resources from the NGO representatives, as one of the NGO members stressed:

Helping facilitate the collaboration and coordination by participating in the steering committee and governance committee meetings. Where I'm able, I try to provide advice from a program and learning perspective, and from a business development perspective (NA1).

The NGO member claimed that he was sharing mostly his tacit knowledge through the regular meetings:

It is quite limited, I would say, in terms of my sharing of knowledge. It's mostly in steering committee and governance committee meetings where I'm sharing that knowledge, mostly through just sharing advice (NA1).

Project members preferred to use Skype for regular meetings. They were supposed to use Zoom, but because of the telecommunication problems they preferred to use Skype because they could connect easily via Skype.

We tried using Zoom. But it was not very effective because of the bandwidth problems within Bangladesh. We use Skype because it seems to get a bit better result (U2).

Using email: using email was an important practice for the NGO project under this mechanism for sharing explicit information associated with tacit knowledge.

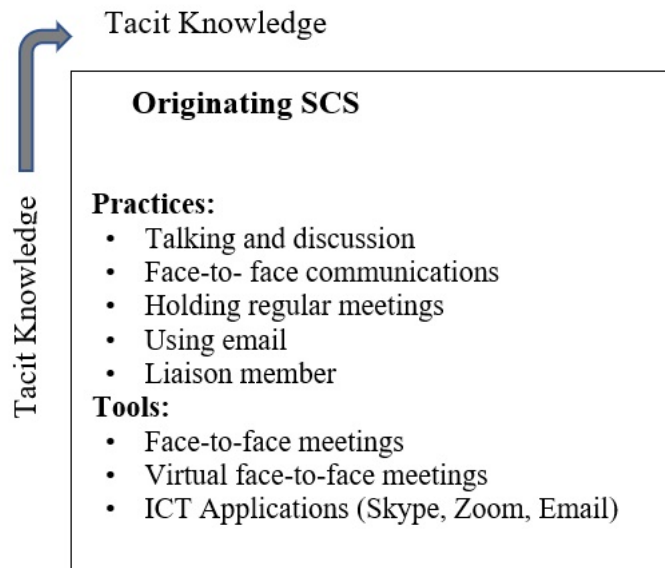


Figure 6-1. Exchange mechanism (ProjectNGO)

For ProjectIndustry, the important practices associated with the theme of exchange included liaison members and using email (see figure 6-2).

Liaison member: In the exchange mechanism, communication between the research university and Dinoco occurred through the academic leader. The required information was provided based on her visit to the industry site, her access to industry's infrastructure and her regular meetings with the Dinoco representatives. One of the academics explained how the academic leader played an important role in this mechanism.

With [Dinoco], we have, so, basically what comes from their side, there is one contact person on their side and one contact person on our side and basically those two people communicate. We are not supposed to [communicate directly in this stage]. I mean, it's not always like that, but that is their [Dinoco] idea. And then one of our people, we have, that person has access to their shared folder, I think it's a SharePoint or something, to exchange documents with them. Because they can't access our Google system (RU5).

Consequently, the academic leader was responsible for passing on the information to the different university team members.

Using email: Since in this mechanism mostly data and information in explicit form were exchanged, email was used as the main practice for exchanging information.

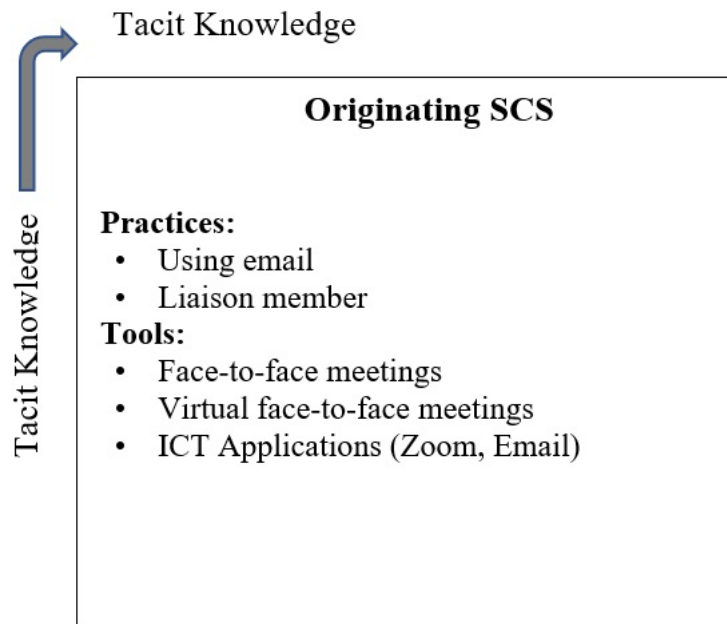


Figure 6- 2. Exchange mechanism (ProjectIndustry)

In the exchange mechanism, it seems that trust was one of the effective factors and preconditions in establishing SCSs for both projects, as covered in Chapters 4 and 5. Building trust was not a main challenge for either projects' members in knowledge sharing processes. They relied on their partner's abilities and knowledge for starting communication. For ProjectNGO, organisational trust existed in the beginning of the project due to the standing of the organisations, levels of expertise and knowledge, and previous experience. As the project continued, frequent direct communications and personal involvement in discussion fostered mutual understanding and trust. There was pre-established organisational trust about the reliability of the information provided by Dinoco because the university had previously collaborated with the Dinoco. The academics believed that Dinoco was expert in its own domain and all the explicit forms of the information based on the Dinoco's routine knowledge were reliable and related to the existing problem. Within ProjectIndustry, the academics trusted industry knowledge because they relied on industry to give them knowledge about its practices and needs, while the Dinoco representatives trusted the academics' knowledge because of their past collaborative experience.

It is significant for both projects the concept of the liaison member was identified as an important practice under all mechanisms. The liaison member acted a connector between partners and played an important role in the collaboration.

In ProjectNGO, this member was well connected with both NGO and academic members. Most of the field visits and discussion occurred through him. He made regular visits to the field. In his visits, more intense interaction and knowledge sharing occurred. He helped knowledge and information exchange between project members. One of the academics highlighted the importance of the liaison member when she said:

With the NGO, we have that collaborative space, Box, and also [X] is the main point, like the hub. [X] communicates with NGO Bangladesh and then he is communicating with us (U3).

With ProjectNGO, although academic leader had the important role in communication, the leader and all the other members interacted directly with NGO representatives and involved in creation of SCSs. However, in ProjectIndustry, as explained above (Section 6-2-1), liaison member was the only connection point for formal communication because of the strict policy of Dinoco. She had access to industry's infrastructure. Intense interaction and knowledge sharing occurred by liaison member during collaboration. Other academics had limit direct interaction with Dinoco representatives in some stages of collaboration.

Two major challenges were identified within the exchange mechanism: language differences and telecommunications access. These will be discussed in Section 6.3

6-2-2. Knowledge sharing through articulation mechanism

For ProjectNGO, in the articulation mechanism tacit knowledge was crystallised and expressed in explicit forms. This mechanism occurred throughout the project. Members of the project were able to externalise tacit knowledge into new explicit knowledge through activities such as analysis of the data collected in the field and writing academic articles and reports. For example, after talking about theoretical, social and cultural knowledge and based on their conversation and exchange of knowledge in the socialisation mode, project members started to write about research processes or the process of research implementation in the field. This resulted in documenting project objectives, designing data collection tools such as surveys and questionnaires, and capturing community requirements and characteristics. One of the academics stated:

We also write the reports and generally speaking because we are interested in the theory and they are interested in practical outcomes. They write the reports, they evaluate the practical side of the project. What has happened? How has information system has been used? Things like that, and we write journal articles to explore the theories. And then we share them. We have been involved, everybody has been involved in one or another of those things but [the university] does much more theory and [the NGO] does more practical. [NGO] Bangladesh also commissioned an evaluation report and they have shared it with us and jointly we decide what data needs to be collected, surveys or interviews in the field and whatever (U1).

For ProjectIndustry in this mechanism, the academics crystallised and expressed their tacit knowledge in explicit forms through dialogue and reflection after face-to-face and online conversation among themselves, based on the details of technical terms and their initial understanding of the practice and complexity of the plant. With the aim of developing a prototype and algorithms for pipe routing, the academics also started to write about the processes of different possibilities for finding optimal solutions in common terms and articulated as concepts in academic articles. Expressing tacit knowledge through dialogue and reflection (conceptualisation) happened through peer-to-peer interactions among academics in ProjectIndustry. Dinoco representatives did not have a direct role in the conceptualisation process.

For ProjectNGO, the important practices associated with the theme of articulation included writing and workshops (see Figure 6-3).

Writing: Writing individually and in teams was mentioned as one way of externalising tacit knowledge in order to share it as data collection tools or report that included the development of the project processes. The NGO members mostly wrote the reports which showed the processes of the project and implementation in the field, while the academics wrote to explore the theories which were applied in implementation. The following quote describes written communication in the project.

[NGO] write the reports, they evaluate the practical side of the project. What has happened? How has the information system been used? Things like that and we [academics] write journal articles to explore the theories (U1).

Different tools were applied to help tacit knowledge turn into explicit knowledge. Based on my observations, one of the academics used a whiteboard as an intermediate tool to help focus ideas before coming up with drafts. He expressed his abstract ideas through writing and drawing of concepts when the academics were trying to explore the theories. The academics also wrote about ideas and theories in Word documents. However, the NGO members mostly used reports, documents and a web-based learning platform to show the processes of implementation. One of the NGO members said about written sharing that:

In this written sharing, we share documents, we have one learning platform that contains learning from the project, those are web-based. Another is, sometimes we have direct email we can send to others and papers and we are a member of different rural area networks] (NB1).

As well, a painted banner and a poster were used to communicate details of the project to the women and communities that were participating in the process and to act as an aid to discussion. The banner was designed by an NGO artist to express the project in a Bengali way through a narrative story. As one of the academics stated:

We talked about [the poster] in Prato and that was used as the way that we are explaining the project. Explaining our experience in the field, what the women are doing. I gave a class in Italy, two classes, one class in Italy, and I used that as part of the class just to talk to students about doing field work. The poster is indigenous because it is done by local artists to express it in a Bengali way. We actually gave it that is based upon ideas I may change a bit and what they did was, we had three or four example stories, experiences of the villages, how it changed their lives. So we asked [the NGO] to build a narrative (U2).

Workshops: Knowledge and experience of the project could be shared and externalised through workshops. Gained knowledge was communicated to other project members via workshops that were held at the NGO or university. The project members went through a process to prepare workshops to make their tacit knowledge explicit and accessible for the whole project. It helped to articulate knowledge in explicit form and communicate it among project members and outside of the project to a broader audience during the running phase. For example, other members of the organisations or to members of other interested organisations. There were two types of workshop: those run internally and those open to the interested public. Both served similar purposes although the audiences were different. This was also a way of confirming or verifying tacit knowledge when using that tacit knowledge to produce drafts. It provided insight and direction into the project. As one of the project members stated:

I think having a workshop with the NGO and partners is a way of sharing the knowledge that you have gained from the project or all experience from the project. This is more externalising (U5).

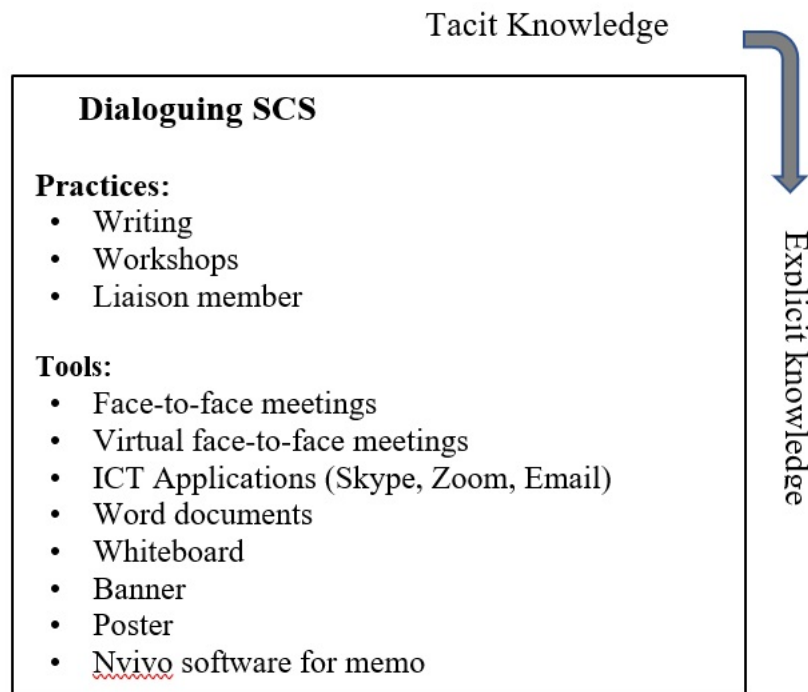


Figure 6- 3. Articulation mechanism (ProjectNGO)

For ProjectIndustry, the important practices associated with the theme of articulation included writing, ad hoc conversations and using online media (see Figure 6-4).

Writing: Writing academic articles for the academics was mentioned as one way of articulating their tacit knowledge to share with a wider audience. In addition, the academics needed to provide bimonthly reports to the Dinoco, as one of the academics stated:

Every eight weeks, there is a report, so I think it's two pages. Every eight weeks, so there's not much knowledge in there. It's just a kind of status report on what have you done and what has improved (RU5).

However, the report was not the elucidation of the produced knowledge, it was mostly about development of the project processes.

Ad hoc conversations: Each member of the visualisation and optimisation teams had many ad hoc and corridor conversations with peers in order to find the solution to the Dinoco problem and wrote academic articles. Ad hoc face-to-face meetings were a common and quick way of sharing information and that ultimately helped the writing process. As the academic leader highlighted about how they mostly shared knowledge during this project:

All the time that can in meeting, ad hoc conversations, ad hoc corridor conversations with [research university] staff, but for [Dinoco] through meetings or emails (RU1).

Using online media: For finding optimal solution and writing academic articles, the academics used online media such as, Zoom, email, Word documents, Slack, GitLab, Google Drive and phones in this mechanism. The nature of the project provided reasonable grounds to use these kinds of tools in order to share codes and technical formulas. Also, being located on different campuses required more use of online media for communication and sharing.

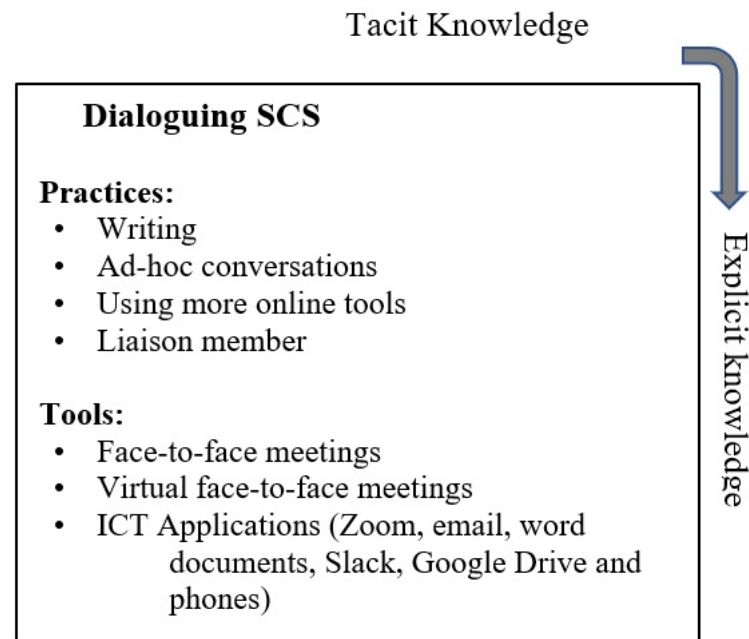


Figure 6-4. Articulation mechanism (ProjectIndustry)

In the articulation mechanism, peer-to-peer interaction was important for creating shared spaces for crystallising tacit knowledge into common terms from both the NGO and university sides. Project members in ProjectNGO interacted consciously together. Based on their discussion and reflection peer to peer (face to face, virtually face to face, via email), they decided to work on the defined task based on individual skills and capabilities. Peer-to-peer interactions gave the members a sense of one another's expertise and engagement with the project. In a similar vein, articulating tacit knowledge in the dialoguing SCS in ProjectIndustry occurred peer-to-peer but only among the academics.

Three major challenges regarding the articulation mechanism for ProjectNGO under Organisational culture differences were identified: Lack of written documents of the procedures for ProjectNGO, difficulty in getting permission from the university IT department to use new software and misunderstanding of the quality of the data. These will be discussed in Section 6.3.

6-2-3. Knowledge sharing through modification mechanism

The modification mechanism occurred through the combination mode of SECI in the systemising SCS of Nonaka's model. In this mechanism, explicit knowledge was shared and co-created sequentially based on the concepts and ideas first developed in the articulation mechanism.

For ProjectNGO, this mechanism could be carried out through breaking down or combining the concepts or combining the separate explicit knowledge or drafts prepared in the articulation mechanism. During the collaboration, different versions of data collection tools such as surveys and questionnaires, and drafts of academic articles were shared and created based on the first drafts which were prepared in the articulation mechanism. In this mechanism, common terms and concepts were negotiated and renegotiated via physical meetings and communication technologies such as Skype, email and phone. Virtual collaborative shared space played an important role. Because of the scattered structure of the project and distances, project members preferred to use Skype for regular meetings and email for sharing documents and files.

For ProjectIndustry, in this mechanism different versions of the prototype and algorithms were shared and created. Virtual SCSs played an important role, such as Zoom, a web-based interface and email between the academics and Dinoco. There were regular weekly meetings with the whole team that occurred through Zoom. A web-based interface was one of the outputs of the project through which people could rotate and zoom the prototype via linked views and navigation. Developing the prototype and algorithms mostly occurred through group-to-group interaction (between the Dinoco representatives and academics) in a web-based interface. After the demonstration, Dinoco representatives provided their insights and opinions based on their experiences in practice.

For ProjectNGO, the important practices associated with the theme of modification included modifying (commenting) (see Figure 6-5).

Modifying (commenting): A broad group of project members started to modify or comment on explicit forms of knowledge such as drafts of academic articles, data collection tools such as surveys and questionnaires, and reports that were created in the articulation mechanism. They changed and modified the content of existing drafts through commenting or developing discussions about them in virtual face-to-face meetings. Modification encouraged rich content and enabled much more interactive relationships between project members until they confirmed the final versions. The following quote shows the importance of modifying, as one of the participants mentioned:

We would create documents and share them with each other, and we created different versions of documents. Just share the drafts and get the comments back so that all we need to change to and make the changes itself. I think it would be easier if we have face-to-face-meetings more regularly because it would speed up the process, so having shared the documents is something we have to do at some stage anyway, but we probably have to start that process of sharing documents a bit earlier because of the difficulty of face-to-face meetings and poor quality of Skype (U1).

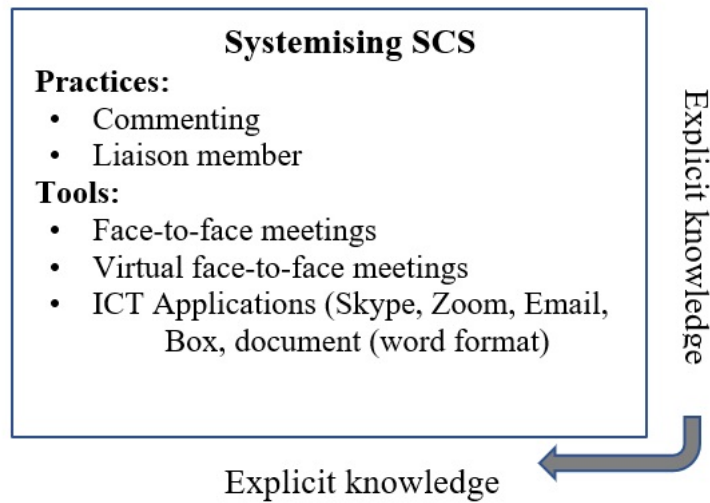


Figure 6-5.Modification mechanism (ProjectNGO)

For ProjectIndustry, the important practices associated with the theme of modification included modifying (commenting) and verbal communication (see Figure 6-6).

Modifying (commenting): The prototype was changed and modified based on the comments of the Dinoco representatives in regards to the applicability of the prototype in practice. In order to provide real insight, Dinoco representatives consulted other personnel who were engaging in practice. A Dinoco representative mentioned how Dinoco provided necessary information in regards to improving the prototype and passed it onto the research university.

We consulted standard engineering, guidelines and regulations, in terms of physical information. We also exploited the experiences of other personnel within [Dinoco] that I was mentioning before. So, we asked them their experience, which we then passed onto [the research university] (X).

The discussions took place wholly within Dinoco and then the comments were passed on in final form for the academics to go away and consider. Based on the comments, the academics started to modify the first version. Different versions were developed until it was finalised.

Verbal communications: Verbal communications through either face-to-face (twice a year) or digital face-to-face (weekly) meetings were important in the modification mechanism. Dinoco representatives were interested to share the required information verbally partly because the information was confidential and partly because this was a more routine form of tacit knowledge in practice. The following quote highlights the importance of verbal communication.

[Sharing information and experiences happens mostly via] videoconferences. To be honest, most of it was in verbal format during our videoconferences, I'd say very little of it was shared via email. So predominantly it was shared verbally via videoconference. I mean, the minutes of meetings, I guess, keep track of what was discussed. If we were sharing information that

wasn't confidential, then using other tools is probably perfectly fine, but any confidential information we share we either do it face to face [verbally] or via email (X).

The Dinoco representatives' interest in expressing their experiences in verbal communications shows the characteristics of the Dinoco that has a different organisational culture. Because of different work styles, they preferred to use simple language to explain know-how knowledge.

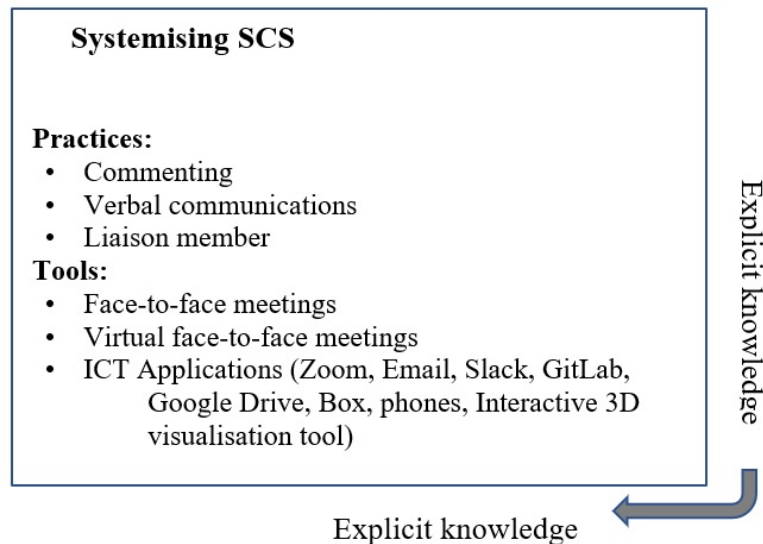


Figure 6-6. Modification mechanism (ProjectIndustry)

In the modification mechanism, group-to-group interaction was a basic condition in the Systemising SCS for modifying the produced explicit knowledge for both projects. In ProjectIndustry, academics and Dinoco representatives for the first time interacted in this mechanism to share and modify the first version of the prototype.

Three major challenges regarding the modification mechanism were identified: Telecommunication access, difficulty in getting permission from the university IT department to use new software and strict industry policies. These will be explained in Section 6-3.

6-2-4. Knowledge sharing through accumulation mechanism

The accumulation mechanism occurs through the internalisation mode of SECI in the exercising SCS. In this mechanism, finalised/created explicit knowledge was shared and absorbed by individuals (project members) and then converted into tacit knowledge in their minds.

For ProjectNGO, in this mechanism the existing explicit knowledge was used to develop new tacit knowledge. New tacit knowledge was accumulated in the individuals' minds after discussion and feedback. Explicit knowledge such as data collection tools like surveys and questionnaires, academic articles and theoretical frameworks were discussed among the project members. Based on the discussion, project members provided feedback and decided to act in the field. In other words, action and practice were the results of this discussion. Learning and training were fundamental in this process.

These could happen through practice like in a workshop or happen through reading and discussion of academic articles and analysis of the data collected in the field. Discussion and reflection led to internalising the explicit knowledge in the individuals' mind and created a basis for new steps in the project. Holding workshops is another example of accumulation in this project. Local organisations were trained in PAR and how it could apply in the project; how to do a survey; how to do interviews. When this knowledge was embodied as individual tacit knowledge, it created a basis for the project because accumulated tacit knowledge in the individual mind is the start of a new knowledge creation spiral.

For ProjectIndustry, in this mechanism the produced explicit knowledge was accumulated in the individuals' minds and the organisation after discussion and practice. During this project, the explicit knowledge, such as different versions of the prototype, algorithms, mathematical formulae and academic articles, were discussed several times among project members. The tacit knowledge of how the university and industry created collaboration with other stakeholders accumulated in the individuals' minds, was also raised. The explicit knowledge that was internalised in the academics' minds after discussion was mostly concerned with conceptual knowledge. The prototype and algorithms were accumulated as new knowledge in Dinoco practices after testing in practice. The prototype helped Dinoco to solve its problem. If the proposed prototype could solve the Dinoco problem in practice, Dinoco could use it as a decision-making tool and accumulated it as a new knowledge in its organisational memory in a competitive market. However, if after putting the new knowledge into practice, it did not work as expected, the Dinoco partner could come back to the academics with feedback. In such a case, this could be the start of a new knowledge creation spiral.

For ProjectNGO, the important practices associated with the theme of accumulation include training through workshops and seminars, and the recording of knowledge and experience (see Figure 6-7).

Training: ProjectNGO used training programs as the exercising SCS. Through workshops and seminars, it improved the quality of members performing work in the field. For example, training about PAR could increase the project members' tacit knowledge base by mentally transferring explicit written knowledge in manuals of PAR into tacit knowledge. As explained by two participants:

We realised the local people, the local NGO, they are not doing very well. So at that point we said, okay, obviously everybody needs more training, what we can do? So we found another person who works for the Research Institute of Bangladesh and who specialised in PAR and we got them to have workshops for everybody in the Bangladesh language in PAR methods (U1).

And then internally, we organised seminars. So, through the seminar, we actually place this knowledge and learning. And the other team also, I asked the other team how are we actually going to use this knowledge? Because this is making some kind of benefit. This is also contributing this way to being changed. So, I mean, these plans, from your perspective, how are we actually going to use the knowledge? Or how do you, going, how are you going to use the practice? (NB1).

In this way, tacit knowledge was developed in all participants in the project.

Recording of knowledge and experience: Recording and documenting of produced explicit and tacit knowledge were an important practice under the accumulation mechanism. Findings show that in both the NGO and the university, there were some online spaces such as Box for the NGO and Google Drive for the university which were considered capable of storing explicit knowledge. This could be in the form of relatively straightforward documents, but the academics also stored and shared their informal knowledge in working documents such as data-analysis coded forms (Nvivo software) and document comments in Google Drive. One of the academics stated that:

We have a shared drive but [NGO] never use it and we have on Google Drive. Datasets like that may not look big, but the amount of work to produce 40 interviews is tremendous. So it is a huge amount of work to get a modest output, unfortunately. There is also all the informal knowledge in memos, stuff that comes out of one's head and emails, comments (U2).

It is worth noting that the academics tried to store part of their scientific tacit knowledge in working documents through converting tacit knowledge to a more explicit form. The other parts, such as their experiences about how the NGO worked and how they could communicate in the field with the community, were just internalised in members' minds or shared through open seminars and academic meetings. There was not a clear policy to capture the experiential knowledge of the academics in the university.

All the official records of the project, such as the minutes, the agendas, all the reports, the budget information, terms and condition of the contract, were kept in a central place in the university. They were managed well. However, there was a lack of organised management of related data about the research; one of the academics explained how management of the research data and related information depended on individual academics' interests and their way of information management.

All the budget information, all the budget papers and everything like that, are centrally managed and well managed. What is not so effectively managed is all the research data, bits of different research data, reports and surveys, all the versions of the articles and papers that get produced and so on. That's more managed by particular members of the team, according to what their particular interest is. So that's not as consistent a management. So the really strong management is the higher you get to the governance, whether it's [NGO] or [university], you have really good management; on the part of the day-to-day management of information by the research team, it's really up to the individual researcher (U1).

Recording explicit forms of official records and related data was needed throughout the project because project members needed to refer to them often to see what was progressing in the project. This was mainly driven by two reasons: first, collaboration is a complex and dynamic process that is difficult to capture; and second, people come and go throughout a collaboration because of the dynamic nature of a collaborative project. As a result, in order to accumulate the produced knowledge in their minds, they needed to refer often to official records and related research data.

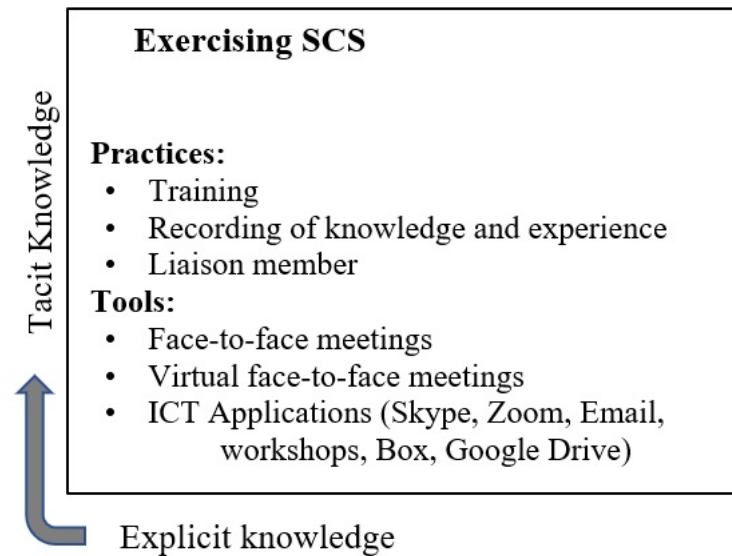


Figure 6-7. Accumulation mechanism (ProjectNGO)

For ProjectIndustry, the important practices associated with the theme of accumulation include learning by doing and recording of knowledge and experience (see Figure 6-8).

Learning by doing: Project members learned in this project through developing the prototype and tool and practising them in actual routines. Dinoco representatives undertook their own predefined tasks by using the prototype and tool in the workspace. They learned from experience by working with and applying the created prototype and tool, and then accumulated the specialised knowledge they gained through this process. While they carried out their own assigned tasks with the new prototype and tool, they learned and accumulated their performances on the assigned tasks.

Recording of knowledge and experience: The findings show that in the research university, the academics used Google Drive and personal computers for recording the produced explicit knowledge such as meeting minutes, the process of developing the tool and different version of the articles. One of the academics stated that:

We also maintain weekly meetings, we maintain a protocol, so we put some results there before every meeting, and we might also update those results or augment them by the actions which we need to do based on the results of the meeting. There is some documentation on those meetings. We also have some documentation for the software we are doing, but that is probably not enough developed, so I'm thinking how to intensify the process of that documentation (RU2).

They did not follow any pre-established guidelines for writing up the produced knowledge such as user manuals or technical descriptions. The academics thought that following standard guidelines would help them to write up the produced knowledge well. The same academic continued to talk about documentation:

I think, again, maybe some more standard tools for documentation can be useful. Right now, we are thinking in which format we should write the documentation, and how to organise

the writing and so on. So, if the university had a standard procedure for that, that could be very helpful. Well, I don't know, but I think this is a problem for us. So, at least some guidelines already can be of help or they're not (RU2).

As a technical project, they needed to write the procedure for developing the software in a clear and easily understandable format. A well-written procedure would help the university to develop the tools and the project more effectively. However, the interview data shows that there was not only a lack of knowledge management (KM) processes to record produced knowledge but also a lack of consistent formatting in writing about technical processes in the research university.

Dinoco did not record the processes of developing software internally. It just recorded meeting minutes and reports. The Dinoco representative explained the process of recording information as follows:

It's all managed on the [university] side of the project. We don't hold the project information created internally within [Dinoco]. We have access to some of the information. Most of the information, if it's sort of like minutes of meetings and things like that, are created by [research university] and they share that with us via email. We do record minutes of meetings here on the [Dinoco] side as well and we keep them internally and unless requested by [the research university] we don't share them with [the research university] (X).

As with the ProjectNGO case study, capturing explicit forms of the official records and related data was needed throughout the project because of the complex and dynamic process of the collaboration such that project members needed to refer them often.

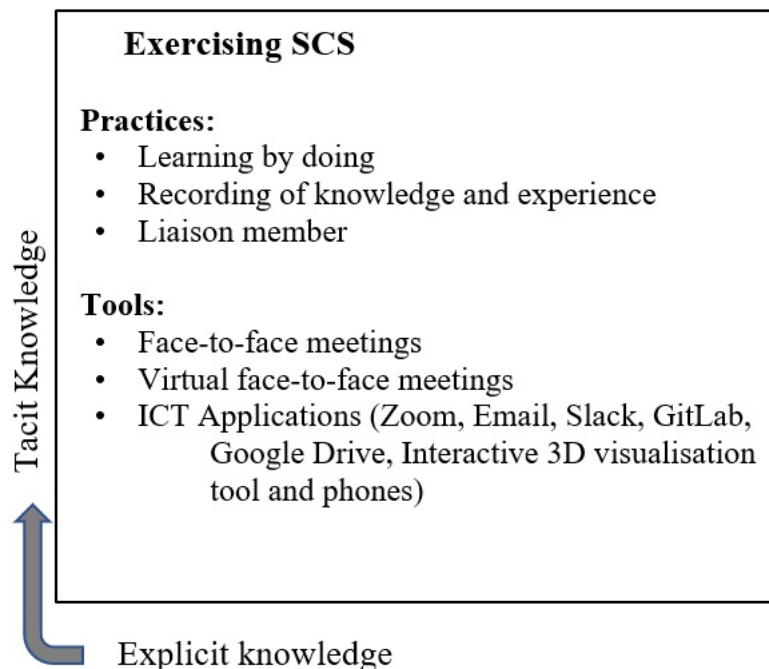


Figure 6-8. Accumulation mechanism (ProjectIndustry)

Two major challenges regarding the accumulation mechanism were identified: Lack of knowledge capture and lack of organised research datasets. These will be discussed in Section 6-3.

6-2-5. Knowledge sharing through feedback mechanism

The feedback mechanism occurred through all modes of SECI in all SCSs. In this mechanism, ongoing findings and information about the processes and contexts of already developed ideas, either explicit or tacit, were shared.

For ProjectNGO, in this mechanism ongoing findings and information about the process were shared to validate the real processes that were happening. Feedback provided an opportunity to the NGO through more timely general reflection on the project needs, processes and outcomes. This mechanism took place throughout the project via monthly interviews with a smaller group of people in NGO Bangladesh, and through face-to-face presentations of the doctoral students to the NGO in Bangladesh after their fieldwork and regular meetings (see Figure 6-9).

For ProjectNGO, important practices associated with the theme of feedback include research progress reports, interviews and holding regular meetings which are discussed in Section 6-2-1.

Interviews: The academics, after carrying out some surveys and some initial interviews, realised that they had not got enough information back to analyse and understand the context. So they requested the NGO Bangladesh to organise monthly interviews in the villages to discuss the best ways to get feedback about the context of the project and the process in order to collect accurate data through video, audiotape or notes. One of the academics said that:

The NGO organises monthly interviews. Not with everybody; a smaller group of people, so that they could get that monthly feedback, and try and discuss the best ways that that might work, should it be through video, should it be through tape or just notes, or whatever. So we're getting advice as to what's going to work best in the field, to get the data that we need. So that's more like a structural thing about the project than the data collection issue of what works best (U1).

Research project reports: There were five doctoral students under this project. Each doctoral student had their own research topic. Their topics were aligned with the project objectives although their research was autonomous. They were exploring and adding new insights to the project by answering some specific questions. Doctoral students' projects were different from immediate sub-projects because they were working and defining the project based on their interest, project objectives, and requirements of doctoral program that involved more research processes. From the point of view of their impact on the practices used under this mechanism, the important issue was the length of their projects and in particular the long delay before any results were seen from their fieldwork.

During their PhDs, the students gave presentations to the NGO in Bangladesh after their fieldwork, because the NGO expected interim reports, and this also provided an opportunity for the doctoral students to get feedback from the NGO because the university research and NGO research work to different time frames. NGO partners expecting quick results that they can act on. As two of the participants mentioned:

I know that [knowledge] is being generated by [PhD topics] and I guess that is looking at how ICT can support women's economic empowerment in rural Bangladesh. It's also looking at areas of how it can support livelihoods. How it can support communications within and across communities, and I can't remember the other PhD topics off the top of my head. But that's

the main – from – probably from [the NGO]’s side, that’s the main area of focus that we’re looking at. More specifically, related to that, actually drilling down into that – the knowledge that’s been developed is what the actual knowledge – the needs are of the rural women who are participating (NA1).

The only thing I would add are the workshops in Bangladesh. It was just that as the project advanced and as those PhD students started to do their work, then it became more obvious to the NGO in Bangladesh how the whole thing was going to work, and they wanted to actually put in a specific request for that earlier feedback (U1).

The doctoral students’ projects were considered valuable for the NGO Bangladesh because could review their processes in the community based on the doctoral students’ project findings and results. The NGO provided feedback to the students about their projects and how they were progressing, in terms of whether they were meeting needs or there were other things they should consider. One of the doctoral students explained the aim of her presentation to the NGO:

After my fieldwork I presented my research questions, some basic information, my observation and primary findings to the NGO teams and some of the community participants, those who I interviewed. It was for me such a validation processes. I wanted to show them what is the major trend I need to follow. I shared my observation and interpretation that I gained based on the data with them to check, not what they said, but how I interpreted them. It is a responsible way of dealing with data because the NGO senior-level people need to see my observation and interpretation because they are aware of the context. They wanted to check community participants did not exaggerate or mention something because of the pressure or expectations (U6).

It is worth adding here that I interviewed the doctoral students to get some insights into the main project. My initial impression was that they were not involved directly in collaboration with the NGO. Since my research aim is to look at collaboration of project members from the university and the NGO, I did not specifically look at how each individual doctoral student ran their own project.

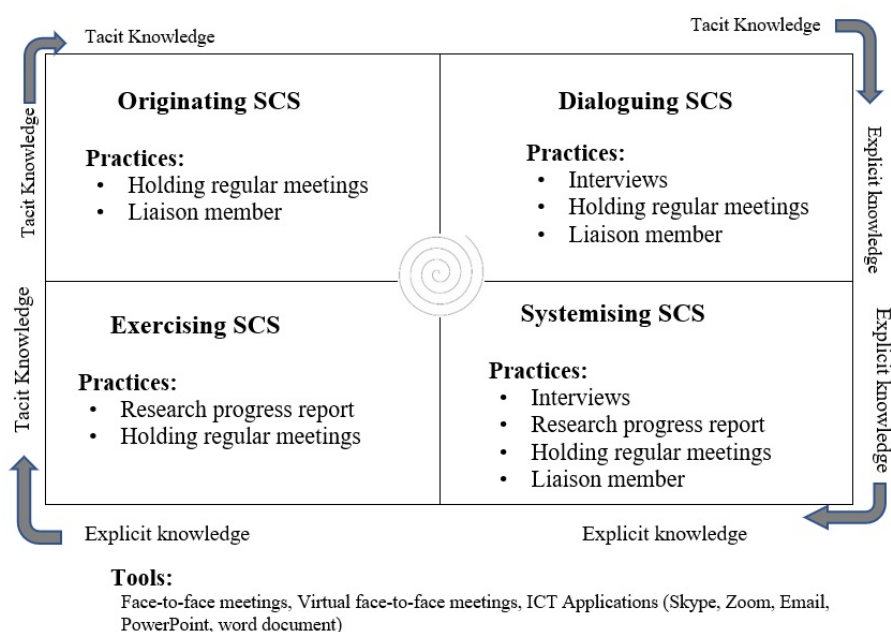


Figure 6-9. Feedback mechanism (ProjectNGO)

For ProjectIndustry, this mechanism occurred in all SECI modes between the academics, but for interactions between the academics and Dinoco it took place only in the combination and internalisation modes in the systemising and exercising SCSs, after modifying and practising the prototype and tool.

Verbal feedback was the main practice under the feedback mechanism for ProjectIndustry.

Verbal feedback: Dinoco mostly provided verbal feedback after designing the first version of the prototype in the combination mode, as explained in Section 6-2-3. Such feedback also took place after applying the prototype to large new plants and other similar projects on the Dinoco site in practice through the internalisation mode of SECI in the exercising SCS. They provided feedback verbally via an interactive 3D visualisation tool that was developed as one of the outputs of this project. It was a specific web-based interface for remote discussion in order to communicate about the design and applicability of the prototype in practice (see more in Section 5-4).

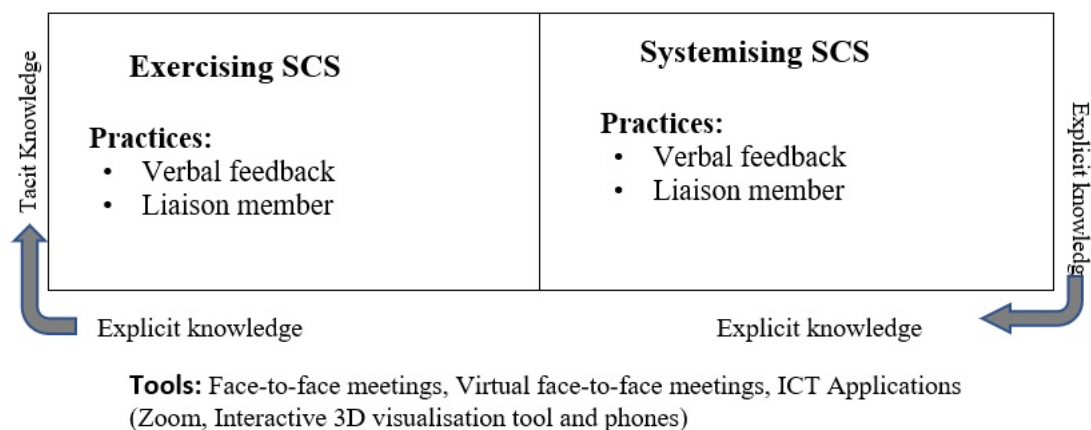


Figure 6-10. Feedback mechanism (ProjectIndustry)

Telecommunication access, organisational culture differences, and time were identified as main challenges under this mechanism and will be explained in Section 6-3.

6-2-6. Knowledge sharing through transfer mechanism

The transfer mechanism could occur between the main parent organisations involved in collaboration in all SCSs, or outside of the collaborative project in specific spaces. It was mostly transferring finalised and official explicit knowledge which was produced by the project or related to the project.

For ProjectNGO, knowledge was transferred from the project to the primary and other stakeholders in different ways:

- Between the main parent organisations (the NGO and university) through workshops, any reports that were generated and doctoral students' research seminars; administrative knowledge of the project were transferred from the project to the NGO and the university and all kept in a central place, as mentioned in the accumulation mechanism

- Within each parent organisation (the NGO and university) through internal reports and regular newsletters about the project that were generally distributed. The NGO had its own internal processes as to how it shared that information between other branches of the NGO and other NGOs
- To Bangladeshi communities through newspaper articles and social media, for example Facebook, to disseminate results of the project and update the progress of the project to the community
- To Academic communities through scholarly publications in journals and at conferences

The explicit transfer of knowledge of the project to the university was not a direct objective. The main purpose instead was to make people aware of the research that was being undertaken, rather than to notify them of the exact results of the research. This happened through open seminars and doctoral students' milestone sessions.

Our goal is not actually to tell everyone else in the faculty what our results are; our goal is to produce results that people interested in this area will be interested in. We try to make the faculty aware of what's going on and the dean is keen for that. So we've had a number of open seminars and invited other staff to come too, so we can tell them about the project (U1).

Transfer of knowledge of ProjectNGO within the discipline mainly occurred through publishing academic articles and attending conferences to present the results of the project.

The university was producing research in response to the NGO's particular problems. The outcome of this kind of research needed to be transferred to the NGO. For example, there were a number of research questions that the doctoral students explored.

I think that there will be a lot that comes out from the PhDs and hopefully from before – you know, as we discussed before, hopefully more of these new ideas and insights could be shared before the completion of the PhDs, but maybe on an annual basis (OA1).

There was a desire to transfer the experiential knowledge of the academics with regards to running this kind of project in the university. However, it was difficult to achieve in practice because each project has its own characteristics and methods. Everybody works according to their area of expertise. Project members sought to transfer knowledge to the other members of the faculty who were attending the general seminars, but there was no knowledge repository in the faculty for capturing this kind of knowledge. When the project members leave the faculty, this kind of knowledge will go with them.

The knowledge produced in this project can be considered a basis for other similar projects under the ICT umbrella. Holding seminars and workshops were mentioned as means of knowledge transfer from the project to partners. The following quotes illustrate the process of the transfer mechanism:

So, passing it onto other members of faculty, if they come to a seminar... Yes, they get it; if they can't come to the seminar and they are particularly interested, they might come and talk to us personally, but that's a handful of people. Is there a knowledge bank in the faculty for storing this sort of information? No. When we leave, that knowledge will go with us (U1).

In the project we have been developing based on the ICT and project knowledge. So, it's like, it's helping other interventions to shape up from the ICT perspective. So, it's happening through seminars, discussions, bilateral dialogues, something like that (NB1).

I mean, sharing with the university, actually, in a governance community meeting, we are actually sharing our expertise ... Like, I shared some of the experiences and case studies. So, this is the only way. And then also we are sharing like today, we had some seminars, so this is one of the ways in which we are sharing. (NB2).

Consequently, workshops, reports, publications, seminars, regular newsletters and social media (Facebook) were the main practices under the transfer mechanism for ProjectNGO (see Figure 6-11).

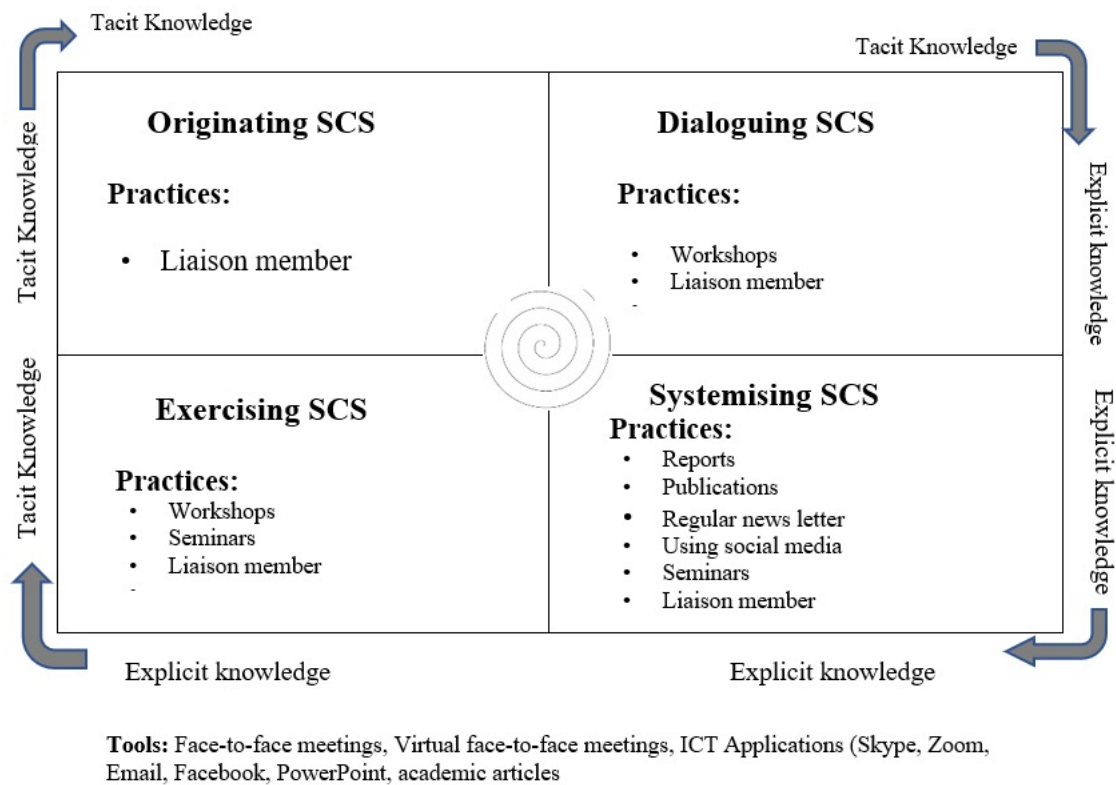


Figure 6-11. Transfer mechanism (ProjectNGO)

For ProjectIndustry, the socialisation mode was used for the sharing of tacit information. However, data and information in the form of documents were made available to the university by Dinoco, even though the specific content was not used initially, to assist academics in understanding the nature of the documents and how to interpret them. These documents were produced by Dinoco before the start of the project and represented confidential Dinoco intellectual property.

In the externalisation and early combination mode, the academics published academic articles in conference proceedings. Using these articles, the academics transferred early know-how and know-what knowledge to wider audiences, detailing the process of finding a solution and developing the

prototype, which were only finalised as the project progressed. During the collaboration, the university also provided regular reports in a written format to Dinoco. In the exercising SCS, the actual prototype was transferred to the Dinoco site to use in practice.

We can conclude that explicit information was transferred through the practices of regular reports and the prototype (initiative) under the transfer mechanism for ProjectIndustry (see Figure 6-12).

Regular reports: The university provided a report to the Dinoco every eight weeks about the status of the project, what had been done and what had improved. The regular reports did not provide detailed information about developing the prototype. They were summary progress reports, as one of the academic stated. It is clear that Dinoco was not interested in detailed information related to prototype development. It was mostly interested in the outcome and its implementation in practice.

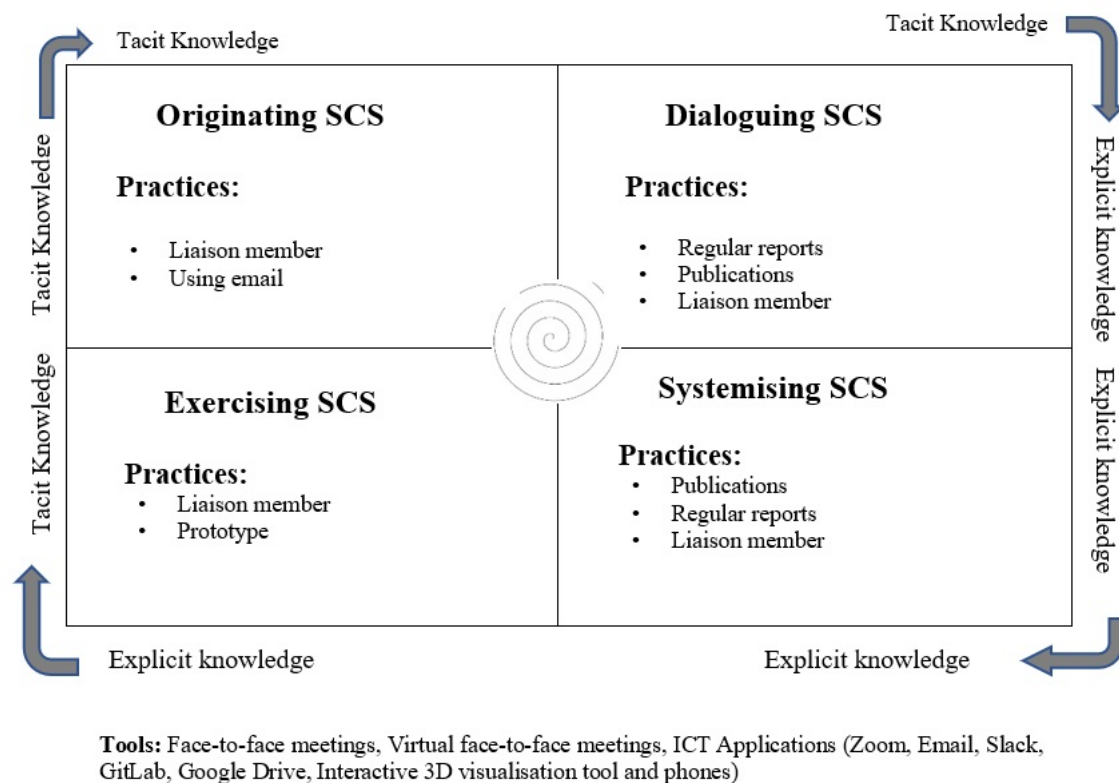


Figure 6-12. Transfer mechanism (ProjectIndustry)

Lack of knowledge capturing, telecommunication access, organisational culture differences and time were identified as main challenges under transfer mechanism. These will be explained in Section 6-3.

This section explained identified knowledge sharing mechanisms and associated practices in the various SCSs for both projects. In total, six mechanisms and 20 associated practices identified for both projects. In both projects, for each mechanism, members used different practices to share knowledge. ProjectNGO members used a wide range of practices compared to ProjectIndustry because of the nature of the project, different geographical location, different culture and different

languages. ProjectNGO members had to use more practices than would be ideal to make up for the problems experienced with each practice and that in turn created problems in terms of using different practices for knowledge sharing. Monitoring and controlling different practices with considering lack of time challenge (see Section 6-3-4) caused additional problems for ProjectNGO.

6-3. Challenges arising with the Mechanisms

Organisational culture differences, language differences, telecommunication access, time, lack of written documents of the procedures for ProjectNGO, lack of knowledge capture and lack of organised research datasets are found to be the main challenges that occurred during knowledge sharing in both projects.

6-3-1. Organisational culture differences

Interviewees mentioned different work routines, different time frames, different research aims and organisational cultures, different languages and difficulty in understanding each other as barriers to knowledge sharing in university–industry/NGO collaborative projects. Cultural differences may reflect, and be reflected in, differences in goals, outcomes, visions, research activities, the allocation of time, management styles, social conduct, languages, national cultures and time perceptions (Bjerregaard, 2010; de Wit-de Vries et al., 2019; Galán-Muros & Plewa, 2016; Ghauri & Rosendo-Rios, 2016; Harryson et al., 2007). These issues were present throughout, and associated challenges occurred under all identified mechanisms.

There is much in the literature on differences in organisational culture. Practices, symbols, values, structures and assumptions that are shared by the organisation's members with regards to specific behaviour are defined as an organisational culture (Schein, 1990). Organisational culture including shared values and experiences gradually evolves over time and influences what members perceive and how they react to each other and their world (Shadur et al., 1999; Smircich, 1983). Organisational culture has an impact on how organisation “members communicate and share knowledge. Vision and goals, trust, and social networks received consistent attention related to effective knowledge sharing as components of organisational culture” (Kim & Lee, 2005). NGOs, industry and universities differ considerably in their underlying values, beliefs and processes (Ehrismann & Patel, 2015). Organisational culture can have a significant influence on the success of project performance (Coffey, 2010; Wiewiora et al., 2013) and also on members' knowledge sharing behaviours and how they learn (Wiewiora et al., 2013).

The main aim of an NGO is to solve community problems through practical outcomes. It allows interaction through research processes (Aniekwe et al., 2012). In the current study, the NGO conducted research from a project evaluation point of view, rather than the theoretical work and type of knowledge creation that universities are interested in. As a result, the theoretical components of the research was not very important for it, as one of the academics explained:

The NGO captured the requirements generally, I think so, yes. Where the issue is, is the quality of research that we ask them to do. So, doing surveys, doing interviews. It's very, very hard to get them to do it to the standard and the timeline we want, because they've never done that sort of thing before, and quality suffers. I think that anything that is new to them in the research area, in the sense of academic research, the quality has been lacking, and that's a problem and they

acknowledge that it is an issue and they need to change, and that's part of their future attempt to work in the knowledge management area and become more skilled (U1).

Misunderstanding of the need for quality of the data was a barrier in ProjectNGO. This barrier can be considered under organisational culture. The international NGO does conduct research, but usually with a more directly practical focus and outcome than the university. The international NGO understood the need for quality data but not necessarily what quality meant for some of the theoretical aspects. There was often a tension between theoretical and practical outcomes, and the problem was exacerbated due to the number of groups involved in data collection and the involvement of additional organisations that did not have such a strong understanding. This long chain of organisations with different cultures and knowledge created a lot of difficulties in data collection. However, the research team was aware of these issues and had to come up with ways to work around the problem.

In ProjectNGO, a large part of knowledge in the NGO was tacit and there were many parties engaged in knowledge sharing including project team members, translators, community members, Bangladeshi universities, community-based organisations etc. In addition, the main NGO did not conduct project research in the field with its own staff. Bangladeshi universities and specific local community-based organisations were responsible for data collection and community contact, and the NGO had to rely on their data collection. Therefore, the NGO had difficulty in collecting accurate data because each organisation, specifically the community-based organisations, had a different set of priorities, skills and experiences in contacting communities.

In ProjectIndustry, Dinoco had its own specific organisational culture. The culture of the industry was not educational. It had commercial settings and was results driven. It was interested in the outcome of the research, not the processes. Dinoco, after giving background information and the problem, was mostly interested in a financially beneficial outcome. It had a strict policy on use and access to different products. As an example, Dinoco did not allow access to or use of Google products for communication and sharing knowledge because of the confidentiality of the information involved. As Dinoco policy, staff had to use Dinoco-affiliated products. This limited and slowed down the knowledge sharing because the academics needed to share everything via email or in meetings, given that the academics internally used Slack, GitLab and Google Drive for communication, as explained in Chapter 5.

We're a little bit restricted on the [Industry] side of what we can use to share knowledge and information. Given that this information is being shared by email, it means it's trackable and recordable. The videoconferences not so, they require, um – I mean, the minutes of meetings, I guess, keep track of what was discussed. If we were sharing information that wasn't confidential, then using other tools is probably perfectly fine, but any confidential information we share we either do it face to face or via email (X).

Dinoco members were not independent in sharing their own personal opinions and discussions, they had to consider Dinoco policy when they communicated with academics and social networks.

Do I share them with young people in the project? Um, probably to an extent. It would probably come through in – I'd say it would come through in some of the discussions, personal opinions and – and the like, um, as an influence on what and how the project moves, um, but – yeah. It's – I wouldn't say – I mean, most of the opinions are – are based on, ah, ah, Industry's direction, personal opinions are – are probably added as required (X).

A university creates knowledge and builds theory to use in practice. “It provides researchers with academic freedom in their choice to pursue scientific initiatives” (Ehrismann & Patel, 2015, p. 4). It is willing to share the produced knowledge with different stakeholders and publish it for different audiences, because academics are more independent in communication and social networks. Publication in high-impact journals and acclaim by peers in the specific field are means of success for them.

In the current study, the university had its own organisational structure and culture. The academics had freedom in doing research. However, for creating online shared space for collaboration with the NGO and using university infrastructure, academics needed to follow their own organisational principles and processes. For example, getting permission from the IT department of the university to create a shared space took time.

[In order to create space for knowledge sharing], if you are thinking online spaces, it does not appear to go more formal really well. So, NGO got a drive, we [university] got a drive, it took month to get permission from IT here because there was a mix-up for them to use particular new software to build a database. So, there is a lot of interfering in building online spaces unless there is all the very high-level skill and interest in this thing. It is very difficult (U2).

In ProjectNGO, in contrast to academic freedom, the academics also needed to follow university policy in accessing and using facilities.

6-3-2. Language differences

Language differences were mentioned as one of the most important challenges in the all mechanisms for both projects. These differences can be divided into two main categories: foreign languages and discipline/subject languages.

6-3-2-1. Foreign languages

For ProjectNGO, project members knew English and it was the main language for starting the communication. It was a second language for the NGO members, who spoke Bengali, and the associate academic researcher, who spoke Italian. The NGO members in Bangladesh wrote documents and reports in English. In other words, written communication happened in standard English. However, they communicated verbally in Bengali in the NGO. Their version of spoken English was unfamiliar to the team members based outside Bangladesh, and this unfamiliarity could sometimes lead to misunderstanding during communications (whether face to face or virtually). This version of spoken English caused some misunderstanding during communication face to face or virtually. The liaison academic in the NGO project explained the role of the foreign language as follows:

This collaboration is international in at least two forms of English, Australian English and Banglish, which is international English. Sometimes grammar is simplified and you do not always understand what is going on and maybe they don't understand me. They can write a report and the grammar is funny. It is exactly what happens in international work around the world, so people do not understand each other. Now internally they communicate. In a formal sense they are writing English, but verbally they talk in Bangla. But in the field, there are also Bangla dialects that are used. So in the villages some of them speak other dialects and [NGO] staff do not understand that kind of language. But the villagers know standard Bangla. They learned it in school, but then

between each other they talk and describe things such as farming tools or local things and some NGO staff do not understand the language. But the villagers sometimes don't understand either. They were only educated to grade 6. [U2].

Furthermore, data collection tools such as questionnaires were developed in English and then translated into Bengali. They were administered in Bengali and the responses were in Bengali, which then needed to be translated back into English. The data in the field was collected by NGO people who spoke Bengali, then translated into English in order to communicate with university. The academics and the associate researcher used the translated versions because they did not know Bengali. The academic associate researcher mentioned that he accessed the English versions of the data.

I have the raw data and I can do analysis on this. Dataset from the interviews are also partially shared, let's say that I don't see the raw data because also I don't speak Bangla. So it would be useless, but I can have access to the data when they are already coded and translated, and I collaborate in order to develop the coding in [translated versions] (R).

The university researchers (apart from two of the doctoral students, who are Bangladeshi) did not have unmediated access to the women because of language issues and this created the potential for additional problems.

It is worth adding here that this issue also relates to the data collection tools, understanding the purpose of the data collection and the meaning of the data to be collected.

The lack of subtlety in translation for the NGO project was mentioned as a foreign language challenge. It was quite possible that something was missing in translation. However, the academics were aware of this issue and worked to minimise the issue as part of this collaboration. One of the academics explained that even then they relied on the translation and that this sometimes had an effect, while not stopping the project itself.

I think about languages because of none of us speak Bengali. Then we have to rely on other people to do the translation for us and we have to trust them. So again, it does not stop the project but slows it down (U1).

Consequently, as the participants mentioned, the foreign language could slow communication verbally and in written format during the collaboration because of translation issues. However, for ProjectIndustry English was the main language for both project partners. Therefore, there was no lack of understanding because of it.

6-3-2-2. Discipline and subject languages

Difficulty in understanding each other was also mentioned as a barrier to knowledge sharing for both projects in initial stages. It seems that this barrier also emanated from cultural differences between the university and industry/NGO because of the different aims of the research, languages, contexts and national cultures.

Discipline and subject languages relate to differences in knowledge backgrounds between the university and industry/NGO (de Wit-de Vries et al., 2019). The academics used more complex language (Pineda et al., 2009) based on the needs of the research and their discipline. For example, "hypothesis", "model"

and “variable” are important in the language of university (Cyert & Goodman, 1997). However, industry/NGOs are not interested in this vocabulary.

In ProjectNGO, the academics used more jargon (discipline/subject language) and complex language in communications which were sometimes meaningless for the NGO members because they used their own language which was based on practice and more conversational. Two of the NGO members emphasised the discipline language barrier as follows:

I think the challenge I find in [collaboration] is language. I mean, academic language and our language is different. I mean, somehow, we need to negotiate. like when you see any of the report, if it is not very much on the table for the practitioner, they know meaning of having benefit. So, from your side [university], you have to negotiate, you have to also change your narratives and also you have to change your thinking and also language and presentation [NB2].

Sometimes a difficult challenge is the language. I can share something good finding with you really because our languages is more or less the same, but with the community it is challenging because writing in a scholarly way to speak in a scholarly way is different than most people talk. Those of type of challenges are happening [NB1].

For ProjectNGO, discipline/subject language caused difficulty in understanding for NGO members. Therefore, the lack of shared language was mentioned as a major challenge in this collaboration. Academics and NGO representatives needed to spend time to reach shared language.

In ProjectIndustry, discipline and contextual language had more impact on knowledge sharing. In the exchange mechanism, most of the explicit knowledge transferred from Dinoco was in industry terminology and technical terms about plants. The academics were unfamiliar with that terminology before starting the project. Therefore, understanding the industry language for academics took time. Three of the academics explained discipline language failure as follows in ProjectIndustry:

There might be some terms we just don't know what it means. We can get the document and can read it, but we just don't know what it means, and then we have to give feedback and let them know, “Look, this is a nice document, but we don't understand. What does it mean?” And then they have to provide us with information [RU5].

We are trying to interpret, convert the rules, constraints, the problem into mathematical equations or into a language that the back end of our tool understands and come up with the algorithm that makes sure – so let's say we have a few pieces of equipment and they give us, “Okay. These are the rules. The equipment can be in this region and this equipment cannot be in this region”, those sort of like human language – the constraints explained in human language, we convert that into mathematical programming language and then get solutions for them [RU4].

I think that [language] is a big barrier because in the beginning we had actually to fight even to explain to each other what we mean. Like, we talked different languages for a whole year or maybe longer. But then, we also had issues, like we had problems organising the work. We could not balance the importance of long-term and short-term goals [RU3].

According to the academics' interviews, it can be concluded that understanding discipline and contextual language was a main challenge in the beginning of ProjectIndustry because they talked in different languages for a year or longer.

Over time, the collaboration continued and all the project members developed a better understanding of each other's aims and experience. One of the industry project members emphasised how they had achieved a mutual understanding after 12 months.

Myself and [Y] who is the second person at [Dinoco] who has, been involved in this project, knew very little about optimisation and visualisation, ah, and on the other side [the university] knew a lot about visualisation and optimisation, but they didn't know a lot about chemical or process engineering. So in terms of knowledge sharing, what we've noticed over the last 12 to 18 months is that each side has been able to better understand each other and that we're now speaking the same language in inverted commas, language, where we can understand what they're talking about to a degree and they can understand what we're talking about to a degree [X].

Mutual understanding and finding shared language developed over time through collaboration.

6-3-3. Telecommunication access

Telecommunication access was mentioned as one of the most important challenges in all mechanisms for ProjectNGO. ProjectNGO, in an international setting, used more email and video-conferencing equipment, such as Zoom and Skype, for communication. It encountered lots of problems in joining and attending both Skype and Zoom meetings because of telecommunication issues in Bangladesh. The sound quality in the online meetings was not good and this even affected phone calls when they were used. This was a frequent issue. Therefore, it led to miscommunication in some meetings. For example, one of the academics highlighted that in one meeting she shared an agenda to discuss with the NGO members. However, due to sound problems, one of the NGO members did not hear and continued to talk based on another document because he was not able to hear clearly the topic of discussion.

We are not always communicating, you know. I don't know if you really picked it up last time, because the sound wasn't good, but [the NGO member] was looking at an older version of a document. So I had sent the updated minutes, but he was still looking at the old minutes. So the conversation continued. You know, he was following those minutes, instead of following the agenda, and there was some miscommunication in there. And the problem with that, you probably can highlight that, also we've had the problem of sound quality all the time. So we normally have the big screen, like we use in [the boardroom], and it's because it was always a problem and once we couldn't connect, so we used my laptop and found that sound quality was much better. So the last couple of times, we have been using the laptop. So there's two aspects; the sound and the quality of the conversation, but also making sure that people are talking about the same thing and following the same agenda (U5).

In response to this challenge, project members after online meetings followed up by email to confirm understandings or actions, and minutes of meetings were produced and shared quickly. These sorts of measures sometimes added extra workload.

For ProjectIndustry, this challenge was not identified because as a collaborative project in a national setting, there was no problem in connecting to the internet and using Zoom. Project members took advantage of using telecommunication technologies during collaboration.

6-3-4. Time

Time limitations were raised as another important barrier under all of the mechanisms for both of the projects.

The time concept can be divided in this study into three main categories: lack of time at an individual level, time orientation and time zones. At the individual level, academics lacked time because they needed to focus on their students, teaching and other administration tasks. Almost all participants had conflicting work priorities. The NGO and Dinoco members worked simultaneously on different projects. Managing time was difficult for them because other priorities could sometimes take precedence. They either could not attend meetings or did not have sufficient time to prepare properly. As a result, they needed to allocate limited time for each of the projects. One of the academics in the NGO project spoke about the lack of the time as follows:

She is really good, but she's so busy. We've been trying to organise one of the steering committee meetings, to have it in the NGO's offices. I think we had one, so I'm not sure if it was a steering committee meeting, but once we had a meeting there, and because ... You know, to get them more engaged, to have occasionally the meeting attendance here, and in there, but it was never working, because she was away that day and was not working. We also have teaching commitments; you know. So it's really difficult to find time, the time to go in there [U5].

The NGO member whom the academic referred to above also mentioned time constraints as a main challenge for her in sharing and collaborating on the project.

I don't really have any challenge in sharing my knowledge. I think it's mostly just in terms of timing. Because, you know, the project team are often working at a very fast pace compared to what I might be able to follow, because you know I can't – I'm not on – there's only a certain percentage of my time for this project. So, I think it's like in terms of timing and making sure my experiential knowledge is timely and relevant and at the level of depth that they need [NA1].

Time limitation has been raised as one of the important barriers in developing collaboration in previous studies (Hamisah et al., 2010). Previous studies considered the time orientation of the research (short term and long term) as a barrier to collaboration because university research is mostly conducted in the long term, while industry and NGOs expect to have results in a short period of the time. Industry requires short-term results to compete in the market and to achieve competitive advantage (Bodas Freitas et al., 2008; Bruneel et al., 2010; Dunowski et al., 2010). NGOs require short-term results to find a solution in order to address some challenges of the end users or community.

Furthermore, the nature of the research needed more time for completion. For example, the doctoral students' research under the ProjectNGO was scheduled for a three or four year span. Their research was under the project objectives; however, their research result could only contribute to the project after three or four years, while the NGO needed a short-term result. Based on my observation, in the shared

meetings between academics and NGO representatives in the Australian branch, the NGO directly requested short-term results from the doctoral students about the processes of their research. It asked them to prepare quarterly reports to the NGO. However, it seems that in practice, this was not possible because the doctoral students were still working to define and understand their own projects. Time orientation was mentioned by participants in both projects as a challenge in collaboration and knowledge sharing. This time orientation can be considered under organisational culture for both of the projects because it refers to different objectives that each of the organisations followed in collaboration.

For ProjectNGO, project members needed to bridge time zones to get the job done. Time zones made it difficult for all project members to communicate simultaneously because it was near impossible to organise meetings at a time that suited all participants. Project members did not mention this as a barrier to knowledge sharing directly in the interviews, however various comments indicate that working across different time zones did at least cause inconvenience in communicating and an increased reliance on more asynchronous forms of communication.

The situation was different for ProjectIndustry. As one of the academic in the ProjectIndustry explained, when they had urgent agenda that needed all academic contributions, they could organise a meeting within project members in different place within a same time zone easily (RU3).

For urgent agenda if it's involving all the members, we have to set up a time and that takes time. There are times that you need to quickly solve some issues so you call an internal meeting, just send a Google chat to the group, "Can we chat at that time today to discuss these issues?" All of them will quickly reply, "Okay. I can or cannot."

However, organising a meeting related to urgent agenda with different time zones was not possible.

6-3-5. Lack of knowledge capture

Lack of knowledge capture was mentioned as a main challenge under the accumulation mechanism for both projects.

The most valuable knowledge of organisations is in the heads of their staff, not in their written procedures which includes best practice of organisational routines and it is also experience-based (Kingston, 2012). Knowledge capture is defined as "The processes of converting the knowledge or experience that resides in the mind of an individuals into an explicit representation, whether in print, electronic, or multimedia form" (Janus, 2016, p. 5).

For both projects, there were inadequacies in the process of capturing knowledge. The knowledge that members gained during collaboration went with members when they left the organisation or project. Staff turnover is a main reason for this challenge because it brings difficulty in tacit knowledge capture. The associate researcher mentioned staff turnover in ProjectNGO as a main barrier to knowledge sharing.

The main problem in this project in terms of sharing knowledge is that in the three years many people have been involved. Some of them have changed. So there has been problems in terms of some information that I think got lost or some idea that was defined at the beginning but then the people were not there and so things get sometimes lost because we go back to your initial question, how many people are involved. So stability of the team enhance the

knowledge sharing, when there is some turnover and also some changes that do not depend on you because there are other organisations that have their own agenda and people just move, change work, change job, go to another place (R).

There was no clear policy in the university, Dinoco or the NGO for capturing tacit knowledge, as mentioned above. One of the Dinoco members emphasised how learned experiences were lost by starting another position in another project.

What you might find is, as people move on, that information and knowledge is lost over time. So, for instance on this project I've moved on from this project now and I'm working on another project. Someone has taken over from me and because they've done that, they probably don't have the same relationship and collaborative nature as I had developed previously (X).

The associate academic researcher in ProjectNGO stated that informal ideas and common understanding were lost by members leaving and both parties, the NGO and the university, did not have clear policies for capturing these.

I would say not key information. The explicit information is very well shared and written, so do not depend on if he goes, but some let's say more informal idea or some shared understanding of what's going on, this is what gets lost. So sometimes we have to rediscuss things (R).

The lack of a local audience in the university was mentioned as another reason for the lack of experiential knowledge capture by one of the academics in ProjectNGO.

The main challenge is I do not have a local audience. Really no one asks about it or they say they are, it is wonderful what you are doing, and no one really asked me to talk about it in the faculty, but to talk about life is a complex thing, like, I can say you know I fly there, I get there, and you are going to sit through hours of traffic to get to the office, you know, to get to the village, you are going to fly three hours, you are going to go on a bus four hours, you are going to get a motorbike, you are going to take a donkey. That is experiential knowledge and then you want high-quality research information and/or you have got two hours in the village. This is a reality I am going to talk about, you know, so the opportunity is not frequent, like, to have formal recording or something like that (U2).

Again, this barrier refers to organisational culture. The university was interested in publications in high-quality journals, not talking informally about experiences. The associate researcher in ProjectNGO also explained this issue as a different requirement for the NGO and the university.

Publications that are not in an official scientific journal are not considered valid at all for the university. So basically speaking for a university, at least for me, every time I write outside a scientific journal it's irrelevant and everything that is written outside a scientific journal is irrelevant, whereas for NGOs, a big NGO like [O], they have their own internal report, their own internal perspective, their own internal guidelines and everything which is outside this kind of publication is irrelevant (R).

Lack of consistent formatting in writing about technical processes in the research university for ProjectIndustry was mentioned as a challenge under knowledge capture in accumulation mechanism.

As a technical project, academics needed to write the procedure for developing the software in a clear and easily understandable format. However, there was not clear guideline in research university for writing the process of the prototype and tools development.

It is worth adding here that collaborative research projects in a university work in isolation from other research groups. Since a small number of researchers are working in any particular area, the opportunities for sharing the gained knowledge with other groups are limited. And also, the areas of interest and expertise of members of each discipline are different. This can also result in less interest about other collaborative research projects.

Capturing and sharing the tacit knowledge of the project members were an important part of the knowledge sharing mechanisms for both projects. Lack of knowledge capture was a common issue for both projects, it seems partly because of the tacitness of this kind of knowledge that makes it difficult to capture and partly because of the lack of clear policies in the NGO, Dinoco and the university.

In addition, it needs to be considered that collaborative projects are evolving through time and they have many changes though the processes of the project. The nature of collaborative projects brings instability in capturing and sharing knowledge. Having a clear policy from initiation of the project in order to capture gained experience would be a solution.

6-3-6. Lack of written documents of procedures for ProjectNGO

Lack of written documents of procedures was mentioned as another main barrier under the articulation and modification mechanisms for ProjectNGO.

NGOs are knowledge-intensive organisations (Berezko & Zhezhnych, 2017). They apply useful and qualitative procedures in implementation. However, they do not record and document those procedures because of a “lack of the critical processes, skills, and tools needed for effective knowledge management” (Berezko & Zhezhnych, 2017, p. 389). In the current study, the NGO had a very well-developed system of documentation and KM to support high-level project management, evaluation and transparency. However, it had a problem in documentation of what happened in the field, especially documentation that related to the collection, management and understanding of research data. Therefore, documentation of the procedures was mentioned in ProjectNGO as one of the barriers to knowledge sharing by one of the academics.

Documentation is the hardest thing to do in this project. We are trying to get them to document, getting an archive, we are trying. I have checked. They are recording meetings. We have to start to analyse them, but when [M] and [A] come back, we begin to analyse these meetings at the group level, but so much of this is about spoken knowledge not through formal documented knowledge in the field, because we are dealing with verbal culture, not with an institutional academic culture (U2).

It seems that in this project, as the academic emphasised, the NGO had lacked all the necessary skills in managing, storing and organising data relevant to the research.

6-3-7. Lack of organised research datasets

Lack of organised research datasets was mentioned as a main challenge under the accumulation mechanism for both projects.

For both projects, members in the NGO, Dinoco and the university were interested in obtaining information about primary research datasets, data interpretation and analysis, and any relevant material regarding the research. Each body had their own policy in organising the research datasets of the project. There was no standard framework even within each body for organising research datasets. The official information such as research proposals, meeting minutes and contracts was stored. Research datasets about the process were organised in the NGO and the university in their own repositories. The NGO had Box in which every dataset about ProjectNGO was stored. The university had Google Drive to facilitate sharing research datasets between members of the project at the university. There were structures and naming systems for organising datasets (see Appendix D). Based on my access and observations about Drive, there was no consistency in organising files and folders. It is worth mentioning that the university–NGO project prepared a research data management plan as a process of the ethics application which clearly discussed storing and managing research datasets. However, it was difficult to implement in practice because the collected research data was used as working data and the researchers thought that it was useful to have working copies on their own computers for ease of access and manipulation, and gave less thought to longer term authoritative data sets. In ProjectIndustry, Dinoco was not interested in organising the research datasets. All the research datasets were organised and collected on the university side.

For ProjectIndustry, the university had a policy for organising research datasets in certain places for storage. One of the academics explained how they preserved research datasets.

Basically, what we are doing, we have a workflow, which is through the editor for the input. Optimisation part, visualisation part, and so on, and all of that went on the server. We have the server in the [university] cloud, that, what is it called, Australian Research Network. Then we have a virtual machine, a server, and on that server is all the information about what you call the data. Everything is on there [RU5].

According to the ProjectIndustry proposal, all data and software needed to be stored on the university's central research data storage area that was managed by the university e-Research Centre in accordance with the university's Research Data Management Policy and Procedures. However, they did not have a clear framework for organising, preserving and making research data available for the long term in that specific place. As already observed, Dinoco was not interested in organising research datasets.

For ProjectNGO, one of the NGO members stated they stored research data and all documentation of the project in specific places.

From the NGO side, we basically store things, the specific things, in our Box. Some (staff) have their own box, like a Dropbox. Nowadays, the products we have for second project, those are kept in Box, like the project documents and the learning documents and other project documents. So, we keep it in a single space and it is accessed obviously by the NGO and sometimes non-NGO people can also access that. Project documents, for example, we have different meetings, so those are there. Evaluation reports are there, we submit quarterly reports and world reports, so those things are stored there (NB3).

However, based on my analysis of discrepancies in the responses of the academics and NGO representatives, it seems that there was no clear policy for recording the research datasets in the NGO. It just stored everything related to not only this project but also every task in Box, without any organisation. For this reason, sometimes getting to a specific document took time for the NGO members and there were many important datasets there and members were not aware of them.

It is worth adding here that ProjectNGO was a PAR project aiming to modify the project based on what they found during the collaboration. However, ProjectIndustry aimed at working on a new technology and expected end results. The different natures of projects and the partners' attitudes and expectations from the collaborative project influence the type of knowledge sharing challenges. These differences are mentioned in many parts of the thesis, but this is particularly discussed in Section 7-2.

6-4. Drivers of knowledge sharing

NGOs need to have professional competencies, be up to date about relevant new theories and applications, revise academic theoretical or modelling approaches based on real case studies via access to NGOs' field experiences (Zolezzi, 2014) and receive mutual benefits in university–NGO collaboration (Chernikova, 2016) as the main drivers of university–NGO collaboration mentioned in previous studies.

Academics' evaluation is based on their contribution to university–industry collaboration, funding for future research, increasing practical knowledge, applying theory in practice and feeling a sense of accomplishment through collaboration with industry (Debackere & Veugelers, 2005), interest of business in accessing scientific knowledge, access to business-sector R&D facilities, employment and short geographical distance of the university from the business partner (Attia, 2015), as mentioned as drivers of university–industry collaboration.

In my research, based on the participants' views there were different factors that motivated the university, Dinoco and the NGO to collaborate and share knowledge.

For ProjectNGO, interest in research, mutual benefit and funding were mentioned as the main drivers of knowledge sharing. These factors have already been mentioned in previous studies (Chernikova, 2016; Zolezzi, 2014). Academics in ProjectNGO mentioned interest in research as the first and main driver for them in order to share knowledge with the NGO.

The drivers for knowledge sharing, we are always interested in research, so if we can get knowledge from external stakeholder that helps with our research and how do know our partners means research can be granted in reality and the experience and what can we benefit from our experience and they can benefit from our research (U1).

The NGO always expressed an interest in learning from applied research to improve both their field practice and processes, including knowledge management processes. NGO representatives explained how they obtained mutual benefit from sharing knowledge through this collaborative project as follows:

I think it is recognition – the main one is recognition that we can add value to each other, we have complementary strengths, we have different knowledge that can complement each other and that there is a sense of kind of trust and collaboration, and there's a sense of common

objectives. Like where we feel like we're adding to each other's objectives or we have shared objectives (NA1).

Access to funds was mentioned as another driver of knowledge sharing in ProjectNGO.

Unfortunately, only money. Money is the main driver. So, if you have an organisation that can fund the research, then you will have knowledge sharing. I know that it's cynical, but I would say that the main driver is this one (R).

Collaborative research projects need fund for running in practice and implementation. Furthermore, after implementation in practice, again funding is needed to continue research and finalise it. It can be concluded that access to funding is an important driver not only in implementation but also in continuation and support of research outcomes. Having collaborative projects can lead university research to be more focused and practical, which in turn actually helps to attract more funding.

For ProjectIndustry, financially beneficial outcomes through finding solutions to a problem for industry, increasing research capacity for the university, developing domain knowledge, running interesting projects for academics, publications and promoting their own capability to a wider audience for the university were mentioned as drivers of knowledge sharing:

I mentioned before, the drivers are, I guess, for [Dinoco] this would be a financially beneficial outcome, for [the university], from our understanding, they're increasing their own research capacity and promoting their capabilities to a wider audience [X].

Well, for industry it's easy. For them it's making money. In our case, if that software works for them, they save time and money. For us, I guess it's running interesting projects, writing papers (RU5).

The motivating factors that have been explored in the literature on university–industry collaboration (Attia, 2015; Debackere & Veugelers, 2005) were similar in ProjectIndustry in knowledge sharing processes. However, promoting university capability to a wider audience is a new driver of knowledge sharing that is explored in the current research.

Employment, access to development facilities and geographical distance between partners were mentioned as main factors in doing collaboration. However, in both projects these factors did not appear to be drivers of knowledge sharing.

6-5. Chapter Summary

In this chapter, I have identified six context-specific knowledge sharing mechanisms after mapping the knowledge creation model. They are labelled: exchange, articulation, modification, accumulation, feedback and transfer. All of these mechanisms led to knowledge sharing and creation in these projects. Table 6-1 gives a summary of the mechanisms and 20 associated practices in the various SCSs identified in both projects. In this chapter, I have also explored the challenges and drivers associated with each mechanism. Table 6-2 gives a summary of the challenges and drivers for both projects. Chapter 7 will provide discussion of the findings regarding the two case studies.

Table 6-1. Knowledge sharing mechanisms and associated practices.

	Associated Practices		Shared Collaborative Spaces	
Mechanisms	NGO	Industry	NGO	Industry
Exchange	- Talking and discussion - Face-to-face interaction - Holding regular meetings - Using Email - Liaison member	- Liaison member - Using Email	Originating	Originating
Articulation	- Writing - Workshops	- Writing - Ad hoc conversations - Using online media	Dialoguing	- Dialoguing - Combination
Modification	Modifying (commenting)	- Modifying (commenting) - Verbal communication	Systemising	Systemising
Accumulation	- Training - Recording of knowledge and experiences	- Learning by doing - Recording of knowledge and experience	Exercising	Exercising
Feedback	- Interviews - Research progress reports - Holding regular meetings	Verbal feedback	- Originating - Dialoguing - Systemising - Exercising	- Systemising - Exercising
Transfer	- Workshops - Seminars - Reports - Publication - Research progress reports - Regular newsletters - Using social media	- Publication - Holding regular meetings	- Dialoguing - Systemising - Exercising	- Originating - Dialoguing - Systemising - Exercising
Exchange Articulation Modification Accumulation Feedback Transfer	Liaison member	Liaison member	- Originating - Dialoguing - Systemising - Exercising	Liaison member

Table 6-2. Barriers and drivers of knowledge sharing in organisational collaborative projects.

Mechanisms	Barriers to Knowledge Sharing	
	NGO Project	Industry Project
Exchange	See all mechanisms	See all mechanisms
Articulation	• Lack of written documents of procedures • Misunderstanding of the quality of the data	See all mechanisms
Modification	• Lack of written documents of procedures • Misunderstanding of the quality of the data • Difficulty in getting permission from university IT department to use new software	• Industry strict policy
Accumulation	• Lack of knowledge capture • Staff turnover • Lack of local audience in the university • Lack of organised research datasets	• Lack of knowledge capture • Lack of consistent formatting in writing about technical processes • Staff turnover • Lack of organised research datasets
Feedback	See all mechanisms	See all mechanisms
Transfer	See all mechanisms	See all mechanisms
All Mechanisms	• Organisational culture differences • Foreign language differences • Discipline and subject language differences • Telecommunication access • Lack of time	• Organisational culture differences • Discipline and subject language differences • Lack of time

CHAPTER 7: DISCUSSION

7-1. Chapter Preview

The purpose of this chapter is to draw together and highlight the findings of this study. It draws heavily on the material presented in previous chapters, and especially the use of Nonaka's model to map the ProjectNGO case study (Chapter 4), the ProjectIndustry case study (Chapter 5), and Chapter 6, which identified the six knowledge sharing mechanisms, and a discussion of the challenges related to those mechanisms.

The chapter is structured as follows. Section 7-2 presents a summary and reflection on the two case studies. Section 7-3, which is the main part of the chapter, presents the answers to the research questions. The chapter concludes with Section 7-4, which, within the limitations of the study, proposes a tentative conceptual model based on the knowledge sharing mechanisms, while Section 7-5 brings together an initial list of guidelines for effective knowledge sharing mechanisms in university–NGO/industry collaborative projects, based on the results of the study.

7-2. Reflection on the Two Cases

My research is contextualised by the knowledge creation theory of Nonaka, specifically Ba, in order to explore knowledge sharing mechanisms within collaborative projects that connect active actors from industry and NGOs with university-based collaborators. Knowledge sharing is a communication process which takes place in diverse SCSs among active actors who are the main participants in knowledge creation. While both organisations utilised SCSs to communicate with the university, there were significant differences between them.

Based on the different definitions, understandings and expectations of the research, knowledge sharing in the university–industry project was generally systematic and linear, aimed at working on a new technology. This is because the initial problem was well-defined and self-contained. Project members were not allowed to act independently because of the strict policies of Dinoco about sharing information and knowledge, given the commercial nature of the ProjectIndustry.

In contrast, sharing knowledge was a social process in ProjectNGO. Since that project was informed by participatory action research (PAR), its members needed to discuss both processes and outcomes. ProjectNGO needed the flexibility to modify or change the direction of the research based on those discussions. This different style of the research influenced the kinds of mechanisms and SCSs for sharing different types of knowledge.

In both projects, different types of knowledge (experiential, conceptual, systemic and routine) were shared during collaboration. Experiential knowledge was mostly shared in ProjectNGO. It came in the form of tacit local knowledge of the NGO and others who were working with the community in the field, from the academics through their experience with different organisations and different research projects. By contrast, explicit data and routine knowledge were the most common forms of knowledge exchanged in ProjectIndustry. Know-how knowledge that was routinised in action within the industry case was shared either in an explicit form such as manuals, guidelines and terminology or as tacit routine knowledge through verbal communication. Conceptual knowledge was not shared in ProjectIndustry because the industry partner was interested in the solution, rather than the process involved in creating

that solution. This supports the observations of Krishna et al. (2004) in their research on the NGO context.

In the context of the university–organisational collaborative projects, face-to-face interactions were mentioned as important to project members. However, in both cases, they mostly socialised online due to the geographical spread of the projects. This finding is strongly aligned with the literature findings concerning face-to-face interaction and physical proximity as important components of an organisational context, as well as triggers for knowledge creation (Niccolini et al., 2018; Nonaka & Nishihara, 2018; Nonaka et al., 2008).

The current study emphasises the importance of virtual interaction when collaborating at a distance. In the context of the university–organisational collaborative projects, virtual spaces and ICT were essential for building virtual SCSs in order to start the communications. This point supports the findings of earlier studies that identified social media or virtual platforms and ICT devices as essential elements of knowledge creation and sharing (Niccolini et al., 2018; Panahi et al., 2013) and virtual spaces and ICT as accessory tools for starting communication in organisational knowledge creation in order to merge and store knowledge (Niccolini et al., 2018). The current study also indicates that in the context of ProjectNGO, workshops were a key space for knowledge sharing, which again supports the findings of previous studies (Llano-Arias, 2015; Mashavave et al., 2013).

Project members shared and created knowledge through interaction between them in SCSs. For ProjectIndustry, the problem was already defined and intense interaction was only realised once the university began to provide solutions. In contrast, the NGO and university used interactive communication from the beginning to explore the problem and had an ongoing creative, dynamic discussion. As a consequence, the timing as to when intense interaction took place was different between the two projects.

For both university–organisational collaborative projects, the project leader acted as liaison or a boundary spanner between partners and played an important role in starting the collaboration. In ProjectIndustry, because of the strict policy of the company, the academic leader was the only connection point for formal communication. With ProjectNGO, the academic leader played a similarly important role in the initial stage, but then the other members became much more active in knowledge sharing and creation, both internally and with outside groups. This finding is strongly aligned with the literature findings concerning the role of boundary spanners (Stevens, 1999; Zhang et al., 2011).

In both projects some of the required knowledge and information already existed in the university and industry/NGO without some members of those organisations being aware of its location. For example, one NGO member mentioned that a lot of information and knowledge was captured in their organisation, but even relevant information was not accessed or used appropriately in this collaboration due to a failure to organise and store that information in a systemic manner and to communicate its existence because that information was created by other project teams. Although all official records such as minutes, agendas and contracts were kept in organised way within the NGO and the university, both organisations failed to manage adequately the data relating to the research.

In ProjectIndustry, official records were organised in a systemic manner in the research university and Dinoco, although Dinoco did not organise or store the process of the research and developing the prototype. The university managed and organised all the produced knowledge related to the research and developing the prototype without following any pre-established guidelines. In addition, there was

a lack of consistent formatting in writing up technical processes in the university. Because the university did not follow pre-established rules or guidelines for writing up the processes and developing the prototype, access to the produced knowledge was limited. This demonstrates that there were challenges in knowledge management (KM) inside each of the partner organisations (university, industry and NGO).

Problems of knowledge capture in both projects made knowledge sharing less efficient and significant tacit knowledge was being lost as a consequence

7-3. Answering the Research Questions

RQ1. How is knowledge shared in university–organisational collaborative projects?

This question was intended to look in detail at the ways in which knowledge was shared in these projects. By mapping the knowledge sharing processes in the context of Nonaka's model, I have identified six context-specific mechanisms, namely, exchange, articulation, modification, accumulation, feedback and transfer, through which ProjectNGO and ProjectIndustry members communicated and shared knowledge.

Many studies have identified knowledge sharing mechanisms (Appleyard, 1996; Bell et al., 2016; Boh, 2003, 2007; Easterby-Smith et al., 2008; Gorovaia & Windsperger, 2010; Hautala, 2011; Hermans & Castiaux, 2017; Hund et al., 2019; Jin & Yaqi, 2011; Kuusinen et al., 2017; Lilleoere & Hansen, 2011; Mason & Leek, 2008; Perrigot et al., 2017). However, these previous studies have largely investigated knowledge flows and types of knowledge transferred between actors in exploring the mechanisms. In contrast, my study has explored knowledge sharing mechanisms by mapping the knowledge creation model with a focus on SCSs in the context of university–organisational collaborative projects.

A summary of the important points relating to each mechanism is given below. A more detailed discussion of the mechanisms is in Chapter 6.

Exchange mechanism

In the exchange mechanism for ProjectNGO, knowledge sharing started from the originating SCS with physical and virtual face-to-face meetings. Here knowledge sharing was related to more ad hoc and informal (tacit) knowledge. The findings about this mechanism are strongly aligned with the literature related to face-to-face tacit knowledge sharing, for example, personalised mechanisms in project-based organisations (Boh, 2007), social mechanisms in franchise networks (Perrigot et al., 2017) and reactive practices in a pharmaceutical context (Lilleoere & Hansen, 2011) which took place outside the department. As ProjectNGO was PAR, the exchange of tacit information using this mechanism was extremely important, with project members needing to discuss processes and desired outcomes through the exchange mechanism and to respond to topics under discussion.

With ProjectIndustry, however, the sharing of direct experience and building of tacit knowledge was limited in the exchange mechanism as only academic leader participated from amongst the academics, acting as a liaison member. Although tacit information was shared on both sides, there was mostly a one-way transfer of information from Dinoco and, apart from a few face-to-face meetings, information and data was shared with academics mostly through online tools such as email. The university liaison member had a very important role in this mechanism, because she had access to Dinoco infrastructure

as well as more regular meetings at the start of the project. The liaison member helped to share the technical and routine knowledge of the Dinoco by accessing and distributing it. Other research has found that a liaison employee is considered a key mechanism in knowledge management, for example, in a digital innovation lab (DIL) (Hund et al., 2019). In a DIL, liaison employees facilitate knowledge exchange between units by identifying and accessing valuable knowledge in different areas. In the current study, the liaison member also facilitates knowledge exchange between parent organisations and project members. The role of liaison members as boundary spanners has been discussed before in the literature (Stevens, 1999; Zhang et al., 2011). What is important in this context, however, is not the liaison member as a person, but the activities associated with that role in managing information sharing, and for that reason the role is considered as a practice under exchange mechanism.

Articulation mechanism

In this mechanism, tacit knowledge was converted into explicit form through the formulation of concepts and through writing, workshops and ad hoc conversations. Different tools were used for writing as one way of articulating tacit knowledge in ProjectNGO. These included academic articles, reports, meeting minutes, whiteboards, Word documents, a web-based learning platform, a painted banner and poster, Skype and face-to-face meetings. The banner and poster were used to share knowledge with the community. This finding is strongly aligned with the literature findings concerning another aspect of the KM literature, boundary objects (Carlile, 2002; Star, 1989). Its role is included here as a practice because of the activities that took place around its use, in particular acting as a focal point for feedback from the community which was then used as input to the project design. In the current study, academics used a whiteboard to articulate their tacit knowledge in face-to-face meetings either with academics or NGO representatives. In a similar fashion as noted in the literature, whiteboards were used in agile teams as communication and collaboration tools (Sharp et al., 2009).

Workshops emerged as an important practice under the articulation mechanism for ProjectNGO. Project members were able to communicate knowledge gained from the project to various individuals in the university and the NGO. Other studies have identified conferences, workshops and seminars as a mechanism of knowledge transfer (Appleyard, 1996; Davenport & Prusak, 1998; Marquardt et al., 2009). Furthermore, conferences and inter-firm reviews are considered examples of knowledge articulation (Mason & Leek, 2008). In a DIL case (Hund et al., 2019), for example, workshops were stated as one of the key mechanisms for communicating knowledge to members. Hasnain and Jasimuddin (2012) in their research stressed that the NGOs in Bangladesh that they studied regularly arranged conferences, workshops and seminars to transfer knowledge to the beneficiaries on the relevant subject areas. However, with ProjectNGO, one of the aims of these workshops was to help project members access to other members' knowledge, and to provide an opportunity to enter insights from other individuals and organisations into the project. In my research, workshops as practice in ProjectNGO related to the organisational culture of the NGO in the Bangladesh context, and because ProjectNGO was dealing with social issues it needed to be perceived as dealing with them in an appropriate way.

In ProjectIndustry, the academics articulated tacit knowledge to formulate concepts and approaches for the project which were later turned into academic articles and shared with a wider audience through conferences and journals. Dinoco representatives did not contribute to this mechanism and were not involved in knowledge sharing during the development of the prototype. They later added their procedural knowledge to the first version of the prototype in regards to its applicability in practice – a procedure which is discussed later under the modification mechanism. Regular reports were also used

as a means of documenting the development of the process, but not as a means of articulating tacit knowledge. Given that ProjectIndustry was outcome-oriented, the industry partners were motivated by their quest to find a technical solution rather than the articulation of experience and tacit knowledge in a written format and sharing this with a wider audience. As a consequence, ProjectIndustry was characterised by the need to produce a prototype that provided business value. Prototypes in the KM literature are considered as boundary objects (Carlile, 2002; Star, 1989).

Ad hoc conversations outside formal meetings constituted a main part of the daily work of academics in both projects. However, the academics in ProjectIndustry reinforced the role of ad hoc conversations in the verbal articulation of tacit knowledge during development of the prototype.

Modification mechanism

In the literature, reflection on explicit knowledge is considered an effective form of tacit knowledge sharing (Ganguly et al., 2019; Haldin-Herrgard, 2000; Joia & Lemos, 2010; Stover, 2004; Yang & Farn, 2009). However, there is little research in the literature about commenting as a space for knowledge sharing in a systematic way in the context of collaborative projects. The current study investigates the question of commenting in this context. In the literature, commenting was mentioned as an aspect of socialisation when people wanted to provide commentary on recent topics and issues posted in social media based on physicians' perspectives (Panahi, 2014). In the current study, by contrast, commenting is explored as a major practice under the modification mechanism. In this practice, produced explicit knowledge was enriched and modified by an individual's own experiences. Although insights and reflections were based on tacit knowledge, they were more systemised than instant commenting because project members in ProjectNGO were involved in creating the first version and Dinoco representatives were aware of the existing problems and routine practices. Therefore, it can be argued that NGO and Dinoco representatives' comments under the modification mechanism not only produced explicit knowledge in a systematic way, but also helped each individual to share and externalise their own insights and experiences in a systematic way.

In providing comments, ProjectNGO used both verbal and written formats, whereas Dinoco representatives focused more on verbal commenting. In this way, verbal communication was explored as another practice under the modification mechanism for ProjectIndustry. Dinoco representatives were involved in a task in their workplace and they were comfortable in talking about their practice. However, because of their organisational culture they restricted the sharing of confidential/sensitive information in an explicit form.

Accumulation mechanism

In this mechanism, knowledge accumulated in the individuals' minds and each organisation's memory via training, learning by doing and recording of knowledge and experience practices. For training practice, ProjectNGO used workshops and seminars to improve the quality of the work performance in the field through sharing experiences and explicit information about PAR and how they needed to run the project in the field. Both organisations (NGO and the university) were involved in this practice. Project members converted newly-created explicit knowledge into tacit knowledge through training and accumulated it in their minds. This accumulation of created knowledge helped project members to understand the methods and how they needed to run the project in the field. Previous research has shown that in an organisational context, training programs created explicit knowledge shared throughout an organisation and then individually converted into tacit knowledge. Consequently, training could help individuals to understand an organisation and themselves (Nonaka, Toyama, & Konno, 2000).

In terms of learning by doing, in ProjectIndustry academics learned by developing the prototype and tool, while Dinoco representatives learned by putting into practice the developed prototype and tool in their daily routine in the workplace. Before this stage, the prototype had been tested and modified in the virtual space under the modification mechanism with contributions from academics and Dinoco representatives. However, testing and using the developed prototype in the Dinoco workplace occurred without the presence of the academics. What Dinoco representatives learned from testing in the workplace and internalised as tacit knowledge in their mind and Dinoco memory became a kind of goldmine (treasury) of information and knowledge for them to problem-solve or improve their operations, strategies, competencies, skills and capabilities in a competitive market. Since testing and using the prototype occurred without academic presence, learning by doing practice was a shared space among Dinoco members in order to accumulate produced knowledge.

The current study found that training in collaborative projects, as in an organisational context, was one way of accumulating knowledge among all project members in ProjectNGO. Learning by doing as one way of accumulating knowledge also occurred in the Dinoco workspace without the academics. It can be argued that because of the nature of the project, the academics did not need to accumulate knowledge of how the prototype worked in practice because they had developed the prototype based on Dinoco requirements and had already tested the prototype in the virtual space in the modification mechanism. On the other hand, Dinoco representatives needed to accumulate specialised knowledge by performing tasks via the created prototype in the workspace. By way of comparison, in enterprise information portals learning by doing occurred when members accumulated specialised knowledge by performing their own specific tasks within the organisation (Ryu et al., 2005). It is worth adding that the prototype included a solution to Dinoco's existing problem that had initially created the basis for the collaborative project. In these circumstances, Dinoco needed to apply the prototype in practice and see if the prototype solved its problem or not.

The recording of knowledge and experiences has been explored as another important practice under the accumulation mechanism. The current study confirms the finding of previous studies (Amabile et al., 2001; Aniekwe et al., 2012; Hanley & Vogel, 2012), namely, the lack of tacit knowledge capture in academic-practitioner research. However, this study has also found that there was a lack of consistent formatting in the writing up of technical processes in the research university with ProjectIndustry, since the academics were not aware of how to write up the procedures of the technical project in a format that was organised and understandable in a manner best suited for the practitioners.

Feedback mechanism

In the feedback mechanism, knowledge was shared via interviews, regular meetings, and research progress reports for ProjectNGO and verbal communication for ProjectIndustry.

Feedback and its role in knowledge sharing have been addressed in the literature (Bock et al., 2005; Cabrera et al., 2006; Foss et al., 2009; Wasko & Faraj, 2000; Zhang & Ng, 2012). For example, individuals in construction teams obtained feedback including comments, suggestions and mistakes pointed out by teammates (Zhang & Ng, 2012). Feedback provided an opportunity for members of electronic communities of practice to refine their thinking and develop new insights via the feedback they received.

The findings of my study confirm the role of feedback in knowledge sharing and evaluating knowledge structures. However, the study has explored interviews and research project reports as practices for getting feedback in collaborative projects. Feedback received in ProjectNGO via interviews added

further value in collecting accurate data about the context of the project and the process in the field. Feedback received via doctoral students' presentations after fieldwork took the form of interim reports for the NGO and progress reviews for the doctoral students. In the literature, Kunttu et al. (2018) in their own research defined a doctoral graduate as a boundary actor between university and industry in transferring knowledge. However, in their study they mostly studied the mobility of doctoral graduates from academia to industry. They focused on how students familiarised themselves with an industrial way of working via this program and continued their careers in industry after graduation. In my study, doctoral students can be considered as having two roles. First, they developed knowledge sharing practices for both the NGO and university, and additionally, they helped in implementing the project by providing interim reports to the NGO and other stakeholders. Consequently, feedback via either interviews or doctoral students made a significant difference to project implementation in ProjectNGO. However, for ProjectIndustry, since the prototype was tested in the virtual space in the modification mechanism, the received feedback via verbal communication after site implementation provided added value only if the tool did not meet the requirements in practice.

Transfer mechanism

Through this mechanism, the knowledge that was produced by the interaction of individuals during the projects was transferred to either the wider project community or to external audiences.

In ProjectNGO, transfer to wider audiences occurred mostly through publishing scientific documentation such as academic articles or presenting in scientific venues such as conferences, workshops and seminars. However, reports, workshops and seminars were mostly used for transferring project-finalised knowledge among partners. In ProjectIndustry, the actual finalised prototype was also transferred from the project to Dinoco. Therefore, transfer of knowledge can happen in all modes of knowledge conversion in all shared spaces.

Transferring early know-how/know-what knowledge for a wider audience in ProjectIndustry took place in the dialoguing SCS. Having said that, ProjectNGO did not transfer to a wider audience before the field implementation stage. It can be argued that this is because of the nature of the research. ProjectNGO had a social nature which was sympathetic to engagement with the community, to educating them and to encouraging social improvement (C. Williamson, 2013) and then sharing the results. On the other hand, the ProjectIndustry as an academic-technical project needed publications and citations before the development stage (Nelson, 2009).

Transferring progress reports for both projects took place in all spaces because they were part of the official documentations of the project for the university, Dinoco and the NGO. Transferring finalised knowledge for both projects took place in the exercising SCSs. In ProjectNGO, the NGO used social media for transferring results of the project to its own community. However, in the university, open seminars and the doctoral students' milestone sessions were used for transferring knowledge to its own community.

The transfer mechanism has been addressed in the literature (Argote & Ingram, 2000; Gorovaia & Windsperger, 2010; Jasimuddin, 2007; Karlsen & Gottschalk, 2003; Lilleoere & Hansen, 2011). Argote and Ingram (2000) considered knowledge transfer as transferring knowledge at higher levels such as the group, product line, department or division in the organisational context. The findings of my study also confirm that transfer of knowledge at higher levels occurred in the context of the collaborative projects, as well as the transfer of knowledge wider related communities in an interorganisational context.

With regard to the transfer of produced explicit knowledge within the organisations themselves, the literature provides an example of a pharmaceutical company in Denmark, where the transfer practice included both tacit and explicit knowledge. Transfer of scientific documentation took place as part of daily work through individual-to-individual or individual-to-group interactions and was integrated in the project organisation (Lilleoere & Hansen, 2011). In my study, produced explicit knowledge was transferred between partners and the community. Transferring knowledge to wider audiences in the university was not the main objective because in each project, individuals worked in their own area of expertise and there were also many other disciplines and groups. Open seminars and doctoral students' milestone sessions were practices for informing other faculty members and students. Transferring tacit knowledge was difficult for both projects because of the lack of knowledge capture. This is discussed in Section 7-5-1-4.

RQ1-1 What are the drivers and barriers in the knowledge sharing processes of university–organisational collaborative projects from participants' perspective in Australia?

The findings have revealed both the motivations for knowledge sharing on the part of the academics and industry/NGO representatives and the range of challenges they experienced when they shared knowledge. These are listed in Table 7-1.

Participants identified different barriers that affected knowledge sharing in both projects. Barriers or challenges to knowledge sharing in these projects refer to the obstacles that active actors faced or might face in knowledge sharing during collaboration.

The more important challenges that were found to potentially raise barriers to knowledge sharing arose in the context of organisational cultures and differences. Organisational differences have a direct impact on knowledge sharing. A university has an explorative nature, while industry and NGOs have problem-solving natures. Based on their objectives and structures, they prioritise different tasks. The university is often interested in long-term results and publication of findings, while the industry and NGO want to have short-term outcomes to use in practice. Schofield (2013) in her research mentioned the differences in missions and objectives, and organisational cultures of industry and universities as barriers to knowledge transfer in university–industry collaboration. Aniekwe et al. (2012) also made the point that NGOs need quick and accessible results for use by practitioners.

In this study, organisational differences were due to a range of issues, as discussed in the following subsections:

Table 7- 1.Summary of the findings

Questions	ProjectNGO	ProjectIndustry
How is knowledge shared?	• Exchange • Articulation • Modification • Accumulation • Feedback • Transfer	• Exchange • Articulation • Modification • Accumulation • Feedback • Transfer
What are the drivers?	• Interest in research • Mutual benefit • Money	• Financially beneficial outcomes via finding solution to a problem for industry • Increasing research capacity for university • Developing domain knowledge • Running interesting projects for academics • Publications • Promoting their own capability to a wider audience for university
What are the barriers?	• Lack of written documents of the procedures for the ProjectNGO • Misunderstanding of the quality of the data • Difficulty in getting permission from the university IT department to use new software • Lack of knowledge capture • Lack of organised research datasets • Organisational culture differences • Foreign language differences • Discipline and subject language differences • Telecommunication access • Lack of time	• Industry strict policy • Lack of knowledge capture • Lack of organised research datasets • Organisational culture differences • Discipline and subject language differences • Lack of time
What kind of knowledge is shared?	• Explicit • Tacit	• Explicit • Tacit
How do participants create SCSs?	• Originating • Interacting • Systemising • Exercising SCSs	• Originating • Systemising • Exercising SCSs
What kind of SCSs are most effective?	• Face-to-face SCSs	• Cyber/virtual SCSs
What are the conditions required to develop SCSs?	• Trust • Time • Resources • Common goals • Clear timelines • Clear objectives	• Trust • [Time] • [Resources] • Having all the knowledge about the topic under the research • Common topic • Understandable scope • Having specific room for discussion

Misunderstanding of the concept of quality data

One of the important findings under organisational culture differences for ProjectNGO has been the misunderstanding of the concept of quality data. This challenge was emphasised by the academics. Since the main NGO did not conduct the relevant research in the field and local Bangladeshi universities and specific local community-based organisations were subcontracted to carry out data collection, the collected data was not well-collected from a foreign academic point of view. This challenge may have resulted from the different organisational cultures of each party involved in data collection. There were different sets of priorities, skills and experiences that came into play.

The NGO was mostly interested in the data from a project evaluation point of view, rather than the theoretical research that universities are interested in. This reflects the findings of Aniekwe et al. (2012) who found that NGOs and universities operate from two different logical frameworks. NGO practitioners are interested in solving a specific problem in a particular context, while academics are more interested in rigorous findings.

Lack of organised research datasets

The study has indicated that a lack of organised research datasets was a barrier to knowledge sharing in both projects. The university, the NGO and Dinoco all had their own policies in organising research datasets. However, there was no clear policy in this regard.

The university in ProjectNGO used Google Drive for organising research datasets with a simple structure and naming system. The NGO used Box in which to store all documentation of NGO activity. It is worth noting that in ProjectNGO, they had to prepare a research data management plan in order to get ethics approval. However, it was difficult to put that plan into practice with two different organisational cultures in play. In the literature, a previous study confirmed that the lack of research data on NGO activities creates difficulty in designing and implementing projects because of a lack of understanding and identifying relevant knowledge on basic issues such as the types of development activities that NGOs are involved in (Mungate & Mvududu, 1991). As discussed under Knowledge Capture below, this study also found a lack of information about previous projects to be a problem.

In ProjectIndustry, the industry was not interested in storing the research datasets. All data and software were stored on the university's central research data storage managed by the university e-Research Centre in accordance with the university Research Data Management Policy and Procedures.

Language

Language problems were mentioned as a barrier in the ProjectNGO. While English was the common language used between academics and NGO representatives, it was not the mother tongue of the NGO representatives or the associate researcher. Written communication was in English; however, face-to-face and virtual meetings instead used Banglish. In a previous study of knowledge sharing among high-tech companies in China and India, foreign language was mentioned as a barrier to knowledge sharing. Communication happened fairly effectively in English; however, meaning was often lost (Teagarden et al., 2008). In my study, in ProjectNGO, since all fieldwork occurred in Bengali, a lack of subtlety in translation and the development of data collection tools such as questionnaires also emerged as a barrier, because there were many things to be translated into English and translation was not always of sufficient quality for the researchers.

Discipline and subject language related to differences in knowledge background for both projects was mentioned as another major barrier to knowledge sharing from the active actors' perspectives. Academics used more complex language in communication due to their research needs, while the NGO and Dinoco representatives used practical and conversational language in communication. In ProjectIndustry, understanding the terminology of the Dinoco took time for academics because they were not expert in the Dinoco domain. Therefore, both projects' members spent time trying to find a shared language. The two sides had to struggle to communicate and understand each other at the beginning of the project, even if mutual understandings and shared language did eventually develop over time through collaboration.

After developing a shared language, project members were more easily able to communicate and share knowledge and information. Consistent with prior research, my study shows that in an interorganisational context such as organisational collaborative projects, shared language also eases communication and knowledge sharing. Shared language for information and knowledge sharing, as well as a capacity to theorise, have also been found in the literature (Lauring & Selmer, 2011; Lesser & Storck, 2001; Tamjidyamcholo et al., 2013).

Lack of knowledge capture

According to the literature, collaborative projects face challenges related to information management and knowledge sharing (Almeida & Soares, 2015). In project work, a lot of information and new content are created by a variety of technologies, leading to the risk of information overload in the implementation of the project (Karim & Hussein, 2008). However, when a project is finished, its content typically disappears because collaborative projects are time-limited settings. There are no time or policies to organise the produced knowledge in appropriate KM systems in order to reuse it (Almeida & Soares, 2015). Existing literature emphasises that the codified information is rarely shared and reused between projects (Bakker et al., 2011) or to contribute to organisational learning (Almeida & Soares, 2015). Therefore, organisational learning is dependent on knowledge creation and sharing of the produced knowledge of collaborative projects. If the produced knowledge is captured, learning takes place and knowledge applies in organisational processes (Almeida & Soares, 2015).

My research findings show that in the NGO and the university, there were some spaces such as Box for the NGO and Google Drive for the university to help to organise the explicit and codified knowledge of the project. ProjectNGO members had their own particular structures for organising information and knowledge. However, Dinoco did not record the codified knowledge of processes internally because it was not interested in the process of creating the solution, only the outcome. Instead, the firm simply recorded meeting minutes and reports. Therefore, this practice highlights how the codified and explicit knowledge was important in the studied collaborative projects and was captured in both projects in the university and the NGO and partially in the industry because of two reasons: first, organisations needed to record the explicit knowledge for their own internal report and organisational learning, and second, organising explicit knowledge is easier.

Both of the projects used several different ICT platforms in order to capture and share knowledge. However, in ProjectNGO they had challenges in getting permission from the university IT department to use new software. Consistent with my study, documentation control, inadequate IT support and information overload are mentioned as information management barriers in R&D projects (Santos et al., 2012). Furthermore, in the existing literature managing information and knowledge is dependent on using flexible and sophisticated information and communication technology (ICT) tools and techniques (Almeida & Soares, 2015).

Project-related knowledge such as skills, insights, collaboration experience and personal motivation which are key in knowledge sharing were not captured well in both projects. In line with my research, previous studies (Amabile et al., 2001; Aniekwe et al., 2012; Hanley & Vogel, 2012) reaffirm the lack of tacit knowledge capture in academic-practitioner research.

The risk of knowledge loss, specifically tacit knowledge, at the end of the collaboration was a serious challenge for the university, NGO and Dinoco because accumulated knowledge in individual minds, if not captured, can be lost and disappear. These findings are consistent with previous studies (Carrillo, 2005; Fong & Kwok, 2009; Landaeta, 2008) which concluded that if accumulated knowledge is not effectively shared throughout the project, outcomes can be lost via errors and time overruns.

Staff turnover as a reason for failures in knowledge capture leads to an inability to use the expertise and experience gained during collaboration by employees leaving the organisation or taking over other responsibilities in the organisation. The findings of Urbancová and Linhartová (2011) reaffirm that if an employee with critical knowledge leaves the organisation, the organisation can be threatened with the loss of knowledge.

A lack of local audience in the university has been identified as another main reason for lack of knowledge capture in ProjectNGO. There are different research groups in a university. Every group has its own setting and culture and activity. Each research group's setting affects the way it conducts its research and its interest in other topics. This setting also affects the ways it can share the outcomes of the research with other groups. Mostly, groups work in isolation. This isolation is also connected to the way that specific research is organised and funded, and interaction or lack of interaction between disciplines.

The conclusion can be drawn that there was a lack of KM processes to record and capture explicit and tacit knowledge in both projects (NGO, Dinoco, university). In addition, in ProjectIndustry there was an absence of guidelines on consistent formatting in writing up of the technical processes among academics. Although stressing the lack of KM processes and guidelines in capturing the produced knowledge of the projects, we need to consider the nature of project tasks, which are idiosyncratic and finite (Almeida & Soares, 2015; Bakker et al., 2011). Additionally, capturing the processes of these projects in the same way as other organisational processes may not have been a priority in the consciousness of the organisations (NGO, Dinoco, university).

Lack of written procedures in the NGO project

NGOs need to have innovative approaches to managing resources and projects. However, the research literature shows that NGOs face implementation challenges because of vaguely defined or weak internal processes. In order to minimise problems in the design and implementation of NGO projects, they need to use proven project management tools, training programs and reporting formats (Batti, 2015). In my study, the NGO demonstrated its capacity in project management and accountability documentation. On the other hand, there was a paucity of written documentation of the procedures, day-to-day operational activities and research information relevant to the project. This can be considered a potential barrier to knowledge sharing in ProjectNGO, which reflected the NGO's view that documentation of procedural knowledge was not a priority.

It can also be observed that intellectual property (IP) and ownership of the results of both projects were defined in the respective contracts before the start of the projects. This was not mentioned as a barrier to collaboration for both projects from participants' viewpoints. In ProjectIndustry, the idea had been

raised about commercialising the software, although in the stage of the project that I studied this had been abandoned. However, other research has mentioned IP as a potential barrier to university–industry collaboration (Fazackerley et al., 2009; Schofield, 2013; Siegel et al., 2003) because universities need to negotiate their IP value to protect their publication rights, keep results for their future research and communicate openly. However, communications are private and confidential for industry because industry wants to protect key technology as a competitive advantage.

Other relevant elements

In the NGO project, there were other elements that affected knowledge sharing. These included the local culture of Bangladesh, cultural distance, time and telecommunication access.

Local culture of Bangladesh and cultural distance

Local cultures and cultural differences were at play in ProjectNGO. Academics needed to adjust to the Bangladeshi social and institutional culture, and this meant considerable travel and time spent establishing mutual understanding. It also made online meetings complex, since mutual understanding across ‘noisy’ Skype, Zoom or phones was sometimes very difficult to achieve.

This finding confirms the research of Allali (2016) that explored local culture and political governance as elements which influenced the practice of knowledge sharing among ICT firms in Libya. Libyan culture was also mentioned as a major barrier to creating a culture of sharing. In my study, in ProjectNGO, however, Bangladeshi culture was not explicitly mentioned as a major barrier. As an international project, academics spent time learning about the dynamics of the Bangladeshi culture and this overcame some, but not all, barriers.

This finding agrees with previous studies which have mentioned that cultural distance increases the cost of entry (Palich & Gomez-Mejia, 1999) and operational difficulty (Mowery et al., 1996) and can lead to misunderstanding and limited sharing of core knowledge components (Lyles & Salk, 1996). Furthermore, cultural distance as a barrier to communication in global teams can negatively influence relationships because it limits the creation of personal ties and direct access to people (Wendling et al., 2013). In my study, geographical distance limited access to people, however, it did not influence relationships negatively because project members who were involved in direct communications kept up their connection virtually.

For ProjectIndustry, geography was much less of an issue, given that the project occurred within one country where time differences were manageable, and all members used Zoom for communication.

Time

Time issues can be divided into three main categories: lack of time at the individual level, time zones and time orientation to outcomes.

At the individual level, academics and industry/NGO representatives mentioned a lack of time as another main barrier to sharing knowledge because they had other commitments. These findings confirm what is known from previous studies which have indicated that a lack of time can be a major constraint to knowledge sharing within virtual teams (Rosen et al., 2007) and in an organisational context (McDermott & O’dell, 2001; Riege, 2005; Szulanski, 1996; Yao et al., 2007). Francis-Smythe

(2008) developed this further, finding that the greatest obstacle to knowledge sharing was not the lack of time per se but, rather, the paucity of adequate blocks of time for knowledge sharing.

ProjectNGO in an international setting and ProjectIndustry in a national setting both operated with time zone differences. While time zones differences resulting in meeting and work problems are attested to in the literature (Teagarden et al., 2008), members in neither project mentioned this as a barrier to knowledge sharing directly in the interviews. However, my observation confirms the effect of time zones differences as a problem in organising meetings.

The NGO and the Dinoco also had the same time orientation. They both needed short-term results. However, academics needed to do research in longer term and this was a barrier that both the NGO and Dinoco representatives mentioned. By contrast, time orientation was mentioned as a barrier to knowledge sharing in the industry case, since there the partners worked in shorter time frames than those common in universities, where PhD and research grants typically have three-year cycles (Plewa et al., 2005).

Telecommunication access

Telecommunication technology facilitates long-distance collaboration via offering access to large amounts of data and information (Riege, 2005). In ProjectNGO, there were many problems in joining and attending online meetings because of telecommunication issues in Bangladesh. With email and video-conferencing equipment, such as Zoom and Skype, commonly used for communication, disconnections and poor sound quality were frequent occurrences and could lead to misunderstandings. In a similar vein, this challenge was mentioned as a communication-related challenge in a university–industry project in software engineering (Garousi et al., 2019).

For ProjectIndustry, communication mostly occurred via email, Zoom, a web-based interface and communication platforms such as Slack and GitLab. Project members did not mention any problems or challenges in online communication, working as they did within the same national setting. In their case, technology and online communication provided the opportunity for ongoing discussion.

Based on the differing experiences of the two projects with telecommunications infrastructure, projects and research need to remain aware that telecommunications may not always work well.

RQ2. How do participants create shared collaborative spaces (SCSs) for knowledge sharing in university–organisational collaborative projects?

RQ2 is an umbrella question made up of three sub-questions, which are answered below.

RQ2-1. What kind of knowledge is shared in SCSs in university–organisational collaborative projects?

Academics and NGO/Dinoco representatives shared various types of both explicit and tacit knowledge during collaboration. These are listed in Figure 7-1.

As discussed, a continuum of tacit and explicit classifications of knowledge (Nonaka, 1994; Polanyi, 1967) was used in this study to guide analysis and interpretation. After mapping the knowledge assets component of the model in both projects, the results suggest that experiential knowledge should be

considered tacit knowledge, and conceptual, routine and systematic knowledge considered explicit knowledge.

In ProjectNGO, experiential knowledge and its subset emotional knowledge (care, commitment, autonomy and openness) were shared mostly in the originating SCS, while in ProjectIndustry, experiential knowledge and its subset (commitment and openness) were mostly shared in the Systemising SCS, the place where direct collaboration between academics and Dinoco representatives began. In both projects, trust as emotional knowledge was the input for starting knowledge sharing because in ProjectNGO, the project members trust each other's knowledge because of the reputations of the partners and in ProjectIndustry, academics relied on Dinoco knowledge in practice and Dinoco representatives trusted academic knowledge because of past collaborative experience.

In ProjectNGO, conceptual knowledge such as theoretical and methodological concepts was shared in the dialoguing SCS by the contributions of the academics and the NGO representatives. However, for ProjectIndustry, conceptual knowledge such as the content of academic articles and methodological concepts in developing new technology were shared only among academics in the dialoguing and systemising SCSs. Dinoco representatives did not have any role in creating or sharing conceptual knowledge.

In ProjectNGO, systemic knowledge such as academic articles, meeting minutes, reports, manuals on PAR, data collection tools such as questionnaires, project proposals, research agendas, memos and comments were shared in the dialoguing, systemising and exercising SCSs, while in ProjectIndustry, systemic knowledge such as actual data about plants and constraints in written form, manuals, mathematical formulae, terminology, algorithms, the prototype, meeting minutes, academic articles, and reports were shared in the originating, systemising, and exercising SCSs.

In ProjectNGO, routine knowledge such as how to engage in PAR, how to do interviews, how to conduct surveys and how to run collaborative projects was shared. However, in ProjectIndustry, routine knowledge such as how Dinoco works in practice and how the industry and the university could collaborate and work with external stakeholders was shared.

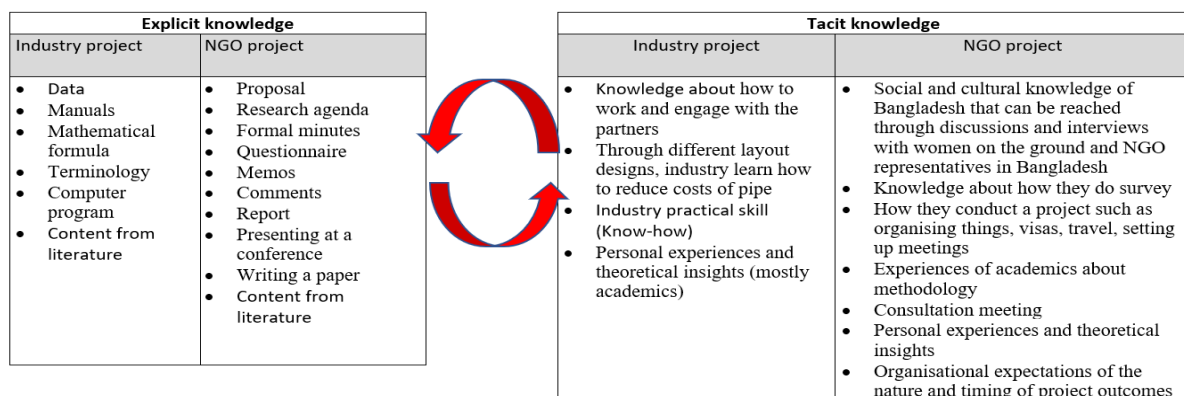


Figure 7-1. Types of knowledge

RQ2-2. What kind of SCSs support knowledge sharing in university–organisational collaborative projects?

As discussed, knowledge creation theory is widely used to study multinational firms, small and medium enterprises (SMEs), NGOs, government organisations, communities, regions and nations (Nonaka & Nishihara, 2018). It is a flexible and practice-based theory for explaining the activities of knowledge sharing and creation. This study takes the knowledge creation model as a given and accepts that it occurs within university–organisational collaborative projects. However, in comparison with previous studies, this study has identified different characteristics of Ba in some spaces.

Sharing knowledge for both projects started in the originating SCS. In ProjectNGO, it began with the sharing of tacit knowledge involving more project members from both organisations. In ProjectIndustry, by contrast, it started with limited number of the project members in negotiation stage of the project. In addition, explicit knowledge was exchanged in this space as well. In the originating SCS, in an intra-organisational context face-to-face interaction is the basis for knowledge sharing and creation (Nonaka & Konno, 1998; Nonaka, Toyama, & Konno, 2000). However, in the university–organisational collaborative projects, virtual interaction also played an important role. In ProjectIndustry, the originating SCS was mostly built upon virtual interaction using email and Zoom. In ProjectNGO, members of the project socialised virtually via Skype due to the geographical spread of the project. At the same time, for a number of reasons they also considered face-to-face communication as foundational for this space: the participatory nature of the project needed more tacit knowledge; cultural and social situations needed to be shared; the poor quality of telecommunications in the developing country made online meetings difficult; and the implications of different organisational cultures between NGO and university needed to be addressed.

Virtual spaces and ICT such as Zoom, Skype and email were considered necessary tools for starting communication and supporting SCSs for both projects. However, in the intra-organisational context virtual spaces and ICT applications are considered an accessory tool in order to merge and store knowledge (Niccolini et al., 2018; Nonaka & Nishihara, 2018; Nonaka et al., 2008).

In Nonaka's model, the originating Ba provides a context for tacit knowledge conversion. This happened in both projects, but in ProjectIndustry Dinoco also made available a number of documents in this space. For ProjectNGO, experiences and mental models were shared in this space, just as in Nonaka's model, due to the participatory nature of the project. On the other hand, limited tacit-to-tacit knowledge conversion happened for ProjectIndustry, because there they were working on developing a new technology that was largely based on systematic information and codified knowledge.

For ProjectNGO, physical and face-to-face meetings were important and effective in knowledge sharing because they needed to discuss and conceptualise tacit knowledge. However, for ProjectIndustry, although project members preferred face-to-face meetings, systemising/virtual SCSs were mentioned as the most effective space in supporting knowledge sharing because of the nature of this project and the characteristics of the web-based interface used. This allowed each individual to drive conversations and suggest changes within the prototype based on their own areas of expertise.

In summary, academics and NGO/industry representatives created originating, interacting, systemising and exercising SCSs for knowledge sharing, as described by SECI and largely conformed to the model. These two case studies found two variations on the original model. The first relates to how well the two cases fit the original model. ProjectNGO provided a good fit to the original model, however

ProjectIndustry was not as easy to fit to the model. This is because the two initial modes of the SECI model, socialisation and externalisation were comparatively little used: socialisation because only a very limited number of project members were involved, and externalisation because it really only involved the academic members of the partnership, who quickly moved into the combination mode. Another important difference is the use of virtual platforms and ICT applications in all of the spaces, including socialisation. These tools enhanced creation of each space and consequently could be considered essential elements for creating SCSs.

RQ2-3. What are the conditions required to develop SCSs between participants in university–organisational collaborative projects?

The conditions required to develop SCSs in this context were found to be closely related to the concepts including care, trust, autonomy, commitment and openness, as were the management of a range of other issues relating to time, resources, common goals and so on.

In the original model, trust formation starts in the originating Ba and is considered an output of this space. However, in the context of the university–organisational collaborative projects there was well-established organisational trust due to prior collaboration experiences and the reputations of the organisations. Therefore, trust could be considered an input to the originating SCS.

For both projects, trust was a precondition in establishing SCSs that best supported the necessary knowledge sharing processes. For ProjectNGO, time, resources, common goals, clear timelines and clear objectives were mentioned as the basic conditions from participants' perspectives. In addition, in ProjectIndustry, having a clear understanding of the project scope and methodology from the start of the project, common topics and understandable scope, and specific room for discussion were mentioned as necessary conditions to develop collaborative spaces.

The Dinoco/NGO representatives trusted the academics' knowledge because they had past collaborative experience, combined with trust in the academics' justifications of what they were doing and why. The academics trusted the Dinoco and NGO representatives' information and knowledge because they recognised their domain expertise and relied on their knowledge in practice. Trust was the strongest factor contributing to knowledge sharing in both projects as the main characteristic of the originating SCS. There was well-established organisational trust between the university and the NGO/Dinoco in the beginning of the projects due to prior collaboration experiences and the levels of expertise and reputations of the organisations. This supports the findings of previous studies in considering trust as a key factor in knowledge sharing process (Allali, 2016; Aulawi et al., 2009; Davenport & Prusak, 1998; Kim & Lee, 2004; Van Wijk et al., 2008).

In ProjectNGO, the level of interpersonal trust between project members during collaboration changed because of the nature of the project as a form of PAR, which entailed considerable discussion of the processes along with the outcomes of the project. As a result, the level of interpersonal trust increased based on ongoing observations and interactions. Due to the nature of PAR, the level of interpersonal trust increased. Project members were willing to share knowledge. It is worth mentioning that with the evolution of the project, the academics came to know the limitations of the NGO in terms of delivering quality research data. However, this limitation of the NGO did not have an impact on the level of interpersonal trust because the academics understood the NGO limitations or the limitations of the situation. In addition, based on my observations and study of related documents, the ProjectNGO members had strong ties because they had many formal and informal meetings and conversations to sit

and discuss the project. Academics also spent a lot of time in Bangladesh and were respected for this. It seems that the nature of PAR was a strong contributing factor in creating interpersonal trust.

In ProjectIndustry, interpersonal trust was developed throughout collaboration. Dinoco representatives asked for and considered the justifications of the academics for specific processes and decision-making. However, the academics also trusted the Dinoco knowledge because they thought that the Dinoco representatives were expert in that specific field and they had more reliable and trustworthy information and practice knowledge. Since the developed prototype and tool worked in practice, they trusted the knowledge and information of the Dinoco team members.

Because of having more regular formal meetings, the ProjectIndustry members did not develop strong social ties during collaboration. This was because knowledge sharing in the ProjectIndustry was generally systematic and linear, aimed at solving a predefined problem. As a consequence, there was not seen to be much need for discussion of developing problems. Instead, their discussion focused on the applicability of the prototype and tool in practice or straightforward problem-solving of technical processes.

For ProjectNGO, care, trust, autonomy, commitment and openness were the main characteristics of the originating SCS. However, for ProjectIndustry only trust was explored in this space. Commitment and openness appeared at the start of direct interaction between Dinoco and the university members in the combination mode in the Systemising SCS.

In the dialoguing SCS, both groups of actors (academics and NGO representatives) in ProjectNGO were engaged in the process and creation of this space. In comparison, the Dinoco representatives did not have a major role in the conceptualisation and articulation of tacit knowledge. Because of this, the partners in that project did not create this SCS. In this space, at the same time, both projects also used many ICT tools, Zoom, Skype, email, Word documents, Slack, Google Drive and the phone, because of the geographical locations of the partners in different countries with ProjectNGO and the different campuses and the need to share codes and technical formulas for ProjectIndustry. This supports a study by Deshpande et al. (2016) which found that collaborative online tools were used to keep track of decisions and to facilitate communication within co-located and distributed teams.

As for the Systemising SCS, explicit knowledge in ProjectIndustry was systemised through implementing and testing the prototype in a web-based interface and modifying it via verbal comments. In the case of ProjectNGO, explicit knowledge was systemised through justifying and modifying concepts through either written or verbal comments.

For ProjectIndustry, commitment and openness appeared in this space because actual interactions started there. Project members mentioned that being open to accepting new ideas was another characteristic of sharing and modifying the produced knowledge despite the fact that the Dinoco representatives needed to consider Dinoco policy in being open to accepting new ideas.

With regards to the exercising SCS, as in the intra-organisational context, interactions in both projects occurred on the site of the individual partner, in the university, the NGO or the Dinoco site. In creating the exercising SCS independently of each other, each partner created their own space for internalising knowledge. For sharing and converting created knowledge, in ProjectNGO workshops were used as a shared space. However, in ProjectIndustry the 3D visualization tool was used as a shared space for interaction to get feedback.

Transcendence and reflection were synthesised through action in the Dinoco and intra-organisational context, but in ProjectNGO this happened through discussion. Internalisation for Dinoco representatives occurred through applying the created prototype (initiative) in practice and for academics through academic articles and recording of knowledge and experience.

For the NGO representatives and academics, workshops, academic articles and recording of knowledge and experience were explored as ways of internalising knowledge. In addition, in ProjectNGO building relationships with others was identified as a means of internalising new knowledge.

The differences discussed above make it possible to reframe the main characteristics of each space based on the intra-organisational context (see Table 7-2).

Table 7- 2. Elements of Ba (Nonaka & Konno, 1998; Nonaka & Toyama, 2003; Nonaka et al., 2000) and application in university–industry/NGO collaborative projects.

Element	Dimension	Main characteristics of Nonaka’s theory	ProjectIndustry	ProjectNGO
Ba	Originating	- Knowledge-creation process begins in this Ba - Physical, face-to-face experiences are the key in this Ba - Tacit-to-tacit - Feelings, emotions, experiences and mental models are shared in this Ba - Care, love, trust, commitment, freedom and safety emerge in this Ba	- Knowledge creation process begins in this Ba - Virtual face-to-face interactions are key in this space - Tacit-to-tacit - Exchange of explicit information - Trust	- Knowledge creation process begins in this Ba - Virtual face-to-face interactions are key in this space - Tacit-to-tacit - Feelings, emotions, experiences and mental models are shared in this Ba - Care, trust, commitment, freedom (autonomy), openness
	Dialoguing	- Individuals’ mental models and skills are converted to common terms and concepts - Tacit knowledge is made explicit in peer-to-peer interaction	- Individuals’ (academics’) mental models and skills are converted to common terms and concepts - Tacit knowledge is made explicit by academics’ peer-to-peer interactions - Industry representatives do not have a major role in conceptualisation	- Individuals’ mental models and skills are converted to common terms and concepts - Tacit knowledge is made explicit in peer-to-peer interaction
	Systemising	- A place of interaction in a virtual world - New explicit knowledge is combined with existing information and knowledge through group-to-group interaction - Explicit knowledge is generated and systemised through justifying the concept - Commonly happens in collaborative environments utilising ICT applications	- A place of interaction in a virtual world - New explicit knowledge is combined with existing information and knowledge through group-to-group interaction - Explicit knowledge is systemised through implementing the prototype in virtual situation and receiving verbal comments - Commonly happens in collaborative environments utilising ICT applications - Commitment, openness	- A place of interaction in a virtual world - New explicit knowledge is combined with existing information and knowledge through group-to-group interaction - Explicit knowledge is generated and systemised through justifying the concept via discussion and receiving verbal and written comments - Commonly happens in collaborative environments utilising ICT applications
		Interaction happens on site	Interaction happens on site	Interaction happens on site

	Exercising	• It synthesises transcendence and reflection through action • New knowledge is internalised through manuals, directories or professional journals	• Practising the prototype can happen on the industry site without the interaction of academics • It synthesises transcendence and reflection through action via learning by doing and recording of knowledge and experience • New knowledge is internalised through applying the created prototype (initiative) in practice and academic articles • The 3D visualisation tool is used for interaction	• These are constantly developing and internalising in people's minds • It synthesises transcendence and reflection through discussion via training and recording of knowledge and experience • New knowledge is internalised through training, building relationships with others and academic articles • Workshops are used for interaction
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RQ3. What are the strengths and limitations of the concept of Ba for understanding the process of knowledge sharing and creation?

In this study, Ba proved helpful in identifying the knowledge sharing activities in the context of both projects. At the same time, my research has indicated some useful ways in which Nonaka's framework might be developed further so as to better understand the process of knowledge sharing:

- The first difference that has emerged is the use of virtual platforms and ICT applications in all of the spaces. Face-to-face interaction was replaced by virtual interaction because of the geographical spread of both projects and the technical nature of ProjectIndustry, which relied strongly on ICT applications for exchanging technical formulas.
- The second difference relates to the originating SCS. For both projects, trust was an input for creating the originating SCS. However, in the original model trust is considered an output of this space.
- The third difference is about the dialoguing SCS. In ProjectIndustry, there was no direct interaction between academics and industry representatives in order to conceptualise and create the solution, because industry representatives were not interested in conceptualisation. However, in the original model individuals were involved in conceptualisation.
- The fourth difference is about the time of intense interaction. In the original model interaction starts from the originating SCS, and ProjectNGO certainly conformed to this. In ProjectIndustry, however, intense direct interaction between academics and industry representatives began from the Systemising SCS.
- The fifth difference is about the experiential and emotional knowledge of the industry representatives. Experiential knowledge and its subset emotional knowledge (commitment and openness) were inputs, outputs and moderating factors in the Systemising SCS, the place where direct interaction between more academics and Dinoco representatives was realised. However, in the original model experiential and emotional knowledge emerge in the originating Ba.
- The sixth difference relates to the exercising SCS. In ProjectNGO, in the exercising SCS, transcendence and reflection are synthesised through discussion of methodology, data collection tools, conceptual knowledge and what was produced. Workshops were used as a shared space for discussion. However, in ProjectIndustry, transcendence and reflection were synthesised through action via using the prototype in practice. The 3D visualisation tool was used as a shared space for interaction to get feedback.

Since, in the context of ProjectNGO, most elements of Ba worked according to the originally proposed model, it can be concluded that Ba is mostly developed through social processes and my study suggests that Ba may more accurately describe social processes. In ProjectNGO, knowledge sharing was a social process; as a result, it is a strong model in showing and understanding knowledge sharing mechanisms. However, ProjectIndustry was a systematic and linear project that aimed to solve existing problems. Project members did not have much discussion in developing problems. Thus, some elements of the original Ba worked differently in the ProjectIndustry context, as mentioned above. These differences resulted in a reframing of the Ba characteristics in the university–organisational collaborative project context.

7-4. Towards a Conceptual Model

This section discusses some initial thoughts on a conceptual framework for knowledge sharing within university-organisational collaborative projects. However, it must be acknowledged that it is based on only two case studies, with both being within IT-related faculties. Such a limited study cannot hope to capture the full range of activities or strategies that might emerge from a broader study, especially given the diverse nature of university disciplines and types of research activity on the one hand, and potential partners on the other. It is offered as a very tentative first step to the development of a more broadly-based model.

As shown in Table 7-3, the framework has four main elements: knowledge sharing mechanisms, SCSs, practices, and tools.

In context of the university-organisational collaborative projects, knowledge sharing mechanisms are defined as activities or processes of exchanging and sharing individually held knowledge in tacit and explicit forms with other project members within a collaborative project structure, or the exchange and sharing of knowledge produced by the project with the parent organisations and parties who were involved in establishing the project and wider audience via SCSs.

These identified mechanisms (exchange, articulation, modification, accumulation, feedback and transfer) derive from the analysis of the context based on the concept of Ba. The application of Ba (originating, dialoguing, systemising, and exercising) is the underlying source for the identified mechanisms. Since the concept of Ba has been adopted as the foundation of the knowledge sharing mechanisms in the university-organisational collaborative projects, corresponding to the four SCSs, the conversion between tacit and explicit knowledge that occurs in SECI is applied to the mechanisms as well.

Ba (SCSs) within university-organisational collaborative projects are shared spaces representing the specific space and time that individuals established in order to share and create knowledge. SCSs are not just a physical space such as a room. They are also a mental space or an interaction space in which individuals can share knowledge.

Individuals in each SCS can communicate using a variety of activities. These activities are called practices, for example writing, commenting, training. The actual practices used depend on the stage of the collaboration, and the context. Within each practice, individuals applied different tools, for example writing, academic articles, reports, meeting minutes, whiteboards and word documents, to create and share knowledge.

The different styles of collaborative projects can influence the sort of SCSs, as well as the number of practices and tools are needed under each mechanism. Each mechanism also had a range of practices to support it.

- The exchange mechanism is occurred in the originating SCS. Depending on the nature of the project, in this mechanism, either tacit knowledge is shared and used to generate new ideas through the socialisation mode of SECI, or explicit information associated with the problem are shared and exchanged.

- The articulation mechanism occurs in the dialoguing SCS. In this mechanism, tacit knowledge is converted into explicit form for the first time either by writing or developing a feasible solution for existing problems by peer-to-peer interaction in face-to-face physical or virtual meetings. This is the creation of explicit knowledge for the first time through the externalisation mode of SECI.
- The modification mechanism occurs in the Systemising SCS. In this mechanism, explicit knowledge was shared, created and co-created. Co-creation of explicit knowledge could occur in peer-to-peer or group-to-group meetings either face-to-face or virtually through the combination mode of SECI.
- The accumulation mechanism occurs in the exercising SCS. In this mechanism, the produced explicit knowledge is implemented in the practice through training, learning by doing, and recording of knowledge and experiences. Implementation of the final produced knowledge occurred through the internalisation mode of SECI.
- The feedback mechanism occurs in all spaces. Ongoing findings and information about the processes and context, either explicit or tacit, are shared.
- The transfer mechanism occurs in in all SCSs. It is mostly transferring the finalised and official explicit knowledge which is produced by the project or related to the project between parent organisations or the wider project community.

Each of these mechanisms shows different stages of the project. All of these mechanisms lead to knowledge sharing and creation in collaborative projects. However, the number and type of the practices depends on the nature of the project. As an inter-organisational collaboration individual needs to interact more in the virtual environment, ICT applications and online tools increase in importance as knowledge sharing mechanisms.

Table 7- 3. Knowledge sharing mechanisms framework in university-organisational collaborative projects

Mechanisms	SCSs (Ba)				Practices	Tools
	Originating	Dialoguing	Systemising	Exercising		
Exchange	Idea generation; Exchanging of explicit knowledge	-	-	-	Talking and discussion Face-to-face interaction Holding regular meetings Using Email Liaison member	Face-to-face meetings Virtual face-to-face meetings ICT Applications (Skype, Zoom, Email)
Articulation	-	Creation of ideas in explicit forms either verbal or codified for first time; Identification of technical solutions; Developing and building methods, prototype, production	-	-	Writing Workshops Ad hoc Conversations Using online media Liaison member	Face-to-face meetings, Virtual face-to-face meetings, ICT Applications (Skype, Zoom, email), Document (Word format) Workshop, Google Drive, Memo Whiteboard
Modification	-	-	Co-creation and sharing of explicit form of knowledge sequentially; Realisation of the final version to implement in practice	-	Modifying (commenting) Verbal communications Liaison member	Virtual face-to-face meetings (Skype, Email), Document (Word format), Google Drive, Box Memo
Accumulation	-	-	-	Implementation of methods or the final version in practice	Training Learning by doing Recording of knowledge and experience Liaison member	Face-to-face meetings Virtual face-to-face meetings (Skype) Workshop Note-taking
Feedback	Instant feedback about shared ideas	Ad hoc and instant feedback about developing methods, solutions, and tools	Verbal feedback about applicability of solution or produced methods	Evaluation of the produced knowledge and production after implementation	Interviews Research progress reports Regular meetings Verbal feedback Liaison member	Face-to-face meetings Virtual face-to-face meetings Workshops
Transfer	Exchanging of explicit information	Distributing and sharing with wider domain through publications, seminar Transferring official explicit knowledge such as progress report	Transferring official explicit knowledge such as progress report	Transferring official explicit knowledge such as progress report Distributing and sharing with wider domain	Publications, holding regular reports, Workshops Doctoral students' research seminars, Regular newsletters, using social media Liaison member	Social media just for community and publicising, email, seminars, Slack, Academic articles, GitLab

7-5. Towards possible guidelines

Based on the mechanisms (exchange, articulation, modification, accumulation, feedback and transfer) explored, actual knowledge sharing is measured by how SCSs are created for knowledge sharing processes and how well knowledge is communicated in different SCSs.

From the results of this in-depth case study of two collaborative projects (university–NGO and university–industry collaborative projects) in identifying knowledge sharing mechanisms and associated barriers and drivers based on active actors' perspectives, proposed guidelines have been developed based on the communication occurring in university–NGO/industry collaborative projects in the IT faculty.

As with the conceptual model, these guidelines for effective knowledge sharing in university–organisational collaborative projects have been drawn from two projects only, and provide only a starting point which could be expanded upon with further study.

Having said that, the proposed guidelines reflect five key steps which are important in order to show how collaborative projects can build a successful knowledge sharing environment.

Step one, addressing generic issues: Many of the major barriers that emerged from the case studies have been generic issues related to managing collaboration projects. This applied in the contexts of the university–NGO and university–industry projects. The factors that are essential to address are active actors, time, physical place for communication, clear KM policy (university and industry/NGO need to create a strategy to build, maintain and utilise the project's knowledge assets effectively after finishing; universities and industry/NGO should create a condition that enables members to know where information is located, where knowledge is accumulated and how information and knowledge can be accessed), KM tools and ICT infrastructure. Furthermore, universities could introduce a role of support for formatting and writing up technical processes to assist academics in reporting the processes of the developing new initiatives. These basic factors should be clear from the outset of the projects.

Step two, collaborative project definition and balancing the requirements: The projects are defined so as to ensure the relevance of the topic to the partners. In this step, the active actors, mostly the main connector, play major roles in defining the project and topic. Negotiation among different stakeholders, between partners and leaders, needs to start before developing the project proposal. A balance between the requirements of industry and NGOs and those of the university must be achieved if partners want to have successful knowledge sharing mechanisms. The needs of each party and associated limitations must be clearly identified and agreed among partners. Balancing the requirements leads to achieving mutual benefit that is strongly dependent on successful knowledge sharing. Cultural differences and expectations of the partners need to be clearly discussed in order to achieve a balance between university, industry and NGO priorities and needs. Each partner can provide solutions or training in the area of limitation during collaboration.

Step 3: Starting collaboration and developing SCSs for communication: Since the different styles of research influence the sorts of mechanisms and SCSs, partners need to consider the nature of the SCSs that are needed for that specific research. Since in each mechanism there are a wide range of practices to support it that in turn weakens knowledge sharing overall, partners need to consider carefully what practices they are going to adopt for the various mechanisms, and either minimise the number, or at least ensure that the practices adopted complemented each other and were capable of being more easily monitored so as not to overly complicate the process of information or knowledge sharing.

In the context of university–organisational collaborative projects, virtual spaces and ICT are essential for building virtual SCSs in order to start the communication. Having understandable scope, common goals, clear timelines, clear objectives, understanding of cultural differences and specific room for discussion should be considered in developing SCSs.

Step 4: Providing feedback: This means providing feedback in a short time in explicit and tacit forms such as regular reports or workshops and seminars. Industry and NGOs need short-term results. Having pre-established forms for reports or guidelines for running seminars and workshops can improve this step. Each partner needs to be flexible in reacting to provide feedback during collaboration. This includes the ability to change the project direction and strategy.

Step 5: Capturing project experiences: University and industry/NGOs need to capture the knowledge that the individuals have. This can happen via KM tools or making short movies about the project in which project members talk about their experience while they are engaging in the project.

A knowledge repository is required in order to create an environment that captures project members' knowledge and experience in different formats. This database can create a virtual treasury for university and industry/NGOs when starting other collaborative projects, and enable collaborative memory. The university and industry/NGOs may require an information and record-management role to design this databank. This role needs to identify and capture the information, knowledge and experience gained during each specific collaborative project to support industry/NGO and university performance in doing more collaborative activities.

All of the five steps mentioned above need to be heeded if knowledge sharing is to be improved in collaborative projects.

7-6. Chapter Summary

This chapter has drawn together and highlighted the findings of this study. After providing a broad overview of the analysis of the two cases, it has presented the answers to each of the research questions, comparing these to the literature where relevant, and finished with some tentative comments relating to the development of a conceptual model for UIC projects, based on the knowledge sharing mechanisms identified, and suggested some guidelines for effective knowledge sharing mechanisms in university–NGO/industry collaborative projects, which have emerged from the study.

The next chapter will conclude the thesis by presenting an overview of the key findings, the contributions of the study, the implications, the limitations of the study and recommendations for future research

CHAPTER 8: CONCLUSION

8-1. Chapter Preview

Chapter 8 is the final chapter of the study. This chapter addresses a summary of the key findings, the contributions to knowledge, the implications and the limitations of the study. It ends with recommendations for future research.

In the context of two collaborative projects within an IT faculty, my study has investigated how interorganisational knowledge sharing mechanisms can assist organisations to understand how these mechanisms differ or are similar. Furthermore, this study has examined and discussed the main issues and important drivers for sharing knowledge, as well as the basic conditions required for creating shared collaborative spaces (SCSs) in which knowledge can be shared. As a result, it has provided a comprehensive overview of strategies for governance of knowledge sharing practices in the interorganisational context. To achieve the research objectives and to answer the research questions, a qualitative in-depth case study approach was employed and 20 interviews were conducted with members of two collaborative projects. The data was analysed using a thematic analysis approach. The analysis revealed six knowledge sharing mechanisms (exchange, articulation, modification, accumulation, feedback and transfer) in the context of university–NGO and university–industry projects, which were introduced in Chapter 6.

8-2. Summary of Key Findings

As presented in Chapters 4 and 5, after mapping ProjectNGO and ProjectIndustry onto the knowledge creation model, the study explored how knowledge was shared and created through SECI, in which spaces and time (SCSs), and what kinds of knowledge were shared and created (knowledge assets) within both projects.

Applying the knowledge creation model within both projects helped to identify knowledge sharing processes. Knowledge conversion through SECI for both projects generally occurred in the same way as in the original model, although the socialisation and externalisation modes were not as strong in ProjectIndustry. Socialisation was the process for converting new tacit knowledge through shared experiences via formal and informal meetings in physical or virtual collaborative spaces with interaction of more ProjectNGO members. However, for the ProjectIndustry socialisation in the beginning of the project was fairly limited and building tacit knowledge occurred between academic leader and industry representatives.

For ProjectNGO, externalisation was the process of expressing the tacit knowledge in explicit form for the first time through written and verbal articulation in peer-to-peer interaction. However, externalisation in ProjectIndustry occurred through written and verbal articulation in peer-to-peer interaction among academics without the participation of the industry representatives in the conceptualisation. Industry representatives only became involved as the project proceeded.

The combination mode was an ongoing process throughout both projects and led to sharing and creation of more systemised explicit knowledge. In ProjectIndustry, the direct interaction between industry and academics began in this mode.

For both projects, internalisation was the process of embodying explicit knowledge into tacit knowledge. Within ProjectNGO, discussion and reflection facilitated internalisation of the produced explicit knowledge as tacit knowledge. Within ProjectIndustry, learning by doing led to internalising of the produced explicit knowledge. After testing the produced explicit knowledge, industry learned how to explore and evaluate an alternative solution and academics learned by developing the prototype and tool.

In both projects, project members utilised four types of SCSs (originating, dialoguing, systemising and exercising) during collaboration for sharing and creating knowledge. In developing the SCSs, virtual platforms and ICT applications were essential elements because of the scattered nature of both projects and the technical nature of ProjectIndustry for sharing technical data and formulas.

Trust was the strongest factor contributing to knowledge sharing in both projects. There was well-established organisational trust between the university and the NGO/industry in the beginning of the projects due to prior collaboration experiences and the levels of expertise and reputations of the organisations.

Different types of knowledge assets were shared and created in different modes of knowledge creation (SECI) based on the characteristics of the tasks involved in each mode. By adopting a tacit–explicit continuum, experiential knowledge were considered tacit knowledge, and conceptual, routine and systematic knowledge were considered explicit knowledge.

After application of the knowledge creation model in both projects, the data was further analysed to answer the main question of the study and determine how knowledge is shared and created in organisational collaborative projects based on the project members' (active actors') perspectives and experiences. Using thematic analysis, six themes and 22 practices were revealed in regards to knowledge sharing among project members.

Each identified mechanism occurred in the different SCSs based on the stages of the collaborative project. They were exchange, articulation, modification, accumulation, feedback and transfer.

- **Exchange:** Sharing and creating tacit knowledge through the exchange of direct experience and reaction for ProjectNGO and ProjectIndustry, however that exchange also included the making available of a number of documents by Dinoco for use later in the project.
- **Articulation:** Expressing and articulating tacit knowledge into an explicit form by writing for ProjectNGO; and writing and developing the prototype and tool for ProjectIndustry through peer-to-peer interaction.
- **Modification:** Sharing and creating explicit forms of knowledge sequentially based on the first versions that were created in the articulation mechanism through group-to-group interaction.
- **Accumulation:** Creating and sharing new tacit knowledge based on learnings and use of the explicit knowledge that was created and shared through the previous mechanisms.
- **Feedback:** Sharing of ongoing findings and information about the processes and contexts.
- **Transfer:** Sharing and transferring the finalised knowledge, progress reports, and actual prototype and tool from the project to the organisation or from one partner to another or from the project to wider audiences.

Based on these six identified mechanisms and with the help of the knowledge creation model specifically concept of Ba (Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995; Nonaka, Toyama, & Konno, 2000), a conceptual model of knowledge sharing mechanisms has been proposed in the context of university–organisational collaborative projects (university–NGO and university–industry) which were introduced in Chapter 7.

Different barriers affected knowledge sharing in each project. Barriers or challenges to knowledge sharing in these projects refer to the obstacles that active actors faced or might face in knowledge sharing during collaboration. Some barriers had impact during all identified mechanisms, such as organisational culture differences, discipline and subject language differences, and a lack of time for both projects; and telecommunication access and foreign language differences for ProjectNGO. However, some challenges only impacted on specific mechanisms, such as the lack of written documents of procedures and the misunderstanding of the quality of data during the articulation mechanism for ProjectNGO; and lack of knowledge capture and lack of organised research datasets during the accumulation mechanism for both projects.

In addition, the study has proposed possible guidelines for effective knowledge sharing based on the identified mechanisms and associated barriers that are reflected in five key steps which are important in order to show how collaborative projects can build a successful knowledge sharing environment in the IT faculty. These five key steps are:

- Step 1: Addressing generic issues
- Step 2: Collaborative project definition and balancing the requirements
- Step3: Starting collaboration and developing SCSs for communication
- Step 4: Providing feedback
- Step 5: Capturing project experiences

8-3. Impact and Original Contribution to Knowledge

According to the literature review, knowledge sharing mechanisms can be explored in different contexts: for example, in project-based organisations (Bell, Van Waveren, & Steyn, 2016; Boh, 2003, 2007), interfirm collaboration (Appleyard, 1996; Easterby-Smith, Lyles, & Tsang, 2008; Mason & Leek, 2008), franchise networks (Perrigot, Herrbach, Cliquet, & Basset, 2017), the pharmaceutical context (Lilleoere & Hansen, 2011), international research contexts (Hautala, 2011) and the university–industry context (Hermans & Castiaux, 2017; Jin & Yaqi, 2011). Previous studies have mostly investigated knowledge flows and the types of knowledge transferred between actors in exploring the mechanisms. My study, by contrast, in addition to knowledge flows and the types of knowledge has explored knowledge sharing mechanisms by mapping the knowledge creation model with a focus on SCSs in the context of university–organisational collaborative projects.

Although previous studies have proposed some mechanisms that facilitate knowledge sharing, few have provided a model which includes the mechanisms and categorising practises under each mechanism. Nor have most provided tools or media under each practice, or identified and demonstrated the relationships between the mechanisms, practices and tools for knowledge sharing based on active actors' perspectives.

Consequently, in this study, knowledge sharing mechanisms are defined as activities or processes through which different kinds of knowledge, explicit or tacit, are shared in SCSs among individuals, groups, parent organisations and wider audiences. The shared spaces are interaction spaces in which individuals are acting to share knowledge. These spaces can be physical or mental. In previous studies, shared spaces or channels in which knowledge is shared are considered knowledge sharing mechanisms. However, in this study I have considered each mechanism as groups of practices in shared collaborative spaces. Practices are used as activities through which individuals are interacted and communicated to share and create knowledge for example, writing, training, commenting. In each practice, different kinds of tools or media by which the knowledge is shared based on the characteristics of that practice are used.

In this manner, the current research makes contributions to new knowledge in a number of theoretical and practical ways.

8-3-1. Theoretical contribution

Based on the thematic analysis of data and through the lens of Nonaka's model, I have identified six key knowledge sharing mechanisms: exchange, articulation, modification, accumulation, transfer and feedback. Identifying six knowledge sharing mechanisms and nearly two dozen related practices could be regarded an important contribution of the current study.

I have also interpreted Nonaka's knowledge creation model in a new context and identified some parts of it that behave differently in that context. These identified mechanisms can potentially facilitate better collaboration between universities on the one hand and industry or NGOs on the other. The identification of these mechanisms is an original contribution to a dynamic approach to understanding the knowledge sharing context. The findings of my research therefore contribute to study of the knowledge sharing context by providing a particular focus on the SCSs in which individuals interact, an area that has not been the subject of much previous research.

In addition, based on the mechanisms that have emerged from the data and mapping to the knowledge creation model, a conceptual model of knowledge sharing mechanisms has been proposed. Although this can only be regarded as a very limited and tentative first step, showing the relationship between mechanisms, SCSs, practices and tools is a further original theoretical contribution is provided by the study.

8-3-2. Practical contribution

While this study has been conducted in the Australian context and based on projects involving an IT faculty, I believe that these findings will assist in understanding of the drivers and barriers of knowledge sharing across other university–industry/NGO collaborative projects. There were shared practices in terms of communication alongside there were marked differences in workplace culture, ICT infrastructure and lack of KM tools in the two case studies. By identifying the enablers and barriers of knowledge sharing in collaborative projects, the research findings could help NGOs, industry or universities by providing them with guidelines through which they can discover new opportunities to facilitate knowledge sharing among the actors. That, in turn, could improve interorganisational collaboration.

Viewing knowledge sharing mechanisms from the actors' perspective may help universities and industry to reflect on their own characteristics in collaboration and create more flexible solutions. It could also assist universities, industry and NGOs to better understand their potential cultural differences, including understandings of the meaning of interorganisational collaboration and to develop appropriate responses.

Furthermore, this study provides a comparative understanding of two different types of university collaboration: with industry on the one hand and with NGOs on the other. The two different case studies provide an understanding of socio-technical and technical processes in collaborative projects.

The study findings could also help academics, industry and NGO representatives by providing an overview of the developing SCSs and practices that emerged in each SCS and the tools used in each space. Through this categorisation, they can better understand the scope and the impact of SCSs on their collaboration processes. Through this study, they could become aware of the perspectives, experiences and challenges in developing SCSs that academics and representatives of industry and NGOs face. This could then help them to decide whether to develop and how to develop SCSs effectively based on the different styles of research.

Policymakers in developing countries could also use the study findings to identify and satisfy the expectations and demands of academics and NGO representatives in using ICT applications and access to the internet.

In addition, the findings of the study may significantly contribute to improving our understanding of how academics, industry and NGO representatives create SCSs and which practices and tools they use in collaboration. Based on the understanding of real situations, universities, industry and NGOs could evaluate the success of the collaborative projects that can provide recommendations for allocating budget and effective uses of ICT applications regarding project specific needs.

8-4. Limitations

The current study also has both theoretical and practical limitations.

As acknowledged at the beginning of this thesis, the distinction between tacit and explicit knowledge was difficult to identify because the definition provided in the theory was not clear in practice. The concept of tacit knowledge is complex with different dimensions. The tacit–explicit continuum (Nonaka & Takeuchi, 1995) was used as a lens of analysis. However, making decisions about different types of knowledge, categorising the knowledge found under the tacit–explicit continuum and interpreting them were not simple tasks.

Because of the context of the research (Australia) and only two case studies being presented, this study's findings may not be generalisable beyond the specific context.

The practical limitations of the research in terms of selecting specific projects as case studies, participant recruitment and data collection were already discussed in Chapter 3. In summary, selecting appropriate case studies was found to be difficult because of the diverse nature of ICT, as well as the different types of university–industry partnerships. I had to restrict my study to two successful projects based on industry/NGO collaboration with an IT faculty.

8-5. Conclusion and Future Research

The purpose of the study was to explore knowledge sharing mechanisms in university–organisational collaborative projects in Australia. The study found six main mechanisms and 20 practices that could be considered knowledge sharing mechanisms through which different kinds of knowledge, explicit or tacit, were shared in SCSs among individuals, groups and organisations who were involved in collaborative projects.

The study has shown how individuals in each case study developed SCSs to share knowledge and collaborate. It has shown how the knowledge creation model works in an interorganisational context, at least within the specific contexts investigated. The study has found that knowledge creation processes in the interorganisational context can be effective in using not only physical face-to-face spaces but also virtual ones. In addition, it has found that physical spaces were replaced effectively by virtual spaces and ICT applications.

The study has found that Nonaka's Ba is mostly developed through social processes, and so the characteristics of the spaces may vary and need to be modified based on different contexts. Two other variations to the model were also identified, namely: in the interorganisational context, all spaces can take place totally and partially in online spaces; and the timing of when intense interaction takes place can vary with different styles of research.

The study has also revealed that the university–organisational collaborative projects encountered some barriers to knowledge sharing. It has also explored the drivers of knowledge sharing and the conditions required for developing SCSs. It is recommended that universities, NGO and industry, for more effective collaboration and knowledge sharing, remove or lessen the barriers to knowledge sharing. They should prioritise the developing SCSs based on the different style of the research and use the knowledge sharing mechanism concept and associated practices in each step of the collaboration to achieve competitive advantage.

There are several interesting avenues of future research that could fruitfully follow on from this study. First, future research could be conducted to extend the investigation into other contexts. Second, the evidence from this study suggests that comparative studies on the two different contexts, NGO and Industry in terms of their impact on knowledge sharing mechanisms could be useful. Third, although I have offered a tentative conceptual framework more studies would be needed to take it more comprehensive and robust. I have explored factors such as trust, care, commitment, autonomy and openness in knowledge sharing mechanisms, but studying them in depth was beyond the scope of this research. Therefore, it would be interesting to investigate how each element can influence knowledge sharing in collaborative projects. Lastly, and connected to the third point, there is a need to validate the proposed knowledge sharing mechanisms and five steps through additional cases involving other universities and external parties engaged in collaborative projects. That would enable modifying the proposed framework and increasing the usefulness of the guidelines in practice.

BIBLIOGRAPHY

- Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, 107-136.
- Allali, B. (2016). *The relationship between organisational culture and knowledge sharing in the information communication technology firms in Libya*. University of Salford,
- Alluri, K., & Balasubramanian, K. (2012). Theoretical perspectives on the contributions of COL-PROTEIN to open and distance learning for development.
- Almeida, M., & Soares, A. L. (2015). From project's information management to project-based organizational learning: The role of knowledge sharing. In *Handbook of Research on Effective Project Management through the Integration of Knowledge and Innovation* (pp. 190-211): IGI Global.
- Amabile, T. M., Patterson, C., Mueller, J., et al. (2001). Academic-practitioner collaboration in management research: A case of cross-profession collaboration. *Academy of Management Journal*, 44(2), 418-431.
- Anderson, J. R. (1989). A theory of the origins of human knowledge. *Artificial intelligence*, 40(1-3), 313-351.
- Andrews, K. M., & Delahaye, B. L. (2000). Influences on knowledge processes in organizational learning: The psychosocial filter. *Journal of management studies*, 37(6), 797-810.
- Aniekwe, C. C., Hayman, R., & Toner, A. (2012). Academic-NGO Collaboration in International Development Research: A reflection on the issues. *Available at SSRN 2995689*.
- Ankrah, S. N., Burgess, T. F., Grimshaw, P., & Shaw, N. E. (2013). Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit. *Technovation*, 33(2), 50-65.
- Appe, S., & Barragán, D. (2017). Universities, NGOs, and civil society sustainability: Preliminary lessons from Ecuador. *Development in Practice*, 27(4), 472-486.
- Appleyard, M. M. (1996). How does knowledge flow? Interfirm patterns in the semiconductor industry. *Strategic management journal*, 17(S2), 137-154.
- Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes*, 82(1), 150-169. doi:<http://dx.doi.org/10.1006/obhd.2000.2893>
- Attia, A. M. (2015). National innovation systems in developing countries: Barriers to university-industry collaboration in Egypt. *International Journal of Technology Management & Sustainable Development*, 14(2), 113-124.
- Aulawi, H., Sudirman, I., Suryadi, K., & Govindaraju, R. (2009). Literature review towards knowledge enablers which is assumed significantly influences ks behavior. *Journal of Applied Sciences Research*, 5(12), 2262-2270.
- Australian Bureau of Statistics. (2008). *Explanatory notes: 8126.0 - Information and Communication Technology, Australia, 2006-07*. Retrieved from Canberra: <http://www.abs.gov.au/ausstats/abs@.nsf/Products/8126.0~2006-07~Explanatory+Notes~Explanatory+Notes?OpenDocument#1618112827149953>
- Australian Computer Society Inc. (2015). *Review of Information & Communications Technology (ICT) Statistics*. Retrieved from <https://www.acs.org.au/content/dam/acs/acs-public-policy/ACS%20Submission%20to%20the%20ABS%20Review%20of%20ICT%20Statistics%20-%20February%202015.pdf>
- Australian Government. (2015). Science and Research Priorities. Retrieved from <http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Documents/Science-Research-Priorities-Factsheets.pdf>
- Australian Research Council. (2017). Excellence in Research for Australia. Retrieved from www.arc.gov.au/excellence-research-australia
- Babbie, E. (2011). *The Basics of Social Research* (5th ed.). Australia Belmont
- Baggaley, R., Calleja, J. M. G., Marum, L., & Marum, E. (2013). Knowledge is power; information is liberation. *Bulletin of the World Health Organization*, 91(12), 898. Retrieved from <http://go.galegroup.com.ezproxy.lib.monash.edu.au/ps/i.do?p=AONE&sw=w&u=monash&v=2.1&it=r&id=GALE%7CA355052701&asid=65c62ee6bcea7438bae4e6a2f58dc2d8>
- Baker, M., Barker, M., Thorne, J., & Dutnell, M. (1997). Leveraging human capital. *Journal of Knowledge Management*, 1(1), 63-74.

- Bakker, R. M., Cambré, B., Korlaar, L., & Raab, J. (2011). Managing the project learning paradox: A set-theoretic approach toward project knowledge transfer. *International Journal of Project Management*, 29(5), 494-503.
- Baller, S., Dutta, S., & Lanvin, B. (2016). *The global information technology report 2016*. Paper presented at the World Economic Forum, Geneva.
- Barber, K. (2005). Care. In: Oxford University Press.
- Bartol, K. M., & Srivastava, A. (2002). Encouraging knowledge sharing: The role of organizational reward systems. *Journal of Leadership & Organizational Studies*, 9, 64+. Retrieved from <http://go.galegroup.com.ezproxy.lib.monash.edu.au/ps/i.do?p=EAJM&sw=w&u=monash&v=2.1&it=r&id=GALE%7CA94448106&asid=73e24c6622b1cf021391946444cc7e18>
- Batti, R. C. (2015). Development project management within local NGOs: 10 recommendations to meet 10 challenges. *Global Business and Organizational Excellence*, 34(5), 21-29.
- Becerra-Fernandez, I., & Sabherwal, R. (2014). *Knowledge management: Systems and processes*: Taylor and Francis.
- Bekkers, R., & Freitas, I. M. B. (2008). Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter? *Research Policy*, 37(10), 1837-1853.
- Bell, L., Van Waveren, C. C., & Steyn, H. (2016). Knowledge-sharing within the project-based organisation: A knowledge-pull framework. *South African Journal of Industrial Engineering*, 27(4), 18-33.
- Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS quarterly*, 369-386.
- Berezko, O., & Zhezhnych, P. (2017). *Rethinking the NGO website from the knowledge management perspective*. Paper presented at the 2017 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT).
- Bhatt, G. D. (2001). Knowledge management in organizations: Examining the interaction between technologies, techniques, and people. *Journal of Knowledge Management*, 5(1), 68-75.
- Bijlsma, K., & Koopman, P. (2003). Introduction: trust within organisations. *Personnel Review*, 32(5), 543-555.
- Bjerregaard, T. (2010). Industry and academia in convergence: Micro-institutional dimensions of R&D collaboration. *Technovation*, 30(2), 100-108.
- Blackler, F. (1995). Knowledge, knowledge work and organizations: An overview and interpretation. *Organization studies*, 16(6), 1021-1046.
- Blindenbach-Driessen, F., & Van Den Ende, J. (2006). Innovation in project-based firms: The context dependency of success factors. *Research Policy*, 35(4), 545-561.
- Boardman, P. C. (2008). Beyond the stars: The impact of affiliation with university biotechnology centers on the industrial involvement of university scientists. *Technovation*, 28(5), 291-297.
- Bock, G.-W., Zmud, R. W., Kim, Y.-G., & Lee, J.-N. (2005). Behavioral intention formation in knowledge sharing: Examining the roles of extrinsic motivators, social-psychological forces, and organizational climate. *MIS quarterly*, 87-111.
- Bodas Freitas, I. M., Argou Marques, R., & Mirra de Paula e Silva, E. (2008). *University-industry collaboration and the development of high-technology sectors in brazil*.
- Boh, W. F. (2003). Knowledge sharing mechanisms in project-based knowledge work: Codification versus personalization. *ICIS 2003 Proceedings*, 68.
- Boh, W. F. (2007). Mechanisms for sharing knowledge in project-based organizations. *Information and organization*, 17(1), 27-58.
- Bolisani, E. (2008). Understanding knowledge transfer on the Net: Useful lessons from the knowledge economy. In *Building the knowledge society on the Internet: Sharing and exchanging knowledge in networked environments* (pp. 110-128): IGI Global.
- Bolisani, E., & Bratianu, C. (2017). *Emergent knowledge strategies: Strategic thinking in knowledge management* (Vol. 4): Springer.
- Bosua, R., & Scheepers, R. (2007). Towards a model to explain knowledge sharing in complex organizational environments. *Knowledge management research & practice*, 5(2), 93-109.
- Brännback, M. (2003). R&D collaboration: Role of Ba in knowledge-creating networks. *Knowledge management research & practice*, 1(1), 28-38.
- Brännback, M., Carsrud, A., & Schulte, W. D. (2008). Exploring the role of Ba in family business context. *Vine*, 38(1), 104-117.

- Brohman, J., Gannitsos, I., & Roseland, M. (2003). Issues of participation in a University–NGO, North–South partnership: Internationalizing a CED program. *Canadian Journal of Development Studies/Revue canadienne d'études du développement*, 24(1), 89-105.
- Brown, S. (2015). Universities Australia response to Review of Research Policy and Funding Arrangements. Retrieved from <https://submissions.education.gov.au/Forms/RRPFA/pages/item?SubmissionID=RPF1500081>
- Bruneel, J., d'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. *Research Policy*, 39(7), 858-868.
- Bryer, T. A., Pliscoff, C., & Connors, A. W. (2020). University–Community partnerships in the literature. In *Promoting Civic Health Through University-Community Partnerships* (pp. 33-61): Springer Nature.
- Buckland, M. K. (1991). Information as thing. *Journal of the American Society for Information Science (1986-1998)*, 42(5), 351.
- Bukowitz, W. R., & Williams, R. L. (2000). *The knowledge management fieldbook*. London: Financial Times/Prentice Hall.
- Cabrera, A., Collins, W. C., & Salgado, J. F. (2006). Determinants of individual engagement in knowledge sharing. *The International Journal of Human Resource Management*, 17(2), 245-264.
- Callaert, J., Landoni, P., Van Looy, B., & Verganti, R. (2015). Scientific yield from collaboration with industry: The relevance of researchers' strategic approaches. *Research Policy*, 44(4), 990-998.
- Camelo-Ordaz, C., Garcia-Cruz, J., Sousa-Ginel, E., & Valle-Cabrera, R. (2011). The influence of human resource management on knowledge sharing and innovation in Spain: the mediating role of affective commitment. *The International Journal of Human Resource Management*, 22(07), 1442-1463.
- Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science*, 13(4), 442-455.
- Carrillo, P. (2005). Lessons learned practices in the engineering, procurement and construction sector. *Engineering, Construction and Architectural Management*.
- Caulfield, T., & Ogbogu, U. (2015). The commercialization of university-based research: Balancing risks and benefits. *BMC medical ethics*, 16(1), 70.
- Cecez-Kecmanovic, D., & Kennan, M. A. (2013). The methodological landscape: Information systems and knowledge management. In K. Williamson & G. Johanson (Eds.), *Research Methods : Information, Systems and Contexts* (pp. 113-138). Prahran, VIC: Tilde University Press.
- Chernikova, E. (2016). Negotiating research collaboration between universities and other civil society organizations in Canada. *Putting Knowledge to Work: Collaborating, influencing and learning for international development*, 71-106.
- Choo, C. W. (1998). *The Knowing Organization: How organizations use information to construct meaning, create knowledge, and make decisions*. New York, NY: Oxford University Press.
- Chou, S.-W., & He, M.-Y. (2004). Knowledge management: The distinctive roles of knowledge assets in facilitating knowledge creation. *Journal of Information Science*, 30(2), 146-164.
- Coffey, V. (2010). *Understanding organisational culture in the construction industry*: Routledge.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative science quarterly*, 128-152.
- Cooperative Research Centers Association. (2016). Overview of CRC Programme. Retrieved from www.crca.asn.au/about-the-crc-association/about-crcs/
- Corry, O. (2010). Defining and theorizing the third sector. In *Third sector research* (pp. 11-20): Springer.
- Creswell, J. W. (2009). *Research Design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage
- Creswell, J. W. (2013). *Qualitative inquiry and research design: choosing among five approaches*. Los Angeles: Sage.
- Cuthill, M., O'Shea, E., Wilson, B., & Viljoen, P. (2014). Universities and the public good: a review of knowledge exchange policy and related university practice in Australia. *Australian Universities' Review (AUR)*, 56(2), 36-46.
- Cyert, R. M., & Goodman, P. S. (1997). Creating effective university-industry alliances: An organizational learning perspective. *Organizational dynamics*, 25(4), 45-58.
- D'Este, P., & Patel, P. (2007). University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy*, 36(9), 1295-1313.
- Dalkir, K. (2011). *Knowledge Management in Theory and Practice*. Jordan Hill, US: Taylor & Francis Group.

- Darke, P., & Shanks, G. (2002). Case study research In K. Williamson (Ed.), *Research Methods for Students and Professionals: Information management and systems* (pp. 93-105). Wagga Wagga, NSW: Centre for Information Studies, Charles Sturt University.
- Davenport, T. H., & Prusak, L. (1998). *Working Knowledge: How organizations manage what they know*. Boston, MA: Harvard Business Press.
- Davey, T., Baaken, T., Galan Muros, V., & Meerman, A. (2011). The State of European University-Business Cooperation. *Part of the DG Education and Culture Study on the cooperation between higher education institutions and public and private organisations in Europe*.
- de Wit-de Vries, E., Dolfsma, W. A., van der Windt, H. J., & Gerkema, M. P. (2019). Knowledge transfer in university–industry research partnerships: a review. *The Journal of Technology Transfer*, 44(4), 1236-1255.
- Debackere, K., & Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. *Research Policy*, 34(3), 321-342.
- Decter, M., Bennett, D., & Leseure, M. (2007). University to business technology transfer—UK and USA comparisons. *Technovation*, 27(3), 145-155.
- Denzin, N. K., & Lincoln, Y. S. (2005). Introduction: The discipline and practice of qualitative research. In *The SAGE Handbook of Qualitative Research* (pp. 1-32). Thousand Oaks, CA: Sage
- Department of Education and Training. (2014). Boosting the Commercial Returns from Research: Discussion paper Retrieved from <https://submissions.education.gov.au/Forms/higher-education-research/Documents/Boosting%20Commercial%20Returns%20from%20Research%20%20-%2024102014.pdf>
- Department of Education and Training. (2016). Sharpening incentives for research engagement. Retrieved from <https://www.education.gov.au/news/sharpening-incentives-research-engagement>
- Department of Education and Training. (2017a). *2017 Higher Education Research Data Collection Specifications for the collection of 2016 data*. Department of education and training Retrieved from www.education.gov.au/higher-education-research-data-collection
- Department of Education and Training. (2017b). Higher Education Research Data Collection. Retrieved from www.education.gov.au/higher-education-research-data-collection
- Department of Industry and Innovation. (2014). *Promoting Productive Industry-Research Collaboration*. Retrieved from Crawford School (ANU, Canberra): <https://industry.gov.au/innovation/InnovationPolicy/Documents/Policy/CollaborationWorkshopReport.pdf>
- Department of Industry Innovation and Science. (2017). Cooperative Research Centres (CRC) Programme. Retrieved from www.business.gov.au/assistance/cooperative-research-centres-programme
- Deshpande, A., Sharp, H., Barroca, L., & Gregory, P. (2016). Remote working and collaboration in agile teams.
- Dooley, L., & Kirk, D. (2007). University–industry collaboration: Grafting the entrepreneurial paradigm onto academic structures. *European Journal of Innovation Management*, 10(3), 316-332.
- Dunowski, J.-p., Schultz, C., Kock, A., Gemunden, H., & Salomo, S. (2010). *Implementing university collaboration strategies through portfolio management*. Paper presented at the Paper to be presented at the Summer Conference.
- Dutta, S., Geiger, T., & Lanvin, B. (2015). *The Global Information Technology Report. ICTs for Inclusive Growth*. Paper presented at the Geneva, World Economic Forum and INSEAD.
- Easterby-Smith, M., Lyles, M. A., & Tsang, E. W. (2008). Inter-organizational knowledge transfer: Current themes and future prospects. *Journal of management studies*, 45(4), 677-690.
- Ebrahim, A. (2003). Accountability in practice: Mechanisms for NGOs. *World development*, 31(5), 813-829.
- Edwards, J. S. (2017). Knowledge sharing: At the heart of knowledge management. In *Managing knowledge resources and records in modern organizations* (pp. 1-14): IGI Global.
- Ehrismann, D., & Patel, D. (2015). University–Industry collaborations: models, drivers and cultures. *Swiss medical weekly*, 145(0506).
- Ezell, M. P. (2017). *How organizations use collaboration to create knowledge*. (Doctor of Education). University of Pennsylvania, ProQuest Central; ProQuest Dissertations & Theses Global.
- Faulkner, A. (2017). Survivor research and mad studies: The role and value of experiential knowledge in mental health research. *Disability & Society*, 32(4), 500-520.
- Fazackerley, A., Smith, M., & Massey, A. (2009). *Innovation and industry: The role of universities: Policy Exchange*.

- Fernández-Esquinas, M., Pinto, H., Yruela, M. P., & Pereira, T. S. (2015). Tracing the flows of knowledge transfer: Latent dimensions and determinants of university–industry interactions in peripheral innovation systems. *Technological Forecasting and Social Change*.
- Fisher, R., Fabricant, M., & Simmons, L. (2004). Understanding contemporary university–community connections: Context, practice, and challenges. *Journal of Community Practice*, 12(3-4), 13-34.
- Fong, P. S., & Kwok, C. W. (2009). Organizational culture and knowledge management success at project and organizational levels in contracting firms. *Journal of construction engineering and management*, 135(12), 1348-1356.
- Fontana, R., Geuna, A., & Matt, M. (2006). Factors affecting university–industry R&D projects: The importance of searching, screening and signalling. *Research Policy*, 35(2), 309-323.
- Ford, D. P. (2004). Trust and knowledge management: the seeds of success. In *Handbook on Knowledge Management I* (pp. 553-575): Springer.
- Foss, N. J., Minbaeva, D. B., Pedersen, T., & Reinholt, M. (2009). Encouraging knowledge sharing among employees: How job design matters. *Human resource management*, 48(6), 871-893.
- Francis-Smythe, J. (2008). Enhancing academic engagement in knowledge transfer activity in the UK. *Perspectives*, 12(3), 68-72.
- Freitas, I. M. B., Geuna, A., & Rossi, F. (2013). Finding the right partners: Institutional and personal modes of governance of university–industry interactions. *Research Policy*, 42(1), 50-62.
- Galán-Muros, V., & Plewa, C. (2016). What drives and inhibits university-business cooperation in Europe? A comprehensive assessment. *R&D Management*, 46(2), 369-382.
- Ganguly, A., Talukdar, A., & Chatterjee, D. (2019). Evaluating the role of social capital, tacit knowledge sharing, knowledge quality and reciprocity in determining innovation capability of an organization. *Journal of Knowledge Management*.
- Garousi, V., Pfahl, D., Fernandes, J. M., et al. (2019). Characterizing industry-academia collaborations in software engineering: evidence from 101 projects. *Empirical Software Engineering*, 24(4), 2540-2602.
- Garrido-Moreno, A., Lockett, N., & García-Morales, V. (2014). Paving the way for CRM success: The mediating role of knowledge management and organizational commitment. *Information & Management*, 51(8), 1031-1042.
- Ghuri, P., & Rosendo-Rios, V. (2016). Organizational cross-cultural differences in the context of innovation-oriented partnerships. *Cross Cultural & Strategic Management*.
- Ghobadi, S. (2015). What drives knowledge sharing in software development teams: A literature review and classification framework. *Information & Management*, 52(1), 82-97.
- Giuliani, E., & Arza, V. (2009). What drives the formation of ‘valuable’ university–industry linkages?: Insights from the wine industry. *Research Policy*, 38(6), 906-921.
- González-Pernía, J. L., Parrilli, M. D., & Peña-Legazkue, I. (2015). STI–DUI learning modes, firm–university collaboration and innovation. *The Journal of Technology Transfer*, 40(3), 475-492.
- Gorovaia, N., & Windsperger, J. (2010). The use of knowledge transfer mechanisms in franchising. *Knowledge and Process Management*, 17(1), 12-21.
- Gourlay, S. (2006). Conceptualizing knowledge creation: A critique of Nonaka's theory. *Journal of management studies*, 43(7), 1415-1436.
- Green, M. (2012). Framing and escaping. Contrasting aspects of knowledge work in international development and anthropology. *Differentiating Development. Beyond and Anthropology of Critique*.
- Grover, V., & Davenport, T. H. (2001). General perspectives on knowledge management: Fostering a research agenda. *Journal of Management Information Systems*, 18(1), 5-21. Retrieved from <http://ezproxy.lib.monash.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=4753177&site=ehost-live&scope=site>
- Guimón, J. (2013). Promoting university industry collaboration in developing countries. *Policy Brief. The Innovation Policy Platform*, 1(3), 1-12.
- Hackman, J. R. (1983). Designing work for individuals and for groups. *Perspectives on behavior in organizations*, 242-256.
- Haldin-Herrgard, T. (2000). Difficulties in diffusion of tacit knowledge in organizations. *Journal of Intellectual capital*.
- Hamisah, T., Nor Aieni, M., Ahmad Fauzi, I., Abdul Karim, M., Suhaila, M., & Fazilah, A. (2010). University-industry partnerships: fostering strategic linkages at institutions of higher learning in Malaysia. In: UTM Press.

- Hanley, T., & Vogel, I. (2012). Effective academic-humanitarian collaboration, a practical resource to support academic and humanitarian organisations working together. *Enhanced Learning and Research for Humanitarian Assistance (ELRHA)*, London.
- Hansen, M. T., Nohria, N., & Tierney, T. (1999). What's your strategy for managing knowledge. *The knowledge management yearbook 2000–2001*, 77(2), 106-116.
- Hansson, F. (2007). Science parks as knowledge organizations. The “ba” in action? *European Journal of Innovation Management*, 10(3), 348-366.
- Harman, G. (2001). University industry research partnerships in Australia: Extent, benefits and risks. *Higher Education Research & Development*, 20(3), 245-264.
- Harryson, S., Klikaite, S., & Dudkowski, R. (2007). Making innovative use of academic knowledge to enhance corporate technology innovation impact. *International Journal of Technology Management*, 39(1-2), 131-157.
- Harsh, O. (2009). Three dimensional knowledge management and explicit knowledge reuse. *Journal of Knowledge Management Practice*, 10(2), 1-10.
- Hasnain, S. S., & Jasimuddin, S. M. (2012). Barriers to knowledge transfer: Empirical evidence from the NGO (non-governmental organizations)-sector in Bangladesh. *World Journal of Social Sciences*, 2(2), 135-150.
- Hautala, J. (2011). International academic knowledge creation and Ba: A case study from Finland. *Knowledge management research & practice*, 9(1), 4-16.
- Hayman, R., King, S., Kontinen, T., & Narayanaswamy, L. (2016). *Negotiating Knowledge: Evidence and Experience in Development NGOs*: Practical Action Publishing Rugby.
- Hermans, J., & Castiaux, A. (2007). Knowledge creation through university–industry collaborative research projects. *The Electronic Journal of Knowledge Management*, 5(1), 43-54.
- Hermans, J., & Castiaux, A. (2017). Contingent knowledge transfers in university–industry R&D projects. *Knowledge management research & practice*, 15(1), 68-77.
- Höglund, L., Mårtensson, M., & Safari, A. (2019). The impact of types of trust in the public sector—a case study approach. *International Journal of Public Sector Management*, 32(3), 247-263.
- Huhtelin, M., & Nenonen, S. (2015). A co-creation centre for university–industry collaboration: A framework for concept development. *Procedia Economics and Finance*, 21, 137-145.
- Hund, A., Holotuk, F., Wagner, H.-T., & Beimborn, D. (2019). *Knowledge Management in the Digital Era: How digital Innovation Labs Facilitate Knowledge Recombination*. Paper presented at the 27th European Conference on Information Systems (ECIS), Stockholm & Uppsala, Sweden.
- industry. (2019). InvestorGuide.
- Innovation and Science Australia. (2016). *Performance Review of the Australian Innovation, Science and Research System 2016*. Canberra: Commonwealth of Australia.
- Jackson, A., & Marques, M. (2019). DIY do's and don'ts: Limitations to building university–community partnerships with low–resource communities of color. *Planning Practice & Research*, 34(3), 318-345.
- Jacob, W. J., Sutin, S. E., Weidman, J. C., & Yeager, J. L. (2015). Community engagement in higher education: International and local perspectives. In *Community Engagement in Higher Education* (pp. 1-28): Brill Sense.
- Janus, S. S. (2016). *Becoming a knowledge-sharing organization: A handbook for scaling up solutions through knowledge capturing and sharing*: The World Bank.
- Jasimuddin, S. M. (2007). Exploring knowledge transfer mechanisms: The case of a UK-based group within a high-tech global corporation. *International Journal of Information Management*, 27(4), 294-300.
- Jiang, Y. (2008). Locating active actors in the scientific collaboration communities based on interaction topology analyses. *Scientometrics*, 74(3), 471-482.
- Jin, Y. W. C., & Yaqi, S. (2011). Research on the knowledge creation process of the university–industry collaboration: A case from China. *African Journal of Business Management*, 5(32), 12586-12597.
- John, P. K., Gregor, S., & Sun, R. (2015). *Mechanisms to facilitate industry engagement with business schools for innovation outcomes*. Paper presented at the ISPIM Conference Proceedings.
- Joia, L. A., & Lemos, B. (2010). Relevant factors for tacit knowledge transfer within organisations. *Journal of Knowledge Management*.
- Jones, L. M. (2004). University-Industrial Research Collaboration - Advantages of the Collaborative Relationships, Disadvantages of the Collaborative Relationships. Retrieved from <http://education.stateuniversity.com/pages/2519/University-Industrial-Research-Collaboration.html#ixzz4HzsJuN4f>

- Kalar, B., & Antoncic, B. (2015). The entrepreneurial university, academic activities and technology and knowledge transfer in four European countries. *Technovation*, 36, 1-11.
- Kale, P., & Singh, H. (1999). *Alliance capability & success: A knowledge-based approach*. Paper presented at the Academy of Management Proceedings.
- Karim, N. S. A., & Hussein, R. (2008). Managers' perception of information management and the role of information and knowledge managers: The Malaysian perspectives. *International Journal of Information Management*, 28(2), 114-127.
- Karlsen, J. T., & Gottschalk, P. (2003). An empirical evaluation of knowledge transfer mechanisms for IT projects. *Journal of Computer Information Systems*, 44(1), 112-119.
- Khan, S. (2015). Research study from industry–university collaboration on “No fault Found” events. *Journal of Quality in Maintenance Engineering*, 21(2), 186-206. doi:10.1108/jqme-01-2014-0004
- Kim, S., & Lee, H. (2004). *Organizational factors affecting knowledge sharing capabilities in e-government: An empirical study*. Paper presented at the IFIP international working conference on knowledge management in electronic government.
- Kim, S., & Lee, H. (2005). *Employee Knowledge Sharing capabilities in public & private organizations: Does organizational context matter?* Paper presented at the Proceedings of the 38th Annual Hawaii International Conference on System Sciences.
- Kingston, J. K. (2012). Tacit knowledge: Capture, sharing, and unwritten assumptions. *Journal of Knowledge Management Practice*, 13(3), 533-545.
- Krishna, S., Sahay, S., & Walsham, G. (2004). Managing cross-cultural issues in global software outsourcing. *Communications of the ACM*, 47(4), 62-66.
- Kunttu, L., Huttu, E., & Neuvo, Y. (2018). How doctoral students and graduates can facilitate boundary spanning between academia and industry.
- Kuusinen, K., Gregory, P., Sharp, H., Barroca, L., Taylor, K., & Wood, L. (2017). *Knowledge sharing in a large agile organisation: A survey study*. Paper presented at the International conference on agile software development.
- Lakatos, E.-S., Bercea, O.-B., Moldovan, A., & Bacali, L. (2015). Partnership between industry and university from an open innovation perspective. *Review of Management & Economic Engineering*, 14(1).
- Landaeta, R. E. (2008). Evaluating benefits and challenges of knowledge transfer across projects. *Engineering management journal*, 20(1), 29-38.
- Lankton, N. K., McKnight, D. H., & Tripp, J. (2015). Technology, humanness, and trust: Rethinking trust in technology. *Journal of the Association for Information Systems*, 16(10), 1.
- Lauring, J., & Selmer, J. (2011). Multicultural organizations: common language, knowledge sharing and performance. *Personnel Review*.
- Law, W. K. (2009). Cross-cultural challenges for information resources management. In *Encyclopedia of Information Science and Technology, Second Edition* (2 ed., pp. 840-846): IGI Global.
- Lee, J.-N. (2001). The impact of knowledge sharing, organizational capability and partnership quality on IS outsourcing success. *Information & Management*, 38(5), 323-335.
- Lesser, E. L., & Storck, J. (2001). Communities of practice and organizational performance. *IBM systems journal*, 40(4), 831-841.
- Lewis, J. D., & Weigert, A. (1985). Trust as a social reality. *Social forces*, 63(4), 967-985.
- Lilleoere, A. M., & Hansen, E. H. (2011). Knowledge-sharing practices in pharmaceutical research and development— A case study. *Knowledge and Process Management*, 18(3), 121-132.
- Llano-Arias, V. (2015). Community knowledge sharing and co-production of water services: Two cases of community aqueduct associations in Colombia. *Water Alternatives*, 8(2).
- Lundvall, B.-ä., & Johnson, B. (1994). The learning economy. *Journal of industry studies*, 1(2), 23-42. doi:10.1080/13662719400000002
- Lyles, M. A., & Salk, J. E. (1996). Knowledge acquisition from foreign parents in international joint ventures: An empirical examination in the Hungarian context. *Journal of international business studies*, 27(5), 877-903.
- Marquardt, M., Leonard, H., Freedman, A., & Hill, C. (2009). Action Learning for Developing Leaders and Organizations: Principles. *Strategies, and Cases*.
- Mashavave, T., Mapfumo, P., Mtambanengwe, F., Gwandu, T., & Siziba, S. (2013). Interaction patterns determining improved information and knowledge sharing among smallholder farmers. *African Journal of Agricultural and Resource Economics*, 8(311-2016-5612), 1-12.
- Mason, K. J., & Leek, S. (2008). Learning to build a supply network: An exploration of dynamic business models. *Journal of management studies*, 45(4), 774-799.

- Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of management review*, 20(3), 709-734.
- McDermott, R., & O'dell, C. (2001). Overcoming cultural barriers to sharing knowledge. *Journal of Knowledge Management*.
- McKechnie, L. E. F. (2008). Participant observation. In L. Given (Ed.), *The SAGE Encyclopedia of Qualitative Research Methods*. Thousand Oaks, CA: Sage.
- McLean, L. D. (2004). *A review and critique of Nonaka and Takeuchi's theory of organizational knowledge creation*. Paper presented at the Proceedings of the Fifth UFHED/AHRD Ireland Conference. Available: [http://www.mcleanglobal.com/public/MGC/publications/Nonaka% 20and% 20Takeuchi.pdf](http://www.mcleanglobal.com/public/MGC/publications/Nonaka%20and%20Takeuchi.pdf) [accessed May 2014].
- Melink, M., Pušnik, T., & Pavlin, S. (2014). *Emerging Modes of Cooperation Between Private Enterprises and Universities-Insights of European Enterprises and Employers Organisations*: University of Ljubljana, Faculty of Social Sciences.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An expanded sourcebook*: Sage.
- Mitchell, R., Nicholas, S., & Boyle, B. (2009). The role of openness to cognitive diversity and group processes in knowledge creation. *Small Group Research*, 40(5), 535-554.
- Molina, L. M., & Llorens-Montes, F. J. (2006). Autonomy and teamwork effect on knowledge transfer: knowledge transferability as a moderator variable. *International Journal of Technology Transfer and Commercialisation*, 5(3), 263-280.
- Mowery, D. C., Oxley, J. E., & Silverman, B. S. (1996). Strategic alliances and interfirm knowledge transfer. *Strategic management journal*, 17(S2), 77-91.
- Mungate, D., & Mvududu, S. (1991). *Government and NGO collaboration in natural resources in Zimbabwe*. Retrieved from
- Myers, M. D., & Avison, D. E. (2002). An introduction to qualitative research in information systems. In M. D. Myers & D. E. Avison (Eds.), *Qualitative Research in Information Systems* (pp. 7): Sage.
- Nelson, A. J. (2009). Measuring knowledge spillovers: What patents, licenses and publications reveal about innovation diffusion. *Research Policy*, 38(6), 994-1005.
- Nemati-Anaraki, L., & Heidari, A. (2014). Knowledge sharing for improving effectiveness of university-industry collaborations. In M. Limbu & B. Gurung (Eds.), *Emerging Pedagogies in the Networked Knowledge Society: Practices Integrating Social Media and Globalization* (pp. 228-245). Hershey, PA: Information Science Reference.
- Neuman, W. L. (2012). *Basics of Socia Research: Qualitative and quantitative approaches* (3rd ed.). Boston, MA: Pearson.
- Niccolini, F., Bartolacci, C., Cristalli, C., & Isidori, D. (2018). Virtual and inter-organizational processes of knowledge creation and Ba for sustainable management of sustainable water systems. *Handbook of Knowledge Management for Sustainable Water Systems*, 20(4), 261.
- Nidumolu, S. R., Subramani, M., & Aldrich, A. (2001). Situated learning and the situated knowledge web: Exploring the ground beneath knowledge management. *Journal of Management Information Systems*, 18(1), 115-150.
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization science*, 5(1), 14-37.
- Nonaka, I., & Konno, N. (1998). The concept of "ba": Building a foundation for knowledge creation. *California management review*, 40(3), 40-54.
- Nonaka, I., Konno, N., & Toyama, R. (2001). Emergence of "ba". *Knowledge emergence: Social, technical, and evolutionary dimensions of knowledge creation*, 1, 13-29.
- Nonaka, I., & Nishiguchi, T. (2001). *Knowledge Emergence: Social, technical, and evolutionary dimensions of knowledge creation*: Oxford University Press.
- Nonaka, I., & Nishihara, A. H. (2018). Introduction to the concepts and frameworks of knowledge-creating theory. In *Knowledge Creation in Community Development* (pp. 1-15): Springer.
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*: Oxford University Press.
- Nonaka, I., & Toyama, R. (2003). The knowledge-creating theory revisited: Knowledge creation as a synthesizing process. *Knowledge management research & practice*, 1(1), 2-10.
- Nonaka, I., & Toyama, R. (2005). The theory of the knowledge-creating firm: subjectivity, objectivity and synthesis. *Industrial and Corporate change*, 14(3), 419-436.
- Nonaka, I., Toyama, R., & Hirata, T. (2008). *Managing flow: A process theory of the knowledge-based firm*: Springer.

- Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long range planning*, 33(1), 5-34.
- Nonaka, I., Toyama, R., & Nagata, A. (2000). A firm as a knowledge-creating entity: A new perspective on the theory of the firm. *Industrial and Corporate change*, 9(1), 1-20.
- Numprasertchai, S., & Igel, B. (2005). Managing knowledge through collaboration: Multiple case studies of managing research in university laboratories in Thailand. *Technovation*, 25(10), 1173-1182.
- OECD. (2011). *OECD Guide to Measuring the Information Society 2011*: OECD publishing.
- OECD. (2018). *Aid for civil society organisations: Statistics based on DAC Members' reporting to the Creditor Reporting System database (CRS), 2015-2016*. Retrieved from <https://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/Aid-for-Civil-Society-Organisations-2015-2016.pdf>
- OECD Publishing. (2017). Collaboration on innovation. In *OECD Science, Technology and Industry Scoreboard 2017: Innovation for Growth and Society*: OECD Publishing.
- Okane, M. (2008). *Collaborating to a purpose: Review of the Cooperative Research Centres Programme*. Canberra: Dept of Innovation, Industry, Science and Research
- Olivier, C., Hunt, M. R., & Ridde, V. (2016). NGO–researcher partnerships in global health research: Benefits, challenges, and approaches that promote success. *Development in Practice*, 26(4), 444-455. doi:10.1080/09614524.2016.1164122
- Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information systems research*, 2(1), 1-28.
- Palich, L. E., & Gomez-Mejia, L. R. (1999). A theory of global strategy and firm efficiencies: Considering the effects of cultural diversity. *Journal of management*, 25(4), 587-606.
- Panahi, S. (2014). *Social media and tacit knowledge sharing: Physicians' perspectives and experiences*. (PhD thesis). Queensland University of Technology, Queensland.
- Panahi, S., Watson, J., & Partridge, H. (2013). Towards tacit knowledge sharing over social web tools. *Journal of Knowledge Management*, 17(3), 379-397.
- Parekh, R. A. (2009). *Knowledge sharing: Collaboration between universities and industrial organisations*. Paper presented at the International Conference on Academic Libraries (ICAL-2009).
- Perkmann, M., King, Z., & Pavelin, S. (2011). Engaging excellence? Effects of faculty quality on university engagement with industry. *Research Policy*, 40(4), 539-552.
- Perkmann, M., Tartari, V., McKelvey, M., et al. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy*, 42(2), 423-442.
- Perkmann, M., & Walsh, K. (2008). Engaging the scholar: Three types of academic consulting and their impact on universities and industry. *Research Policy*, 37(10), 1884-1891.
- Perrigot, R., Herrbach, O., Cliquet, G., & Basset, G. (2017). Know-how transfer mechanisms in franchise networks: A study of franchisee perceptions. *Knowledge management research & practice*, 15(2), 272-281.
- Pineda, J. L., Zapata, L. E., & Ramírez, J. (2009). Strengthening knowledge transfer between the university and enterprise: A conceptual model for collaboration. *Cultural Implications of Knowledge Sharing, Management and Transfer: Identifying Competitive Advantage: Identifying Competitive Advantage*, 134.
- Plewa, C., Quester, P., & Baaken, T. (2005). Relationship marketing and university-industry linkages: a conceptual framework. *Marketing Theory*, 5(4), 433-456.
- Polanyi, M. (1967). *The Tacit Dimension*. London: Routledge & Kegan Paul
- Polt, W., Gassler, H., Schibany, A., Rammer, C., & Schartinger, D. (2001). Benchmarking industry–science relations: The role of framework conditions. *Science and Public Policy*, 28(4), 247-258. doi:10.3152/147154301781781453
- Prasasti, K., Andrawina, L., & Rizana, A. (2018). *Framework for community of practice for Blood Center*. Paper presented at the Proceeding of International Seminar & Conference on Learning Organization.
- Rai, R. K. (2011). Knowledge management and organizational culture: A theoretical integrative framework. *Journal of Knowledge Management*, 15(5), 779-801.
- Redlich, T., Basmer, S.-V., Buxbaum-Conradi, S., Krenz, P., Wulfsberg, J., & Bruhns, F.-L. (2014). *Openness and trust in value co-creation: Inter-organizational knowledge transfer and new business models*. Paper presented at the Proceedings of PICMET'14 Conference: Portland International Center for Management of Engineering and Technology; Infrastructure and Service Integration.
- Reichers, A. E. (1985). A review and reconceptualization of organizational commitment. *Academy of management review*, 10(3), 465-476.

- Riege, A. (2005). Three-dozen knowledge-sharing barriers managers must consider. *Journal of Knowledge Management*.
- Roberta, C., Paolo, B., & Matteo, B. (2011). Distributed knowledge management. In *Encyclopedia of Knowledge Management, Second Edition* (2 ed., pp. 198-208). Hershey, PA, USA: IGI Global.
- Rohrbeck, R., & Arnold, H. M. (2006). *Making university-industry collaboration work: A case study on the Deutsche Telekom Laboratories contrasted with findings in literature*. Paper presented at the The International Society for Professional Innovation Management Conference, Networks for Innovation, Athens, Greece.
- Rolland, N. (2000). Knowledge transfer in strategic alliances in despres C and Chauvel D (eds) knowledge horizons: The present and the promise of knowledge management. In: Butterworth Heinemann, Boston, MA.
- Roper, L. (2002). Achieving successful academic-practitioner research collaborations. *Development in Practice*, 12(3-4), 338-345.
- Rosen, B., Furst, S., & Blackburn, R. (2007). Overcoming barriers to knowledge sharing in virtual teams. *Organizational dynamics*, 36(3), 259-273.
- Ryu, C., Kim, Y. J., Chaudhury, A., & Rao, H. R. (2005). Knowledge acquisition via three learning processes in enterprise information portals: learning-by-investment, learning-by-doing, and learning-from-others. *MIS quarterly*, 245-278.
- Sabherwal, R., & Becerra-Fernandez, I. (2005). Integrating specific knowledge: Insights from the Kennedy Space Center. *IEEE Transactions on Engineering Management*, 52(3), 301-315.
- Santoro, M. D. (2000). Success breeds success: The linkage between relationship intensity and tangible outcomes in industry-university collaborative ventures. *The journal of high technology management research*, 11(2), 255-273.
- Santos, V. R., Soares, A. L., & Carvalho, J. Á. (2012). Knowledge sharing barriers in complex research and development projects: an exploratory study on the perceptions of project managers. *Knowledge and Process Management*, 19(1), 27-38.
- Sarrica, M., Denison, T., Stillman, L., Chakraborty, T., & Auvi, P. (2017). "What do others think?" An emic approach to participatory action research in Bangladesh. *AI & SOCIETY*, 1-14.
- Schartinger, D., Schibany, A., & Gassler, H. (2001). Interactive relations between universities and firms: Empirical evidence for Austria. *The Journal of Technology Transfer*, 26(3), 255-268.
- Schein, E. H. (1990). *Organizational culture* (Vol. 45): American Psychological Association.
- Schofield, T. (2013). Critical success factors for knowledge transfer collaborations between university and industry. *Journal of Research Administration*, 44(2), 38-56.
- Schwandt, T. A. (Ed.) (2007) *The SAGE Dictionary of Qualitative Inquiry* (3rd ed.).
- Shadur, M. A., Kienzle, R., & Rodwell, J. J. (1999). The relationship between organizational climate and employee perceptions of involvement: The importance of support. *Group & Organization Management*, 24(4), 479-503.
- Shanks, G., & Bekmamedova, N. (2013). Case study research in information systems. In K. Williamson & G. Johanson (Eds.), *Research Methods: Information, systems and context* (pp. 172-187). Prahran, VIC Tilde University Press.
- Sharp, H., Robinson, H., & Petre, M. (2009). The role of physical artefacts in agile software development: Two complementary perspectives. *Interacting with computers*, 21(1-2), 108-116.
- Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. *The journal of high technology management research*, 14(1), 111-133.
- Simonin, B. L. (1999). Ambiguity and the process of knowledge transfer in strategic alliances. *Strategic management journal*, 20(7), 595-623.
- Smircich, L. (1983). Concepts of culture and organizational analysis. *Administrative science quarterly*, 339-358.
- Soetanto, D., & Jack, S. (2016). The impact of university-based incubation support on the innovation strategy of academic spin-offs. *Technovation*, 50, 25-40.
- Soska, T., & Butterfield, A. K. J. (2013). *University-community partnerships: Universities in civic engagement*: Routledge.
- Star, S. L. (1989). The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving. In R. Gasser & M. N. Huhns (Eds.), *Distributed artificial intelligence* (pp. 37-54). London: Pitman Publishing.

- Stevens, D. D. (1999). The ideal, real and surreal in school–university partnerships: Reflections of a boundary spanner. *Teaching and Teacher Education*, 15(3), 287-299.
- Stover, M. (2004). Making tacit knowledge explicit: The ready reference database as codified knowledge. *Reference services review*.
- Strier, R. (2011). The construction of university-community partnerships: Entangled perspectives. *Higher Education*, 62(1), 81-97.
- Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic management journal*, 17(S2), 27-43.
- Tamjidyamcholo, A., Baba, M. S. B., Tamjid, H., & Gholipour, R. (2013). Information security–Professional perceptions of knowledge-sharing intention under self-efficacy, trust, reciprocity, and shared-language. *Computers & Education*, 68, 223-232.
- Tanner, K. (2000). Survey research In K. Williamson (Ed.), *Research Methods for Students, and Professionals: Information management and systems* (pp. 73). Wagga Wagga, NSW: Centre for Information Studies, Charles Sturt University.
- Teagarden, M. B., Meyer, J., & Jones, D. (2008). Knowledge Sharing Among High-Tech MNCs in China and India: Invisible Barriers, Best Practices and Next Steps. *Organizational dynamics*, 37(2), 190-202.
- Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic Analysis. In C. Willig & W. Stainton Rogers (Eds.), *The SAGE Handbook of Qualitative Research in Psychology*. London, UK: SAGE
- Thiry, M., & Deguire, M. (2007). Recent developments in project-based organisations. *International Journal of Project Management*, 25(7), 649-658.
- Thune, T. (2007). University–industry collaboration: The network embeddedness approach. *Science & Public Policy (SPP)*, 34(3).
- Turpin, T., Aylward, D., Garrett-Jones, S., & Johnston, R. (1996). *Knowledge-based Cooperation: University–industry linkages in Australia*.
- Ulleberg, I. (2009). The role and impact of NGOs in capacity development. *From replacing the state to reinvigorating education*. Paris: International Institute for Educational Planning UNESCO.
- Urbancová, H., & Linhartová, L. (2011). Staff turnover as a possible threat to knowledge loss. *Journal of competitiveness*, 3(3).
- Van Wijk, R., Jansen, J. J., & Lyles, M. A. (2008). Inter-and intra-organizational knowledge transfer: a meta-analytic review and assessment of its antecedents and consequences. *Journal of management studies*, 45(4), 830-853.
- Vijayan, K. K., Mork, O. J., & Hansen, I. E. (2018). *Knowledge Creation in Engineering Education (University–Industry Collaboration)*. Paper presented at the European Conference on Knowledge Management, Padua.
- Von Krogh, G. (1998). Care in knowledge creation. *California management review*, 40(3), 133-153.
- Walsh, J., & Lannon, J. (2018). *NGO Knowledge Management Challenges and Investment Priorities: A Sectoral Case Study*. Paper presented at the European Conference on Knowledge Management.
- Wasko, M. M., & Faraj, S. (2000). “It is what one does”: why people participate and help others in electronic communities of practice. *The journal of strategic information systems*, 9(2-3), 155-173.
- Weckowska, D. M. (2015). Learning in university technology transfer offices: Transactions-focused and relations-focused approaches to commercialization of academic research. *Technovation*, 41, 62-74.
- Wei Choo, C., & Correa Drummond de Alvarenga Neto, R. (2010). Beyond the ba: managing enabling contexts in knowledge organizations. *Journal of Knowledge Management*, 14(4), 592-610.
- Wendling, M., Oliveira, M., & Maçada, A. C. G. (2013). Knowledge sharing barriers in global teams. *Journal of Systems and Information Technology*.
- Wiewiora, A., Trigunarsyah, B., Murphy, G., & Coffey, V. (2013). Organizational culture and willingness to share knowledge: A competing values perspective in Australian context. *International Journal of Project Management*, 31(8), 1163-1174.
- Williamson, C. (2013). Action research: theory and practice. In *Research Methods: Information, Systems, and Contexts* (pp. 188-202): Tilde University Press.
- Williamson, K. (2002). Research techniques: questionnaires and interviews. In K. Williamson (Ed.), *Research Methods for Students and Professionals: Information management and systems* (pp. 217-231). Wagga Wagga: Centre for information studies, Charles Sturt University.
- Williamson, K. (2013a). Questionnaires, individual interviews and focus group interviews. In K. Williamson & G. Johanson (Eds.), *Research Methods : Information, systems and contexts* (pp. 349-372). Prahran, VIC: Tilde University Press.

- Williamson, K. (2013b). Research concepts. In K. Williamson & G. Johanson (Eds.), *Research Methods: Information, systems and contexts*. Prahran, VIC: Tilde University Press.
- Williamson, K., Burstein, F., & Mckemmish, S. (2002). The two major traditions of research. In K. Williamson (Ed.), *Research Methods for Students, Academics and Professionals: Information management and systems*. Wagga Wagga, NSW: Centre for Information Studies: Charles Sturt University.
- Williamson, K., Given, L. M., & Scifleet, P. (2013). Qualitative data analysis. In K. Williamson & G. Johanson (Eds.), *Research Methods: Information, systems and contexts*. Prahran, VIC: Tilde University Press.
- Wright, M., Clarysse, B., Lockett, A., & Knockaert, M. (2008). Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. *Research Policy*, 37(8), 1205-1223.
- Yang, S.-C., & Farn, C.-K. (2009). Social capital, behavioural control, and tacit knowledge sharing—A multi-informant design. *International Journal of Information Management*, 29(3), 210-218.
- Yao, L., Kam, T., & Chan, S. H. (2007). Knowledge sharing in Asian public administration sector: the case of Hong Kong. *Journal of Enterprise information management*.
- Yaziji, M., & Doh, J. (2009). *NGOs and corporations: Conflict and collaboration*: Cambridge University Press.
- Yin, R. K. (1994). Discovering the future of the case study. Method in evaluation research. *Evaluation practice*, 15(3), 283-290.
- Yin, R. K. (2003). *Case Study Research: Design and methods* (3rd ed. Vol. 5): Sage
- Zahra, S. A., Neubaum, D. O., & Larrañeta, B. (2007). Knowledge sharing and technological capabilities: The moderating role of family involvement. *Journal of Business research*, 60(10), 1070-1079.
- Zeleny, M. (1987). Management support systems: Towards integrated knowledge management. *Human systems management*, 7(1), 59-70.
- Zhang, C., Viswanathan, S., & Henke Jr, J. W. (2011). The boundary spanning capabilities of purchasing agents in buyer-supplier trust development. *Journal of Operations Management*, 29(4), 318-328.
- Zhang, P., & Ng, F. F. (2012). Attitude toward knowledge sharing in construction teams. *Industrial Management & Data Systems*.
- Zolezzi, G. (2014). Partnerships between academia and NGOs in technical studies in Italy. *JUNCO| Journal of UNiversities and international development COoperation*(1).
- Zubielqui, G. C. d., Jones, J., Seet, P.-S., & Lindsay, N. (2015). Knowledge transfer between actors in the innovation system: A study of higher education institutions (HEIS) and SMES. *Journal of Business & Industrial Marketing*, 30(3/4), 436-458. doi:doi:10.1108/JBIM-07-2013-0152

APPENDICES

Appendix A: Interview Questions

Definitions:

Knowledge Sharing: Two-way exchange of meaningful information, skills, opinions, ideas and suggestions along with interpretation among different entities such as individuals or organisations.

Experiential knowledge: Experiential knowledge is gained through lived experience (Faulkner, 2017) and is built through shared hands-on experience among the members of the organisation, and between the members of the organisation and other stakeholders (Nonaka, Toyama, & Konno, 2000; Rai, 2011). It is job-specific knowledge and skills, for example, tips, rules of thumb, know-how, new ideas, perspectives, etc. (Panahi, 2014).

Q1. I'd like to start by learning a little about you. Please tell me about yourself.

- What is your degree? What is your field?
- What is this collaborative project?
- What are partners' roles?
- How many people are engaged in this project?
- Did you help develop it or did you join at a later stage?
- What is your position in this collaborative project? What are you doing exactly?

Q2. What does the term "knowledge sharing" mean to you?

- What sort of knowledge do you think is generated by or undertaken by this project?
- How do you share knowledge with other collaborative project members?
- How do you trust other members' knowledge?
- Have you ever changed your knowledge and information as a result of your interaction with other researchers?
- How easy is it to share your knowledge with other researchers in this collaborative project?
- Have you ever obtained new ideas and insights while sharing knowledge?

Q3. Can you tell me what kind of knowledge you usually share in the collaborative project?

- What kind of information do you think is primarily shared in collaborative projects among researchers?
- Do you ever share your personal experiences or opinions in this collaborative project?
- Can you give me some examples of this kind of knowledge?
- How easy is it to share your experiential knowledge?
- What are the main challenges you experience in sharing your experiential knowledge?
- On a recent occasion when you shared knowledge, what form of knowledge was involved (written, verbal, ...)?
- How was this knowledge shared?
- What are the knowledge resources that you consult during this collaborative project?
- Do you consult library resources during this collaborative project?
- How the research datasets that are produced by the project managed?
- What is the project output up to now?

- What will project outputs be?

Q4. How do you create shared collaborative spaces for knowledge sharing in this collaborative project?

- When do you share knowledge? Can you tell me some concrete examples?
- Are there particular places where you share knowledge, for example, in meetings, sharing of drafts or virtually? Can you tell me some concrete examples?
- Where do you usually meet project members?
- When do you usually meet project members?
- Do you use the library as place for interaction?
- What kind of tools do you use for knowledge sharing?
- Do you use social media (SM) for sharing knowledge in this project?
- What kind of social media (SM) tools do you usually use for knowledge sharing?
- Do you think SM help to increase knowledge sharing?
- Have you found any limitations/difficulties in sharing your knowledge virtually?
- Which space or tool do you prefer for knowledge sharing more? And why?
- Do you need different places for a different kind of knowledge?
- Is there any tool or system to enable knowledge distribution and creation during this project?
- What additional tools/systems would you like to see in facilitating knowledge sharing process during this project?
- What are the conditions required to develop shared collaborative spaces between researchers in this collaborative project?

Q5. Talking in generalities, collaborative projects are one of the main ways for knowledge sharing between university and industry.

- Is this collaborative project used to generate knowledge between your organisation and your partner? If so, how? If not, what are the barriers?
- What could a university/industry do to capture the knowledge you and your colleagues have?
- How can university/industry in general do a better job capturing, retaining and sharing that knowledge?
- What are the barriers to knowledge sharing between university and industry?
- What are the drivers to knowledge sharing between university and industry?

Q6: Is there anything else that I haven't asked or that you think is relevant to add to the discussion?

Appendix B: Summary of the interview questions and their purpose related to research questions

The list of interview questions which were asked of the study participants regarding the main research question. The questions were revised and modified after conducting a first interview to ensure the relevance and clarity of the questions. The summary of what each question measures and its purpose is found in the table:

Questions	Purpose
1	Background information of the participants
2 & 3	Main Q1: “How is knowledge shared in university–organisational collaborative projects?”
3 & 4	Main Q2 and its subquestions: - How do participants create SCSs for knowledge sharing in university–organisational collaborative projects? ○ What kind of SCSs are most effective in supporting knowledge sharing in university–organisational collaborative projects? ○ What are the conditions required to develop SCSs between participants university–organisational collaborative projects? ○ What kind of knowledge is shared in shared collaborative spaces (SCSs) in university–organisational collaborative projects?
5	Main Q1, first sub question: “What are the drivers and barriers in the knowledge sharing processes of university–organisational collaborative projects from participants’ perspective”
6	Additional comments

Appendix C: An example of coding interview (using NVivo software)

Knowledge sharing challenges

Reference 1 – 0.49% coverage

With the other partners there are various things that can make it more difficult. One is obviously they're in Bangladesh. They have different work routines, different working hours, they have different organisational cultures and aims.

Reference 2 – 0.48% coverage

So that is not so easy to come to terms immediately because they had not written about that, they have no list of procedures they had to do, they had necessarily explained why, so we only found out to talk about that thing like that.

Reference 3 – 0.62% coverage

We say what data we want to collect, but there are other people who have to organise the collection. So there can be misunderstanding about what data is to be collected, forms, there can be misunderstanding about how we need the data to be collected, there can be misunderstanding about the quality of the data.

[<Files\\M2>](#) – § 3 references coded [2.02% coverage]

Reference 1 – 0.92% coverage

Because often it is back to phone lines, Skype is not working and there is real interference. We had this meeting and nobody asked what was going on because we could not understand each other and mutually I do not know whether they understood me or not. Time is a cultural thing to a [researcher] and we have written about that, we are not all in the same space, you know, so if they say yes, maybe it is to something else.

[<Files\\W3>](#) – § 1 reference coded [1.02% coverage]

Reference 1 – 1.02% Coverage

Yes, I think that is a big barrier because in the beginning we had actually to fight even to explain to each other what we meant. Like, we talked different languages for a whole year or maybe longer. But then, we also had issues, like we had problems organising the work. We could not balance the importance of long-term and short-term goals.

[<Files\\W4>](#) – § 1 reference coded [1.29% coverage]

Reference 1 – 1.29% coverage

Yes, I do. Like I said, I did have a challenge because I couldn't communicate it straight away. I would think I did a good job communicating, but it might be, "Okay, people didn't get it." But they would say, "We didn't get it." So then I would think of another way of explaining it to them. It's just that sometimes our team leader will quickly pick up what I'm trying to say and she tries to say, "Okay, let me explain what you said." It's not just always me, but I get help from others as well. So yeah, so there are times that some get it and some don't. So those who have got it, they can jump in and help me out. I hope I answered that.

Reference 5 – 0.65% coverage

At least no one told me anything about what's required. I'm not aware of anything. Let's put it that way: If the four team members, the four research fellows, who are really the ones who are doing the work, if they would leave tomorrow, the project would probably die because no one could continue.

Appendix D: Structures and naming systems for organising datasets in the ProjectNGO

This team drive is established to facilitate documents/resources sharing between members of ProjectNGO team at University. The folder structure and naming system are as follows:

ROOT: ProjectNGO				
Sub-Folder1	Sub-Folder2	Sub-Folder3	File Naming System	Notes
Project Reports	Progress Reports		[Author]_[Name]_[Version]_[Date]	
	Evaluation Reports		[Author]_[Name]_[Version]_[Date]	
	Visits Reports		[Author]_[Name]_[Version]_[Date]	
Project Management	Implementation Plan		[Name]_[Date]	For project management docs
Research Output	Articles		[Author]_[Brief Title]_[Date]	
	Posters		[Author]_[Brief Title]_[Date]	
	Presentations		[Author]_[Brief Title]_[Date]	
Media and Publicity			[Media]_[Brief Title]_[Date]	
Resources and References	References		[Author]_[Brief Title]_[Year]	Resources are to be merged here
Research Data	[Surveys Name]_[Date]	Survey Material	[Name]_[Created/revised/commented by]_[Date]	
		Analysis	[Name]_[Created/revised/commented by]_[Date]	
		Data	[Name]_[Date]	
	[Interview Name]_[Date]	Data collection	[Name]_[Created/revised/commented by]_[Date]	
		Analysis	[Name]_[Created/revised/commented by]_[Date]	
		Data	[Interviewee]_[Created by]_[Date]	
Events/Marketing	[Type]_[Date]_[Location]	Doc	[Doc Name]	
		Photos	[Photo_tag]	
PhD students				
FURTHER NOTES:				
Date Format: dd-mon-yy				
Version control: Google Drive will keep versions of doc				

with the same file name (Version History). Manual version control might be better.				
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Appendix E: Consent Form: Research Services Managers and Business Development Managers



MONASH University

CONSENT FORM

(Research Services Managers and Business Development Managers)

Project: Knowledge sharing mechanisms in university-NGO/industry collaborative projects in IT-related faculties in Australia

Chief Investigator: Dr Tom Denison

I have been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
To participate in the interview for the PhD thesis	☐	☐
To have my interview audio-recorded	☐	☐
I would like to receive a copy of the research results.	☐	☐

Name of Participant _____

Participant's Signature _____ Date _____

Appendix F: Consent Form: Research Services Managers and Business Development Managers



MONASH University

CONSENT FORM

(University Researchers and Industry Representatives)

Project: Knowledge sharing mechanisms in university- NGO/industry collaborative projects in IT-related faculties in Australia

Chief Investigator: Dr Tom Denison

I have been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
To participate in the interview for the PhD thesis	☐	☐
To have my interview audio-recorded	☐	☐
To provide access to work-related documents collected, such as minutes of meetings, official reports, personal journals, diaries, letters and emails	☐	☐
I would like to receive a copy of the research results.	☐	☐

Name of Participant _____

Participant's Signature _____ Date _____