The influence and role of social capital in managing technological change in industry contexts

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ACN	Adelaide CleanTech Network
ACT	Australian Capital Territory
ARC	Australian Research Council
ASBEC	Australian Sustainable Built Environment Council
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CLT	Cross Laminated Timber
CRC	Cooperative Research Centres
R&D	Research & Development
RBV	Resource-based View
SME	Small and Medium-sized Enterprise
US	United States
VC	Venture Capital

ABSTRACT

Technological change has been at the centre of economic and industry development debate over many years. Despite the recognised importance of social aspects linked to technology adoption and the transitions to new paradigms, a more detailed exploration of the role of relationships in industry contexts has received less attention.

The overall understanding emerging from the literature on technological change is that factors and social influences for technology adoption are multiple, dynamic and interdependent. Complementing this understanding, the social capital literature contends that the value of relationships in technology adoption relies on the access to and exchange of resources embedded in social structures. Extant research suggests that social phenomenon contributes to technological change, although the intricacies of its occurrence remains in a "black box".

This thesis integrates the two literature streams – technological change and social capital – with a specific focus on how industry actors engage with the complexities involved in embedding the new technology into various industry contexts. Using the pragmatist perspective, the researcher carried out explorative qualitative research based on the interrogation of actions and interactions of industry actors, and suggests an alternative view of social capital in technological change, beyond the recognised resource view.

The exploration of the social phenomena is done within the context of clean technologies in Australia. It represents a rich context due to the multiple and diverse technologies converging across different sectors and fields of knowledge, the combination of specialised intangible and tangible assets, and the specialised communities of actors. Data was collected using semi-structured and informal interviews, and participant observation, and was analysed using content analysis.

Results indicate that, by adopting a pragmatist approach to the social aspect of technology change, the role of social capital goes beyond the predominant resource-based view approach. The role of social capital has a four-fold influence: (1) on the industry context, (2) the new technology, (3) the interactions among industry actors, and (4) the perception of time. The latter is a new insight derived from this research. Bringing these influences together, results suggest the coexistence of the transactional and transitional role of social capital in technological change.

This research extends the *social capital literature by suggesting that the contextuality and temporality of relationships is important.* It does so by identifying the *contextual, technological, relational and temporal influences* and their interplay through the lens of pragmatism. The perception of time, in particular, is identified as a key element in the manageability of social capital. It also contributes to the *technological change literature by proposing two roles of social capital* – transactional and transitional – in the adoption of new technologies. These influences and roles are integrated in a holistic model.

Overall, the thesis is part of a growing body of research and provides significant insights into the role that the professional relationships of industry actors play in the process of new technology adoption. Social capital allows industry actors to (1) adapt to the changes posed by the contextual conditions, and (2) enables them to create new conditions to foster technological transitions.

DECLARATION

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1. INTRODUCTION

"It is just this occurrence of the 'revolutionary' change that is our problem"

(Schumpeter, 1934, p. 38)

1.1. Background and focus of the research

The development and adoption of new technologies have been key factors that explain economic and industry growth and change (Romer, 1990; Solow, 1956). The adoption of new technologies constitutes a complex process connected to changes in the social, economic and political aspects of an industry (Bijker, Hughes, & Pinch, 2012; Geels, 2002) that result in changes in social behaviour and communication and even individual actions and mindsets. This process will be referred to henceforth as technological change.

Within this complex process, social aspects have been recognised to play a key role. These social aspects then continuously impact the process of technology adoption (Bijker et al., 2012), manifested, for example, in changes in regulations, institutions, networks and norms (Geels, 2002). Despite this evident connection between technology and socio-industrial change, extant literature suggests that the reciprocal relation between people and technology remains in a "black box" (Bijker et al., 2012, p. xliii). Research is still in its infancy in regard to the multiple interdependencies of social relations that shape technological change.

The predominant economic perspective in technological change literature fails to explain how change emerges (Van de Ven, 1993), therefore this thesis takes a sociological view that complements the existing economic view. This view recognises the social nature of technological change and focuses on the role of industry actors' engagement during the adoption of new technologies and the associated contextual changes. An actor's engagement is given a strategic value for organisations and industries as it provides access to resources that creates value, which is known as social capital (Bourdieu, 1986; Ireland, Hitt, & Vaidyanath, 2002; Nahapiet & Ghoshal, 1998).

Social capital has been predominantly understood from a resource-based view (RBV) and research has been primarily done under stable context conditions (Barney, 2001). However, the implications of complex and uncertain contexts, as commonly found in technological change, are yet to be explored. The spirit of this thesis is to research in an exploratory way the intricacies of the social relations aspect of technological change beyond its value as a resource. Attention is given to how industry actors engage with the complexities involved in embedding the new technology into various industry contexts using a pragmatist perspective. Following Farr (2004), the pragmatist view throws new light on the complex interplay between the social and technological aspects of change in industry contexts. This approach is not to dismiss the contribution of the predominant RBV of social capital but rather to contribute to micro perspectives of the rich interplay between the social and technological aspects.

Broadly, this research explores how social capital influences the adoption of new technologies, which often causes uncertainty and change in industry contexts. Further, it seeks to address questions such as, how do these changing conditions influence the interplay of social capital with new technology adoption? How do they interact and influence each other? These questions underline the point that new technology adoption is embedded in a nexus of interactions within an industry context, which brings into focus the role that the professional relationships of industry actors play in the process of new technology adoption. The underlying assumption is that social capital, notably through the roles and relationships of industry actors, influences the adoption and integration of technology into the everyday practices of industry activities. This thesis accepts the multifaceted nature of social capital and argues its value in the understanding of the complex social interactions related to technological change (Batt, 2008). Therefore, by recognising the social nature of technological change and the reciprocal effect of this change on social capital, this research focuses on the social engagement of industry actors.

The following sections present an overview of this research. Section 1.2 introduces the conceptual framework guiding the research. It builds on the literature streams of technological change and social capital, with a focus on the professional engagement and the resulting relational assets available in an industry. Section 1.3 then outlines the characteristics of clean technology and its industry context and why they are a fertile ground for this research. Section 1.4 presents the research questions derived from the literature analysis. Section 1.5 summarises the methodological approach, section 1.6 focuses on the contribution and significance of this research, and finally section 1.7 outlines the structure of the thesis.

1.2. Conceptual framework

The next two subsections present an overview of the two literature streams which explore the social aspects of change occurring in an industry due to new technology adoption.

First, literature on technological change is used to explore the contextual and exogenous factors influencing the adoption of new technologies in an industry. Second, literature on social capital is introduced to explore the role and value of social relations and the assets derived thereof in various contexts, including the appearance of new technologies.

1.2.1. Technological change

Technology is understood in this research as a physical object or artefact (Bijker et al., 2012) that can be incorporated into products, processes or services, and is considered to be "capital-embodied and firm-specific" (Winter, Kaniovski, & Dosi, 2000, p. 257). Building on this understanding, technological change encompasses the interplay of factors, elements and conditions that occurs during the diffusion and adoption of new technologies in an industry context (Geels, 2002). Technological change is understood here as both the process and effect of the dynamic and heterogeneous "interactions among market structure, R&D [Research & Development] spending, technical change, and other aspects of industry performance" (Nelson & Winter, 1982, p. 276). To further explore technological change, the evolutionary and the socio-technical view are presented.

The literature on technological change includes the evolutionary view that recognises the dynamic interactions between the multiple elements involved (Nelson & Winter, 1982). The evolutionary view of technological change assumes the industry context as an external reality in which multiple factors interact, actors adapt and technology is selected by market forces (Geels, 2002; Nelson & Winter, 1982). The context in which new technologies are introduced is shaped by existing conditions and historical trajectories (i.e., path dependency) that influence the speed, direction and success of establishment (Ford, Routley, & Phaal, 2010; Fredin, 2012; Ruttan, 1997). It also includes social factors, which suggests that the industry context is a social negotiation about and around technologies (Bijker et al., 2012; Dosi & Marengo, 2014; Geels, 2004). However, it overlooks the specific social elements and attributes involved in this interplay.

The socio-technical view has been introduced as another perspective to complement the evolutionary view of technological change. It proposes that technologies are built through a process of social construction and negotiation (Ford et al., 2010). A socio-technical system describes a context of change in which multiple configurations of actors, rules and physical resources interrelate during the appearance of new technologies (Malerba, 2007; Negro, Alkemade, & Hekkert, 2012; Truffer, 2012). The role of actors and their interactions challenges the assumption that the context is external, as put forward in the evolutionary view. Instead, it suggests an alignment of individual activities in social groups as a key element of change (Geels & Schot, 2007), explicitly including the role of social norms, rules and the process of technology negotiation (Geels, 2005).

The evolutionary and socio-technical views both provide frameworks to understand the multiple factors involved in technological change. However, the literature remains at a macro level which makes it difficult to understand the intricacies involved. Specifically, the role of actors and their interactions is not yet fully explored and there is a need to further investigate the role that relationships among industry actors play in the adoption of new technologies (Klein & Kleinman, 2002).

This research draws on the social capital literature, presented in the next section, to explore the attributes and dynamics of social relations and relational resources that all play a role in the adoption of new technologies in an industry.

1.2.2. Social capital

Social capital focuses on the value attributed to relationships and, therefore, enables the analysis of professional interactions and business relationships in an industry context in which new technologies appear. Social capital is recognised as the resources embedded in relationships that contribute to value generation (Bourdieu, 1986; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998; Walter, Lechner, & Kellermanns, 2007; Yli-Renko, Autio, & Sapienza, 2001). The potential value of social interactions is evident in networks and the assets accessed through these networks, and in a set of shared attributes and cognitive frameworks such as trust, norms and beliefs (Nahapiet & Ghoshal, 1998). This multifaceted nature of social capital suggests a social phenomenon which is difficult to assess and manage (Adler & Kwon, 2002).

RVB is one approach that can be used to explore the complex social phenomenon of social capital. This theoretical framework can be used to analyse the causality of social elements and the acquired benefits (Brehm & Rahn, 1997; Fernández-Pérez, Verdú-Jóver, & Benitez-Amado, 2013; Knack & Keefer, 1997), as well as the mechanisms (Maurer, Bartsch, & Ebers, 2011) and operationalisation processes (Carpenter, Li, & Jiang, 2012; Rocha-Goncalves & da Conceição Gonçalves, 2011). This resource approach has provided a theoretical basis for understanding how social capital can be created and used in organisations.

However, the RBV limits the understanding of the multifaceted and complex nature of social capital, its dynamism, manageability and its role in complex industry contexts. The dynamics of technological change suggest that industry, institutional, technological, organisational and individual factors are embedded in the social dynamics and these are yet to be explored in an interconnected way (Geels, 2002; Walsh, 1991; Woolcock, 1998).

This thesis, therefore, proceeds with a different approach. It follows Farr (2004), who proposes using a pragmatist lens (this approach is explained in section 1.5 and in more detail in Chapter 3). Pragmatism allows for a better exploration of social capital in rapidly changing and sometimes unstable conditions, such as a period of technological change. In accordance with this approach, this research assumes social capital as "attributes of individuals and of their interactions that enhance their ability to solve collective-action problems" (Ostrom & Ahn, 2003, p. 4). This definition allows for a broader understanding of social capital beyond the notion of resources (Robison, Schmid, & Siles, 2002), and allows for exploration of the interconnections and dynamics between its elements (Woolcock, 1998). Also, the role of social capital for collective action (Coleman, 1988) can be better related to turbulent environments in which rapid action is required.

To summarise, this research integrates two parent literature streams, namely technological change and social capital. With respect to the former, this thesis aims to move beyond the macro level by investigating the intricacies of the social aspects of technological change. With respect to the latter, this research uses social capital from a pragmatist perspective to explore the attributes of social relations and their dynamics under uncertain conditions, and to contribute to the understanding of the influence and role of social capital in technological change.

1.3. Identifying the research question

The analysis presented above reveals shortcomings in the literature and aids in defining the purpose of this research. This section focuses on outlining two of the main shortcomings: (1) a lack of consideration of social relationships and interactions in technological change literature, and (2) a lack of consideration of context complexity and uncertainty in social capital literature.

First, the literature on technological change, from both the evolutionary and socio-technical perspectives, provides a framework to understand the multiple factors involved. The evolutionary view provides a perspective on the contextual, organisational and

technological factors that bring change about, complemented with the socio-technical view which emphasises the co-evolution of technology and social factors. Consequently, the multiple factors of technological change include different configuration of actors and interactions, institutions, regulations and practices, and infrastructure (Negro et al., 2012) .

Extant research identifies the importance of these factors to manage the lack of knowledge, technical capacity and investment, poor connections among actors, lack of developments and insufficient resources (Almlund, Jespersen, & Riis, 2012; Negro et al., 2012), and lack of specialised intangible assets such as perceptions, communication, commitments and behaviours (Erzurumlu & Erzurumlu, 2013), that are inherent during periods of technology discontinuities. Despite this understanding of the social aspect of technological change, it remains difficult to identify and integrate the intricacies of the social attributes influencing the industry context and its interplay with the multiple factors (Dosi & Marengo, 2014). Therefore, the consideration of social relationships and interactions in technological change demands more research.

Second, social capital refers to social relations that acquire value through the resources derived thereof. Thus, it provides an appropriate theoretical lens through which to explore the occurrence and relevance of social interactions in industry contexts. It has been analysed from the RBV in an effort to understand its benefits to create competitive advantage (Inkpen & Tsang, 2005; Walter et al., 2007; Yli-Renko et al., 2001). However, the RBV has limited the understanding of the multifaceted nature of social capital, its dynamism, and manageability (Lappé & Du Bois, 1997), and has limited its analysis to stable conditions of the context. The dynamics of technological change suggest that industry, institutional, technological, organisational and individual factors are embedded in social dynamics and are yet to be explored in an interconnected way (Walsh, 1991; Woolcock, 1998).

Social capital, by definition, embeds the context through social norms and membership to communities (Bourdieu, 1986; Putnam, 1995). However, literature implicitly assumes that

an industry context is stable and not continuously changing and influenced by technological transitions (Geels, 2002). Despite the detailed exploration of the role of relationships in business contexts, social capital has not been analysed in contexts in which multiple factors are highly and reciprocally influencing the changes, such as in technological change. Research is needed, to address the role of relationships among industry actors in a context that is highly dynamic and ambiguous, beyond the value of relational resources (Robison et al., 2002). Social capital literature lacks the specific analysis of the impact of changing contexts and technologies on social relationships and how this supports the process of change given the adoption of new technical artefacts. Thus, this research intends to contribute to social capital knowledge by identifying the intricacies of how this context interplay.

To better understand the engagement of industry actors during the process of new technology adoption, this research takes into account rapid changes and uncertainty within an industry context. More explicitly, the underlying assumption is that technology adoption is a complex long-term process in which multiple contextual factors connected to the social aspect play a role (Walsh, 1991; Woolcock, 1998). In technology-based industries, the great variety of actors, including specialised investors, particular scientific and engineering communities, high-power policy-makers (Erzurumlu & Erzurumlu, 2013) and sensitive consumers (Meyskens & Carsrud, 2013), suggest that communication, negotiation and transfer become highly entangled (Erzurumlu & Erzurumlu, 2013). Thus, the ongoing intertwinement between different understandings of industry actors and the multiple elements in the context are complex and demand a closer view. The role of actors and their interactions is not yet fully explored, and there is a need to further investigate relationships among industry actors in the adoption of new technologies.

Consequently, this research brings together two gaps in two literature streams: technological change and social capital. On one hand, the literature on technological change lacks specific exploration of the social attributes influencing changes. On the other hand, social capital lacks specific analysis of the impact of changing context dynamics

and technology on relationships and how it supports the process of change. In accordance with this, the main research question of the thesis is:

How does social capital influence technological change in industry contexts?

To summarise, technological change implies disruption of the industry context conditions that cause uncertainty and which may have a reciprocal influence on social capital. However, the multiple influences on social capital have not been explicitly described in the literature. To explore this shortcoming, three research sub-questions were developed as presented in Figure 1.1. The first sub-question refers to the relation between industry context and social capital, the second sub-question addresses the interplay between technology and social capital, and the third sub-question refers to the social aspects involved in technological change. The nature of these sub-questions is presented in detail in Chapter 2.

Research question	How does social capital influence technological change in industry contexts?		
Sub-questions	How does the industry context influence social capital?	How does the adoption of technologies influence social capital?	How is social capital understood and used by industry actors?
Related to	Contextual aspects	Technological aspects	Relational aspects

Figure 1.1. Research question and sub-questions

1.4. Context of research: Clean technology

To examine the research questions, this research takes place within the multiple dimensions of technological change, including organisational, institutional and socio-economic (Markard, Raven, & Truffer, 2012). To understand the social aspects of these dimensions, this research uses clean technologies in Australia as a good example of how technological change occurs due to technological advances, and explores the impacts

and changes generated and the social dynamics which occur as a result of change. The next three sections first present the different definitions and characteristics of clean technologies in general, and then focus specifically on Australia.

1.4.1. Definition and understandings of clean technology

Clean technologies have been developed in response to the concerns about the impact of human and industrial activities on the environment. These technologies represent technical advancements aligned with socio-economic trends on sustainability and energy-resource efficiency, aim to address the environmental impacts of human and industrial activities (Erzurumlu & Erzurumlu, 2013). Clean technologies reduce ecological impact and at the same time generate commercial value. The different fields of application of these technologies leads to recognising clean technologies as a source of socioeconomic wealth (Almlund et al., 2012).

The adoption of clean technologies in industry has revealed new and increased intertwinement of social and environmental issues with technological developments and existing industry conditions (Dosi & Marengo, 2014). It involves the creation of business value and new market opportunities (Hargadon & Kenney, 2012), and the contribution to regional development through the creation of jobs and sources of income (OECD, 2012). These multiple interdependencies reflect the complexity and uncertainty of the industry context.

The complex process of technology adoption and industry development implicitly suggests the coexistence of multiple understandings of clean technology that are interconnected and are presented here as a technology, an industry and a concept. *Technology* refers to clean technology as an artefact adopted and established in an industry context. *Industry* is the context in which conditions change due to the adoption of new technologies. The *concept* refers to the understanding and perception of industry actors in relation to the technologies.

These multiple understandings of clean technologies are unavoidable due to the coevolution and dynamics of technology adoption which generate multiple changes in the political, economic and social contexts. Simultaneously, the technologies are continuously shaped and selected according to the contextual conditions. These understandings are intertwined and will be referred to in this thesis as (clean) technologies, industry and concept, respectively.

As a technology, it refers to the wide variety of technical artefacts used in a broad range of products, processes and services in numerous sectors such as energy, water, materials, waste and renewable sources, among others (Almlund et al., 2012; AZoCleantech, 2013). The energy sector includes renewable energy and conventional fuels, transport, smart grid and storage. Resource efficiency refers to the improvement of resource use in infrastructure, appliances and electronics, materials and building. The water sector comprises water management, irrigation and waste water, while the waste sector includes treatment, reuse and recycling. Other applications are in the fields of manufacturing, agriculture, food and chemicals. Additionally, the multiple applications of the technologies that co-occur in diverse sectors reflects the interdependencies of technologies, contexts and actors.

Understanding clean technology *as an industry* allows for an identification of the influence of historical trajectories. The transition to more sustainable use of technologies is "at stake" (Truffer, 2012, p. 182), as new technologies challenge the traditional way of producing and using resources. The multiple technologies that are developed and applied in diverse fields should optimise production costs and create business opportunities (KPMG International, 2013). Thus, the diverse use of new technologies need to be aligned to the industry contexts through new business models, funding schemes and commercialisation processes (Almlund et al., 2012).

As a concept, clean technology refers to the combination of business models and technologies that aim to mitigate the environmental impact of human activities (Beise &

Rennings, 2005; Clift, 1995; Erzurumlu & Erzurumlu, 2013; Kinnear & Bricknell, 2013). This concept recognises the specific technical purpose of contributing to energy efficiency, sustainable production, responsible use of natural resources, and resource efficiency (KPMG International, 2013). Clean technology has evolved from related concepts such as clean production, green technology, environmental technology, eco innovation and greening business (Clift, 1995; Porfir'ev, 2012). The terminology has evolved as a response to the perceptions of the environmental impact of industry activities (Almlund et al., 2012; Kirkwood & Longley, 1995), and is related to other theoretical streams such as social corporate responsibility, sustainability and industrial ecology (Markard et al., 2012).

The multiple understandings of clean technology reflect the complexities involved in technological change and demonstrate how challenging it is to analyse. In the case of clean technology, the industry and technology interplay suggests an interlock between technical artefacts, industry conditions and the general social connotations. Clean technologies refer to the artefacts, the industry in which those technical artefacts are adopted, and the conceptual understanding of the value of the technologies by industry actors.

For the purpose of this thesis, the three understandings are considered intertwined (although it is noted that in the literature clean technology is primarily assumed to refer to the technology adopted in an industry). Thus, clean technologies are understood here as the technical artefacts used to reduce environmental impact (cf. Organisation for Economic Co-operation and Development, 2014; Truffer, 2012) and create business opportunities (Beise & Rennings, 2005; Erzurumlu & Erzurumlu, 2013; Kinnear & Bricknell, 2013).

1.4.2. Analysis of the clean technology industry context

An analysis of the socio-technical system in clean technologies shows multiple and entangled operational, market and regulatory aspects influencing industry change and shaping the transition to the new technologies (Erzurumlu & Erzurumlu, 2013). These

aspects include the complementarity and advancement of technologies and industry capacity and infrastructure, including investments in R&D.

The technological developments that triggered industry change occurred over two periods. During the first period, in 1970–90, market dynamics triggered new technological developments that affected competitiveness and performance characteristics (Almlund et al., 2012; Irwin & Hooper, 1992; Negro et al., 2012). The development of these clean technologies involved highly complex technical and operational efforts that were difficult to transmit to stakeholders (Erzurumlu & Erzurumlu, 2013) and new technologies were often 'killed' by the market (Koester, 2011, p. 25).

The Industrial Revolution in the 19th century changed economic activities, technology use and social structures. These changes greatly impacted the environment and there was increased social pressure on industry and political actors to mitigate these impacts. The installation of environmental legislation (Koester, 2011) triggered new conditions in the socio-economic context and the development of new clean technologies that drove industry development at the time.

The second technological period, after 2000, built upon the previously developed technologies and complemented them with investment and business models within a constantly changing regulatory context (Koester, 2011). However, previous regulatory drivers such as economic conditions and policies posed entry barriers to the adoption of the new clean technologies. These regulatory aspects reinforced path-dependency (Negro et al., 2012) and the problem of lock-in (Markard et al., 2012), manifested in the embeddedness and inertia in a large, traditional and highly regulated system (Hargadon & Kenney, 2012; Porfir'ev, 2012). Also, the stagnation in established regulations, technology infrastructure, user practices and organisational structures (Markard et al., 2012), and costs and investments limited industry development and caused inertia in the technological base (Porfir'ev, 2012).

As a result, different incentives, subsidies and policies have been introduced and changed over time with the rationale that public and private investment can overcome the existing limitations of long technology cycles, policy instability, poor records of returns for investors and a prevailing conservative market (Wüstenhagen & Teppo, 2006). Technological advancement followed an initial technical response to mitigate industrial environmental effects (Australian Clean Tech, 2014; Poyyamoli & Rasmi, 2011) that shifted to a political response via regulations and policies (Almlund et al., 2012). This paved the way for a transition from an environmental approach to a business approach and, with this, new dynamics in the industry took place. Industry drivers shifted from a top-down approach of *reducing* environmental effects through regulation and technology development to a bottom-up approach of *avoiding* these effects through technological and business opportunities (Kirkwood & Longley, 1995).

Clean technology industry has evolved from an initially regulatory-driven sector to a currently market-driven sector (Australian Clean Tech, 2014) and developed into new socioeconomic contexts (Almlund et al., 2012). Clean technologies have gained popularity as a business opportunity, and both financial and social influences have also increased (Lange, 2016; Truffer, 2012). A new approach to business models, funding schemes, technology development and commercialisation processes has emerged and fostered interest from investor groups, entrepreneurs and companies (Almlund et al., 2012).

However, the clean technology industry has experienced convoluted dynamics and the market has remained underdeveloped, despite government and private initiatives in regulatory framework and capital investments (Hargadon & Kenney, 2012). New challenges are constantly appearing, due to the potential risks and previous failures, and established industries and competing technologies (Lange, 2016).

The technological transition of the clean technology industry implies that changes also occurred in industry actors' perceptions on how to manage environmental effects and the social dynamics. Consumer response, investor strategy and institutional roles have gained

relevance as drivers of change. Actors' perceptions, the risk to the population, and societal costs influence the adoption and acceptance of technologies (Negro et al., 2012; Roper & Tapinos, 2016). This context offers an opportunity to explore the role of social relations in technological change and industry development.

Some efforts have been made to analyse the social dimension of clean technology dynamics. The role of partnerships to mobilise resources for green technology ventures (Meyskens & Carsrud, 2013) and professional associations in the adoption of technologies (Erzurumlu & Erzurumlu, 2013) have been identified. Bergek, Mignon, and Sundberg (2013) indicate the importance of networks, intentions, shared experience, norms and values in investor groups. There have also been isolated efforts to analyse the role of trust and intangible resources in managing the uncertainties of change to a sustainable industry (Bellaby, Eames, & Flynn, 2010). Intangible resources such as culture, commitment and communication, and the combination with technology (Almlund et al., 2012; Erzurumlu & Erzurumlu, 2013) have been acknowledged as success factors in addressing environmental issues. Further research has found that the difference in attitudes, motivations and beliefs, and the influence of social, institutional and market actors, all play a role in technology development (Almlund et al., 2012).

The above analysis reflects the complexity and interdependency of industry aspects involved in the appearance and adoption of new technologies. Within the multiple aspects and changes occurring, the social dynamics have been identified as playing a key role and more research is needed in this area.

1.4.3. Clean technology in Australia

Australia as a commodity-driven economy presents challenges to the clean technology industry. The "old energy regime" (Copenhagen Cleantech Cluster, 2012, p. 7) represents a traditional pattern and culture in which multiple actors, such as manufacturers, service providers, wholesalers, research organisations and exporters, compete for investments, resources and institutional support (Copenhagen Cleantech Cluster, 2012).

The industry has been driven by regulatory schemes. In 2012, the Copenhagen Cleantech Cluster identified Australia as an emergent market due to new policies and economic support. Government initiatives, including the Clean Energy Initiative, have focused on research and development on carbon capture and renewables. Other initiatives include the Solar Flagship Program, the Australian Centre for Renewable Energy, the National Low Emissions Coal Initiative and the Australian Renewable Energy Agency (Geoscience Australia and ABARE, 2010). The renewable energy sector leads the clean technology industry in Australia, although it still accounts for only 5% of the market. This sector emerged as a direct result of government support and regulation that encouraged the use of renewable energy sources (Copenhagen Cleantech Cluster, 2012).

However, recent changes in the political arena have posed challenges to industry development and technology adoption. The Australian Clean Tech report in 2014 showed that Australia lagged behind Asia and other regions in terms of developing policy initiatives. The term "clean technology" is "out of fashion" in political and investment circles (Australian Clean Tech, 2014, p. 8) and there is constant debate and policy changes around economic initiatives in this industry (Kinnear & Bricknell, 2013).

Despite the struggles, the industry accounts for more than a thousand companies, mainly concentrated in the sectors of water, waste and sola, but also in other sub-sectors, such as construction materials, energy efficiency, carbon trading and environmental services (Australian Clean Tech, 2014). Each Australian state specialises in a different area– New South Wales has more companies in wind, solar, carbon and green building, Victoria is strong in transport, wind and energy efficiency (Australian Clean Tech, 2014), and South Australia has played an important role in the waste management sector (Zero Waste SA, 2011). However, economically the industry remains small in the stock market with a 0.7% share of the total index (Australian Clean Tech, 2014). Small and medium companies dominate the market, and large diversified companies such as AGL, Origin and Pacific Hydro (RIAA, 2011) have started competing in new markets.

This scenario of an unstable political context with changing policies and regulatory frameworks, together with an incipient investment community and a small market reflects the complexity of the context in which social and technological changes take place. Due to these characteristics, clean technologies in Australia represent an appropriate context of research.

1.5. Methodological approach

This research adopts a pragmatist philosophical view. Thus, explorative qualitative research is undertaken, with data collection and data analysis methods appropriate to the nature of the research questions.

The underlying argument of this thesis is that social interactions and the meanings associated have an influence on the process of technological change in an industry. Pragmatism allows for an exploration of the social phenomena by focusing on individual actions as building blocks of the social reality and on interrelated actions that enable change (Elkjaer & Simpson, 2011). The multidimensional and dynamic nature of the social phenomena implies that an understanding of individual intentions, actions and consequences is needed (Schwandt, 1994).

Pragmatism recognises the contextual and procedural nature of social phenomena through actions that constitute social reality, which allows this research to incorporate the highly dynamic context of technological change. It does so by focusing on the dynamics of social actions and relations interconnected to the process of technology adoption. Thus, pragmatism constitutes an appropriate philosophical view with which to address the research questions.

Pragmatism is aligned with the explorative nature of this research as it provides the opportunity to analyse the social phenomena between industry actors through the exploration of actions, interactions and meanings in an uncertain industry context due to technology advancement. This research can also, therefore, explore the implications of

intersubjective meanings and actions to change, and contribute to existing theory in this area (Eisenhardt, 1989).

The exploration of the social phenomena is done in the context of clean technologies in Australia. To gain a holistic perspective, the research context involves industry actors in the process of new technology adoption in various sectors, such as water, energy, waste and materials. Participants include researchers, investors, start-up and small enterprise managers, government agents, and industry association members.

The methods used for data collection include semi-structured and informal interviews, and participant observation. The combination of methods allows the researcher to explore the multiple perceptions and meanings given to interactions and to identify the context conditions surrounding them (Shenton, 2004). Further, data analysis explores the meanings grounded on the individual reflections of industry events and actions through content analysis (Saldana, 2013). Multiple cycles of coding develop themes to address the three research sub-questions (Gioia, Corley, & Hamilton, 2012; Saldana, 2013).

An in-depth discussion of the research design, including the philosophical view, methodology and methods, can be found in Chapter 3.

1.6. Significance and contribution

The thesis, by adopting a pragmatic approach to the social aspect of technology change, goes further than the predominant RBV approach. For this approach to be demonstrated as meaningful, the findings should reveal that industry actors use social capital according to their perception of the industry context, the technology and the interactions with others.

The thesis argues that the analysis of social capital from a pragmatist perspective allows for the identification of new influences with respect to technological change. The research brings together two streams of literature, incorporating social capital as a key factor of technological change, and identifies two clear roles of social capital during technological transition. Social capital allows industry actors to (1) adapt to the changes posed by the

contextual conditions, and (2) enables them to create new conditions to foster technological transition. The complexity and dynamism of the social phenomena are acknowledged in a context that is also complex and uncertain. This recognises the continuous interplay between industry actors, context and historical dependencies, and the interdependencies of this interplay.

Industry and economic changes that have been brought about by technological innovations have attracted research interest. With regard to clean technology, literature has focused on the development of technological artefacts and policy-related issues (Babl, Schiereck, & Flotow, 2012). This thesis extends this view and addresses a gap in the literature regarding the social elements and organisational management that contribute to the understanding of technological change (Meyskens & Carsrud, 2013).

Consequently, this research builds on previous work on how an industry changes from one system to another due to the appearance of new technologies. Specifically, it contributes to the socio-technical systems perspective that incorporate social dynamics as a key factor (Geels, 2002; 2004; Malerba, 2002). The exploration of the interconnections of industry actors, context and new technologies will contribute to the understanding on "how economic activities and processes may influence and transform the sociological structures in which they are embedded" (Geels, 2004, p. 899).

1.7. Structure of the thesis

This introductory chapter has provided a general overview of the context and content of the research. In Chapter 2, literature on technological change and social capital are explored and three research sub-questions are presented. Chapter 3 presents the philosophical view and methodological approach, and provides detail regarding the process for data collection and analysis. In Chapter 4, the results are described and in Chapter 5 the findings are discussed. In Chapter 6, theoretical contributions, practical implications, limitations and recommendations for further research are presented.

2. LITERATURE REVIEW: TECHNOLOGICAL CHANGE AND SOCIAL CAPITAL

2.1. Introduction

This research explores the influence on and the role of social relations among industry actors undergoing technological change in an industry. This focus implicitly suggests a process of change occurring in the industry context triggered by the development and adoption of new technologies. Thus, the literature review focuses on the streams of technological change and social capital to address the research question: "**How does social capital influence technological change in industry contexts?".**

A combined systematic and the narrative approach is used to conduct the literature review. A systematic review allows the researcher to synthesise evidence through establishing appropriate methods for data search, inclusion and analysis (Petticrew & Roberts, 2006; Tranfield, Denyer, & Smart, 2003). Some authors have shown the usefulness of systematic reviews for business streams in general and social capital in particular (Matthews & Marzec, 2011; Tranfield et al., 2003). However, some critics argue that this methodology can be too rigid to analyse complex and multidisciplinary research questions (Greenhalgh et al., 2005) and discourages deep reading of the content (Easterby-Smith, Thorpe, & Jackson, 2008). Therefore, a narrative critical review is also conducted, to allow a deep examination and a critical argumentation (Easterby-Smith et al., 2008) that aims to provide conclusions and validate the research questions (Green, Johnson, & Adams, 2006). Literature reviews in the organisational management field are predominantly narrative which has led to criticism about the lack of structured criteria for retrieving information and an integral perspective, and on the tendency to bias (Tranfield et al., 2003). Consequently, the combination of the two approaches offers a robust analysis of the literature: the structured systematic review is complemented with the analytical reflection from the narrative critical review.

This chapter is organised as follows. Section 2.2 presents the current debate on how technology contributes to industry and economic development by outlining two approaches to technological change – the evolutionary and the socio-technical perspectives. Section 2.3 explores the literature on social capital, specifically presenting the current debates on the definition, characteristics and the mechanisms for accruing value for organisations. Section 2.4 then integrates technological change and social capital literature to explore social dynamics in the industry context, including social elements, processes and contextual factors. The chapter concludes with section 2.5 which presents the development of the three research sub-questions derived from the understanding of the diverse interplay and reciprocal influences of social capital and technology change in an industry context.

2.2. Technological change

"Technological possibilities are an uncharted sea"

(Schumpeter, 1942, p. 118)

The understanding of change in economic systems has long been a core concern for researchers and practitioners. The evolution of technologies has been recognised as an influence on these industry and socioeconomic changes (Malerba, 2007; Schumpeter, 1934). The multiple factors and mechanisms involved in the contextual changes triggered by the appearance of new technologies are defined as technological changes (Nelson & Winter, 1982) and they have been examined in the literature from two perspectives – the evolutionary and the socio-technical.

The next sections present the current state of the understanding of technological change in an industry context through the evolutionary and socio-technical perspective.

2.2.1. Evolutionary perspective of technological change

The evolutionary perspective recognises the multiple avenues that industry actors take to advance technologies and the relation to the context that acts as a selection factor

(Malerba, Nelson, Orsenigo, & Winter, 2016). This co-evolution between context, actors and technologies implies a complex system of interrelations in which new paths are constantly created (Ford et al., 2010). The evolutionary view of technological change contributes to our understanding of the multiple influences of constitutive elements and interactions in this system.

The evolutionary perspective explains how "changes […] resulting from the practical application of innovations in technology and in economic organisation" (Ruttan, 1959, p. 606) cause economic growth and industry development (Romer, 1990; Solow, 1956). Different concepts have been proposed to explain such a phenomenon, for example technological regimes (Nelson & Winter, 1982), technological paradigms and trajectories (Dosi, 1982), technological revolutions (Perez, 2002) and regime transformations (Van de Poel, 2003), among others. The common basis of these concepts is that patterns of technology adoption further influence industry development (Van de Poel, 2003). These patterns reveal guidelines for activities, actions, interactions and boundaries for technology development (Nelson & Winter, 1982).

In a technological regime or paradigm changes occur when a core rule is modified either by new guiding principles, design criteria or new technical tools and artefacts (Van de Poel, 2003). In the case of a new technology, previous understandings of this complex phenomenon were described to occur in a period of stability followed by a new technological discontinuity that changed industry dynamics (Utterback & Abernathy, 1975; Utterback & Suárez, 1993). The analysis of how past events are carried through and influence future conditions reflects the importance of stability in an industry that leads to lock-in (Geels, 2004). Stability allows the diffusion of rules, development of industry structures, and interdependencies among actors that contribute to the positioning of the new technologies (Tushman, Virany, & Romanelli, 1985).

However, contrary to that sequential process, technological change has been further described as "frequent, relentless, and even endemic" (Brown & Eisenhardt, 1997, p. 3) in

industries that show short product lifecycles and shifting environments. The complex phenomenon of technological change has been understood as constantly dynamic involving multiple factors such as knowledge, technology, demand, firms and institutions and is characterised by instability and discontinuity according to the nature of industries and technologies (Malerba, 2006, 2007; Malerba et al., 2016).

Literature on technological change exposes various multidimensional factors of an industry context that play a role in the adoption of new technologies. Among these, *path dependency* and *market forces* influence context conditions for take-up of technological opportunities. These opportunities are also shaped by *interconnected industry actors* and *new combinations of knowledge*, including R&D processes and investments (Malerba, 2007). The complexity of this process demands an analysis of the organisational and individual actors, and their interactions in the industry context.

Path-dependency refers to existing conditions and the historical events that have influenced the emergence and trajectory of technologies and enabled industry development (Fredin, 2012). Pre-existing conditions include quasi-irreversibility of investments, economies of scale and technical interrelatedness (Fredin, 2012), escalation of commitment (Fredin, 2012; Routley, Phaal, & Probert, 2013), and complementary technologies and interconnection of different industry relations (Routley et al., 2013). The type, duration and timing of historical events shape present decision-making which influences the future dimensions of technology (Ruttan, 1997). The local context and historical trajectories influence industry events and, therefore, technological change (Ruttan, 1997).

Market forces manifested in fluctuation in price and production, changes in market shares, and market strategies have also influenced technology adoption (Klepper & Graddy, 1990; Routley et al., 2013). Fluctuations in the price output pattern are more variable in the early stages when technologies appear in the industry, and extreme price fluctuations of new technologies contribute to shakeout periods, which affect the dynamics of technological

change (Klepper, 1996). Additionally, rapid changes in market shares influence technological change as they are often linked to a high number of new entrants with heterogeneous and innovative products or technologies coming into the industry context (Klepper, 1996). The literature also refers to technological and market strategies as survival factors to identify and use as entry windows for new technologies (Christensen, Suarez, & Utterback, 1998).

The constant feedback from the industry through path dependency and market forces can enable notional opportunities for technological learning (Malerba, 2007) as *interconnected actors* are intertwined with the context, the present state and the history of the system (Ford et al., 2010). Heterogeneous actors interact and their unpredictable interactions influence individual behaviour as well as context factors (Ford & Mouzas, 2008). These interconnected actors develop cognitive frameworks and "patterns of culture, norms, and ideologies" (Tushman & Romanelli, 1985, p. 177) that enable a common agenda and implicit agreements for further developments and setting up standards to enhance technology acceptance (Utterback & Suárez, 1993). The establishment of a technology is a process of industry actors competing for the dominant technology (Routley et al., 2013) based on "imitable innovations [that] are more likely than other to generate collective action" (Aldrich & Fiol, 1994, p. 654).

Industries rely on *new combinations of knowledge* that enable innovation activities and technological artefacts to maintain competitiveness, development and evolution (Fredin, 2012; Peltoniemi, 2011; Schumpeter, 1935; Van de Ven, 1993). Technological opportunities involve new combinations of knowledge that follow a commercial path (Fredin, 2012) and occur through rapid organisational learning (Utterback & Suárez, 1993). Organisational learning is enforced through activities and routines that search for innovation opportunities, imitate others' practices, and adjust to economic conditions (Nelson & Winter, 1982). Knowledge and the activities that foster its development are key drivers for the development and adoption of technologies, and influence industry dynamics such as entrance, turbulence, concentration and growth (Malerba, 2007).

To summarise, multiple contextual factors are interconnected and play a role in technology development and adoption in an industry. These dynamics indicate the complexity of the technological change context in which this research takes place.

2.2.2. Socio-technical perspective of technological change

Technology development cannot lead to economic change by itself (Geels, 2002). Rather, it works alongside other changes in organisational and social paradigms and the industrial system (Van de Ven, 1993). The social conditions that lead to different possible forms of technological change (Klein & Kleinman, 2002, p. 28) reflects a socio-technical system.

The development and adoption of new technologies is recognised as an open process shaped by the interpretations of and negotiations by multiple actors (Klein & Kleinman, 2002). Technologies are built through a process of social construction and negotiation (Ford et al., 2010) that reflects a "seamless web of technology and society" (Bijker et al., 2012, p. 185). This social process leads to changes in the organisational and social paradigms and in the industrial system (Van de Ven, 1993).

The socio-technical perspective analyses the role of individual actions to influence the development of industrial communities and potentially transform established systems (Van de Ven, 1993). The view distinguishes between technical systems, actors and institutions to understand human and social activity through organisational practices, and individual perception and symbolic meanings (Geels, 2004).

An important factor in the technological change process is the engagement of key actors into new institutional activities. Certain individuals isolate themselves from traditional industry dynamics when they perform new activities iteratively which result in the creation of a new institutional space with its own characteristics (Van de Ven, 1993). Contextual change arises from a collective understanding of the need to undertake new actions to overcome path dependence and lock-in in the emergence of new industries (Schienstock, 2007). It has been argued that industry innovation is the result of the interaction of

different actors engaged in formal and informal collaborative or competitive relationships (Malerba, 2007).

The socio-technical perspective complements the evolutionary view of technological transitions by including "changes in user practices and institutional (e.g., regulatory and cultural) structures, in addition to the technological dimension" (Markard et al., 2012, p. 956). The socio-technical perspective recognises reconfiguration processes that break established linkages in an industry and create changes in elements such as regulation, industrial networks, infrastructure and symbolic meanings (Geels & Schot, 2007). Those changes are highly interdependent and vary in difficulty and length in existing industries with new technologies to create new system functions.

Socio-technical systems in clean technologies indicate long-term, multidimensional transformation processes towards more sustainable modes of production and consumption (Markard et al., 2012). Technological change in the clean technology industry reflects a shift in the current way of doing things that could lead to a "new historical period of industrial growth" (Truffer, 2012, p. 183). Understanding this shift as a socio-technical system allows the researcher to include the role and influences of actors, their networks and their context into the occurring changes (Garud & Gehman, 2012; Gosens, Lu, & Coenen, 2015).

In conclusion, the socio-technical perspective investigates social aspects of technological change and emphasises the interplay of these social elements and the industry context.

2.2.3. Summary

Research on technological change has focused on the understanding of how technology, organisations and institutions evolve. Scholars have found that economic approaches fail to explain how change emerges (Van de Ven, 1993), thus a better understanding of how new technologies impact industry dynamics and economic development is needed. The established evolutionary view suggests that change occurs through the interplay of contextual factors in a cyclical period of stabilisation followed by disruption of

technologies. Other perspectives suggest that rather than cyclical periods, continuous and fast changes occur in certain industries (Brown & Eisenhardt, 1997).

Research on technological change has broadened from focussing on technology development to identifying multiple contextual factors and social influences for its adoption and implementation. The socio-technical perspective has allowed the identification of the role of individuals and their social dynamics in influencing change (Garud & Gehman, 2012).

Social aspects have been referred to as the characteristics of the individual actors and their interactions and are evident in knowledge building, learning processes and legitimation occurring in an industry context (Aldrich & Fiol, 1994). This entanglement of actors, technologies and context influences industry development and reflects a relational interplay. However, the analysis of this relational interplay still offers room to analyse the role of social relations in managing contextual and technological factors that have been previously reported as out-of-control for individual firms, i.e., exogenous factors (Adner & Kapoor, 2010).

Therefore, this research focuses on investigating the social aspect so that it can contribute to this particular understanding of technological change. To do so, this research explores the role of social relations in an industry context that experiences change triggered by the appearance of new technologies. The next section explores the literature on social dynamics in an industry context by using the conceptual framework of social capital. This will be followed by a deeper and more specific analysis of social capital within industry dynamics driven by technological change.

2.3. Social capital

"The social process is really one indivisible whole"

(Schumpeter, 1934, p. 22)

Social relationships play a key role in economic exchange and the development of the economic system (Coleman, 1988; Granovetter, 1985). Relationships have been attributed a strategic value for competitive advantage (Ireland et al., 2002; Krause, Handfield, & Tyler, 2007), for example as governance and linkage mechanisms (Ireland et al., 2002), as valuable resources (following the RBV) (Barney, 1991), and as rent generation mechanisms (Relational-based View) (Dyer & Singh, 1998). Relationships also play a key role in knowledge sharing (knowledge-based view) and the learning process (dynamic capabilities and absorptive capacity) (Cohen & Levinthal, 1990; Teece, Pisano, & Shuen, 1997). This attributed role of relationships suggests that the management of relationships can derive value for organisations.

One well established theoretical approach for analysing the role of relationships is social capital. Social capital aims to explore and describe the complex phenomena of social relations and the diverse contributions to society, communities and businesses (Portes, 1998). The multiple definitions attributed to the term suggest that it is an "umbrella concept" (Adler & Kwon, 2002, p. 18), an "aggregate concept" (Brehm & Rahn, 1997, p. 1000) or a "joint concept for all social sciences" (Paldam, 2000, p. 631). Some authors consider the diversity of definitions as a problem that limits the study of the phenomenon in organisations (Payne, Moore, Griffis, & Autry, 2011), while others suggest that the diversity of definitions demonstrates the multifaceted nature of social phenomenon and posit the value in its complexity (Batt, 2008). From a business perspective, social capital has been accepted as "resources embedded within, available through, and derived from the network" (Nahapiet & Ghoshal, 1998, p. 243). It is tacit in nature (Pearson, Carr, & Shaw, 2008) and difficult to imitate (Dess & Shaw, 2001), and is used in the establishment of social norms, diffusion of information and management of inter-organisational relationships (Coleman, 1988; Walker, Kogut, & Shan, 1997).

This definition reflects a RBV of relationships, predominant in the literature, that suggests a causal model of social capital that focuses on the sources and outcomes (Nielsen & Chisholm, 2009). However, this view of social capital lacks the incorporation of multiple contextual attributes and the interplay with the surrounding contexts (Walsh, 1991; Woolcock, 1998). Therefore, and complementing RBV, this research understands social capital as an "attribute of individuals and of their relationships that enhance their ability to solve collective-action problems" (Ostrom & Ahn, 2008, p. 5). In addition to that, the multiple contextuality attributed to social capital suggests that an exploration of social capital in a context of ambiguity and uncertainty is yet to be done. Consequently, this thesis aims to contribute to a better understanding of the role of social capital and of the interconnections with contextual factors.

2.3.1. Multifaceted social capital

"…is it the infrastructure or the content of social relations, the 'medium' as it were,

or the 'message'. Is it both?" (Woolcock, 1998, p. 156)

Due to the complexity of social interactions associated with technological change, the concept of social capital has been analysed from multiple perspectives leading to debate over its multifaceted nature (Dasgupta & Serageldin, 2000). The multifaceted nature of social capital raises questions about whether: a) it is a resource in itself or the conduit for resources (Burt, 2000; Granovetter, 1973; Hanifan, 1916; Nahapiet & Ghoshal, 1998), b) it is an attribute or a function of relationships (Portes, 1998; Putnam, 1993), c) it is the source or the outcome of relationships (Coleman, 1988; Dyer & Singh, 1998; Ireland et al., 2002; Leana & van Buren, 1999), and d) there are diverse types or levels (Adler & Kwon, 2002; Putnam, 1995). Taken together, this describes a complex social phenomenon that arises from multiple interactions and influences on the nature of technological adoption and chenge. These debates are reviewed in the following subsections with the aim of exploring how social capital has been understood thus far and which elements can be related to technological change.

30

2.3.1.1. *Resource or conduit*

The RBV of the firm suggests that valuable resources are a source of competitive advantage (Barney, 1991). From the RBV, social capital is both a resource and conduit to exchange resources (Nahapiet & Ghoshal, 1998). The duality of social capital comprising both the network and the assets mobilised though it (Bourdieu, 1986; Coleman, 1988; Nahapiet & Ghoshal, 1998) has implicitly generated a linear and causal analysis of relationships. Hanifan (1916) described this linearity thus: "first the people must get together. Social capital must be accumulated. Then community improvements may begin. The more the people do for themselves the larger will community social capital become, and the greater will be the dividends upon the social investment" (p. 138). From then on, scholars have accepted social capital as an embedded resource in the form of elements such as trust, reputation, status and reciprocity (Moran, 2005; Payne et al., 2011).

Causality has been explained as both a linear and a reverse model. The former indicates that a (strong) social structure facilitates engagement and cooperation (Putnam, 1995). The latter, reverse causality, represents a "virtuous (vicious) circle" (Brehm & Rahn, 1997, p. 1002) in which sources (for example, individual participation and collective experience), generate social attributes (for example, interpersonal trust and cooperation), and this in turn reinforces the process of creating and maintaining social capital (Brehm & Rahn, 1997).

Linear causality between the social structure and its elements is a process of development of social capital in which the social structure is seen as an "antecedent" (Tsai & Ghoshal, 1998, p. 467) from which different elements are derived, for example how "social identity emerges through network processes" (Ibarra, Kilduff, & Tsai, 2005, p. 363), how trust allows access to networks (Coleman, 1988), and how resources are gained in such networks (Payne et al., 2011). The linear approach that reveals a causality and duality between the conduits and resources has dominated the analysis of social capital in organisations. In this way, network analysis and antecedents of social capital are common in extant literature (Burt, 2000; Granovetter, 1983).

The causality approach has also focused on the external sources of social capital, such as income, job opportunities (Brehm & Rahn, 1997; Levi, 1996), and other types of capital, such as intellectual (Nahapiet & Ghoshal, 1998), human (Adler & Kwon, 2002) and cultural (Lindon, Schmid, & Siles, 2002). The co-evolution of intellectual and social capital constitutes an iterative dialectical process in which time, interactions, interdependencies and closure are key factors in the development of social capital (Nahapiet & Ghoshal, 1998).

As a *resource*, social capital can be obtained from a network or as a product of a relationship (Bourdieu, 1986; Ireland et al., 2002; Nahapiet & Ghoshal, 1998), which indicates that it is created and maintained by exchanges that in turn facilitate further exchanges (Nahapiet & Ghoshal, 1998). For example, trust is seen as an outcome of relationships (Ireland et al., 2002; Lin, 2001), repeated exchanges, and institutionalised actions (Krause et al., 2007). Simultaneously, it is considered as a source (Adler & Kwon, 2002; Portes, 1998; Putnam, 1995), as a prerequisite (Moran, 2005) to create relationships and social capital, and as an outcome of collective action (Leana & van Buren, 1999).

Additionally, the structure of social capital is the *conduit* that facilitates access to resources. The instrumental function of linkages or relations relies on the possibility of accessing resources to exploit opportunities (Aldrich & Zimmer, 1986; Lin, 2001). Business relationships and interfirm linkages are sources of resources that generate rents, known as relation-specific assets, and are outside the firm's boundaries (Dyer & Singh, 1998). These assets are tangible in the form of knowledge-sharing routines, shared production schedules and technology plans (Krause et al., 2007). Access to and exploitation of these assets can generate rents, thus the value of inter-firm linkages is derived. This is the case of alliances that serve as a mechanism to access the necessary assets for achieving a sustainable competitive advantage (Dyer & Singh, 1998; Ireland et al., 2002). Social capital reflects the connections that form between these networks, and the characteristics of the networks can indicate the value of social capital.

This RBV approach suggests that resources have an intrinsic value within an organisational setting and the dynamics around them and in a wider context are yet to be explored.

2.3.1.2. Attribute or function

Social capital acts as the social spirit, such as shared values, shared experiences, shared vision and common ground, that fosters collective action (Coleman, 1988; Putnam, 1995). The identification of relationship-specific values and the enhancer effect of those values within a social system contribute to the role of social capital within an industry setting (Cots, 2011). Traditionally, values are implicit in the cultural setting as sets of norms and beliefs (Fukuyama, 1996).

Social capital has been attributed with the function of social control, social action, and social support (Portes, 1998) which are known collectively as "habits of cooperation" Putnam (1993, p. 89). There is an intrinsic relationship between research investment, formal and informal collaborations, and product and market development (Malerba, 2007). The role of relationships in an industry context is regarded as a coordination of behaviour among individual and organisational actors, especially for knowledge sharing and investment activities (Forbes & Kirsch, 2011).

Another function of social capital is in legitimation. At the beginning, the social mass is unfamiliar with a new activity and the interactions among different actors lack credibility. This lack of legitimacy has a multiplier effect that magnifies all other constraints and may mislead the progress of the new industry in terms of public acceptance and general language, human capital and training opportunities, and recognised experience of related technologies (Aldrich & Fiol, 1994).

Other researchers refer to social capital as an attribute, such as an institutional agreement (Murray, 2004) or institutional linkage (Baum & Oliver, 1991), and as a soft attribute of relationships, for example, "partners that cared about each other's learning" (Ireland et al., 2002, p. 431). This is evidence of the importance of cognitive attributes when developing

a relationship, in which "caring" reflects shared understandings, shared goals, expectations and reciprocity that affect relationships.

Additionally, managerial rationalities, that is, systems of shared meanings among top managers and decisions on human resource practices influence the development of social capital (Arregle, Hitt, Sirmon, & Very, 2007). An organisation also needs to identify valuable knowledge outside the firm (in another firm or in a relationship) to transfer and use it (Dyer & Singh, 1998). This relation-specific absorptive capacity refers to an awareness of learning how to identify the social capital attributes needed to develop certain relationships, and when and how to adapt such attributes according to the context.

2.3.1.3. Outcomes or value

"Social capital is productive" (Coleman, 1988, p. 98) and this productivity has been framed in the literature as multiple outcomes and benefits. Leana and van Buren (1999) differentiate primary and secondary levels of outcomes based on their distribution among social units. When outcomes directly benefit one individual, social capital is seen as a private good; whereas when outcomes derived from social capital benefit a group of individuals, it is seen as a public good (Coleman, 1998; Leana & van Buren, 1999).

Social capital is linked to performance outcomes according to the type of relationship (i.e., buyer-supplier), in which social capital elements vary (Krause et al., 2007). Relationships are valued according to the performed activity and the obtained outcome (Arregle et al., 2007). Therefore, social capital value is related mainly to the organisational task, the type of relationship, and the influence on both the relationship and the task. Benefits of social capital are classified as multilevel and vary according to a given situation and the "moderating factors" (Adler & Kwon, 2002, p. 18). One of the most recognised benefits of social capital is the information benefit, in other words "who you know" affects "what you know" (Nahapiet & Ghoshal, 1998, p. 252).

Benefits are related to employment turnover and information sharing. Information is then a "direct benefit" (Adler & Kwon, 2002, p. 29) that facilitates opportunities (job, mobility,

acquired skills and knowledge) and positive externalities (brokering activities, forecast demand and market opportunities) (Adler & Kwon, 2002). In these cases, trust is a functional resource for exchanges in innovation (Tsai & Ghoshal, 1998), job success (Burt, 2000; Granovetter, 1973), knowledge sharing (Zheng, 2010), and reduced transaction costs and increased business transactions (Bhandari & Yasunobu, 2009; Fukuyama, 1996).

Social capital research has focused on the benefits of mobilised resources (Batt, 2008) through network dynamics (Nahapiet & Ghoshal, 1998). Additionally, the relational view of the firm proposes that value creation is proportional to investment or participation of each party (Dyer & Singh, 1998; Ireland et al., 2002). The incentive for entering a relationship is different for each individual actor (individual or organisation) and it is generally linked to costs and rent generation (Lin, 2001). Research shows that managers need to see a return on their investment in relationships (Adler & Kwon, 2002), which suggests that the value of social capital is directly related to the investment made.

The relational-based view identifies the outcomes and value of relationships for organisations. However, it reduces the role of social phenomena to quantifiable investments and rents. Dyer and Singh (1998, p. 663) mention the importance of "non-recoverable investments" for firm performance, which indirectly reflects the intangible value associated with social capital. In this way, this view of social capital reveals a need to assess value the value of relationships beyond instrumental usage and rent generation (Robison et al., 2002). As a result, this research challenges the overall view of a firm as a mechanism for rent and profit generation to enable an alternative assessment of the role of social capital.

2.3.1.4. Levels or types

Research on social capital includes analysis at the organisational, network, industry and societal level (Batt, 2008). The different analyses include individual-aggregate levels (Putnam, 1995), dynamics between levels (Brehm & Rahn, 1997), and types of social capital (Bhandari & Yasunobu, 2009).

The categorisation of the dynamics among levels is based on characteristics of the social structure, such as frequency (high/low), density (many/few), intensity (strong/weak) and scope of linkages (internal/external) (Burt, 2000; Granovetter, 1983). Social capital is assumed to be *good,* "functional" or "dysfunctional" (Adler & Kwon, 2002, p. 32) when a balanced combination of strong, external and numerous ties occur (Uzzi, 1997). For example, strong social capital refers to wide networks, a significant number of contacts and a high frequency of interaction.

Types of social capital have been categorised in the literature as group social capital (Davidsson & Honig, 2003), organisational social capital (Pearson et al., 2008), or stakeholder social capital (Cots, 2011). However, it is not clear if this differentiation refers to a level of analysis or the richness of capital. The debate on levels and types of social capital is yet to include how the diverse factors and characteristics adapt to different contexts and situations based on the multifaceted nature of social capital reported in the literature. Therefore, an analysis of social capital in terms of its changing elements is needed, rather than a static classification based on specific characteristics.

2.3.2. Approaches to social capital

The conceptual debate on how to differentiate between sources and benefits of social capital remains open (Portes, 1998; Woolcock, 1998). The focus on the causality of social capital arises from the definition of "social capital (…) by its function" (Coleman, 1988, p. S98), for "defining social capital functionally makes it impossible to separate what it is from what it does" (Edwards & Foley, 1997, p. 669). In an effort to clarify what social capital is and its underlying mechanisms, researchers have proposed two analytical approaches – the content and the process perspective.

2.3.2.1. Content perspective

The content perspective embraces social capital elements. Traditionally, these elements are classified in a three-dimensional model composed of structures (networks), relations (norms and obligations), and cognition (shared representations) (Nahapiet & Ghoshal, 1998). It has been suggested that structural and relational components of social capital

play a role in achieving organisational outcomes; the cognitive dimension has also been explored but to a lesser extent (Zheng, 2010).

Structural social capital refers to the way linkages among actors are configured (Nahapiet & Ghoshal, 1998). This linkage reflects a pattern of connections between actors (nodes) and the subsequent connections derived thereof that constitute a network. Strength, frequency of interaction, embeddedness, structural holes, and closure are considered to be the key features and the foundations of social capital (Burt, 2000; Granovetter, 1983). Networks and ties represent channels to access available information and to enable opportunities to exploit it (Burt, 1992).

Relational social capital refers to the attributes created and leveraged through relationships, such as trust, norms, expectations, obligations and identity (Nahapiet & Ghoshal, 1998). Diverse definitions of social capital pose trust as a common element to shape the dynamics of social processes (e.g., business transactions and exchanges) (Moran, 2005) and institutional mechanisms (e.g., norms) in a self-reinforcing and self-fulfilling manner (Aldrich & Fiol, 1994). Some researchers refer to it as the "glue" that sticks the actors together (Batt, 2008), or as a "lubricant" in the legitimacy building process (Dasgupta & Serageldin, 2000). The multiple relations between trust and social capital described by different researchers indicates the diversity of social capital definitions (Adler & Kwon, 2002). Norms are described as the degree of consensus in the social system (Nahapiet & Ghoshal, 1998), obligations as a commitment to act (Coleman, 1988), and identity as a recognition of belonging to a group (Nahapiet & Ghoshal, 1998).

Cognitive social capital refers to the attributes that characterise shared representations and common meanings, in the form of shared language and codes and collective narratives (Nahapiet & Ghoshal, 1998). Other elements identified in the cognition dimension include participation (Brehm & Rahn, 1997) or engagement (Teece, 2014), (organisational) identity (Arregle et al., 2007), shared vision (Gold, Malhotra, & Segars, 2001; Krause et al., 2007), status (Portes, 1998), commitment and willingness (Graves &

Thomas, 2008), and reciprocity (Putnam, 1995). Adler and Kwon (2002) underpin the goodwill from friends and acquaintances as the core of social capital. These shared representations influence perceptions and provide a frame of reference for interpreting and understanding the context (Nahapiet & Ghoshal, 1998).

This content perspective reflects the RBV of social capital that emphasises the importance of resources and the conduit to access other embedded resources. It provides a framework with which to identify the multifaceted elements of social capital and the implications in value creation. However, it remains a static view of social capital and emphasises the causal links of social capital.

2.3.2.2. Process perspective

The process perspective debates whether social capital is created or transferred. Some researchers argue that it needs to be created, especially in new organisations (Leana & van Buren, 1999), while others refer to the dynamics of "cultivating" (Nahapiet & Ghoshal, 1998, p. 259) and the possibility of transferring attributes from one organisation to another (Nahapiet & Ghoshal, 1998). Arregle et al. (2007) state that social capital can be "borrowed" and "protected" which highlights the possible impact of external conditions on social capital.

This debate acknowledges the role of the individual who possesses social capital and the importance of cooperation in its development, which implies that specific elements of social capital could be transferred among actors. The implicit message is that an underlying process exists, for the development and accumulation of social capital in an organisation. In the case of either creating or transferring social capital, there are two elements in the development process, namely the interaction between multiple elements and the social processes involved (Leana & van Buren, 1999; Nahapiet & Ghoshal, 1998).

First, the *interaction between different factors* involved in the creation of social capital have been proposed. The relation between network ties and cognitive attributes (Baron & Markman, 2003) suggest the importance of information corridors (social capital as

channels) and cognitive individual properties (perception and rationales) as the basis of social capital.

The interaction between trust and social capital is positively related to structural social capital (networks) in terms of density of the networks and strength of ties (Zheng, 2010), and to relational social capital in terms of reciprocity between civic engagement and trust (Brehm & Rahn, 1997), and cooperation and trust (Nahapiet & Ghoshal, 1998; Putnam, 1993). Some researchers equate trust with social capital (Fukuyama, 1996), while others see trust as a form of social capital (Coleman, 1988).

Second, *social processes* directly contribute to the development of social capital through institutional mechanisms and context conditions. The development of routines of communication and coordination support institutional mechanisms (Krause et al., 2007) and recurrent transactions tend to develop governance arrangements (Dyer & Singh, 1998). Similarly, Leana and van Buren (1999) propose the "give and take aspects […] of social capital" (p. 541), positing that the resource exchange in cooperative relationships creates positive externalities. Thus, social processes (shared experiences in transactions) facilitate institutional mechanisms (shared norms in arrangements) that in turn support the development of social capital. This process indicates that institutional isomorphism, organisational identity and human resource practices play a role in the transfer of social capital (Arregle et al., 2007).

The process perspective focuses on the interaction between multiple factors and the social processes involved in the development of social capital. It provides a starting point for analysing the multifaceted elements and the interplay in value creation. However, it lacks the incorporation of contextual elements into the process of its development.

2.3.3. Summary

The theoretical debates on whether social capital can be defined as a resource or a channel (Burt, 2000; Granovetter, 1973; Hanifan, 1916; Nahapiet & Ghoshal, 1998), an attribute or a function (Portes, 1998; Putnam, 1993), a source or an outcome (Coleman,

1988; Dyer & Singh, 1998; Ireland et al., 2002; Leana & van Buren, 1999), and multiple existing types (Adler & Kwon, 2002; Putnam, 1995) reflect the multifaceted nature of social capital that makes analysis and manageability a challenge.

The analysis of literature suggests that there is a causal linear process to create and develop social capital in which actors first access resources through network ties and then social attributes support the exploitation of opportunities. There is a need to extend the linear causality research to incorporate the interplay of social elements and contextual factors in social capital.

Extant literature recognises the interplay between sources, processes and outcomes of social capital in its development. It is not clear, however, how an organisation identifies and incorporates external contingencies and contextual factors into a process to create and maintain social capital. Therefore, the analysis of social capital needs to incorporate not only the resource exchange and collective action but also the creation of collective and shared value.

Drawing on existing literature, there is a need to investigate the interplay among internal capabilities, social competencies (Baron & Markman, 2003), organisational performance (Lee, Lee, & Pennings, 2001) and contextual factors (Reagans, 2004) which can trigger different expressions and roles of social capital. Social capital should, then, reflect a dynamic and complex interplay of the elements and processes.

2.4. Social capital and technological change

The previous sections have reviewed the extant literature on technological change and social capital. This section integrates both literature streams by exploring social aspects in an industry context. The social phenomenon is a multilayered and multi-dynamic milieu of individual interactions within a technology industry context. The academic debate has centred on the role and value of relationships and the diverse nature of cultures, governance mechanisms and behaviours existing within such an industry context (Forbes & Kirsch, 2011). The following sections present the organisational and institutional

context, as well as the corresponding social processes and industry mechanisms, to explore the role and influence of relationships within an industry experiencing technological change.

2.4.1. Organisational context

An organisation can be seen as a group of people who come together for a common interest thus forming a collective social order through interactions (Nayak & Chia, 2011). The shared pursuit is a convergence of rational and non-rational expectations of both the individual and the collective. Thus, organisations are collective cognitive-cultural constructions (Suddaby, Elsbach, Greenwood, Meyer, & Zilber, 2010) that evolve through a process of negotiation of common, usually conflicting, interests to reconcile differences (Langley & Tsoukas, 2010). Therefore, they are not homogenous entities or a collection of subparts (an actor and their interactions) but rather an assembly of transitory and changing interconnections that respond to specific interests, expectations and contexts (Rowlinson, 2004).

The organisation hinges upon human activity for its existence and continuity (Fleetwood, 2005) which makes the organisation complex and dynamic by nature. The individual entities constitute a collective through the actions and interactions within a context, and this continuous interplay is what constitutes the only possibility of its existence.

Social phenomena do not emerge from a singular entity (one individual or one organisation) rather they are sourced from the uncertainties present in social situations (interactions) (Elkjaer & Simpson, 2011). The assumption that the organisation, the relationships, and the meanings are forged through social interactions (Spencer, Pryce, & Walsh, 2014) suggests that the process and the actions prevail and constitute the essence of social reality. Therefore, this thesis has a relational focus on the different entities and the interplay with the historical and cultural contexts.

2.4.2. Institutional context

Technology and the social context co-evolve to create industry contexts (Utterback & Suárez, 1993) including the institutional and market contexts. The *institutional context* represents a common setting that offers a formalised support by means of a generalised culture and social recognition that facilitates acceptance of activities and actors (Fredin, 2012). The institutional environment, norms and visions are seen as pre-conditions of the existing culture, while actors and their activities (social processes) are considered triggers of development.

The institutional context recognises an industry through negotiation and the appearance of regulations, and institutional and business arrangements (e.g., licensing) to operate and to access resources (Van de Ven, 1993). Thereby, government regulations can act as a barrier if there is a lack of understanding of the new technology and the long-term effects of its use (Negro et al., 2012). Collective organisational forms such as alliances can address this lack of understanding and overcome regulatory requirements (Aldrich & Fiol, 1994). These multiple and interconnected factors reflect that the institutionalisation of an industry is a cumulative process of small and interdependent events (Aldrich & Fiol, 1994; Van de Ven, 1993).

Additionally, institutional forces play an important role in influencing the selection process of a dominant technology (Peltoniemi, 2011). The uncertainty of early stages of technology adoption is linked to institutional arrangements and resource endowments that are not yet developed (Van de Ven, 1993). Uncertainties can, then, be reduced when those community settings and industrial functions emerge, and support the definition of technical and institutional parameters.

The *market context* reflects the dynamics of an industry in which selection processes occur so that a dominant technology or design emerges. The nature of competition influences the nature of interactions in an industry. As interactions are thought to be more cooperative than competitive in the emergence stages, collective learning takes place. As the industry develops, the rationale for interactions and relationships change (Balland,

Vaan, & Boschma, 2013; Peltoniemi, 2011). The network approach has been widely used for the analysis of inter-organisational agreements such as joint ventures, consortia, alliances, merges and acquisitions (Bonaccorsi & Giuri, 2001).

Industry and market networks have been proposed as forms of social organisations to analyse the group of actors that operate in a market based on transactions (Bonaccorsi & Giuri, 2001). Interactions and networks are recognised as pre-existing factors that support industry emergence, and as part of the self-augmenting dynamic of the industry over time. Those networks are provided by the local context and correspond with the starting point to develop new and specialised networks (Brenner & Mühlig, 2012).

In an industry, both competitive and cooperative relationships coexist during the process of defining and institutionalising technology standards and dominant designs (Van de Ven, 1993). A firm competes to gain an industry position, and at the same time it tries to cooperate to build the industry system, which has been called the competition-cooperation paradox (Van de Ven, 1993). This pattern changes within the industry and leads to knowledge and skills specialisation and division of labour. This allows for the identification of roles, entry of new actors, and intensification of competition (Bonaccorsi & Giuri, 2001).

2.4.3. Social processes

Social processes are activities and interactions among actors in the inter-organisational field around technologies (Van de Ven, 1993). Social processes are common activities that actors engage in to overcome resource scarcity and to consolidate the industry, such as accessing investment, managing internal organisation, undertaking market development and seeking government support (Aldrich & Fiol, 1994). Shared views foster activities (social processes) that allow a combination and co-creation of social capital elements (resources and attributes) (Tomlinson, 2012).

An industry actor, be it an organisation or an individual, performs a limited and specific set of roles and depends upon other actors and the system to do so. The actor is limited in both resources and roles which consequently determines the activities and interactions

they engage in. The choices around activity engagement have to be strategic and will vary according to the individual needs and, more importantly, to the response of other dependant counterparts (Van de Ven, 1993). These interdependencies show how the boundaries of an organisation are undefined, interconnected, and in constant flux, and influence the overall system.

Industry actors play a central role in bridging the nature of the performed activity and the collective perception of such activity. By closing the gap between the individual expression and the collective understanding through communication and engagement, legitimacy can be built (Aldrich & Fiol, 1994). In this respect, individual actors should promote "trust-building" and "reliability-enhancing" strategies as a ground floor for reputation and attaining legitimation (Aldrich & Fiol, 1994, p. 659).

To undertake innovation activities, interactions among individuals can be either cooperative or competitive. An iteration of such activities will isolate certain individuals from the traditional industry dynamics, and it is this isolation that creates a new institutional space with its own characteristics. Interactions are then coordinated by new mutual agreements or adjustments within the new dynamics. This new aggregate becomes the new industrial sector (Van de Ven, 1993).

Industry actors show an inherent capability to identify individual, organisational and collective needs and to synchronise coordination, cooperation and competition with others (Van de Ven, 1993). The individual actor plays a role in the initiation of social interactions and business relationships. From an industry perspective, the role of the individual is evident through the engagement in the social activities and communication processes (Lee, 2009). These processes are interconnected and self-reinforcing and constitute a common ground for developing collective attributes, such as identity and trust, and collective actions. Consequently, an industry relies on community dynamics based on social processes.

2.4.4. Industry mechanism

Industry mechanism refers to the process of reaching agreement within a social system. These agreements are reflected in shared visions and collective values that lead to industry recognition and legitimacy (Clegg, Rhodes, & Kornberger, 2007). Legitimacy is understood as the commonly accepted institutional setting in which the industry operates (Aldrich & Fiol, 1994). The interdependence of industry actors' actions and interactions influences the recognition and legitimation of an industry (Peltoniemi, 2011). Cognitive and socio-political legitimation represent knowledge about the industry, cultural norms and general agreements reached among actors (Aldrich & Fiol, 1994). Legitimation reflects the ability to reach collective goals and the degree of congruence among actors, which is described as "institutional thickness" (p. 9) that provides an industry with collective strength (Tomlinson, 2012).

Legitimation is a meaning-making process that relies on communication forms, such as symbolic language and narratives, that are manifested through identification (Aldrich & Fiol, 1994). Narratives help to understand the situation without agreeing on "explicit criteria" and bridge the gap between the existing collective understanding and the new meanings (Aldrich & Fiol, 1994, p. 652). There is coherence between narratives and activities in the form of vision and story, and willingness to participate and carry out subsequent actions (Howell and Higgings, cited in Aldrich & Fiol, 1994) which influence the development of trust, reliability and reputation. The activities undertaken by an actor follow an organisational objective to fulfil shared expectations to create trust. Individual initiatives become collective action through "legitimizing strategies" (p. 657) that should include other actors in the industry (suppliers, investors, etc.) (Aldrich & Fiol, 1994).

Symbolic communication plays a key role in the process of trust and legitimation building by influencing and changing social beliefs and norms (Aldrich & Fiol, 1994). Symbolic communication refers to shared codes, for example, the use of "we" instead of "I" (Putnam, 1995), '"unassailable" values and organisational dreams that can cause the social change needed (Aldrich & Fiol, 1994, p. 651). Symbolic language supports the

identification of characteristics and behaviours that reflect a collective community. Those features are reinforced when the individual actor enters into any sort of association.

Industry institutions act as "vehicles" to connect incumbent actors (Tomlinson, 2012). In this process, the "collective voice" (Tomlinson, 2012, p. 2) of the industry is developed and relies on the participation of actors to reach collective action. Collective action can enhance the reputation and acceptance of the new industry, which involves a generalised adoption of new vocabulary, symbols (labels), and public expectations (Aldrich & Fiol, 1994).

2.4.5. Summary

Different streams of literature have focused on the social phenomena occurring in an industry, and more specifically during the appearance of new technologies. Section 2.4 provided an overview of the current state of the industry context that influences social phenomena.

By definition an organisation is a social entity and its existence is based on social dynamics (Nayak & Chia, 2011). The literature suggests that the complexity of actions and interactions occurring in an organisation create meaning and help reach business objectives. This intertwinement involves the historical and cultural context in which the industry and individual actors also have an influence (Rowlinson, 2004).

Multiple organisations are part of the inter-organisational field in which social dynamics occur based on accepted social agreements and norms. This process of institutionalisation reflects the recognition of interdependencies among actors and the consolidation of shared views (Aldrich & Fiol, 1994; Van de Ven, 1993). Social phenomena are manifested in negotiations and interchanges, and foster the institutional context (Fredin, 2012).

The social phenomena forms the organisational and institutional context based on social engagement through activities and interactions, referred to as social processes (Van de Ven, 1993). The multiple and interconnected activities and actions in which individuals

engage are informed by resources and business interests. The coordination, complementarities and negotiation that occur during social processes reinforce collective attributes such as trust, identity, common understandings and collective agreements (Tomlinson, 2012).

Social processes and social agreements are reflected in industry mechanisms that show the acceptance reached by industry actors. This institutionalisation of social phenomena serves as a mechanism to foster social interactions and, further, to consolidate the industry. Legitimation of the industry is then a process of recognition that acts as the basis for collective action (Aldrich & Fiol, 1994; Peltoniemi, 2011).

In conclusion, the nature of the context and the social processes and mechanisms constitute the social phenomena that occur in an industry, and therefore provide the basis to explore the influences of social capital in technological change. However, the literature is not explicit about how the specificities of technological change, that is, uncertainty and ambiguity, affect social capital and in turn how social capital can contribute to such conditions.

2.5. Connecting the literature review to the research question

The previous sections presented the discussion of the literature on technological change and social capital and the integration of the two to provide a conceptual framework for this research. The literature review was guided by the overall research question: **"How does social capital influence technological change in industry contexts?".**

Through this analysis, two main shortcomings in the literature were identified: (1) a lack of consideration of social relationships and interactions as endogenous aspects in technological change literature, and (2) a lack of consideration of context complexity and uncertainty in social capital literature beyond the resource value. To address these shortcomings, three research sub-question were developed.

The first shortcoming led to identifying the contextual and technological aspects influencing technological change. Firstly, technological change has been analysed from the evolutionary and socio-technical view to provide a conceptual framework of how the appearance of new technologies affect the socioeconomic context, which suggests that contextual aspects influence technological change. Secondly, the literature reveals the highly contextual interactions that occur during the adoption of new technologies and the effect on the technology itself, which suggests that technological aspects influence technological change. The second shortcoming led to identifying the third aspect, namely the relational aspect. The review on social capital indicated an understanding of relational resources from an RBV to contribute to competitive advantage.

The model in Figure 2.1 brings these three aspects together and demonstrates the existing view of technological change. The current understanding of the three aspects of technological change in industry contexts suggests that a deeper exploration of the influence of social relations on each of the aspects needs to be conducted. The literature review indicates that these three aspects offer an opportunity to explore the influence and role of social capital in technological change from an alternative perspective, other than the RBV.
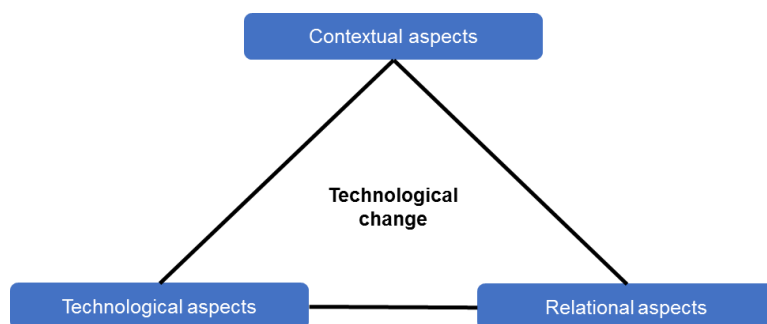
Figure 2.1. Existing aspects of technological change in literature

The next three sections present the corresponding research sub-questions developed to guide the empirical research on social capital and technological change.

2.5.1. Contextual aspects

The first research sub-question refers to the relation between contextual aspects of an industry context and social capital. The literature suggests that industries are self-organised open systems that learn from, adapt to and modify their surroundings. During those processes, industry actors engage in activities and constantly gain feedback on further needs and the context conditions (Ford et al., 2010). The system relies on the interactions among individuals and this context during the different stages of development (Ford et al., 2010).

Technology is then a constitutive part of the industry system that shapes and is shaped by other components of the system and the overall context. Technological change demands that organisations evolve with the context accordingly (Utterback & Suárez, 1993). However, the focus of the evolutionary perspective on exogenous factors has led to the fact that organisational factors such as learning and R&D processes remain in a "black box" (Ruttan, 1997, p. 1521).

Klepper and Graddy (1990) suggest that there is a variation in development across industries due to the different contextual factors and their interactions that affect the process of development in different ways. There are multiple factors likely to interact within social systems including contextual factors such as path dependency and market forces and internal factors (Fredin, 2012; Klepper & Graddy, 1990; Routley et al., 2013). There is an interrelation among the individual and collective actions for developing trust, reliability, reputation and legitimation, as well as the interaction with the context (Aldrich & Fiol, 1994). Initial pre-attributes present in the individual enable interactions and relationships to develop. Additionally, some complementary capabilities and social competencies facilitate the identification of those pre-attributes and signals, which helps to develop relationships.

The first research sub-question explores the industry context. This entanglement of actors, technologies and context influences industry development and has been studied as a socio-technical system. This socio-technical system explains the role and influences

of actors, their networks and their context into the industry changes (Garud & Gehman, 2012; Gosens et al., 2015). However, the analysis of how social aspects influence industry dynamics still offers room to analyse the role of social relations in managing factors that have been previously reported as out-of-control for individual firms, that is, exogenous factors (Adner & Kapoor, 2010).

From the clean technology point of view, industry dynamics are based on social resources, dynamics and capabilities that are industry-specific (Rocha-Goncalves & da Conceição Gonçalves, 2011). The clean technology industry demands an analysis of how social capital occurs in a technological change context. According to Hargadon and Kenney (2012), although policies and regulations in the clean technology industry have been researched, there is still a gap in the knowledge about the interactions among stakeholders such as policy-makers, companies and investors.

The question of how social capital occurs in an industry context in relation to the aforementioned technological change remains. Therefore, the first sub-question is:

Research sub-question 1:

"How does the industry context influence social capital?"

2.5.2. Technological aspects

The second research sub-question addresses the interplay between technology and social capital. The literature contends that industry actors, be they individuals or organisations, become influential when they share and perform creation processes and use technology (Malerba, 2002). This complex phenomenon involves interplay between globalised relationships, knowledge and technology (Forbes & Kirsch, 2011). Consequently, the development and adoption of new technologies, and further industry development, relies on a social construction process (Ford et al., 2010). There is link between social structures and industry dynamics that suggest interdependencies in an industry setting (Bonaccorsi & Giuri, 2001).

Technology influences industry development and economic change (Schumpeter, 1934). Influences on contextual factors (Ford & Mouzas, 2008) and market conditions (Malerba, 2007) occur through technological opportunities that are created by the interaction of heterogeneous actors, new combinations of knowledge (Fredin, 2012) and organisational activities and routines (Nelson & Winter, 1982). Further, technology adoption relies on the establishment of dominant designs that are more likely to generate collective action (Aldrich & Fiol, 1994). The establishment of the dominant technology reflects an "implicit agreement" (Aldrich & Fiol, 1994, p. 654) that enables a common agenda among those industry actors who carry out further development (Utterback & Suárez 1993). This implicit agreement reflects a process of legitimation of the technology, the actor and the industry, in which social capital facilitates meaning-making (Aldrich & Fiol, 1994).

The development and adoption of new technologies follows changes in the organisational and social paradigms, and in the industrial system (Van de Ven 1993). Derived from the understanding of technological change as a socio-technical co-evolution, this thesis explores the relation between technology adoption and social capital. Therefore, the second sub-question is:

<div align="center">Research sub-question 2:</div>

<div align="center">"How does the adoption of technologies influence social capital?"</div>

2.5.3. Relational aspects

The third research sub-question refers to the social aspects involved in technological change. Analysis of the interactions among different individuals, organisations and the context has contributed to our understanding of industry evolution (Forbes & Kirsch, 2011) by recognising the role of relationships mainly in terms of resource access (Bourdieu, 1986; Ireland et al., 2002; Nahapiet & Ghoshal, 1998), social action (Coleman, 1988; Portes, 1998; Putnam, 1993), and industry legitimation (Aldrich & Fiol, 1994). The literature suggests that reciprocal influence between network dynamics, firm performance and industry evolution is likely to occur through industry events (Madhavan, Koka, & Prescott, 1998). However, an understanding of the different social phenomena involved in

processes of change within an inter-organisational field is still being explored (Routley et al., 2013), especially with regard to changes triggered by new technology adoption.

The predominant approach to causality of social capital suggests that value resides in the resources embedded in relationships (Nielsen & Chisholm, 2009). The analysis of the social phenomena has tended to be causal as "individuals must first have shared experiences and interactions over time to develop trust, norms, and identity" (Pearson et al., 2008, p. 958). The linear causality, predominantly in the literature from an RBV, focuses on the resources in a relationship and leaves room for the identification of and interactions between social capital elements. This RBV might limit the understanding of the complexity of social phenomena and might be insufficient to explain the role of social capital in technology development. As the social structure is dynamic and interdependent with social processes, a more holistic approach is needed to see the social phenomenon as an evolving interplay between structure, process, actors and context.

A holistic understanding of social capital suggests the need to complement the causal analysis with the dynamic emergence and formation of relationships in an industry (Balland et al., 2013). Further, industry dynamics research offers room to reformulate "several concepts […] in terms of the implied relations between network measures and industry measures" (Bonaccorsi & Giuri, 2001, p. 227). Consequently, scholars have established the groundwork for employing a complex framework to analyse interactions and social relations within an industry, and acknowledge that the interactions and effects are dynamic rather than linear or causal (Lee et al., 2001).

Thus, exploring social capital from a view other than causality and resources is still needed, as proposed by Farr (2004) who suggests a pragmatist view instead. Therefore, this research strives for an integral analysis of social capital in technological change that explores both the social and industry dynamics (Woolcock, 1998) that integrates multiple factors and their interactions.

Despite the recognition that social aspects play a part in clean technologies adoption, research on professional relationships and actors' engagement within the clean technology industry has been scarce (Bergek et al., 2013). Therefore, this thesis explores the use of social capital in an industry context to contribute to the transition of technologies by analysing the question:

<div align="center">

Research sub-question 3:

"How is social capital understood and used by industry actors?"

</div>

2.6. Summary

Change in technology and the economic system is a complex cumulative phenomenon that transforms human activity (Nelson & Winter, 1982). An organisation and emergent industry are dynamic systems that continuously change and interact with an indefinite number of internal and external factors. An understanding of organisations as interacting entities that are able to co-create and re-design an emergent industry (overcoming path dependency) places social capital in a role beyond the value of resources.

The approach of social networks and mobility of resources has prevailed in organisational and management theories (Burt, 2000; Granovetter, 1983; Portes, 1998). The focus on the instrumental function of social capital (Nielsen & Chisholm, 2009), social exchange and the value derived from social relations has dominated the concept of social capital in business environments (Batt, 2008; Dyer & Singh, 1998; Ireland et al., 2002; Nahapiet & Ghoshal, 1998). The definition of social capital should encompass organisational and industrial dynamics; hence, it should be based on constant change and complex interplay. Social capital analysis needs to include the institutional and contextual factors and other social cognitive, processes and actions. The notion of social capital as an "internal coherence" (Dasgupta & Serageldin, 2000, p. 44) or "coherent theory"" (Nahapiet & Ghoshal, 1998, p. 242) can be taken as an invitation to integrate it with other concepts and posits the value in its complexity (Batt, 2008).

This chapter reviewed the literature on technological change and social capital to understand the social phenomena that influence such change. The literature review indicated that social capital and technological change can be integrated to explore the role of social relations among industry actors in a rapidly changing industry context. This thesis focuses on the social aspects that co-evolve with contextual influences to inform collective action. Three aspects (contextual, technological and relational) were identified and transformed into research sub-questions to explore a holistic understanding of the influence and role of social capital in technological change from an alternative perspective other than the RBV.

The next chapter presents the methodological approach employed for this research.

3. RESEARCH DESIGN

"[Deleuze]…gives philosophy one task of which is the creation and invention of new

concepts, an instrumental, tool-like, pragmatic flavour, and invites a philosopher, whose

intellectual practice therefore becomes one of a constructive pragmatist, to think the

unthinkable" (Semetsky, 2006, xxi)

3.1. Introduction

Following the literature review on technological change and social capital and the development of the three research sub-questions in Chapter 2, this chapter is dedicated to outlining the research design. This includes the philosophical view and the research methodology used to explore the phenomena and address the research question: "**How does social capital influence technological change in industry contexts?"**

To answer this question, the researcher accepts that social phenomena reflect a continuous interplay between multiple actors and contexts, and examines the interplay that occurs in technology-based industries during new technology adoption. This research follows a pragmatist philosophical view to analyse the dynamic phenomena of social influence and change. An explorative qualitative research was undertaken, that demonstrates a reflective character of inquiry and interpretive analysis in a continuously evolving process.

This chapter is organised as follows. Section 3.2 presents the framework of this research and how it was designed. Section 3.3 describes the nature of the phenomenon and the unique features of the industry context and the social relations that influence the research paradigm, and provides justification for the research approach. Section 3.4 presents the research paradigm, and section 3.5 presents the methodological approach and methods used for conducting the data collection and analysis. Section 3.6 confirms the research soundness criteria that ensures the reliability of this research, and section 3.7 concludes with a summary of the research design.

3.2. Research framework

This section presents the way in which the research was structured and conducted to explore and contribute to the understanding of the influence and role of social capital during technological change. This framework provides the basis of alignment between the research question with the philosophical view and the theoretical background, as shown in Figure 3.1.

This thesis focuses on exploring the intersubjective meanings and contexts of social interactions (Creswell, 2012). These social phenomena were initially investigated from practical and theoretical perspectives, including industry issues and theory debates. From a practical perspective, the industry context was identified through general observation, previous knowledge about the industry and informal conversations with industry actors to get a close view of the reality of social groups and anchor the context of study (Crotty, 1998; Flyvbjerg, 2006). From the theoretical perspective, a preliminary literature review was conducted to establish a theoretical basis and form questions around this phenomenon. The practical and theoretical information were then analysed and integrated in a recursive way to formulate the main research question.

The research question allowed the researcher to conduct a theoretical investigation to develop a conceptual framework appropriate for the thesis, including the development of research sub-questions, as presented in Chapter 2. Further, the philosophical view was defined, as this view guided the understanding of social reality and how it could be explored (Crotty, 1998; Guba & Lincoln, 1994). Both the conceptual framework and the philosophical view are fundamental pillars for establishing the methodology and methods to collect data and analyse the evidence. The research process was finalised with the findings and conclusions.
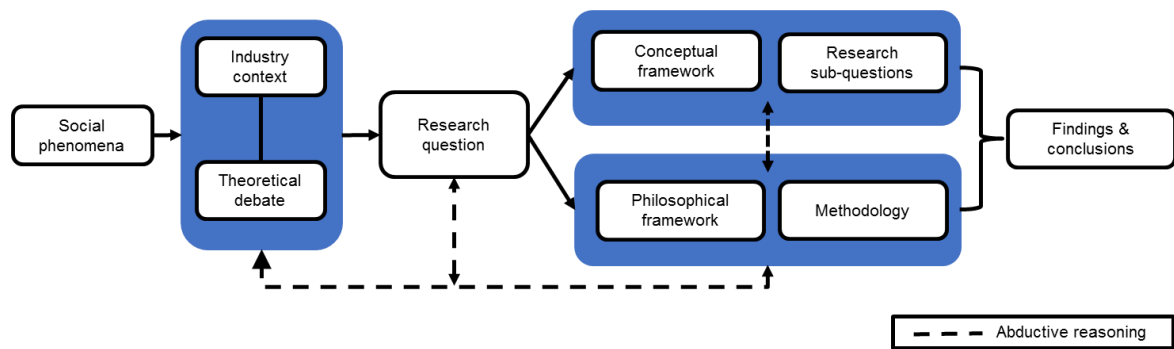
Figure 3.1. Research framework

The dotted lines in Figure 3.1 indicate the abductive reasoning followed in this research. Abductive reasoning suggests an iterative process of understanding the research problem, theory and data which implies a "look forward" to guide actions that are simultaneously evaluated through those same actions (Cavallo & Ireland, 2014). Abductive reasoning occurs when the researcher aims to derive new meanings from the social phenomenon under analysis by experiencing the situation and interpreting the experiences of participants in an alternative way (Denzin & Lincoln, 2011). This reasoning occurs in an iterative process of analysing the social phenomena, the conceptual framework and the emerging meaning through the philosophical view (Dubois & Gadde, 2002).

Thus, abduction is not a theory-data matching exercise, but a reflexive engagement with the context, the subjective perceptions of the participants and the anticipated consideration of their intentions (Charmaz, 1994) that "something may be" (Gold, Walton, Cureton, & Anderson, 2011, p. 234). It is a continuous process present in everyday events, language and concepts (Dubois & Gadde, 2002; Lipscomb, 2012). The emphasis and value of the analysis relies on the recursive informative relations between each research stage to support the unveiling of the underlying social phenomena. Therefore, a constant adjustment of the findings in light of the philosophical view and the conceptual framework guided this research (Dubois & Gadde, 2002).

3.3. Nature of the research phenomenon

This section presents the main aspects of the research phenomenon and justifies the philosophical view used. The thesis examines the social aspects of technological change; in other words, the connection between people and technology as a reciprocal and intertwined process (Bijker et al., 2012; Van de Ven, 1993). The social genesis of technology has been documented in terms of knowledge sharing, creativity and the invention that occurs among actors (Bijker et al., 2012). Similarly, the social effect of technology has been identified in terms of its use in society and the changes triggered in social and contextual elements such regulations, institutions, networks, infrastructures and norms (Geels, 2002). Thus, it becomes evident that social entities and their relationships influence the context, and vice versa (Wooten & Hoffman, 2008).

The social nature of technological change reflects a social view of organisations. An organisation is a collective actor that reflects a complex interplay between heterogeneous individuals (Nayak & Chia, 2011). These individuals are in constant tension showing synergies, complementarities, contradictions and conflicting interests rather than a homogeneous agreement and understanding. This tension and heterogeneity between actors implies the appearance and/or disappearance of actors' beliefs, expectations and practices (Dacin, Goodstein, & Scott, 2002) that occur in constant flux within and outside the organisation (Wooten & Hoffman, 2008).

The continuous changes that occur in the industry context imply multiple interplays and interdependencies of actors and elements within and across organisations. In an industry context, the relationship between entities and context constitutes a highly interactive relational space (Wooten & Hoffman, 2008) in which collective understandings are negotiated (Senge, 2013). There is an ongoing exchange, negotiation and reciprocal influence embracing individuals, collectives and organisations in the industry context.

The interplay of the "wider social environment" (Senge, 2013, p. 77) and the organisation is manifested in symbols, cultures and values (Senge, 2013; Suddaby et al., 2010). Thus,

the interplay between entities and context is a complex scenario whose value resides in the frameworks for interaction rather that in the resources provided (Senge, 2013; Wooten & Hoffman, 2008), which suggests an action focused analysis.

Organisations show interdependent actions and exchanges with other actors in the context. The dynamics can originate in the environmental space, in the interaction between organisations, and within an organisation (Dacin et al., 2002). However, an understanding of the different dynamics that lead to inter-organisational change is still being developed (Routley et al., 2013). This research analyses the means by which individual beliefs and actions evolve towards collective action through actors' engagement. Specifically, it examines how this interplay affects simultaneously the individual and the collective. This reciprocal ongoing influence is assumed here to be at the core of the change and development process (Langley & Tsoukas, 2010; Rowlinson, 2004). For that, pragmatism is suggested as the philosophical view with which to explore the social phenomena (Farr, 2004).

Defining social phenomena from an action perspective, as suggested by the pragmatism philosophy, implies that the dynamics and consequences of engagement constitute the existence of an organisation (Farr, 2004). Engagement can be in terms of formal and informal relationships and can be expressed in the structures and practices of an organisation (Meyer & Rowan, 1977; Suddaby et al., 2010). Formal systems and structures are the result of formal expectations, including individual and collective goals, and are used to establish roles, relations and organisational boundaries (Selznick, 1948). Meaning is mutually created through a dialogue based on interpretation and negotiation; it is "not necessarily constructed (created, assembled) but negotiated (matter of coming to terms)" (Schwandt, 1994, p. 195). In principle, such boundaries are essential for the process of identity building and, consequently, for the way an organisation acts and interacts (Santos & Eisenhardt, 2005; Scott, 2004).

Interactions are heterogeneous due to the nature of individuals and the influences from the organisation and environment (Barringer & Harrison, 2000). Informal relationships and informal structures emerge from an emotional and cultural dimension to interact with the formal structures. Although the boundaries constitute separate entities by means of a social identity, the actions and interactions are flexible and permeable so they allow a constant interplay of organisations (Scott, 2004; Wooten & Hoffman, 2008). Formal and informal interactions are interdependent and are based on organisational goals and individual-social-institutional expectations (Barringer & Harrison, 2000; Scott, 2004).

Consequently, and following a social view of technological change and organisations, this research examines the individual actions that form interpersonal interactions to enable changes in the context. This action-focus approach follows a pragmatist view of the social world. The focus lies on the relational interplays among entities (individuals or organisations) as part of the process of developing and commercialising new technologies. Engagement between entities emerges from the uncertainties present in social situations (Elkjaer & Simpson, 2011). By recognising the social nature of technological change, this research explores how such processes may impact changes in industry actors and their context, and contribute to the role of social engagement during periods of change.

3.4. Research paradigm

A research paradigm is considered to be a system of principles that sets the ontological, epistemological and methodological assumptions needed to conduct research (Guba & Lincoln, 1994). Building on Flyvbjerg (2006), this research aims to derive interpretations on how the different perspectives of social interactions contribute to technological change. To explore such complex social phenomena, a research paradigm that encompasses the characteristics of the phenomena is needed to enhance its exploration and understanding. Thus, the research paradigm is a recurrent interplay between the philosophical underpinnings and the nature of the research problem to provide a unique research framework (Fleetwood, 2005).

This section comprises the philosophical view, epistemology, methodology and methods, as presented in Figure 3.2. First, pragmatism is presented as the philosophical lens to explore the social phenomenon. Pragmatism suggests that actions are the building blocks of reality (Feldman & Orlikowski, 2011) that involve a continuous process of experience and engagement between the self, the collective and the context. Specifically, the pragmatist view of social capital in the context of technological change allows the researcher to focus on actions and experiences to explore intersubjective interpretations and creation of meaning (Farr, 2004).

Next, the explorative qualitative research methodology used in this research is described. Data collection methods included informal conversations, semi-structured interviews and participant observation (Bryman, 2012), and analysis methods included thematic content analysis (Saldana, 2013).
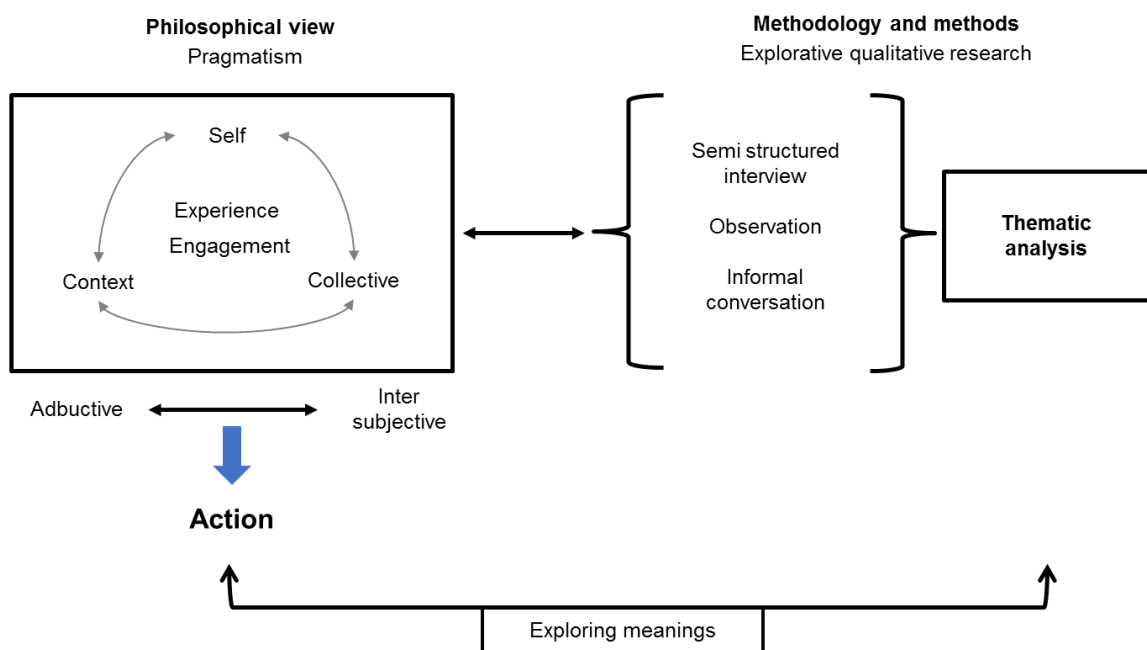
Figure 3.2. Research paradigm

3.4.1. Philosophical view: Pragmatism

"We might ask ourselves: how would sociology have developed if the philosophy of

pragmatism had shaped, comprehensively and lastingly, its theoretical

foundations? What could we expect if sociology reformed itself in accordance with

the principles of pragmatism?" (Joas, 1990, p. 168)

The potential for pragmatism to reshape organisational studies has been suggested by a number of researchers (Elkjaer & Simpson, 2011; Wicks & Freeman, 1998). Pragmatism aims to clarify the meaning of signs to facilitate communication and to "make our ideas clear" (Nerlich & Clarke, 1996, p. 120). It does so by considering the effects of practical bearings and our conception (meaning) of those via the assessment of our actions and the identification of divergence from the initial intention (Pierce, cited in Elkjaer & Simpson, 2011).

The research question concerns the "human construction of social realities" (Lincoln, Lynham, & Guba, 2011, p. 120) as it focuses on whether social capital influences technological change in industry contexts. Social reality comprises social entities that become real by means of their manifestations, that is, actions and consequences. Thus, social entities are viewed as "evolving phenomena" (Langley & Tsoukas, 2010, p. 2) that reflect a complex interplay of activities and transactions in continuous flux.

Social reality exists through interwoven activities occurring among different selves (Feldman & Orlikowski, 2011; Langley & Tsoukas, 2010) that is dynamically constituted by change and derived from actions (Dawson, 2005). This understanding of the world suggests focusing research on the role of actions, interactions, exchanges and consequences for creating meaning (Feldman & Orlikowski, 2011). Both entities and actions constitute a social reality "inseparable from the contexts in which they are embedded" (Emirbayer, cited in Scott, 2004, p. 13). Action and context are mutually influencing and dynamically iterated as every action is founded in the historic and cultural context (Flyvbjerg, 2006). There is dynamic feedback within the context in such a way that

every action is "qualitatively different" (Langley & Tsoukas, 2010, p. 3) depending on the interplay action context (Langley & Tsoukas, 2010).

The dynamism of social reality is based on interactions among entities, actions and contexts. Nayak and Chia (2011) suggest that interactions, relations and processes are the attributes that give existence to the sociality. Hence, it is in the interaction where different events and qualitative changes occur to bring an organisation to life. Such events and changes emerge from the motivations, actions and signals of the individual, the collective and the context, that provide unique characteristics for the existence of the social organisation. The interaction is simultaneously a start and an outcome, a process and a component, a structure and content. It constitutes the "intersubjective processes of social engagement by means of which becoming emerges" (Elkjaer & Simpson, 2011, p.69). Consequently, social entities and their interactions constitute the social world.

From this view of social reality, the phenomena of social capital in technological change can be explored based on the actions and interactions that construct the collective industry reality (Kivinen & Piiroinen, 2007). The social phenomenon analysed through pragmatism indicates that actions are the "constellations of interlinked activities" (p. 103) among actors that generate intended and unintended outcomes in the industry context (Kivinen & Piiroinen, 2007). Consequently, this research uses the pragmatism lens through which to examine social capital and technological change constituted by actions and interactions and relational practices of the inter-organisational socialisation (Elkjaer & Simpson, 2011).

Actions represent the building blocks of a social reality that is formed in a continuous cycle of intention and reflexion that occurs in response to interaction and consequences, and is evident in the experiences that belong to a specific context, and cause consequences that are both expected and unexpected (Elkjaer & Simpson, 2011).Thus, social reality is a constant creation of actions, as illustrated in Figure 3.3.
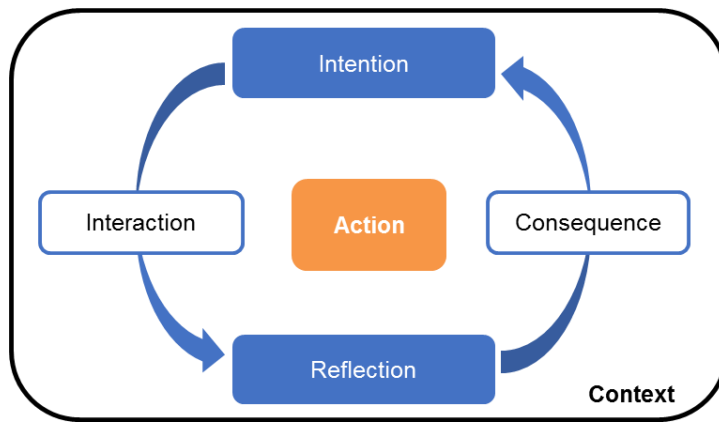
Figure 3.3. Pragmatism cycle

Intentions and the assessment of the experienced consequences occur at an individual cognitive level, which is described in pragmatism as reflexivity. Reflexivity refers to the cognitive process that links past experiences and the creation of newly informed and negotiated actions for building the collective reality (Joas, 1990).

Social reality is negotiated through the interconnections between the individual, the collective and the context to create meaning, which is described in pragmatism as an inter-subjective process that leads to engagement and experiencing consequences (Elkjaer & Simpson, 2011). Therefore, pragmatism suggests that actions occur in a cycle of inter-subjective and reflexive engagement, as shown in Figure 3.4.
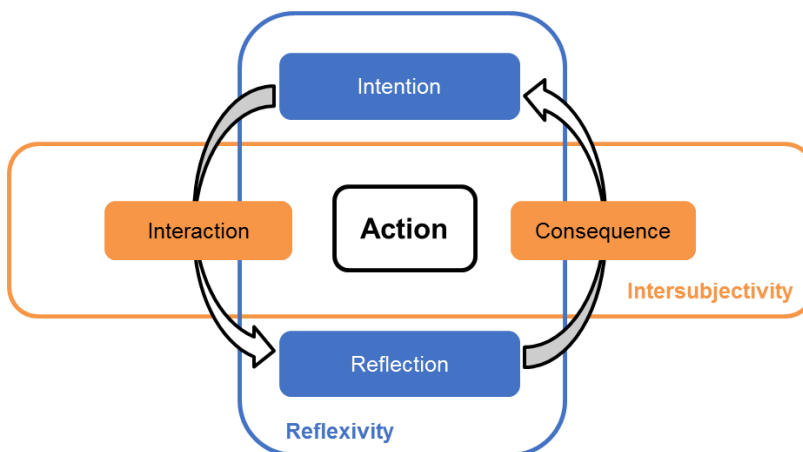
Figure 3.4. Inter-subjectivity and reflexivity

This research explores how social capital can be understood from a pragmatist view based on inter-subjectivity and reflexivity. First, the analysis through inter-subjectivity reveals the flexibility of social capital. Second, the analysis through the lens of reflexivity allows the researcher to identify the anticipation of social capital, as shown in Figure 3.5. The next two sections explore social capital within a technology-based industry through the lenses of these two specific pillars.
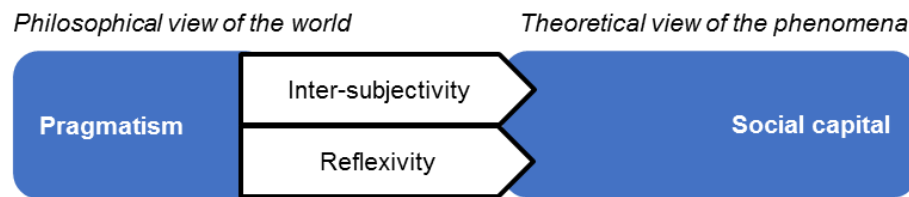
Figure 3.5. Pragmatism approach to social capital

3.4.1.1. *Inter-subjectivity and social capital*

Pragmatism defines inter-subjectivity as the notion of reciprocal influences and the intertwinement of individuals and their contexts to create meaning (Elkjaer & Simpson, 2011). Inter-subjectivity reflects an essential relation between the self, the others and the collective through an active engagement and interplay (Joas, 1990).

Pragmatism emphasises that shared experience is based on subjective perspectives that are interlaced with others and the context to validate actions. This subjective perspective suggests that experience is individually embodied and contextually engaged (Hellan, 1998). Individual embodiment refers to the individual consideration of ideas, expectations and interpreted meanings, while contextual engagement refers to the relative influence of situations to inform actions. Both the individual and the contextual worlds come together in a shared experience. The interpretation of others' actions and external situations inform and influence new understandings, new ideas and new actions (Hellan, 1998), and consequently constitute the collective becoming (Elkjaer & Simpson, 2011).

Thus, the constant recursive engagement of individuals is the basis for making sense of the self, others and the surroundings, and to achieve a collective meaning through

actions. This intertwinement of social engagement and situated purpose brings together a diversity of historic and cultural contexts that provides a heterogeneous setting for social dynamics. Pragmatism recognises the evolving nature, the context interdependency and the continual malleability of the social world (Elkjaer & Simpson, 2011).

Based on that, a dynamic interplay between actions, consequences and a transient and fluctuating combination of heterogeneous attributes constitute the anchor for this research. Consequently, inter-subjectivity allows the researcher to analyse social capital in terms of the changing nature of relationships and multiple interpretations of consequences. This changing nature reflects an innate flexibility of social relations to construct social realities.

The ability of social relations to change according to the conditions of the context and the consequences of individual actions denote the multiple functions that social relations can have in a collective. Social capital can then be analysed in terms of the way relationships change and the multiple uses or functions that social elements have in a collective (Farr, 2004). The way that new meanings are constructed and actions influenced and reshaped according to the perceived context includes reflection on past experiences and expectations and changing context conditions that creates new expectations, engagement and experiences. The multiple experiential dynamics reflect that social capital is malleable and is used to constantly inform the actions of industry actors in various ways (Lappé & Du Bois, 1997).

The technological change context suggests that changes and contingencies demand a continuous adjustment from actors. As a result, the choice of each actor to engage varies according to individual needs and, more importantly, to the response of other dependant counterparts to create meaning according to their context (Van de Ven, 1993). Pragmatism indicates a recursive and iterative influence where expectations inform values, objectives, culture and vice versa (Elkjaer & Simpson, 2011).

3.4.1.2. Reflexivity and social capital

Pragmatism suggests that reflexivity is the link between past experiences and new actions as there is a co-evolution of experiences, retrospective analysis, interpretation of signals and the living reality (Joas, 1990). Reflexivity involves actors' engagement based on an intersubjective interpretation of actions and consequences. These consequences (expected and unexpected) are critically analysed as they are happening, immediately impacting the actions in train. This critical analysis elucidates a perceived intended meaning (ideal, motivation) and, by a creative process of reasoning, meaning is revisited and new collective meanings can be created (Hellan, 1998).

Reflexivity allows for the awareness of disruptions, and inquiries into standard behaviours and beliefs that lead to the appearance of unintended consequences (Joas, 1990). Awareness of intended future consequences is at the core of the social relation as this awareness is a possibility to adjust the actions that build relationships. Awareness reflects a future-oriented reasoning of the engaged individuals. This thesis argues that reflexivity enables anticipation in individuals and can be used to explore the nature and role of social relations within the context of technological change.

Pragmatism enables us to see social phenomena as a complex interplay of actions, reflections and anticipation. A pragmatist view of social capital suggests that "society means association; coming together in joint intercourse and action" (Dewer, cited in Farr, 2004, p. 14). Reflexivity links the action with the meaning though a process of observing consequences and reviewing habits (Kelemen & Rumens, 2013). Thus, social capital can be analysed in terms of heterogeneous beliefs, ideas, values, and meanings that coexist in the collective (Farr, 2004), and examined with regard to how they inform the actions that build industry contexts. It is through this reflexive cycle that new meanings can be developed – through a collective effort of doubting, explaining, exploring, imagining and creating (Kelemen & Rumens, 2013).

Inter-subjectivity and reflexivity of pragmatism are used to analyse the influence and role of social capital in technological change.

3.4.2. Epistemological approach

The aim of social inquiry is to understand how individuals negotiate social reality and how such meanings influence interactions and new realities. As social phenomena exist due to human action and the interpretation of it (Crotty, 1998), this philosophical view aims to support the understanding of how individuals give meaning to collective actions (Suddaby & Greenwood, 2009) based on the interactions between them and their context (Crotty, 1998). The intersubjective process of meaning-making is related to the context and actors' inter-relations more than on individuals and their isolated actions (Crotty, 1998). This emphasis on an interdependent process allows to "transcend levels of analysis" (p. 78) based on the notion of the reciprocal influence and intertwinement of individuals and contexts (Elkjaer & Simpson, 2011).

In the context of this research, knowledge is derived from the "clusters of interactions among and between social actors" (Suddaby & Greenwood, 2009 pp. 178-179). Knowledge is enabled from the ability of the collective to understand a situation through the interplay of existing and potential meanings. Knowledge refers to the meaningful reality that emerges from the human practices embedded in the interactions between individuals and their environment (Crotty, 1998). Thus, as meaning is founded on intersubjective constructions, it is diverse, changing and dynamic (May, 2011). Knowledge is an ongoing process of reconciling individual beliefs, experiences and visions of the future (Nonaka & Toyama, 2007) with the individual and collective interpretation and reflection on actions and consequences within the context in a way that interpretation of the social reality is embedded in the social action (Lincoln et al., 2011). The connection between the self and the collective is a process of constant alignment of the individual, the social and the meanings. The interpretation of multiple narratives reflect individual perceptions of experiences based on intentions, expectations, and emotions that are sourced from, and will return to, the social world by means of actions (Spencer et al., 2014).

Knowledge is sourced from experience, and experience is always active; it is grounded on ideas and intentions, and linked to the context in the form of action (Hellan, 1998). Social inquiry is directly linked to experience in terms of interpreting actions through meaning (understanding the situation), and it should contribute to informing understanding of new ideas (Hellan, 1998). Action should be evaluated both in terms of tangible outcomes and on the basis of the contextual circumstances for decision-making to serve the common good (Nonaka & Toyama, 2007). This includes consideration of the unintended consequences of "purposive action" (Scott, 2004, p. 3), the limitations of existing knowledge, and the novel possibilities (Nonaka, Chia, Holt, & Peltokorpi, 2014) in the understanding of collective meanings.

Experiencing the phenomena involves a retrospective analysis of the event (action) and the consequences it has for both the individual and the collective. The meaning is then re-negotiated (new, adapted) as a prospective reflection on self-experiences, context relations, and collective interactions and exchanges. The ability to reflect on actions, consequences and meanings within a framework of common good is enhanced through experiences and the insights of the historical and social contexts (Nonaka & Toyama, 2007).

This research aims to unveil the influences and role of social phenomena on technological change. This is done by uncovering individual and collective meanings, perceptions and expectations of the actors involved in the industry (Nonaka & Toyama, 2007). Meanings are analysed from an action perspective, which means that the researcher should focus on shared practices, understandings, symbols and the potential consequences and reactions these trigger (Schwandt, 1994). The inquiry is directed towards the intentions and values, including expectations and intentions to new actions and interpretation of them in the process of collective meaning-making (Kivinen & Piiroinen, 2007). Meanings are grounded in the individual narratives and co-constructed based on experiences, reflective understanding, values and empathy (Nonaka & Toyama, 2007). The aim is to

relate the participant experience to their belonging to a collective (industry) by analysing reciprocal influences, interactions and contextual interplays.

3.5. Research methodology and methods

The next section presents the methodology and methods used to conduct the empirical investigation for this research.

3.5.1. Methodology

Methodology refers to the process of seeking knowledge about the phenomenon under research (Denzin & Lincoln, 2011). This thesis is a qualitative inquiry that follows an abductive reasoning based on a dialectic and dialogic process (Guba & Lincoln, 1994). The nature of this inquiry is based on the dialogue between the researcher and participants to elucidate and refine the meaning that constitute actions. This intertwinement between the researcher and the researched shows an abductive process of meaning-making.

Abductive reasoning allows the researcher to implicitly assess and judge events based on experiences to cultivate knowledge in a specific context. In this sense, the context plays a central role in the research process: "As circumstances change, so the very meaning of the rule (…) changes too" (Fish, cited in Thomas, 2010, p. 578). The abductive approach seeks to understand the inter-organisational phenomenon, in which meaning is negotiated in a specific context and constituted by the multiple experiences and interpretations striving for a common good.

This abductive methodology represents the creative convergence of new meanings that could possibly help to understand the social phenomenon under investigation. Instead of seeking causality and general explanations of the phenomenon, this approach looks for alternative options of meaning-making towards a collective good by incorporating context circumstances that are malleable and interpretable according to the situation (Thomas, 2010). Abduction allows the researcher to have a continuous flow 'back and forth' from field observations and theory, which further allows to "expand his understanding of both

theory and empirical phenomena" (Dubois & Gadde, 2002, p. 555). This iterative and intertwined analysis leads to contribution to theory by means of exploring understandings and making sense in different contexts (Gold et al., 2011).

3.5.2. Methods for data collection

A method is a tool for making social inquiry real based on the relations between observable events and their consequences (Kivinen & Piiroinen, 2007). It is a way to access and analyse evidence through subjective experiences. Data collection was conducted using a combination of methods, including participant observation at industry events and semi-structured interviews.

3.5.2.1. Participant observation

Observation is considered a fundamental part of social research that takes place in the natural setting of the phenomenon and includes human activities and context characteristics (Angrosino & Rosenberg, 2013). In this research, participant observation was conducted by attending different industry events to gain insights about the industry and its social dynamics. The choice of events was guided by a well-known industry leader chosen due to his extensive expertise, reputation and visibility in the industry. This reputation was evident in his recognised influence in supporting the development of a conducive environment for new technologies and new industry practices, processes, and structures (Volberda, Van Den Bosch, Frans A. J., & Heij, 2013). The selected events included networking sessions, workshops and showcases in Adelaide, Sydney and Melbourne, as shown in Table 3.1.

Table 3.1. Events attended for participant observation

Event	City	Topic	Type	Date	Attendees
Adelaide CleanTech Network (ACN)	Adelaide	Industrial innovation and emerging clean technologies	Talks and networking	15-Oct-15	30
Adelaide CleanTech Network (ACN)	Adelaide	Climate knowledge and innovation communities	Talks and networking	26-Aug-15	20
Adelaide CleanTech Network (ACN)	Adelaide	Adelaide: The world's first Carbon Neutral City and the opportunity for green industry	Talks and networking	28-Apr-15	20
Technology Industry Association	Adelaide	Clean technologies	Talks and networking	18-Jun-14	30
Export Readiness Workshop	Melbourne	Export clean technologies	Workshop and talks	15-Oct-14	20

All-Energy and Inter Water	Melbourne	Clean technologies	Expo	16-Oct-14	300
Australian Clean Technologies Competition	Sydney	Australian leading technologies	Competition	16-Sep-14	150

During the events, the researcher gathered information about the industry in relation to current socio-economic conditions and attendees' general perspectives. These events also provided an opportunity to make initial contact with industry actors for the interview process.

3.5.2.2. Interviews

Interviews focused on personal experiences and on the reflective understanding of personal actions. Personal experiences are the subjective point of view from which understanding and meaning are derived (Kvale & Brinkmann, 2009). Interviews are a tool for compiling those different perspectives and constructing knowledge. Semi-structured interviews were used to garner personal insights into the phenomenon under investigation. The interviews conducted in this research resulted in a social conversation that produced relational and contextual knowledge (Kvale & Brinkmann, 2009).

3.5.2.3. Participant selection

In this research, participants are the actors in the clean technology industry in Australia who "have lived experience that is the focus of the study, who are willing to talk about their experience" (Laverty, 2008, p. 18).

The phenomena under analysis are a compendium of connecting and overlapping actions undertaken by different actors. Industry actors differ in their roles and responsibilities in their organisations as well as their involvement and influence in the industry context. They also differ in individual characteristics such as expertise in the industry and position, professional and personal background. According to these differences, actors bring different value to the industry and have relationships and interdependencies accordingly (Gretzinger & Royer, 2013). Multiple types of industry actors were included to ensure that

participants provided different perspectives and unique interpretations of the experience (Laverty, 2008). The co-production of meaningful data is rooted in a participant's interpretations and collective negotiation of meanings (Goldkuhl, 2012). Following the pragmatism view and the abductive methodology, meaning is created in the intertwinement of the researcher, the participants and the context.

Participants were selected using a combination of purposeful and snowball sampling. Purposeful sampling for data collection allows the researcher to select participants based on their appropriateness to the research topic (Bryman, 2012). The researcher attended relevant industry events and developed contacts and established relationships with potential interview participants. This process allowed the researcher to identify the main actors in the industry as well as the appropriate criteria that aligned with the research question. Participant selection criteria included: a) should be part of an organisation that is involved in the development of new technologies, and b) should interact with other organisations in the industry. Five types of participants were identified, as presented in Table 3.2.

Snowball sampling was used in few cases when participants provided contact details for potential interviewees. The same selection criteria applied. In total, four interviews were generated through snowball sampling.

Table 3.2. Types of participants

Type of organisation	Type of participant	Description
SMEs or start-ups	CEO	Small companies launching a new technology (product or service)
Investors	CEO, Manager	Organisations providing capital to new technologies
Research Institutions	Director	Organisations providing technical knowledge and research outputs
Government	Manager, Director	Government organisations supporting innovation processes
Industry associations	Manager, Director	Organisations that support specific industries or sectors

The potential participants were contacted either by email or in person during industry events. Participants were informed of the research objectives, and confidentiality and ethics agreements. The interviews were carried out mainly at the participants' offices which allowed the researcher to gain insights into the organisation type and context. On

some occasions, the participant provided a guided tour though the premises which contributed to the understanding of the phenomena. In the other cases, information about the organisation was obtained through websites and brochures.

3.5.2.4. Conducting the interview

Three rounds of interviews were conducted. The first round consisted of informal interviews with industry actors to get their insights about the industry. These included six conversations with scientific experts and business leaders that provided the researcher with industry background information and referred contacts for potential interviewees, as shown in Table 3.3.

Table 3.3. First round of interviews conducted

Interview	City	Type of actor	Sector	Time (min)
RADL1	Adelaide	Research	Chemistry	30
RADL2	Adelaide	Research	Energy	30
IaADL3	Adelaide	Industry Association	Clean tech	30
RCAN28	Melbourne	Research	Energy	15
IaSYD29	Sydney	Industry Association	Waste	15
BSYD39	Sydney	Business	Resource efficiency	35

The second round of interviews consisted of 30 semi-structured formal face-to-face interviews with industry actors, conducted in Adelaide, Sydney and Melbourne. Although some of the participants were based in other cities, all of the interviews were conducted in Adelaide, Sydney or Melbourne depending on their availability. Table 3.4 summarises the interviews conducted.

Table 3.4. Second round of interviews conducted

Interview	City	Type of actor	Sector	Time (min)
GADL4	Adelaide	Government	General	48
IaADL5	Adelaide	Industry Association	Water	54
RADL6	Adelaide	Research	Chemistry	49
GADL7	Adelaide	Government	Clean tech	24
BQLD8	Queensland	Business	Chemistry	32
BQLD9	Queensland	Business	Water	27
BQLD10	Queensland	Business	Air	43
BSYD11	Sydney	Business	General	45
BSYD12	Sydney	Business	Waste	60

IaSYD13	Sydney	Industry Association	General	34
BSYD14	Sydney	Business	Resource efficiency	44
InSYD15	Sydney	Investor	General	38
BSYD16	Sydney	Business	Energy	80
BSYD17	Sydney	Business	General	91
GADL21	Adelaide	Government	Clean tech	43
BMEL22	Melbourne	Business	Resource efficiency	45
RMEL23	Melbourne	Research	Water	23
IaWA24	Perth	Industry Association	Energy	75
RMEL25	Melbourne	Research	Water	60
BMEL26	Melbourne	Business	Energy	42
BMEL27	Melbourne	Business	Energy	60
BMEL30	Melbourne	Business	Consultancy	35
InADL32	Adelaide	Investor	General	53
GMEL33	Melbourne	Government	General	49
IaSYD34	Sydney	Industry Association	General	36
IaSYD35	Sydney	Industry Association	Building	41
InSYD36	Sydney	Investor	Clean tech	53
InSYD37	Sydney	Investor	General	52
BSYD38	Sydney	Business	Building	61
RADL40	Adelaide	Research	General	57

The third round of interviews consisted of four semi-structured formal telephone interviews with industry actors in Brisbane, Perth, and Canberra who were selected using snowball sampling (see Table 3.5).

Table 3.5. Third round of interviews conducted

Interview	City	Type of actor	Sector	Time (min)
BWA18	Perth	Business	Resource efficiency	46
BWA19	Perth	Business	Energy	39
GCAN20	Canberra	Government	General	28
InQLD31	Brisbane	Investor	Clean tech	25

All interviews were conducted using a guiding questionnaire with open questions (see Appendix 7.3). The pragmatist approach was followed to develop the guiding questionnaire focusing on actions and interactions, and seeking reflection on and insights into the consequences and the experienced changes within the industry. The questions aimed to encourage the participant to reflect on their personal expectations and subsequent actions and consequences, and to foresee future actions according to

75

previous experiences. By reflecting on their own actions, as well as the consequences of others' actions on their own expectations, the questionnaire tried to explore their perceptions and intentions that drive social action in the industry context.

In total, 40 interviews were conducted. The semi-structured interviews produced a total of 25.5 hours of recording. Interviews were transcribed using Nvivo 10 and resulted in 315 pages of text.

3.5.3. Methods for data analysis

Qualitative data analysis is a process that allows the researcher to make sense of the qualitative evidence gathered in the interview process (Schreier, 2012). The data collected reflects the interpretation of a reality by the participant; at this stage, the researcher acknowledges that meaning is not inherent in the text (transcripts) and instead is an active construction between the participant and the researcher (Guba & Lincoln, 1994). This active construction of meaning is facilitated by using the qualitative content analysis method. This flexible and systematic approach allows the researcher to focus on the relevant aspects of the research problem and gain an in-depth analysis of its meaning (Saldana, 2013).

Content analysis was conducted to develop themes in a systematic and flexible (Schreier, 2012). Content analysis is an iterative process in which progress is made by coding and re-examining previously coded data as new insights develop and meanings are uncovered. Following an abductive reasoning, previously coded material can be re-interpreted by combining concept- and data-driven codes, resulting in deeper insights (Schreier, 2012). An iterative process is followed, to generate and adjust codes and themes to ensure a robust and holistic exploration of the data (Saldana, 2013).

Data analysis was done through a four-stage process: coding system, data divergence, data convergence, and data synthesis (see Figure 3.6.) (Gioia et al., 2012; Saldana, 2011, 2013; Strauss & Corbin, 1998). Coding was done using Nvivo 10 software to facilitate the process of organising and recording codes. Excel was also used to keep a record of the

codes generated in each coding cycle. The coding process started with a detailed reading of each transcript to identify sentences or words that provided insights about the data (Goulding, 2009). Subsequent cycles of coding were done to reveal meanings and develop themes. This process was not as linear as described here, as it followed the abductive reasoning ethos that allows a recursive analysis. However, to facilitate an understanding of the process, it is presented here as a simplified sequence. Simultaneously, notes were taken to support the analysis process and provide insights into why the code was chosen, how the data provided insights into the phenomena, and possible relations between codes, themes, theory, and context (Saldana, 2013). Each of these stages is described in detail in the next section.
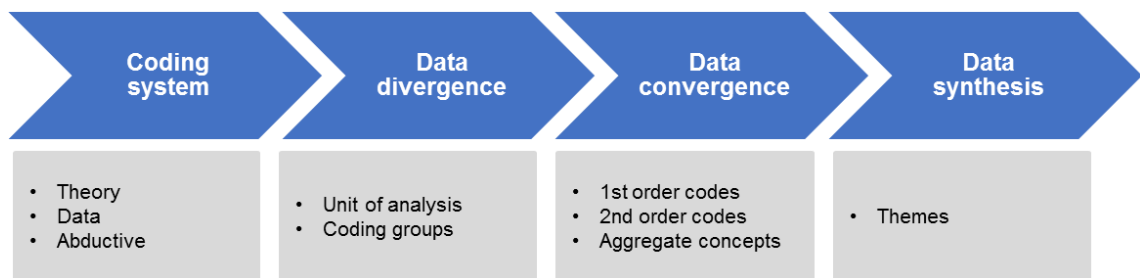
Figure 3.6. Coding process

3.5.3.1. Coding system

A coding system refers to the identification of possible groups that can be further analysed (Schreier, 2012). The development of the coding system involves both a deductive and an inductive analysis. A deductive analysis refers to an initial definition of codes based on the theory to develop a provisional system of groups. It is referred to as priori theoretical orientation (Creswell, 2012) or organisational categorisation (Maxwell, 2012) and reflects previous theoretical explanations about the phenomena aligned with the research questions (Weston et al., 2001). An inductive reasoning refers to the identification of codes emerging from the data. These potential codes were identified by analysing the interview transcripts and making notes of words and sentences that provided insights to the research questions (Maxwell, 2012; Saldana, 2013).

This initial analysis of theory and raw data was used to develop preliminary and provisional codes into a system that supported the analytical coherence during the remaining process. The subsequent emergence, combination, complementation and adjustment of codes in the next coding cycle reflected a transition from deductive-inductive to abductive reasoning (Gioia et al., 2012).

3.5.3.2. Data divergence

Once the coding system was identified, raw data were analysed and divided into "paragraph-length units" (Saldana, 2013, p. 16), referred to here as data divergence. This process enabled the researcher to analyse embedded meanings. Saldana (2013) proposes conducting an initial data layout before coding to obtain a sheer number of data units (Gioia et al., 2012).

At this stage a sample coding was also done, in which data units were labelled with codes to analyse the coherence with the research questions (Weston et al., 2001). This initial sampling led to a further adjustment of the coding system. Transcripts were coded using the coding system which allowed to continue with the next cycle of coding (Saldana, 2013; Weston et al., 2001).

3.5.3.3. Data convergence

Once numerous data units were identified, the convergence phase focused on the development of first and second order codes and aggregate concepts through an iterative process of analysis. First order codes refer to the assignment of labels to the data units to further allow an identification of embedded meaning. This was a process of labelling data units, creating codes, and grouping or relabelling them into the coding system so that the meaning revealed aligned with each code and was coherent with the theory and relevant to the context of research (Saldana, 2013).

Second order codes extend the exploration of meanings to converge first order codes into new categories based on similarities, connections, contradictions or other types of

relations that reflect a deeper meaning. This stage reflects an abstract analysis that results in the reduction of the number of codes (Gioia et al., 2012).

The process of abstract analysis continued in subsequent coding cycles until sufficient robustness was achieved to understand the phenomenon (Weston et al., 2001). These cycles enabled the formulation of aggregate concepts that reflected a conceptual meaning embedded in the data (Gioia et al., 2012).

3.5.3.4. Synthesis

The synthesis phase corresponds to the last coding cycle, which consisted of grouping aggregate concepts into themes. Themes serve as an "umbrella that covers and accounts for all codes and categories formulated" (Saldana, 2013, p. 163). Themes provide the basis for contribution to theory, as they integrate embedded meanings that support an understanding of the phenomena. The process is referred to here as synthesis because this final stage of analysis converges all of the data into clear themes that address the research questions.

3.6. Research soundness criteria

Each philosophical paradigm guides the researcher's decisions about the criteria needed (Schwandt, 1994). This section outlines the specific criteria needed for a qualitative inquiry to ensure its value, applicability, consistency and neutrality (Guba & Lincoln, 1994). The framework for trustworthiness and authenticity is defined under the pragmatist view to ensure a robust, rigorous and transparent research process, by including and adjusting the credibility, transferability, dependability and confirmability criteria.

3.6.1. Credibility

Credibility refers to the truth value and the acceptability of findings to others (Guba & Lincoln, 1994). It addresses the question, "How believable are the findings?" (Bryman, 2012, p. 49) and is linked to the relationship between results and reality that is dependent upon the research context (Maxwell, 2012), rather than a standard method to achieve credible results.

In this research, credibility is evident through adopting well-established methods, purposeful sampling and iterative questioning (Shenton, 2004). Credibility was then ensured by including participant observation, informal conversation, continuous updates on industry endeavours and personal communication with industry leaders. The multiple sources of data provided sufficient background to assess the data and enable the researcher to engage with the research question, the theoretical and philosophical views, and the findings (Shenton, 2004) .

Additionally, the process of data collection reflected the time spent in the field, the depth of descriptions, and the closeness between the researcher and the participants (Creswell, 2012; Lincoln & Guba, 1986). In this way, the researcher was able to nurture relationships with the participants and gain an understanding of the industry culture, and consequently to develop a sense of criteria required and check for misinformation (Creswell, 2012).

Additionally, the researcher constantly checked the theoretical concepts against data findings, following an abductive reasoning. This aimed to ensure that the conceptual findings were coherent with theory and were credible, trustworthy and defensible (Onwuegbuzie & Leech, 2007).

3.6.2. Transferability

Transferability refers to the consistency of results and addresses the question of whether they are likely to apply to other situations or contexts (Bryman, 2012) by assessing the extent of similarity or fit between the contexts (Krefting, 1991). Qualitative research contextualises information to gain an in-depth understanding of phenomena (Kvale, 1996). Thus, qualitative research focuses on the transferability of the results (Guba & Lincoln, 1989), as opposed to the goal of generalisation in quantitative research (Ulin, Robinson, & Tolley, 2005).

Creswell (2012) and Lincoln and Guba (1986) suggest that there must be sufficient descriptive data to ensure transferability, and that the researcher or practitioner needs to ensure the analysis and quality of the transfer. As highlighted by (Tobin & Tippins, 2009,

p. 19), "[t]he purpose is not to convince readers of the generalizability of what has been learned but to provide sufficient details of the contexts in which the theory is embedded and to enable readers to decide on the extent to which what has been learned can help them meet their goals" and can be applied to other contexts.

To provide readers with a good understanding of the context in which this research has been implemented, detailed information on the clean technology industry in general and in Australia specifically was presented in chapters 1 and 3. Additionally, interview results are extensively presented in chapter 5. Reference is made to interviewee statements from the transcripts, in order to showcase the actual language used by interviewees.

3.6.3. Dependability

Dependability refers to the consistency of results and answers the question, "Are the findings likely to apply at other times?" (Bryman, 2012, p. 49). Dependability can be evident at any stage of the research design, from the preparation to the reporting phase, to contribute to the trustworthiness of the research (Elo et al., 2014).

During the preparation phase, dependability is ensured through the choice of collection method that is most appropriate to answer the research questions. Interviews "attempt to understand the world from the subject's point of view, to unfold the meaning of their experiences" (Kvale & Brinkmann, 2009, p. 1), and where knowledge is constructed in the interaction between the interviewer and the interviewee (Kvale & Brinkmann, 2009).

In this research, the guiding questions were developed following the chosen philosophical view and the conceptual framework. During data collection, dependability was achieved through the initial informal interviews which were used to validate and adjust the questions and to check the quality of the data generated (Elo et al., 2014). At the same time, informal interviews allowed the researcher to gain insights into the industry context which enhanced the criteria for the analysis phase (Shenton, 2004).

Dependability during the analysis and discussion was considered in two ways. Firstly, a continuous review of themes and codes, results and interpretation was done. The results, presented in Chapter 4, will include quotes to show the accurate interpretation of the data, and the connection between data and results. Secondly, results were contrasted with the information about the industry context. The discussion prioritises elements that can be interpreted as criteria to be transferred to other settings. In both cases, connections between data, results, theory and context are emphasised (Elo et al., 2014).

3.6.4. Confirmability

Confirmability refers to the neutrality of the findings (Guba & Lincoln, 1994) and addresses the question of how the researcher's values influence the research (Bryman, 2012). It aims to ensure that the findings reflect the experiences, narratives and interpretations of the participants (Shenton, 2004).

Reflexivity in pragmatism acknowledges the active involvement of the researcher in the research process, especially data collection and analysis, thus influencing the nature and findings of the research (Cassell, Buchanan, & Bryman, 2009). This research follows Denis and Lehoux (2009) in defining reflexive learning from practice – a conscious ongoing experience of the research problem and the engagement with the research process (Lincoln et al., 2011). Confirmability was achieved by constant immersion in the field and the data with the aim of deepening the analysis through the reflexivity of participants' contribution, and the researcher's own role (Lincoln et al., 2011; Schreier, 2012).

Confirmability includes interrogating the researcher-researched relationship and examines the broader research context and procedures (Shenton, 2004). In this thesis, reflexivity was facilitated by keeping notes about the researcher's interpretations and insights and considering them in the analysis process. The researcher was able to consider personal factors that could influence the research, embrace them in the analysis and identify with the context and the data (Cassell et al., 2009).

Onwuegbuzie and Leech (2007) suggest considering both the effects of the researcher on the participants, and effects of the participants on the researcher. The effects of the researcher on the participants was managed by developing a deep engagement with industry actors and persistently observing their social interactions for contextual insights. The researcher also took into account industry reports to complement her knowledge about the industry. The effects of participants on the researcher was managed by interviewing different types of actors, gaining background and historical information from different informal conversations, and continuously going back to the research questions and theoretical concepts (Onwuegbuzie & Leech, 2007).

The confirmatory bias unconsciously leads the interviewer to confirm what is already understood or known, rather than investigate all the possibilities in detail (Nickerson, 1998). This might be the case when the researcher gathers information prior to the interviews or the interviewer uses information from past experiences and thus makes assumptions about the interviewees' opinions. In this research, detailed information about the industry context was collected prior to the execution of the interviews so it is possible that the interviewer might have been influenced by this information, which then might have influenced how the data was obtained, recorded or interpreted. The social desirability bias, on the other hand, refers to situations in which interviewees do not respond truthfully and/or accurately in order to obtain higher valued social acceptance (Mitchell & Jolley, 2013). Given that this research investigated social relations between industry actors in detail, the interviewees' answers might have been influenced by the interviewees' desired need for social acceptance.

3.7. Summary

In this chapter, the research design, including the nature of the research problem and the research paradigm, was presented. This research aims to explore the role of social phenomena during technological change, which is understood not as a quantified outcome but as an enabling framework formed through the collective meaning-making

process that fosters the ongoing interpretation and negotiation of reality towards future action.

A pragmatist approach was identified as an appropriate lens through which to explore such a context, employing inter-subjectivity and reflexivity. By adopting a pragmatist stance, the contextual and ongoing negotiated reality could be used to explore social interplay based on individual actions. Similarly, this perspective allowed the researcher to explore the social phenomenon beyond the current level of analysis, situating it across different levels and embedding it in interactions.

The methodology and methods of data collection and data analysis follow an abductive reasoning that allows a dynamic iteration between context, theory and data throughout the interviewing and interpreting process. Abductive reasoning allows for an alternating analysis of the reflection on intentions, individual and collective actions and consequences that are constantly shaping the industry, in both data collection and data analysis. Data collection consisted of participant observation, informal conversations and semi-structured in-depth interviews with industry actors involved in the development of new technologies. Data analysis used content analysis for theme development through multiple cycles of coding. Themes serve as the basis for conceptual contribution to the understanding of the phenomenon.

The next chapter presents the results obtained through this research approach. It starts with presenting in detail the process and results of the data analysis. Further, the chapter presents the analysis of the themes in line with the three research sub-questions that focus on the contextual, the technological and the relational aspects. In this way, a deeper reflection of the role of social capital in technological change is explored.

4. FINDINGS: CONTEXTUAL, TECHNOLOGICAL AND RELATIONAL INFLUENCES ON SOCIAL CAPITAL

"Human beings interact, and act jointly; the locus of social action is a shared world which each

individual must make his own in order to play his part effectively"

(Kaplan, 1964, p. 35)

4.1. Introduction

In previous chapters, the conceptual framework and philosophical view of this research have been presented. This chapter outlines the analysis of the obtained interview data and the findings in terms of codes, aggregate concepts and themes.

The chapter is structured in two parts. The first part details the process of data analysis and the results of each stage of the research approach. As stated in Chapter 3, the research process includes establishing an initial coding system, data divergence, data convergence and synthesis to develop themes. Once themes are developed, the analysis is guided by the research sub-questions. Thus, in the second part of this chapter, themes are analysed and organised under the corresponding research sub-question they address. This analysis is based on the researcher's interpretation of the reflections and perceptions provided by the participants. The analysis is developed from participants' insights into their professional relations in a context in which technological change occurs.

4.2. Data analysis and results

The content analysis approach presented in Chapter 3 was followed to analyse the data. This section presents the results obtained in the three stages of data divergence, data convergence and data synthesis, as shown in Figure 4.1. Data divergence divides the data into units that can be further interpreted in a meaningful way (Schreier, 2012). Data convergence seeks for a conceptual condensation of data to achieve higher levels of abstraction to draw meaning (Graneheim & Lundman, 2004). It is done through subsequent coding cycles to develop first and second order codes and aggregate

concepts (Gioia et al., 2012). Data synthesis aims to relate the underlying meanings between aggregate concepts to develop themes (Graneheim & Lundman, 2004). In the following sections, each stage is presented in detail with the corresponding results.
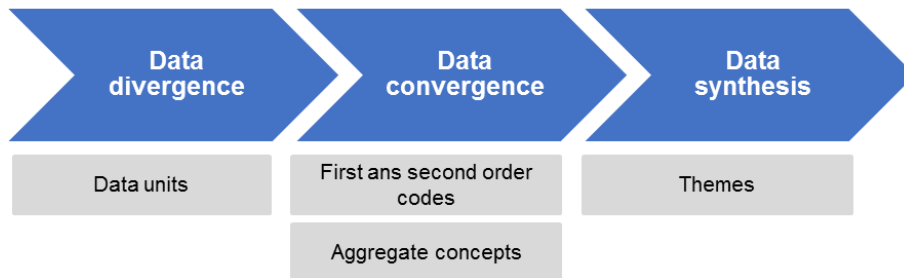
Figure 4.1. Theme development process

4.2.1. Data divergence

The data divergence phase started with the development of the data units. Sentences or phrases that provided meaning or insights were identified by reading and analysing each interview. Each of these textual statements identified in the interviews transcripts formed a data unit and were organised under the provisional coding system, as shown in Figure 4.2.
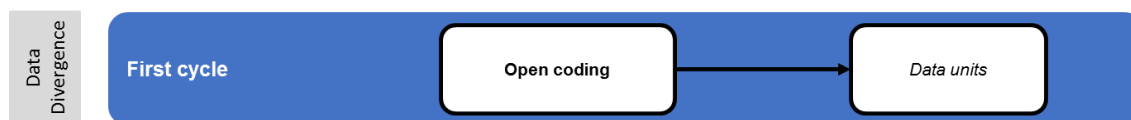
Figure 4.2. Data divergence.

Data units were identified through open coding (Saldana, 2013). Open coding enables identification of meanings in the data while it is needed to "pay meticulous attention to the rich dynamics of data through line-by-line coding"(Saldana, 2013, p. 83). This type of analysis is also called microanalysis or data splitting (Strauss & Corbin, 1998). The focus of the analysis was on the identification of antecedents, actions and consequences expressed by the participants.

The sequential analysis of each interview transcript followed a process of code contrasting (Saldana, 2013). This means that a new data unit was compared to the previously identified ones to identify similarities in the embedded meaning; this contrasting allowed the researcher to combine data units under the same code or to create a new code depending on the meaning expressed by the codes. Code contrasting allowed the researcher to modify and adjust the coding system to the data. An extract of the resulting coding system is presented in Table 4.1.

Table 4.1. Coding units and verbatim

Coding system (provisional codes)	Examples of verbatim
Mindset, knowledge and background, personal history and values, personal preferences to interact	"He is a very persuasive person so can act as chief scientist" RADL40 "The reason we are here is because we've got three boys that love surfing!" BWA18
Managerial practices, organisational culture, organisational resources and capabilities, teamwork, organisational change	"I worked for a number of sister companies and in the last one I was involved with funding and running" InSYD36 "the chairman can be look on as someone that is someone that is just a judge almost" RADL40
Actors and cooperation, innovation ecosystem, resources	"if we have some leader thinkers delivering workshops or training that companies are coming to that in itself bring people together" GADL21 "good program, structure and how it works is something that we are quite interested in and that is why we are partner and there is a little bit of talk around on how it is a really good model for getting the industry to work together" GMEL33
Support mechanisms, general context, government, institutional changes	"So, government stimulates in many ways direct subsidies through regulation, stimulates through R&D tax incentives" GCAN20 "I don't think they realise the backlash that the gov to the normal people; it just kicks off lots of people, turns backwards" IaWA24
Industry culture, industry, market, industry capacity and capabilities	"The water industry has been a state monopoly which is hard for commercial innovation" GADL7 "And then sustainability started to sort of morphing into liveability and liveability has sort of merge into a new driver for the industry so this is now been the new vision" RMEL25
Agreements, norms, activities, actions	"establish ways of doing things that are not always public, they are not secret but perhaps they are not recorded anywhere in a public space" IaADL5 "in terms of relationship building stuff like today and customer meetings face to face are very important" BMEL27
Type, formality, skills, networks	"Business relationships are very different between the two organisations because of the type of organisation" BQLD9 "we are starting to do some research, so we are starting to engage with universities to prove what we are doing" BWA19
Unexpected and new elements	"you might not have known how to tell the story, well Tanya is really good" RADL40 "The real success stories have happened in pockets of isolation" IaADL5

Data units organised into initial codes allowed a systematic and deeper analysis of the subsequent coding cycles. They enabled an organised exploration of a huge amount of data to ensure the analysis quality and process tracking.

4.2.2. Data convergence

Data convergence represents the analytical process of data reduction by the analysis of the meaning embedded in the data units. This stage corresponds to the analysis of the data units identified and classified into codes in the previous stage, through iterative coding cycles, as shown in Figure 4.3. The following sections explain each coding cycle to develop first codes, second codes and aggregate concepts (Gioia et al., 2012).
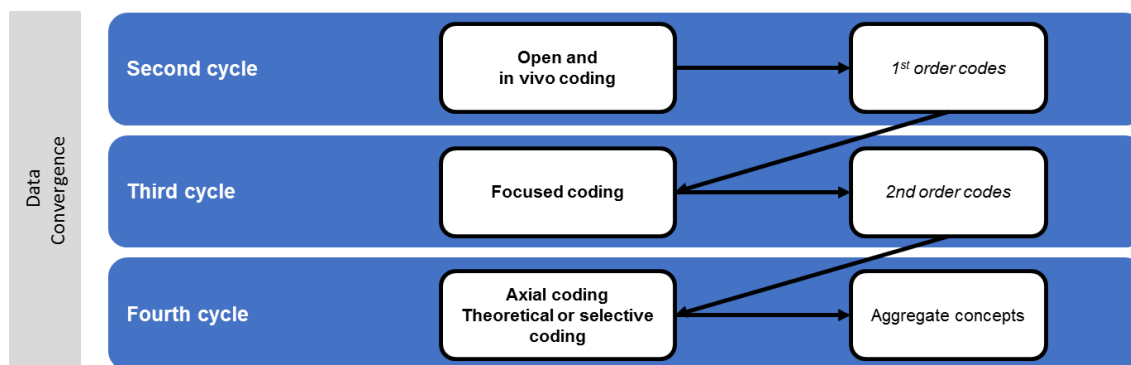
Figure 4.3. Data convergence

4.2.2.1. First order codes

Saldana refer to this first coding as "preliminary jottings" (Saldana, 2013, p. 17) that describe insights and use participant-centric terms (Gioia et al., 2012). A data unit is an extract of the transcripts that was identified to contain meaning and was assigned to a preliminary code in the previous stage. At this stage, each of the codes (data units) identified in the previous stage was reviewed and analysed, and were reassigned to a different code if necessary. In some cases, codes were merged, deleted or created, and in other cases, data units belonged to more than one code. This reflected the multilevel analysis and the complex character of the data. In the case of the latter, data units were duplicated and maintained in every code accordingly.

This analysis maintained the open coding used in the previous stage and incorporated in vivo coding to identify meanings in the antecedents, actions and consequences expressed by participants (Saldana, 2011). The root meaning of "in vivo" is "in that which is alive" (p. 99) and refers to a code based on the actual language used by the participant (Saldana, 2011). In vivo coding maintains the language so that it can "adhere faithfully to informant terms" (Gioia et al., 2012, p. 20). This was important for understanding how participants describe the industry and the phenomena.

An example of the development of first order codes is shown in Table 4.2, which shows how data units were analysed to develop first order codes. The highlighted verbatim corresponds to an example that will be used along the coding cycles in this chapter. The reader can follow the same verbatim in the subsequent coding cycles as an example of how data was analysed.

Table 4.2. Example of first order codes

Coding system	Example of verbatim used	1st order codes
Mindset, personal elements	*"He is a very persuasive person so can act as chief scientist"* RADL40 "the person seems to be more [comfortable] behind their desk than meeting people" RADL40 "you have a bunch of leaders who are accustomed to leading" IaSYD35 "our CEO Tony he is very good at those things" RMEL25 "the first chairman of the company and that person was quite a brilliant" InADL32	Personality matches position and roles.
Organisational resources and capabilities	*"I worked for a number of sister companies and in the last one I was involved with funding and running"* InSYD36 "for example, our manager director is also the president for the association" BMEL27 "I've also been in the communication office since a year and three quarters" BSYD16 "I think what we don't have is the same common group of investors being involved in lots of different companies" InADL32	Multiple positions and roles coexisting
Actors and cooperation, innovation ecosystem, resources	*"if we have some leader thinkers delivering workshops or training that companies are coming to that in itself bring people together"* GADL21 "Tonsley is like a key node" GADL7 "all they need to do is sit down in our council meeting one day and see who is there and hear the discussion and usually that completely helps them to understand why they like to be there" IaSYD35	Central actors attract people and create opportunities to interact
Support mechanisms, general context, government, institutional changes	*"So, government stimulates in many ways direct subsidies through regulation, stimulates through R&D tax incentives"* GCAN20	Incentives generate and maintain interest in an industry sector

Industry culture, industry, market, industry capacity and capabilities	*"The water industry has been a state monopoly which is hard for commercial innovation" GADL7* "in the relatively small community so most people would know the other players within that community but they don't necessarily go out of their way out" InADL32 "People from the waste sector in particular are quite alternative, in terms of the way they do business, some of their business values" InSYD36	Conservative culture deters innovation but provides stability
Agreements, norms, activities, actions	*"establish ways of doing things that are not always public, they are not secret but perhaps they are not recorded anywhere in a public space" IaADL5* "but it is more than words we have a belief that the more different background we have involved in a discussion the better the likely decision would be" InSYD37 "We don't really design anything half the time, we are just putting the frameworks and the strategies together so the whole project can be improved from that resource efficiency perspective" BSYD38	Collective belief supporting norms
Type, formality, skills, networks	*"Business relationships are very different between the two organisations because of the type of organisation" BQLD9* "we (private business) are quite well with the private companies" BSYD12 "You work with gov differently than you work with universities than you work with consultants than you work with construction" InSYD37	Relationship changes according to the type of organisation
Unexpected and new elements	*"you might not have known how to tell the story, well Tanya is really good" RADL40* "Obviously if you tell them the same story you get more practice on telling that story" BMEL26	Tell the story

These examples illustrate how open coding enabled a "line by line" analysis (Saldana, 2013, p. 82) to ensure the focus on the intentions and consequences of actions and interactions described by participants. For example, the code "personality matches position and roles" shows how individual characteristics have an implication on business attributes. In some cases, codes maintain the terms used by the participants (in vivo coding previously identified) because they reflect the participants' insights that were found to be relevant to the understanding of social capital; for example, in the case of "tell the story" and "success stories".

The outcome of this cycle of coding is the first order codes that reflect the researcher`s interpretation of the participants' understanding of their experiences. This first coding cycle concluded with 1503 initial codes. This high number of codes reflects an exhaustive and in-depth analysis of the data (Gioia et al., 2012). An in-depth analysis produces a comprehensive list of codes that "tends to explode on the front end of a study [so that] the sheer number of codes initially becomes overwhelming" (Gioia et al., 2012, p. 20).

4.2.2.2. Second order codes

The first order codes were re-analysed in a subsequent coding cycle to consolidate meanings and reduce the number of codes. This step enabled the development of second order codes. The reconfiguration of codes into second order codes focuses on whether the codes "suggest concepts that might help us describe and explain the phenomena we are observing" (Gioia et al., 2012, p. 20), which reflects an integration of codes based on the embedded common meaning, that is, a conceptual integration. To do so, focused coding was used at this stage for the development of major codes with a focus on the phenomena occurring, instead of on its characteristics or attributes (Saldana, 2013), which allowed the researcher to focus on action, reflections and consequences.

shows an example of the analysis done in this cycle. The table shows how first order codes were integrated into second order codes based on conceptual similarities and complementarities. In some cases, the terms or words used in the first order codes were kept as they were, because they reflected the meaning expressed. In the table, the underlined first order code corresponds with the example presented in the previous cycle, which is here integrated into a second order code. For example, "Personality match position and roles" was identified as a first order code in the category "individual". In this case, individual characteristics to engage in social interactions appear to be connected to organisational characteristics. Other codes reflecting this connection were identified, such as, "Some positions are thought to be more suitable for a type of personality" and "Ideas need to be coupled with managerial practices". Together they reflect a correspondence between personal motivations and organisational characteristics that are captured in the second order code, "Correspondence between personal motivations and organisational characteristics".

Table 4.3. Example of second order codes

1st order	2nd order
<u>Personality match position and roles</u> Some positions are thought to be more suitable for a type of personality Size of the company influences the thinking and the initiatives Ideas need to be coupled with managerial practices	Correspondence between personal motivations and organisational characteristics
<u>Personal commitments and circumstances can determine factors of the business</u> Personal activities can lead to professional outcomes, ways of doing things and values Family history can determine factors of the business	Personal commitments and family background determine business opportunity
Changes in position may have changes in roles and relationships <u>Positions and roles coexisting</u> Different identity according to position	Multiple positions and roles in one person
Communication and understanding varies with the position Title or name of the position affects role and decision-making <u>Participation and relationship building activities</u>	Importance of the position for relationships
<u>Central actors attract people and create opportunities to interact</u> Actor who backs up, supports, refers, connect. A bit more than a connector. Leader starts processes, signals, create the atmosphere	Champions and leaders
<u>Incentives generate and maintain interest in an industry sector</u> Support from gov – grants specially for tech dev Focus of programs: transversal, specialised, R&D, not for a specific industry	Diverse ways government supports industry development
<u>Conservative culture deters innovation but provides stability</u> People moving from traditional industry to new ones Competing with traditional technologies and traditional industries	Competing traditional context
<u>Collective belief supporting norms</u> Trust and norms Rules support trust, trust create norms	Reinforcing between trust and norm
Type of Inter-organisational relationships depend on the context <u>Relationship changes according to the type of organisation</u> Type of relationship corresponds to position and background Type of business affect type of relationship	Versatility of relationship according to contextual factors
<u>Tell the story</u> <u>Awareness of hidden successful stories</u> Make people know Spread the word Referrals	Tell the story

In this coding cycle, the number of initial codes was reduced by conceptual integration. In total, the 1516 first order codes were reduced to 282 second order codes.

4.2.2.3. Aggregate concepts

The 282 second order codes were further analysed and were condensed into groups with consolidated meaning. In this step, axial coding was used. It allowed the identification of relations between the previously constructed codes through connections between actions and consequences found in participants' reflections. Axial coding allowed the researcher to integrate second order codes into aggregate concepts that reflected a consolidated meaning (Saldana, 2013).

Table 4.4. presents an example of how first and second order codes were consolidated into aggregate concepts. In the table, the underlined first and second order codes correspond to the example presented in the previous cycles, which are now integrated into the aggregate concept. Following the same example in the step before, the correspondence between organisational and individual characteristics reflects the importance of "matching" these characteristics. This correspondence (matching) is also reflected in other second order codes such as "mix and complementary personalities" and "Alignment and understanding create collective action". The aggregate concept "matching" corresponds to the conceptual identified meaning.

Table 4.4. Example of aggregate concepts

First order codes	Second order codes	Aggregate concepts
Personality match position and roles Some positions are thought to be more suitable for a personality type Organisation size influences thinking and initiatives Ideas need to be coupled with managerial practices	Correspondence between personal motivations and organisational characteristics Mixed and complementary personalities influence working process Empathy facilitates action Alignment and understanding create collective action	Matching
Personal commitments, and circumstances can determine factors of the business	Personal commitments and family background determine business opportunity Context as a facilitator of interactions Diverse ways government supports industry development Other support different from money is needed	Conflicting support
Positions and roles coexisting Multiple roles and organisational identity Different identity according to position Understand Need to communicate position/ role	Multiple positions and roles in one person Importance of the position for relationships Size and type of organisation Social expressions are catalysed through organisation and influence perceptions and decisions	Operational intermediary
Tell the story Awareness of hidden successful stories Adapt the message to the position, background, technical knowledge Industry message affects business Cultural narratives influence the message and interpretation	Tell the story Success stories influence perception Technical message vs. value proposition Adapt the message according to the context or situation	Narratives

This analytical convergence process resulted in 26 aggregate concepts that integrated the 282 second order codes and 1516 first order codes.

Table 4.5 presents the aggregate concepts developed and Appendix D details the second order codes that belong to each aggregate concept.

Table 4.5. Aggregate concepts

Name	Aggregate concepts	Second order codes
C1	Anticipation	16
C2	Dual trust	5
C3	Envisioning change	5
C4	Traditional Industry	16
C5	Conflicting support	20
C6	Experience	10
C7	Identity	4
C8	Introduced uncertainty	12
C9	Alignment	14
C10	Momentum	3
C11	Multiple and diverse perspectives	14
C12	Technology language and narratives	23
C13	Negatives	7
C14	Relational interface	23
C15	Worth	9
C16	Reflection	8
C17	Relationships	9
C18	Resilience	9
C19	Roles	10
C20	Spill-overs	10
C21	Serendipity	5
C22	Collective value	17
C23	Transactions	8
C24	Uncertain value of relationships	10
C25	Versatility of technology	11
C26	New context	4
	Total	**282**

4.2.3. Data synthesis

This stage corresponds to the final coding cycle during which the conceptual analysis of the meanings was identified from the previous coding cycles with the aim of creating themes. Themes are developed through theoretical coding and, consisting of "few words that seem to explain what research is all about" (Strauss & Corbin, 1998, p. 146). Themes are systematically linked or related to the overarching research question in a way that seems to have a more comprehensive explanation of the phenomena (Saldana, 2013). This step integrates and synthesises data which can contribute to theory, as shown in Figure 4.4.
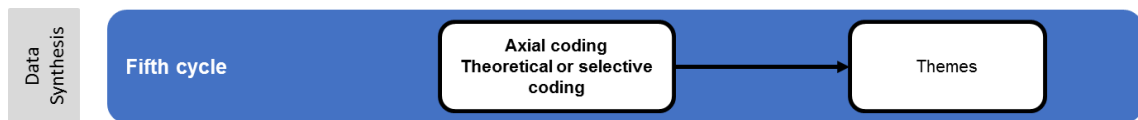
Figure 4.4. Data synthesis

The researcher followed Saldana's (2013) recommendation of developing diagrams for the phenomena, as "these illustrative techniques bring codes and analytic memos to life and help the researcher see where the story of the data is going (…) [and] to explore the complexity of relationships among the major elements of the study" (Saldana, 2013, p. 162). The diagram developed was a representation of the three research questions, as shown in Figure 4.5.: a) how does the industry context influence social capital, b) how does the adoption of technologies influence social capital, and c) how is social capital understood and used in a context of technological change? It represents the identified elements of social relations that influence and are influenced by a changing context, and how they support technological change.

The aggregate concepts previously developed (C1 to C25) were analysed and located in the diagram according to how the meaning could address each research question. Those aggregate concepts that were located closely together were identified to be related and address the same research question. A further analysis of the aggregate concepts that were identified to be related was done to understand the connections and meanings between them. The use of the diagram to identify how the aggregate concepts relate to each other and address the research questions allowed the identification of themes. In this way, eight themes (T1 to T8) were developed.
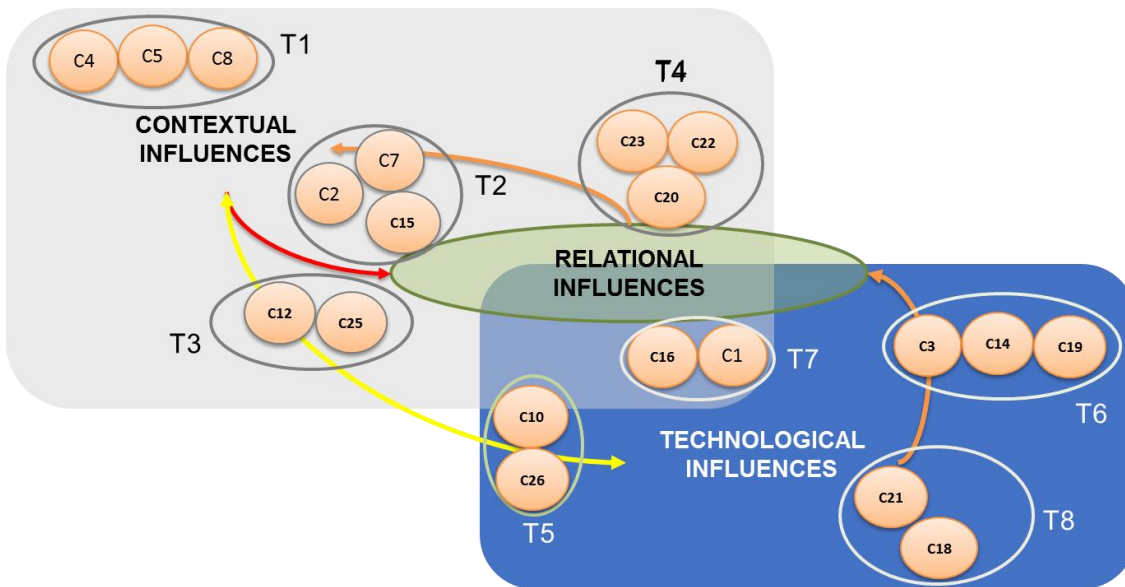
Figure 4.5. Diagram for theme development

Table 4.6. presents the aggregate concepts that were grouped to develop the eight themes (T1 – T8).

Table 4.6. Themes developed

Theme		Aggregate concepts
T1	Conflicting and competing industry context	C5: Conflictive support C8: Introduced uncertainty C4: Traditional industries
T2	Elements and influences	C2: Dual trust C7: Identity C15: Worth
T3	Technology transitions	C12: Technology language and narratives C25: Versatility of technology
T4	Role of relations	C23: Transactions C22: Collective value C20: Spill-overs
T5	Reaching horizons	C26: New context C10: Momentum
T6	New organisations	C14: Relational interface C3: Envisioning change C19: Roles
T7	Creating futures	C16: Reflection C1: Anticipation
T8	Dealing with unknowables	C18: Resilience C21: Serendipity

In conclusion, the data analysis undertaken was a recursive process that was guided by the overarching research question about how social capital influences technological change in industry contexts, and involved three phases. The initial phase involved data

fragmenting to explore the embedded meaning – data divergence. This was followed by a second phase of data convergence in which meaning was conceptually consolidated into aggregate concepts through iterative cycles of coding. The final coding cycle constituted the data synthesis in which themes were developed. The results of each stage of the process is summarised in Figure 4.6.

Data divergence	Data convergence	Data synthesis
Data units	1516 first order codes	8 themes
	282 second order codes	
	26 aggregate concepts	
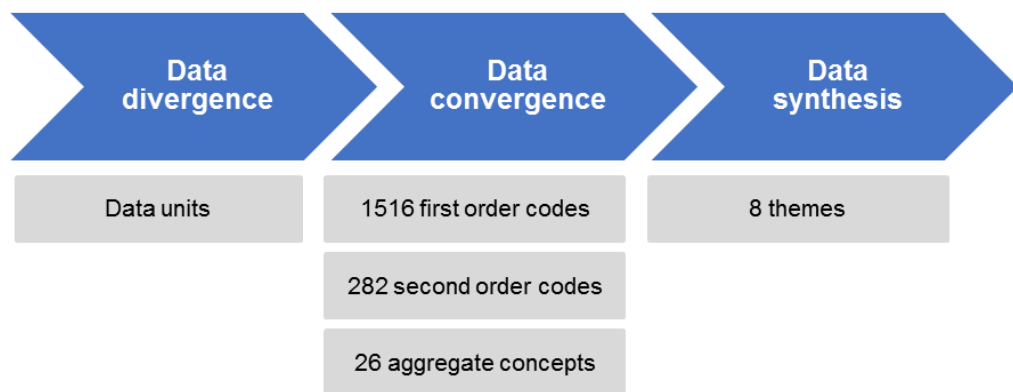
Figure 4.6. Results of coding process

In this section, the process of theme development has been described in terms of methodological steps. The next section describes the content of each theme in relation to the three research questions and the meanings embedded. Themes were further analysed to identify interrelations between them and explore deeper meanings relating to the research questions a) how does the industry context influence social capital, b) how does the adoption of technologies influence social capital, and c) how is social capital understood and used by industry actors? This analysis is presented in the next section.

4.3. Findings

Section 4.2 described the results of the qualitative content analysis that led to the development of eight themes. In this section, an analysis of these themes, guided by the three research sub-questions, is conducted to identify central concepts explaining the phenomena (Strauss & Corbin, 1998). The eight themes are analysed around the sub-questions and presented accordingly in different sections, as shown in Table 4.7.

The analysis of the themes in this way allowed the researcher to identify emerging themes that showed a new type of influence occurring in this context. This research has identified that industry actors' temporal perception influences social capital in technological change. This finding is considered an emerging influence as it did not directly address any of the three research sub-questions derived from the literature.

Table 4.7. Research questions and findings

Sub-questions	Findings
How does the industry context influence social capital?	Contextual influences
How does the adoption of technologies influence social capital?	Technological influences
How is social capital understood and used by industry actors?	Relational influences
Emerging themes	Temporal influences

4.3.1. Contextual influences

The first research sub-question, "How does the industry context influence social capital?", aims to explore the influence of the socioeconomic context, in which technological change takes place, on social capital. The theme "Conflicting and competing industry" addresses this question by referring to the participants' perceptions of the socioeconomic context in which technological change and social interactions occur. Participants identified two main actors in the context – government and existing actors – that through their actions inform other actors. This information is referred to here as signals that are perceived as ambiguous and competing and reflect the need of industry actors to align technological opportunities with context circumstances. Results indicate that changes at a government and industry level influence how industry actors perceive technological opportunities.

4.3.1.1. Theme: Conflicting and competing industry context

The theme "Conflicting and competing industry" is informed by three aggregate concepts: conflicting support, traditional industry, and introduced uncertainty, as shown in Figure 4.7. This section describes how these aggregate concepts were analysed and integrated into this theme and how altogether they address the research question: "How does the industry context influence social capital?".
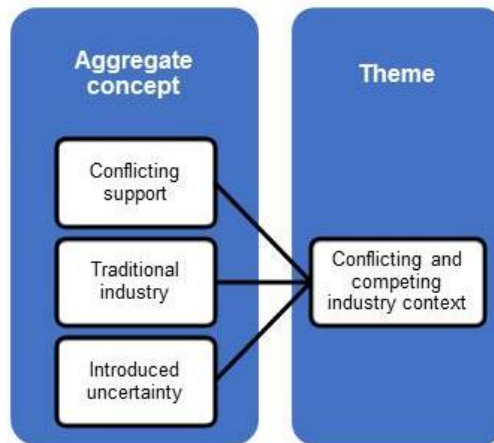
Figure 4.7. Theme *Conflicting and competing industry context*

4.3.1.1.1. Conflicting support

Participants recognised that government institutions are industry actors that provide valuable information to inform actions. Such information is referred to here as signals and corresponds to information that influences how industry actors manage their organisations, identify opportunities for technology adoption, and provide guidance and inputs for industry development. Participants described signals as multiple and varied and perceived them to provide contradictory information. The analysis of the perceived effects of such information on participants reveal that the multiple signals range from having **deterring to leveraging** effects on the actions of industry actors. Signals that inhibit actions or that limit individual initiatives are referred to here as deterring signals. Contrarily, signals that stimulate initiatives towards organisational and industry development are named here as leveraging signals. Figure 4.8 shows the diverse types of signals described by participants and the perceived effect.
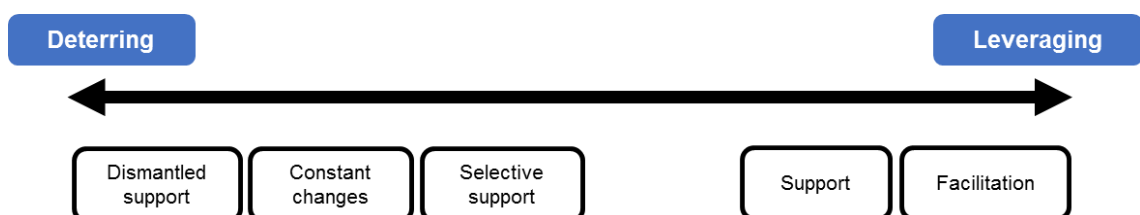
Figure 4.8. Signals from the industry

Signals are considered to have a deterring effect for example in the form of dismantled support, constant changes to existing programs and selective support to specific industry sectors. These signals come from changes in government policies, programs and support. Constant changes in regulations and policies that were initially set to incentivise industry actions but were then modified or dismantled, impacted technology and business development by affecting the perception and motivation of actors involved in the industry. For example:

> *that is what is going to happen to Australia with all these cuttings of funding the*
> *ARC or lose their better researchers that go off to places where might be more*
> *money available, you lose innovation within Australia the whole thing would wound*
> *down in innovation everywhere because of this reduction, because you will lose*
> *some of the luminaries. RMEL23*

Signals that were perceived to contradict each other generated ambiguity and conflict among participants. For example, political messages were not always coherent with government regulations:

> *what they say, what is reported and what they do are different things, they say they*
> *won't invest at all in clean tech or anything like that and we just have one of the*
> *ministers opened the even today. BQLD8*

Some political narratives were identified by participants to be especially contradictory and affected industry dynamics because they incentivised or deterred action:

> *People have changed and stop using the word clean tech because the federal*
> *government doesn't like clean things, they like the dirty old way, so they reinvented*
> *language… we are state government, it is clean tech. So the whole world apart*
> *from the federal government thinks clean tech, so whatever. GADL7*

Changes in funding and in existing support schemes generated a perception that government limits industry development. Participants indicated the existence of multiple

types of support from government when referring to the diverse programs, incentives, policies and the like. These support mechanisms were described to coexist simultaneously and to be industry-specific based on political and economic interests. They appeared to send conflicting message to the industry:

> *The clean tech sector faces more difficulties in getting support (funding) from the government compared to the health or biotech sector. RADL1*

Actors involved in clean technologies perceived that there was selective support for traditional industries, which generated feeling of antagonism and competition between the existing and established industry actors and the new developers. Different or new technologies found it difficult to find a supporting scheme as they were not a prioritised industry, and had to compete for funds and other support programs with the mainstream industries.

The prioritisation of other industries over clean technologies may have been the cause of participants perceiving a political interest towards traditional sectors and a general disapproval of clean technologies. The government was seen to have a short-term vision driven by immediate results that favour quick and safe outcomes in traditional sectors, over long-term investments in risky and new areas. Thus, there was a general perception of government favouritism towards established industries over clean technology:

> *I guess Australia being what it is carbon is a political football and depending on which party is in power will determine the policy around the carbon and unfortunately the one we've got, the liberals, they are not really supportive, they are more interest in supporting the old technologies and the old fossil fuel there"*
> *BWA19*

Another type of support described by participants was the capability-based support. This type of support was targeted to a specific stage of the business development rather than a specific sector. Funding schemes were described to be targeted to specific stages of technology and business development such as research, development, pilots or exports.

Participants seemed to perceive these supports as contradictory. On one hand, it was perceived beneficial to create opportunities to venture into new fields. On the other hand, conflict seemed to arise with regard to new ventures that could not access continuous support throughout different technology and business stages, as the support was specific to the early stages. This was described in the case of clean technology development and commercialisation:

> *And we had all our milestones and we spent all the money and we did everything*
> *they wanted us to do, that was all good. And then it feels like after that it got sort of*
> *loose, so they gave us all the money to build this thing but not help really to sell it*
> *and it turns out that building it was the easiest part. BMEL22*

Participants perceived that R&D funding corresponded to the initial stages and that additional support was needed to progress to further stages of technology development and the path to market.

On the other hand, leveraging signals correspond to government support and facilitation of industry initiatives through R&D programs and collaborative work that foster industry development. Industry actors strived to interpret and manage these signals to maintain a consistent environment in which they could operate. Leveraging signals foster and encourage new actions by industry actors:

> *federal government scheme brings industry together with the research*
> *organisation, and together with a collaborator in CSIRO and Adelaide uni we*
> *applied for one of the first rounds and got that. RADL40*

Leveraging signals are perceived to strengthen and enrich the industry context in such a way that context conditions are perceived to be facilitators of opportunities. Participants indicated the need to align industry needs with the institutional framework (infrastructure, policies and regulations). This was referred to by a participant as a "consistent landscape" – an enabling and supportive context in which such alignment is possible.:

then again comes back to wanted to feel like you are playing in a consistent

landscape. You kind of want to know what the conditions are in terms of support,

policy, market drivers. InSYD36

Thus, conditions for technological opportunities are enabled, as will be explained in Theme 5 "Reaching horizons".

Participants recognised that the supportive context also nurtured social relations among industry actors. For example, participants described the existence of government support and institutional resources used for facilitating constant face-to-face interaction and creation and use of business contacts. Consequently, government support was seen to reinforce context conditions through an overall enhancement of industry and organisational capabilities for the extension of business networks and the maintenance of long term relationships.

In conclusion, signals that come from government initiatives can have either a deterring or leveraging effect on industry actors for organisational and industry development. The diverse signals come from multiple government initiatives, including policies, regulations, programs, and incentives. These signals are perceived to provide multiple and contradictory messages by simultaneously inhibiting and facilitating actions towards technology adoption. Participants recognised that constant and unexpected changes of signals create ambiguity and introduce uncertainty to the industry context which affects motivation, perception and actions of industry actors, especially those fostering new technologies.

4.3.1.1.2. Introduced uncertainty

As described above, participants considered that the adoption of clean technologies was especially affected by ambiguous government signals. This section explores those signals and the way they affect industry actors. According to participants' descriptions, ambiguous signals can be either implicit or explicit. Explicit signals refer to messages transmitted in the form of government decisions, for example regulations, direct investment and specific

support frameworks (rebates, incentives, funding programs). Implicit signals refer to indirect support, for example training programs for networking and skills development. Implicit signals are described in the form of narratives and messages to inform industry actors' business decisions. Figure 4.9 shows that the signals lead to a perception of the government as a paradox but one that an organisation still has to align itself with identify business opportunities.
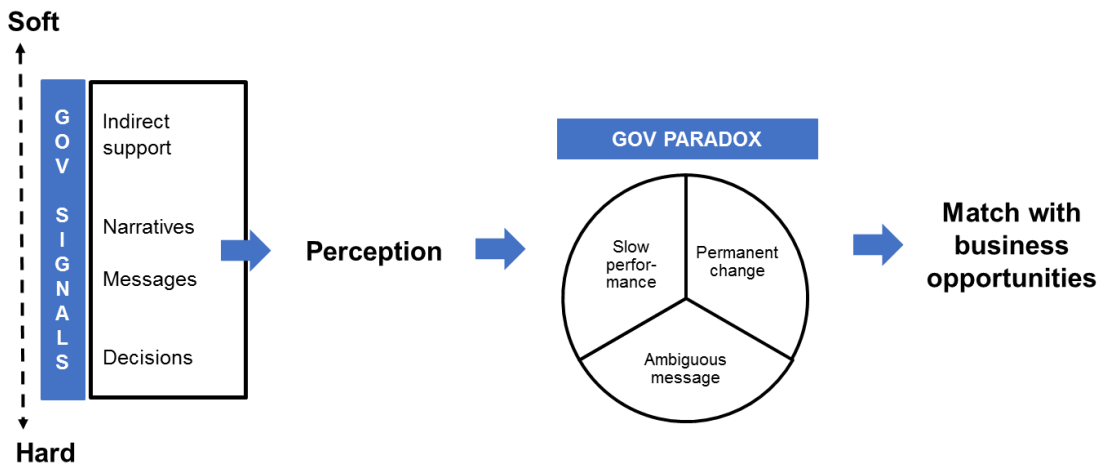
Figure 4.9. Perception of government

The ambiguity caused by government changes affected participants' perceptions of the role of the government in technological change. Participants' insights suggest that the government is perceived to be a slow mover with difficulties in adapting and implementing changes, while simultaneously effecting fast-changing support mechanism to industries. It is referred to here as the "gov paradox". This perceived paradox reflects how ambiguous signals from the government created uncertainty in industry actors:

> *largely traditional government driven, or government guided, slow moving, larger organisations. IaADL5*

> *I think they've been held back in many cases by the lack of aggression and the regulation changes. GADL7*

Participants implicitly indicated that the government is expected to provide stability and general guidance for industry development. However, participants described how government decisions generated a "backlash" due to changes in policies and regulations, and lack of clarity and efficiency in procedures:

> *I don't think they realise the backlash that the government causes to the normal*
>
> *people; it just kicks off lots of people, turns backwards. IaWA24*

The negative perception of government due to contradictory decisions and changes in support schemes suggest that the government's reputation is affected and its role becomes unclear. Participants described the government as a conglomerate of individual political interests that cause instability in the policy framework. This was the case with support for clean technologies, perceived as cyclical and based on political short-term interests:

> *I sort of have a sense that the clean tech sector is always bouncing back and forth*
>
> *due to the uncertainty of the federal level. GADL7*

As the government seemed to make decisions based on political interests, participants perceived changes in the expectations and roles of industry actors, especially government:

> *I can't see how any company in the clean tech or environmental space can make it*
>
> *in Australia without major corporate support, they won't get it from government*
>
> *they have to be major corporate support, banks won't help, government won't help*
>
> *but you have to so it yourself. BSYD12*

The resulting confusion about the government's role created uncertainty in the industry that affected the conditions for technology diffusion and adoption. Thus, the momentum for technological change was deterred, as will be explained in Theme 5 "Reaching horizons".

The government signals seemed to affect relationships between industry actors as relationships responded to the changes in government priorities, support and resources. Results suggest that actors responded to their own interest and shaped their interactions and relationships according to the available opportunities to access resources and transactions. This focus on transactions and resources guided actors to follow the opportunity that directly led to a desired business outcome, and to adjust their interactions and relationships towards their aims, as will be explored in Theme 4 "Role of relations":

> *this industry is heavily dependent on the relationships of the governmental*
>
> *legislators and whatever they put in place to drive clean tech or not to drive it.*
>
> *GADL4*

Specifically, the interaction between government and other industry actors changed as expectations were reduced and motivations to interact with government were lowered. The uncertainty introduced by government ambiguity seemed to have caused a negative perception of the general context that interferes with technology and business development, as shown in Figure 4.9:

> *it will be quite positive once the government makes a decision and that allows to*
>
> *get back to business. BMEL27*

Within this ambiguous context, participants perceived the need to reinterpret the underlying messages hidden in the ambiguous and changing signals. For some, for example, unstable political cycles and policy frames can reveal business opportunities. Participants referred to the need to perceive the context as a business opportunity. In an unstable context, organisations need to develop the capability to cope with ambiguity and uncertainty through transforming expectations and action. Expectations need to be reassessed continuously and adjusted so that they could be fulfilled under uncertainty while retaining their value propositions:

I think obviously the changing government send different emphasis on value placed on aspects on clean technology has really impacted the industry stability to come together and be represented together. InSYD15

when this government leaves and we hopefully have a new one that... they'll get another boost. BMEL22

Participants recognised an inherent capability of organisations to elucidate government signals and the effects on individual and collective perception. That meant that industry actors strived to match ambiguous signals with their business capabilities and resources. For example, industry actors were constantly aligning their business objectives with government narratives and existing support programs:

That won't change and that is something we have to deal with. BQLD8

We voted in favour and when you have a government that maybe not so sympathetic to a sustainability agenda you do get a grassroots search in supporting the agenda that is not being adopted. IaSYD35

In conclusion, the uncertainty introduced by contradictory and unstable government signals influenced the way actors perceived the government, and motivated them to align their business opportunities with the signals, as shown in Figure 4.9. The government was perceived as paradoxical as it exhibited a slow-mover action to new technological opportunities, but a fast-changing pace in terms of support schemes. This gov-paradox affected the interaction between industry actors and government. It affected their business decisions and how industry actors took action with regard to their interactions and relationships. Thus, industry actors seemed to be constantly aligning their actions with the external ambiguity to match technological business opportunities based on their organisational capabilities.

4.3.1.1.3. Traditional industry

In addition to government, participants identified that they were surrounded by well-established, traditional industries that also emitted signals that affected new technology

adoption. Participants' descriptions reflected the existence of well-established **conditions** and **resources** that influenced their actions, as shown in Figure 4.10. Conditions refer to industry culture and individual backgrounds, while resources refer to physical, relational and human resources existing in the traditional industry. The perception of conditions and resources seemed to influence how actors perceived new technologies.
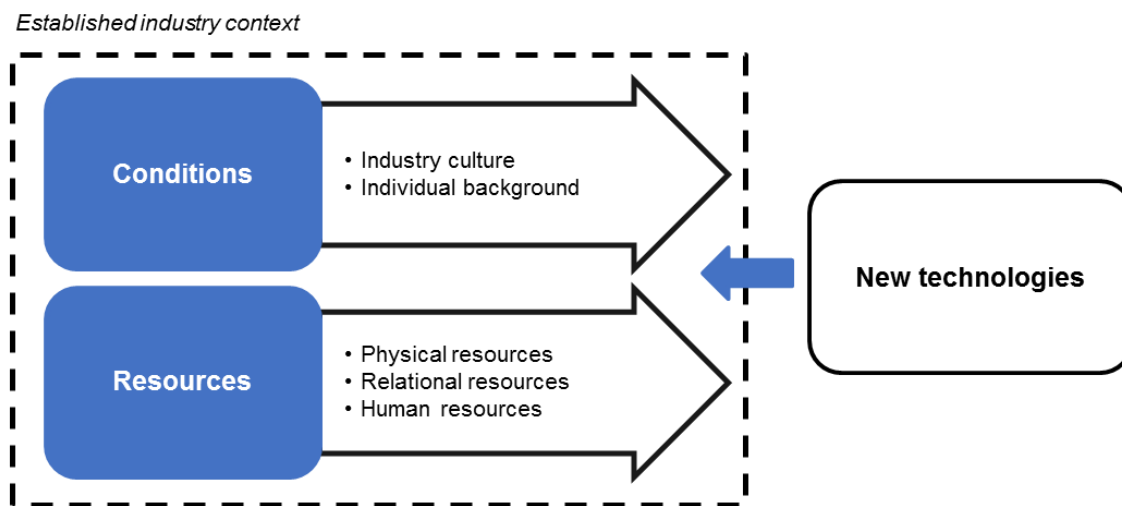
Figure 4.10. Traditional industry

Participants describe the conditions in which they operate as mainly a conservative and steady culture that has a widely accepted "way of doing things", for example, the way businesses are managed and technologies are used. Although the established culture was perceived to provide stability to the industry, it was also perceived to limit innovation and acceptance of new technologies:

> *the water industry has been a state monopoly which is hard for commercial*
> *innovation, it is changing now; the building sector it is commercial but its resistant*
> *regulation to force it to become more energy efficient, for a lot bunch of reasons...*
> *different reason but same result, a lack of innovation. GADL7*

Individual backgrounds were described to also be part of the industry conditions. Individual circumstances and backgrounds seemed to foster and influence individual

actions that shaped the industry context, for example, personal commitments and family background:

> *I have an agriculture background, a farmer by trade, I grew up on a farm and*
>
> *worked in a farm. I also have an agribusiness degree. BWA19*

Both the industry culture and the individual backgrounds seemed to have an influence on how actors perceived and (re)acted to the industry context and, therefore, how businesses operated, as expressed by participants:

> *it is so hard because you have to find someone that suits your technology, you've*
>
> *got to work through agreements in the long run what to agree on, what they want*
>
> *for investing this money and they obviously want more than you want to give them*
>
> *and it is a many year process generally. BQLD10*

From this, it is possible to suggest a reciprocal interplay between industry conditions, in which industry culture is challenged by individual actions and vice versa. This reflects a dynamic effort to align industry culture to individual expectations and conditions.

New actions occurred as a response to individual perceptions of experienced situations in a continuous cycle of adjustment between intended and unexpected consequences. The resulting and experienced situation was the outcome of individual actions that in turn reflected the actors' perceptions and interests. Individual expectations influenced how actors built common ground and understanding to create a collective experience. For example, one participant described how the frustration related to other actors' actions influenced their own actions and the resulting situation:

> *I've seen businesses very frustrated in dealing with universities because they don't*
>
> *deliver what they say. I've seen frustrations with the government because the*
>
> *government is very interested in documenting, making sure the processes are*
>
> *followed whereas the business is only interested in the outcome and gets very*
>
> *frustrated with this type of process. InSYD37*

Individuals interact to reach agreements on the different individual expectations existing in the industry collective. These agreements reflect a collective outcome, that is a combination of individual expectations in a continuous adjustment of actions. This was perceived as a constant tension between the interests of the traditional industries and the new dynamics introduced by new technologies:

> *But the industry sees the building of those pipelines in a very different way; and we*
> *saw those things have been the way industry wants to go in the future. And with*
> *that, expanding the way the government policy settings for the water industry*
> *embrace liveability, sustainability and resilience as outcomes for the industry to*
> *deliver. RMEL25*

Actors' individual actions are influenced by their perceptions, that are further embedded in the industry culture. Personal backgrounds are part of this culture and were mentioned to play a role in guiding actions towards engagement.

Participants also described the traditional industry in terms of existing resources that include physical, relational and human resources. The availability of resources in an industry context informed actors' perceptions of and actions towards what it considered to be another signal emitted by actors in the established context.

Physical resources, such as existing infrastructure, were perceived as a limitation on adapting and implementing new technologies. A clear example of this is came out of the energy sector:

> *existing companies using coal instead of using solar, we got this infrastructure and*
> *all these businesses using polluting technologies and you can't shut them down*
> *overnight. BQLD10*

Participants indicated that pre-existing capital investments in established technologies could deter the entrance of new technologies as the latter would have to compete with costs, prices and revenues with the established ones, especially when the new technologies incurred higher development and implementation costs:

> *It is because they've got this massive chemical industry plan of acres and acres*
>
> *and acres and it is piling this around and do they want to change that billion dollar*
>
> *investments? Probably not. RADL6*

Moreover, capital for new technology-based ventures was perceived to be scarce. Participants described the Australian investment market as small and emergent, which suggests that investors are still in a process of consolidating common ground, collaborations and availability of resources:

> *the VC [venture capital] market is very small because they cannot raise the money*
>
> *to invest in small companies because it is not making the return when investing in*
>
> *small companies. Why is that? Partly because it is a small market. InSYD37*

Participants recognised that the investor community was affected by government signals and support mechanism. For example, international investors would withdraw from Australia due to the unclear and changing support schemes. Subsequently, this lack of capital in the industry increased competition between organisations and resulted in the loss of new ventures to international markets:

> *Investment companies are very adverse and nobody wants to invest in renewable*
>
> *energy because it is untestable; people want to but from a business point of view it*
>
> *is very hard to play with the uncertainty currently around the RET [Renewable*
>
> *Energy Target]. IaWA24*

In terms of relational resources, participants recognised that professional, personal and business relationships could provide them with access to resources. In this sense, relationships were a resource, referred to here as relational resources. The industry context surrounding clean technologies was described as a small business community that facilitates making and maintaining contacts, and the formation and consolidation of relationships within the industry:

> *that is the advantage of being in Australia, working in this small niche market,*
>
> *small community, normally where lots of people know lots of people. BSYD14*

As a small community, participants rely on the connections they have created and maintained in both the personal and professional environments (previous jobs, studies, personal and family contacts). Participants could sporadically reconnect with these pre-established contacts and share information to extend their networks:

> *Most of the relationships that we have the clean tech industry have come through*
> *working relationships or personal contexts for example the small tech company*
> *has a very well connected advisory board of directors who have been in business*
> *in many aspects of business for a long time so they know people who know*
> *people. InSYD37*

Participants also reported existing well-established business and personal networks in traditional sectors. The interplay between traditional industries and new technologies seemed to influence social networks. Existing networks could be both a source of and a limitation on relationships for industry actors. As a source, established networks in the traditional industry have more contacts and influence on government decisions, the media and general society. As a limitation, the difficulty resides in how to create and integrate new actors to existing networks and how to get new technologies recognised and accepted:

> *in order for those businesses to be successful they have to integrate into the*
> *business stream of those traditional systems, so you need to fit into energy, into*
> *hospitality, into health care, and need to be the relationships around those*
> *traditional industries not around clean tech. InSYD15*

In terms of human capital, the traditional industry embeds knowledge, skills and capabilities that need to be adapted to the new technologies. Participants reported that the mobility of actors from existing industries to new technology-based ventures influenced the conditions and dynamics of the new field. Industry actors with different backgrounds and expertise seemed to contribute to technology and business development. This transfer of skills was seen as a support from the existing industry to the new ventures:

> *that people that has got some sharp commercial skills they are leaving the big dirty*
>
> *utilities and working on clean tech. InADL32*

Existing skills and human resources in general were considered an opportunity to support the new technologies in getting established. For example, service providers that work indistinctively across different industries, such as lawyers, accountants and IT experts among others could offer support to the new technology industry. These actors support industry development through sharing contacts and information with the new ventures:

> *they are serviced by consulting companies, engineering consulting companies,*
>
> *urban planning companies. RMEL25*

In conclusion, the traditional industry was perceived to be stable and conservative and maintained through industry culture. Individual backgrounds contributed to creating and maintaining industry culture, and vice versa. The traditional industry was also perceived in terms of the resources available, mainly physical, relational and human. Existing physical resources seemed to limit technology adoption and new ventures entering the industry. Relational resources could support new technology when the business community shared contacts and provided support. Existing human resources could be transferred to new ventures and in this way extend networks, expand knowledge sharing and translate skills and capabilities.

4.3.1.1.4. Conclusion "Conflicting and competing industry context"

The theme "Conflicting and competing industry context" describes how the surrounding context in which technological change takes place has a reciprocal interplay with the social relations occurring between industry actors. The analysis suggests that the government is recognised as a main actor influencing the process of technological change and social capital development by informing business actions. Participants' insights into the industry context suggest that signals from government in the form of policies, regulations, programs and political narratives influence the process of technology diffusion and adoption. The multiple and diverse signals emitted by government and industry actors

inform new decisions and actions related to relationships and technological opportunities. Such signals are perceived to have either a deterring or leveraging effect on industry actors. The coexistence of these effects generates a sense of ambiguity and uncertainty in industry actors experiencing technological change. The perception of ambiguity influences the expected role of the government in technological change and, based on participants' insights, this is referred to here as gov-paradox. This paradox reflects a perception of the government as an actor that moves both slow and fast: slow to adapt to technological change but fast to change supporting mechanisms for technology development and adoption.

Established industry actors and their resources are presented here as a traditional industry context. These traditional industries are described as conservative and locked into previous and existing resources, such as investments and infrastructure. This is also perceived as ambiguous because on one hand, it limits the adoption of new technology and on the other, it facilitates knowledge sharing and legitimation of new technologies and actors.

This theme contributes to an understanding of how the industry context influences social capital. The context is generally perceived as ambiguous and uncertain and this perception affects actions and interactions among industry actors. Both signals from the government and traditional industries influence the social dynamics occurring in the appearance and adoption of new technologies in the industry. Relationships between individuals and organisations play a key role in responding to those challenges, and that will be explored in subsequent sections.

To summarise, Theme 1 illustrates that:

- signals from government are perceived to be contradictory and ambiguous

- ambiguous signals influence the motivations, interactions and actions of industry actors

114

- existing and traditional industries with their resources influence how new technology ventures are accepted.

4.3.2. Technological influences

The second research question explores the influences of technologies on social capital, that is, how the adoption of new technologies leads to technological change that affect the social relations and social dynamics occurring in an industry.

4.3.2.1. Theme: Technological transitions

The theme "Technology transitions" suggests that technology adoption and social capital are related through two aspects: language and narratives, and the versatile use of technology. The type of language and the narratives that are predominantly used by industry actors during technological change influence organisational identity, values and social bonds. Language and narratives are perceived to be related to the value attributed to the technology which is derived from its diverse uses. These multiple uses of technology are recognised here as the versatility of technology. Participants referred to these three uses of technology in an industry context: technical, relational and potential. The way language and narratives, and how technology is used to influence social capital and technological change (see Figure 4.11), are explored in the next section.
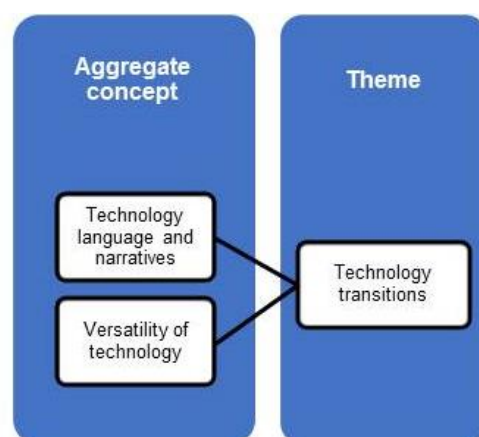
Figure 4.11. Theme *Technological transitions*

4.3.2.1.1. Technology language and narratives

Participants recognised that clean technologies respond to the need to mitigate the environmental impact of human activities. Thus, clean technologies respond to a specific need around environmental effects. Participants referred to the need to cultivate a collective identity around the specific aim of clean technologies. Despite the common environmental aim, multiple labels are used by industry actors to describe these technologies. Participants recognised that the varied terminology corresponds to the multiple uses and applications of technologies, and that it creates difficulties in reaching a unified definition of clean technologies:

> *All those kinds of outcomes can be achieved in many different ways by businesses*
> *using different technologies, so it is very hard to define what clean tech is.*
> *BMEL30*

Participants recognised that a change in the way technologies are known could influence technology acceptance and adoption in the industry. Results show how having a common understanding of clean technology could guide the process of technology development and inform business objectives:

> *And then sustainability started to sort of morphing into liveability and liveability has*
> *sort of merge into a new driver for the industry so this has now been the new*
> *vision. RMEL25*

Participants noted that the language that was used when referring to technologies in industry systems could influence technology adoption, for example "agendas", "certification", and "quality control". Industry systems are developed around specific technologies with a specific language. The use of such language influences the way technology is understood and communicated, and further influences technology adoption:

> *it is called neighbours rating which is a rating for environmental efficiency.*
> *InSYD37*

market has changed as well, when it first... when we look at this curve in 2003 we

had a green start [and some tools] came into the market place, two rating tools.

BSYD35

Changes in language evidence a constant interplay between uses and applications of new technologies and the common understanding and shared ground built around technology. This interplay influences technology diffusion and adoption that in turn evidences how actors are recognised. Participants described the efforts needed to achieve technology acceptance through a process of consolidating collective understandings, shared language and shared value around the technology:

There is no a commonality of interests between people doing different things in

clean tech that justifies the shared objectives that makes an industry. And an

industry is only an industry when there is a certain culture of the way things are

done, people are sharing ... If you don't have that it is hardly an industry. That is

my just my sense. InSYD37

The acceptance of new technologies as either a new industry or part of an existing one seemed to be influenced by the recognition of a common label. This accepted label was shown to be related to both individual and organisational identity, as will be further explored in the Theme "Elements and influences". In turn, identity influenced how actors related to each other and to their context. A common identity evident in a recognised label of the technology seemed to give participants shared symbols and a common recognised context in which they could operate.

Participants felt that a common understanding of the value of clean technology could shape the feeling of belonging to an industry. Instead, due to the multiple understandings that coexist in an industry context, the feeling of belonging seemed fragmented, which influenced the development of a shared identity:

But being able to be involved in that, it shows you how clean tech is not specific it

is actually an umbrella that have a lot of different meanings under it. BQLD8

> *someone making water irrigation, something that reduces water loses through*
>
> *irrigation so it would be water efficiency rather than clean tech. GADL21*

There was a common perception that the use, acceptance and value of technology should overcome the debate on the name used. The process of development and adoption of technology development should incorporate more than the debate on the technology name, and actions should focus on building common understandings of the technology meaning and value:

> *But again the whole point is products and services that require less inputs and are*
>
> *more efficient in the use of energy and water and so on. That hasn't change"*
> *IaSYD13*

> *Regardless the name of the industry, it is growing, especially in sectors like energy*
>
> *efficiency, building and water" IaADL3*

However, participants recognised that an overarching label, in this case clean technology, represented multiple technologies and multiple understandings of the value associated to the technologies. The consensus was that clean technology was simply an umbrella term that held multiple definitions and reflected the ambiguous use of the term based on perceived benefits:

> *an industry that is completely polarised between those that believe in it and want to*
>
> *invest in, and bring it along to those that think it is a waste of time and money.*
> *InSYD15*

A lack of understanding around the label of technologies and the language used seemed to affect business transactions. Participants indicated that on occasion the label seemed to be used like a buzzword or a 'catchy' phrase in an attempt to take advantage of certain benefits that have been previously associated with it:

> *our main message at the moment is energy efficiency. Also, make the link by being*
>
> *energy efficiency you are reducing to greenhouse gases and depending on the*
>
> *client we emphasise on that or not. BWA18*

So at the moment the term clean tech is a little bit as a marketing catch for all that. GCAN20

Language is used to communicate the value of the industry technologies. Results suggest that the type of language used supports the development of understandings and common visions of the industry. Participants described language as influencing the perceived value of technology and, thus, the acceptance of new technology as new ways of doing things:

many people didn't believe in global warming at that stage so we found that it was best to modify the message do instead of making carbon savings the main message we made energy efficiency the main message so we didn't mention the climate too much because it was too confrontational and we wanted to be non-confrontational. BWA18

Participants identify the need to align language with the way of communicating the potential benefits offered by a technology and the industry needs and conditions. Results suggest that communicating the value of the technology implies the ability to combine technical knowledge with the commercial value offered in relation to the traditional conditions of the industry context, as mentioned in the Theme "Conflicting and competing industry context":

it becomes a confrontation when they are going "you are wrong you are wrong" and you are trying to explain it, maybe you don't understand I write it again for you or I show you more information or I send you a paper or whatever and you try to explain what the potential issues they have and why they can't do whatever it is they want to do BMEL22

Additional to communicating technical and commercial value, participants indicated that the language used needed to transmit personal and organisational values to reinforce the value of the technology. Explicit communication to create a common understanding of the actor's rationale with respect to the technology facilitated the adoption of the technology:

> *you actually need to articulate them (personal values) and communicate them and*
>
> *continue to communicate them regularly. InADL32*

Participants referred to the importance of spreading successful stories within the industry to reinforce credibility and acceptance of technologies. Participants identified the need and value of these stories, referred to here as to 'tell the story'. The ability to 'tell the story' includes the identification and communication of collective values and the experiences of achieving reciprocal value. Participants stated that successful stories created awareness and interest, thus supporting actor recognition and identity building. This constituted a central avenue in the transition to new technologies, and the potential to nurture uncertain contexts, as will be discuss in the Theme "Dealing with unknowables":

> *so what we are doing is telling them the story on how we are working and that*
>
> *could give people an entrée into wanting to partner or at least to follow us*
>
> *somehow. GADL7*

> *the more success stories around the better it would be for my business, definitely,*
>
> *more confidence in the sector more confidence in the market. InSYD15*

Similarly, the label and the language used seemed to affect the actors' reputation as well as their interest in the industry. Political narratives are ambiguous signals that can either leverage or deter industry development, as described in the Theme "Conflicting and competing industry context". Thus, the use of a name that had been associated with a negative connotation affected the willingness to interact and to act:

> *The term "clean technology" is no longer used in Australia, mainly for political*
>
> *reasons; government doesn't want to talk about it. IaADL3*

In conclusion, the language used by industry actors reflected an understanding of the use and acceptance of technology. Language was evident in the name attributed to technologies and it has been shown here how this naming influenced the development of a common identity of industry actors. A shared and recognised language supports building common understandings that cultivate recognised contexts. On some occasions, identity

was perceived as fragmented due to the multiple applications of technology. Also, identity seemed to be based on specific benefits and the interests of actors in the clean technology industry. This affected the way actors interacted with each other and therefore, how their business transactions occurred. The narratives used by industry actors in technological change support technology adoption by reinforcing their social capital.

4.3.2.1.2. Versatility of technology

Participants identified that technology could be used in different ways. The different functions associated with the technology that is developed and commercialised are referred to here as "versatility of technology". The multiple functions, including technical, relational and potential functions, as shown in Figure 4.12, are detailed below, and are derived from the industry actors' perceptions of technology.
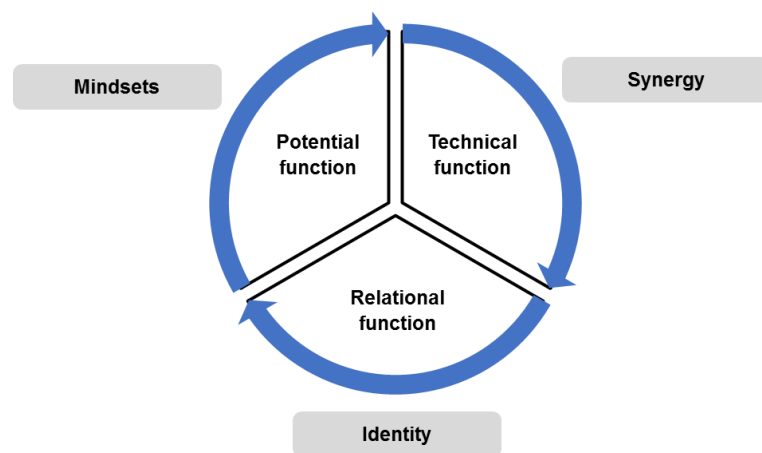
Figure 4.12. Purpose of technology

<u>Technical function</u>. The technical function refers to the specific practical application of the technology. It refers to the performance of the technology and its incorporation in different industry processes and final applications. Participants described a diverse range of technology applications across multiple industries:

> *Our industry is measurement so I don't know if that is a real industry but we are not across the typical food and beverage or iron or mining, we are involved in all of them but we don't belong to any of them. BMEL22*

The use of similar technologies across various industries was perceived as a challenge to industry actors, with regard to how to integrate the new and existing technologies, and align them with the industry context and organisations:

> *I think the [challenge] would be in the clean tech industry to really get up to speed*
> *and have products that can be integrated quite easily in the farming systems.*
> *BWA19*

Technology adoption and integration into different industries are linked to the complementarity of technologies from a functional perspective. Participants described it in terms of an actor's ability to synergise diverse technical knowledge and transform it into tangible outputs of different technologies in different industries. Actors' relationships during this process of complementarity and synergies of technology were valued for allowing sharing, exchanging and creating multidisciplinary knowledge:

> *We think we can do some work for those guys to try to develop the aquaculture*
> *industry further and by-product of that could be in the medical field. BSYD12*

> *Collaborate with some yes. That depends if you got complementary expertise you*
> *collaborate with them. RMEL23*

Participants reported that relationships were supported by the technical knowledge of industry actors and enhanced the reliability of technologies and organisations in an industry. Thus, actors' expectations of technologies were negotiated through social relations based on technical knowledge:

> *now that we have the product that it's been demonstrated that work, now their*
> *attitude changes, from yes you are nice guys to we actually want it, the one*
> *company that we've got into commercial trial now is talking to other partners we*
> *already collaborate with. BSYD11*

Relational function. The relational function of technology refers to the implicit use of technology as a medium to build collective identity around the recognition of similar

characteristics of technology. Participants referred to those similarities in terms of the sector of application (water, energy, etc.) and in terms of shared needs and common values (environmental aims). These characteristics contributed to form collective cognitive framework in which actors identified themselves and were recognised (referred to here as identity). Therefore, technology was used as a mechanism to reinforce the perception of belonging to an industry group.

Participants described feelings of belonging to multiple industries while maintaining the common aim of clean technology, that is, environmental and business performance. The perception of multiple belongings enabled actors to create diverse relationships in different industries, that in turn facilitated new business opportunities.

> *Most of the money we have spent comes from clean tech area although we also*
> *have opportunities in the food industry to save money and to work as well.*
> *BSYD11*

> *it is part of an ecosystem, all of these, it is not one technology that belongs to a*
> *completely different ecosystem that use to work together. BMEL26*

Thus, technologies that were used across multiple industries acted as a medium for social interaction. Technology was perceived to offer the opportunity to initiate conversations around technology performance and technical feedback, which enriched the constitutive elements of social capital such as credibility, trust, reliability and reputation. This will be explored in the Theme "Elements and influences":

> *now we can, instead of talking about it and showing power points, we can actually*
> *turn on a machine and demonstrate it and that is a big hurdle to overcome, if*
> *farmers can see that production process they understand a lot better and with*
> *understanding comes acceptance. BWA19*

The adoption of technologies is linked to the technical function. Participants indicated that practices used for technology demonstration were based on mutual understandings of technical knowledge and value of technologies. Demonstrating the functionalities of

technology supported building organisational credibility and reputation which in turn reinforced both relationships and technology adoption:

> *Because we have potential solutions so they just see us as a provider of the*
> *solution and they don't care whether it is a clean tech solution or just a tech*
> *solution, they just care that is a solution. So it is good, if they think we've got*
> *something they want they are more than happy to talk to us. BMEL22*

Participants also indicated that technology influenced the type of relationship developed. They described changes in the formality of relationships during the process of technology development due to the different resources needed. The development of relational bonds that support knowledge exchange and creation and that lead to forming common and unique understandings seemed to have different importance at different stages of development:

> *we are starting to do some research, so we are starting to engage with universities*
> *to prove what we are doing. BWA19*

> *Those technologies don't completely exist yet... there is research needed to do*
> *that so there may be a need for an ARC linkage project with government*
> *assistance, with commercial entities as well and that could lead to commercial*
> *outcomes. GADL7*

Potential function. Participants attributed a potential function to technology, that is, the possibility to challenge the established ways of doing things through the development of innovations:

> *I think the real issue I believe is we need to see the next round of innovation, the*
> *next round of invention that creates an opportunity. GCAN20*

This potential function of technology is, however, affected by a general scepticism around new technologies. Participants described how people's perception enable technological change by the adoption and acceptance of new technologies. Participants acknowledged that a change in people's mindsets and perceptions is needed to introduce new

technology because changes in expectations influences understanding and acceptance of technology:

> *incremental improvements are much easier to introduce in this industry, disruptive*
>
> *changes and disruptive technologies, there are a lot of scepticisms towards*
>
> *reliability and proof to demonstrate that actually works. IaADL5*

> *The transport system is running behind. People don't want to buy electric, hybrid*
>
> *cars. There has to be a change in people's perception. RADL1*

Results suggest that there is an implicit and intangible potential of technology to generate changes in the mental frameworks and understandings of people. In this way, new technologies seem to have the potential to enable context conditions and opportunities:

> *I'd suggest within 10 years, but that can actually happen because of the new*
>
> *technology at the moment. That is one part of the big shake up for the utilities and*
>
> *they are already seeing that is going to happen. BSYD38*

In conclusion, the analysis suggests that participants assigned three different functions to technology: technical, relational and potential function. Technical function is based on the performance of the technology and supports identity building and transfer of knowledge, relationships and resources across multiple industries. The relational function refers to the development of a collective identity based on perceived commonalities of the technology. Thus, technology acts as a platform to develop relationships. The potential function refers to the possible challenges to existing paradigms that new technologies brings. This implies changes in mindsets and understandings that are cultivated through relationships.

4.3.2.1.3. Conclusion "Technology transitions"

The theme "Technology transitions" refers to how technology and social capital are interconnected and both influence technological change. The understanding and acceptance of technology consolidates a technological paradigm. Such an understanding is influenced by the language used around the new technologies and their value. In turn, the perceived value of technology is multiple and evident in three roles: technical, social

and potential. This versatile role of technology influences the social dynamics that occur in the industry.

Results suggest that there is an interplay between technology and social capital influenced by language and specific narratives. The language used in an industry is developed around the new technologies and directly affects how the technologies are accepted and adopted. The evolution of language suggests changes in the acceptance that in turn reflect a shift in the technological paradigm. These changes are also linked to the application of technologies in different industries. Such multiplicity in use reflects the versatile character of technologies that influence social capital elements such as identity, language and networks.

To summarise, Theme 3 illustrates that:

- the link between technology and social capital is shaped by perception of the technology and the communication of its value

- language and narratives influence technological change through influencing identity, social bonds and new values

- the multiple functions of technology influence social capital and technological change.

4.3.3. Relational influences

The third research question explores how industry actors understand and use professional relationships and the embedded benefits. The theme "Elements and influences" presents the elements of relationships that participants identified as having a key role in technological change, and how those elements interplay with each other. Thus, multiple influences between elements and the contextual conditions are recognised by participants. Once the elements and influences of relationships were identified, results show how participants used them, as suggested in the Theme "Role of Relationships". These roles are further examined in an organisational context and allow the researcher to

explore the participants' understanding of the role of organisational relationships in technological change. This is presented in the Theme "New Organisations".

In this section, the three themes related to the perception of social capital were analysed and integrated to address the research question, "How is social capital understood and used by industry actors?". The next sections present Themes 2, 4 and 6 with the corresponding aggregate concepts.

4.3.3.1. Theme: Elements and influences

Results suggest that different facets of social capital are recognised as constitutive elements of technological change, and this is confirmed by the literature. This section presents three elements of relationships that participants recognised as having a key role in the dynamics of social capital and technological change. These are trust, identity and worth, as shown in Figure 4.13. This section presents how each of the elements is perceived to be related to the industry context to provide an understanding of the multiple influences occurring. This discussion helps to answer the research question, "How do industry actors understand social capital?".
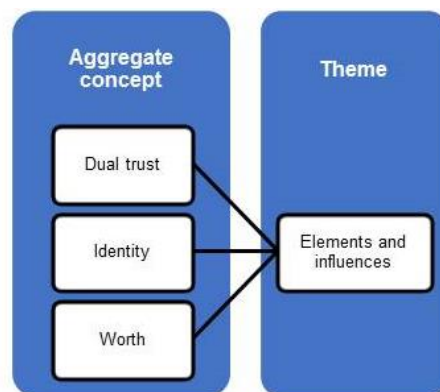
Figure 4.13. Theme *Elements and influences*

4.3.3.1.1. Dual trust

Trust is a key element of relationships. In technological change, it is referred to by participants in two ways. First, relational trust is perceived to be based on empathy and reciprocity. Secondly, trust is perceived as a resource relevant for business transactions.

These perceptions of trust are based on mutual expectations and play different roles, for example as a "safety deposit box" and for business transactions, respectively, as shown in Figure 4.14. Each type of trust and their use is described in the next sections.
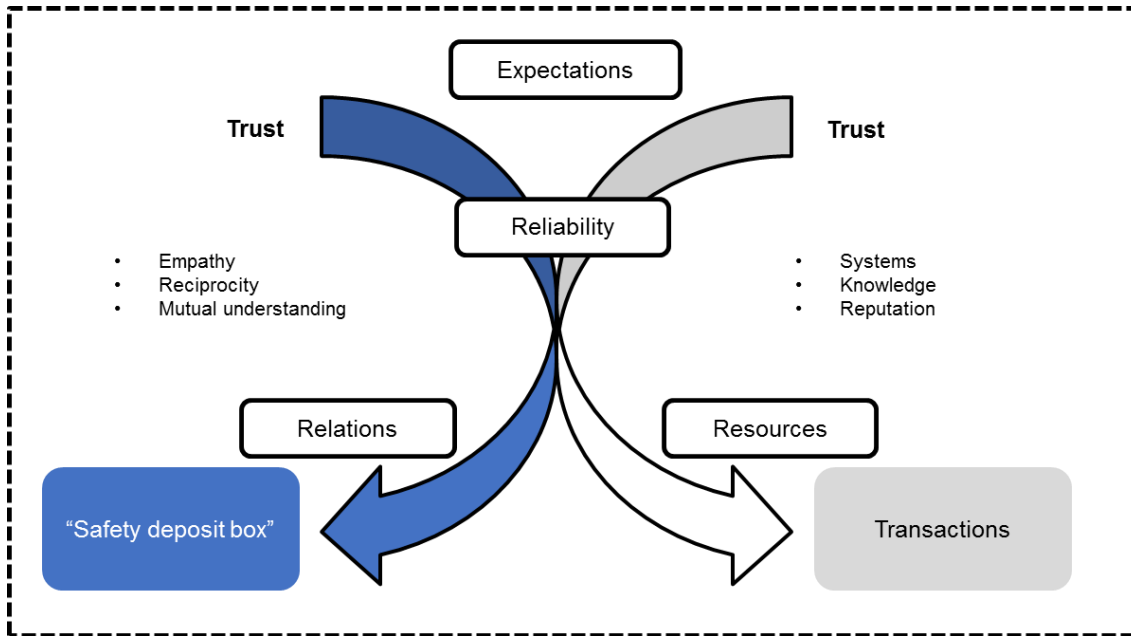
Figure 4.14. Trust

Relational. Some participants saw trust as an attribute of a long-term and close interpersonal relationship in a business environment. Trust in a business relationship was perceived to be based on individual expectations and it was evident in the initiatives taken by actors to build mutual understandings:

> *I think you have to be simply very proactive and trust other companies. BSYD14*

This perception of trust is referred to here as relational trust and was described by participants to be based on reliability and reciprocity. Reliability refers to the confidence that another party will act as agreed or expected. Reciprocity refers to mutual expectation and confidence. Reciprocity and reliability were reflected in personal attitudes towards others to foster actions and activities in the process of building and strengthening relationships:

> *you really need to be fair and hopefully they are fair as well. BQLD10*

128

Based on the reciprocity and reliability of close relationships, relational trust was referred to by participants as a key element during difficult situations. Participants perceived that a deep engagement could act as a "safety deposit box" that offered support during a period of ambiguity and uncertainty around technological change. Engagement that was independent of business outcomes and through meaningful personal connections served as a basis for resilience, as will be explored in the Theme "Dealing with unknowables":

> *that is just about trust and your relationships because when time get tough and*
> *you need it then you need to draw on that. It is like a safety deposit box. BMEL26*

Participants perceived that their involvement in social processes in organisations, such as work experience and social activities, was an opportunity to cultivate and demonstrate reliability. Simultaneously, they perceived reciprocity in the commitment of other actors and the willingness to engage in such social processes. People who worked together and engaged in social activities developed and negotiated expectations that contributed to building trust.

Organisational practices such as training, team work and staff turnover were described to influence trust. Team work and training reinforced mutual understanding as they allowed for social processes to occur. Contrarily, staff turnover was perceived to negatively affect the development of inter-organisational relationships as they interrupted the process of relationship building. Thus, organisations can influence trust building through organisational practices:

> *At a certain point, you cannot do that anymore, you need more people to do that,*
> *you have to train them and you have to trust them. BSYD14*

Relational trust was perceived as a key element in interpersonal relationships that provided mutual understanding, common ground and a sense of reliability that supported business dynamics under the uncertainty of technological change.

<u>Resource</u>. Additional to relational trust, there was a common perception that the development of trust was linked to successful results and business outcomes of industry actors. Trust was perceived as an outcome of a "good" relationship in a linear process in which "we trust each other; we will have good results". In this way, trust was perceived to enable successful business outcomes. Trust was described here to be used as a resource in business transactions:

> *If there were more trust from companies, there could potentially be more funding*
>
> *for research on those companies. RADL1*

Trust as a resource was described in terms of the reputation and credibility of industry actors, be they individuals or organisations. Reputation was perceived to be connected to the name or brand of an organisation and to be used as a credential to get support and access to other resources. In this case, trust as a resource was perceived to be transferable across relationships, that is, one actor used the existing relationships with a well-known organisation to gain credibility in an industry context. This became relevant for actors with new technologies that required recognition and support:

> *because (the company was) involved within an institution for instance a university*
>
> *or one with DECRA we've been supplying the technology. InQLD31*

Participants described credibility as linked to business success, evident through industry systems like prizes, contracts, alliances and investments. Such signals of credibility and success were perceived to support trust building and act as substitute social processes that require constant personal engagement to do so:

> *We have won some (prizes) internationally and it is good for marketing purposes.*
>
> *People trust, customers trust on your product more because you got awards, so it*
>
> *gives you more credibility or independent accreditation or so. BSYD14*

> *If we are successful, they always come to us and want to be our friends. If we fail*
>
> *nobody ever knew about us, I don't know this guy! BSYD14*

Within an organisation, trust was perceived to be linked to the position held by an individual due to the skills, expertise and knowledge associated with the position. In this case, reputation was built on previous positions and used to perform business activities to create trust:

> *I guess I've done a lot of that and that sets me up in the position that people therefore trust me as being someone who is unbiased, fair, see the big picture, help them. RADL40*

Trust as a resource was transferable when there were changes in roles or positions, for example, changes from being the funder of an SME to a shareholder when the SME was bought by investors or when competitors started collaborating on a project. The perception of trust changed according to the commitment and responsibilities of each position. In this case, trust was transferable with the individual and used to perform business activities:

> *we are moving towards collaborating with these companies. BSYD11*

Participants referred to organisational systems as another way to signal and identify credibility. The existence and use of operational systems, managerial procedures, regulations and the like were perceived to signal organisational competencies and transparency that reinforced trust building. In this case, organisational systems could either reinforce or replace social processes to build trust:

> *If you have trust in the person you are dealing with that they are not going to be disclosing the stuff that is confidential, it is much easier to work with. BQLD9*

> *The trust issue could be managed by setting clear rules, and warranting transparency of all actors. RADL1*

Technologies were recognised to support reputation and credibility based on the knowledge and capabilities embedded in the technology. In this way, technological products were used to support trust building by acting as a platform to negotiate meanings

and create understandings that were further used in business transactions, as shown in the Theme "Technology transitions":

> *if farmers can see that production process they understand a lot better and with*
>
> *understanding comes acceptance. BWA19*

In conclusion, participants perceived that trust supported the process of technology change in two ways. First, relational trust was built on social processes of personal engagement and acted as a support mechanism in the uncertainty of technological change. Second, trust as a resource was used in business transactions though organisational mechanisms and industry systems. As a resource, it could be transferable which is important for building recognition of new technologies. This dual role of trust evidences the flexibility of this element according to the industry context and individual expectations that is required during changing conditions. Technology acts as a platform to reinforce trust by signalling credibility based on technical knowledge.

4.3.3.1.2. Identity

Participants' insights suggest that the perception of belonging to an industry group is another key element of relationships, which is described here as identity. The identity as a clean technology industry was perceived to be multiple and fragmented due to the diversity of technological applications and the conditions of the context, as shown in the Theme "Technological transitions"

In an organisation, the feeling of belonging was described to come from the recognition of common personal attributes such as motivations, mindsets, goals, values and perspectives. Participants identified that a connection to a group and the feeling of belonging were developed through the interaction with others which allow them to share rationales and interests for the development of a common or shared vision. Shared attributes enabled opportunities for the involvement and participation in social processes to create shared experiences that reinforced collective identity:

I think that is just the fact that we both... I think we come across very honest; we

don't try to do things, we set ourselves very steep goals as well. TALKS

Participants recognised that the expertise and reputation of individuals supported the development of a shared identity. Individuals with specific expertise and a recognised position in an organisation were identified as elements that reinforced participation and engagement of industry actors in social processes. Simultaneously, social processes that led to successful outcomes implicitly contributed to building a shared identity through signalling recognition and credibility:

when I came into this role I think I have developed the reputation of being

someone that is very fair, being fair and building that persona is important, so

people don't look at me as someone who is going to take sides inappropriately and

so forth. RADL40

Social processes were recognised as generating a sense of belonging and a shared identity. Involvement in, for example, different industry events and activities facilitated interactions and shared experiences that signalled the willingness to contribute to a common vision. This involvement of actors in social process seemed to be driven by the implicit perceived benefits that could be obtained from industry activities.

I think it is important to be seen in those events and be sort of part of the

community. InQLD31

if there is a clean tech association everyone who is involved in clean tech would

likely be part of that association. InSYD37

The feeling of belonging was perceived to be created around technology. In the case of clean technologies, the multiple applications of a technology across different industries helped build commonalities between actors from different industry groups. For example, water technology can be used in building, water management and irrigation. Due to multiple uses, the developer had the opportunity to share experiences and characteristics with actors in diverse sectors:

having some specialised technology that can be used by the water industry but

can be used by other things as well. RMEL25

Participants recognised that the perceived value of a technology in different sectors of application influenced actors' interest in belonging to specific industry groups. Therefore, feelings of belonging to an industry group was influenced by business objectives:

you've got a number of companies you can say "ok it's clean tech" when it suits

them, like us when it suits us we can be clean tech and when it doesn't we pull

back and we say we do quality control or measurements or something like that.

BMEL22

people dress themselves up as clean tech trying to attract support. InSYD37

An organisation engages with the sector in which a better gain is perceived, which reflects an interest in transactions and resources, as will be explored in the Theme "Role of relations".

The different interests that informed how an individual developed a sense of belonging and a shared identity suggest that actors can develop multiple identities. Results suggest that actors developing new technologies share different identities in different industries according to the context conditions and the perceived business opportunities. However, although multiple identities can be an opportunity for the individual to develop interactions and relationships, and enter different markets, in the case of clean technologies, the participants perceived this lack of identity as an industry that was not unified:

They wouldn't see themselves as a clean tech company per se, they would say

they are in construction or in building products. So, I don't think that a lot of

companies identify with the clean tech sector. GADL21

A fragmented identity and a lack of an overall recognition as an industry affected the acceptance and adoption of new technologies. Participants indicated that this occurred because industry actors recognised that technology defines the industry due to the shared

identity developed around it. Therefore, a lack of common identity was regarded as an obstacle to identifying interconnections and crossovers of common goals for technology development and adoption. The diversity of clean technologies and their multiple applications was perceived to affect the consolidation of a common vision and shared understanding among industry actors. As industry actors operated in different sectors simultaneously, they pursued different collective goals:

> *being a water industry person I haven't thought of myself as part of clean tech*
> *industry. RMEL25*

> *clean tech covers solar panel, environmental consulting, construction, wind farms,*
> *it covers so many different diverse businesses that I don't think it makes an*
> *industry. InSYD37*

In conclusion, personal attributes such as mindset, motivations and values influenced the creation of a shared identity by influencing the willingness to participate in social processes and develop interactions. Social capital elements such as reputation and credibility also influenced participation and interactions, therefore influencing the shared identity. The multiple applications of technologies enabled the existence of multiple identities due to the industry groups in which similar technologies are used. The multiple identities generated a feeling of a fragmented industry and a lack of recognition. However, they also supported knowledge sharing, expansion of networks and access to resources.

4.3.3.1.3. Worth

Participants indicated that interactions and the development of relationships were guided by the benefits perceived by industry actors. Results suggest that benefits are perceived as a continuous process of motivation, interpretation and interaction, rather than an assessment of a tangible outcome accrued from relationships. Worth is, then, a broad perception that includes shared motivations and abilities.

Results suggest that personal motivations affect how interactions occur by influencing individual expectations and the willingness to interact. Further, participants described

personal motivations as rooted in individual values and rationales which allowed them to assess the benefits perceived in relationships beyond tangible outcomes:

> *but some companies they are not there... I guess they are busy but they don't see the value in collaborating whereas others do. We see that with companies that access to our programs, they are willing to work with you. So, I think it is that attitude makes all the difference. GADL21*

For clean technologies, participants recognised the existence of two types of motivations to interact and operate in the industry: the interest in business outcomes and the interest in mitigating environmental impacts. Together they reflect an underlying combination of "business thinking" and "green thinking" that influenced the sense of worth:

> *we are going to go out there, get a profit and make some difference. BQLD8*

> *People only – businesses – will only do something if it saves their money not because it is the right thing to do. There is an element of that but at the end of the day directors have responsibilities to their shareholders to run the business. InSYD15*

Results reflect an ongoing debate on the common objective pursued by industry actors in clean technology; some participants expressed both motivations (i.e. business and environmental), whilst others focused on environmental interests that evidenced a moral connection to the environmental aims of the clean technologies:

> *in the clean tech space, you always have two customer types. One is they want to do something for the nature and they are the green thinking people. And you have certainly the business people with the business purpose in mind. GADL4*

Other actors were only interested in the business aspect. Participants stated that benefits are also assessed through the tangible outcomes obtained from interactions with other industry actors. This reflects that an interest in specific business transactions and outcomes influenced the willingness to interact:

if there is no sense of an immediate benefit of knowing someone you won't

necessarily take it to the next step to explore further so they are limited by

transactional thinking. BMEL30

Tangible benefits seemed to be assessed through the recognised skills, expertise and motivations of industry actors. Participants relate that an actor's reputation and their ability to align expectations with capabilities allowed them to achieve benefits. Previous experience and knowledge of the context was recognised as part of the ability to identify the appropriate actor and align expectations:

we know who we'll be dealing with, who all they are, we probably successfully

engage in the way other companies make and that is now where we are moving

towards collaborating with these companies. BSY11

Industry actors seemed to recognise others' interests and perceptions by means of the social process in which they engaged (e.g., which event they attend). These signals influenced willingness to engage, involve and commit, therefore affecting individual action and shared identity. Participants recognised that continuous participation in social processes without tangible benefits affected interest and commitment:

Also, obviously, all these hold training seminars, information seminars, which are

very important networking events. You go there, you get a concentrated view of

what is happening and you meet number of people in one place, it is very

important. IaSYD34

We are not directly affiliated to any of those associations now. We were a while

ago those xx to the food one, and the mining one, and I was a member of all of

them but just got to be... you know, I was going to like every other night of the

week to a mining meeting or a food meeting or whatever and you know it is too

much. BMEL22

Benefits were also related to the technology itself. In the case of clean technologies, participants indicated that industry actors faced the challenge of communicating the

benefits of the new technologies and aligning them to existing industry conditions because the benefits of new technologies were perceived a posteriori. Hence, it became difficult to interpret and assess the benefits of relationships built around new technologies:

> *That is great but it needs to have a commercial outcome at the end, it is not just for*
> *fun o for publications it is for commercial outcomes. GADL7*

Worth attributed to relationships acted as a motivation to interact. Participants recognised that interactions were influenced by organisational attributes such as value proposition. Different perceptions of an organisation's value proposition influenced how industry actors interacted with others and how they contributed to action:

> *usually the stories I hear is that the funders usually want more equity and the*
> *investor usually want more equity for their money so it is hard for them to meet in*
> *the middle where mutually they agree on valuation. BSYD30*

Additionally, participants described that the size and type of organisation could facilitate interactions. These organisational characteristics seemed to inform how resources are distributed and used towards relationship building; small and emerging organisations rely more on relationships and business connections than established ones. For the small enterprises, relationships offered more benefits so that more resources (e.g. time) could be directed into building them:

> *I suppose the difference is with a bigger company you probably need them*
> *(relationships) less whereas with the smaller company those interactions can*
> *actually make a big difference to what you are trying to do. BQLD9*

Finally, participants discussed their ability to interact with the role of an actor in the organisation and in the industry. Benefits from industry actors were related to their ability to influence industry processes and decisions and associated outcomes. Therefore, worth of interactions influenced the ability to identify the "right contact" that would play a key role in individual and collective development:

call up someone in that network and get plugged into that network and then very

quickly gets you plugged into the rest of the network in the US. InADL32

Roles are further explored in the Theme "New Organisations".

To sum up, identifying the benefits of relationships and deciding to interact involved a continuous assessment of motivations, interpretation of benefits and ability to interact, rather than a specific tangible outcome. This is referred to here as worth. In clean technologies, there are two types of motivations: business and environmental. Those actors who pursued an environmental aim developed connections based on morals and personal values. Business aims focused on the perceive tangible benefits that influenced the wiliness to interact and develop relationships. The value of new technologies is difficult to assess as the benefits are difficult to communicate. Motivations need to be translated into interactions. The ability to interact was influenced by organisational attributes such as value proposition, organisational type and size and the role of actors in the industry. This reflects that there is a continuous assessment of motivations, perceived value and ability to interact, that constitutes worth.

4.3.3.1.4. Conclusion "Elements and influences"

The theme "Elements and influences" presented how trust, identity and worth are key elements of social capital that guide and maintain relationships in an industry context during technological change. These elements are evident in individuals and organisations and are constitutive of the social dynamics in technological change. The multiple uses and expressions of these elements reflects the flexible nature of social capital. Motivations play a central role in guiding the way industry actors develop and use those elements in technological change. There are mainly two motivations of actors in the clean technology industry: one is related to environmental mitigation that drives deeper connections between industry actors, and the other is focused on business objectives and guided by resource access and transactions. Technology appears to affect, on some occasions, these elements and act as a platform for interaction.

To summarise, Theme 2 illustrates that:

- constitutive elements of social capital in a technological change are trust, identity and worth

- social processes influence the development of these elements, and conversely, these elements influence the willingness and ability to interact

- these elements are individual, temporal and contextual.

4.3.3.2. Theme: Role of relations

The theme "Role of relations" reflects participants' descriptions of their use of relationships during technological change. Results lead to the identification of three roles of relationships: transactional, collective value and spill-over (as shown in Figure 4.15). Understanding how industry actors attribute these three relationship roles under uncertainty helps address the question, "How is social capital understood and used in a context of technological change? The next sections present in detail the identified roles of relationships.
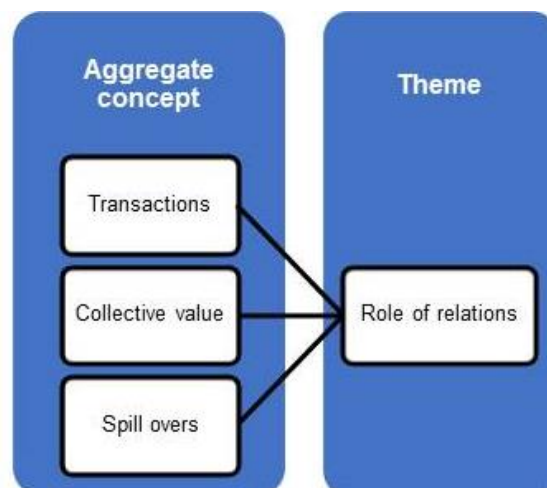
Figure 4.15. Theme *Role of relations*

4.3.3.2.1. Transactions

Participants indicated that relationships were built around a clear identified outcome, which was referred to as tangible benefits in the previous section. Among the motivations to interact were the expectations of achieving a business objective, and specific interests in accessing resources, both tangible (for example, capital and infrastructure), and intangible (for example, technical or contextual knowledge). These motivations responded to an opportunity to profit based on common expectations, for example, with capital investments in new technologies or the integration of technology products as inputs in industry processes:

> *It is a relationship build on something that we can supply and that they need. So, it is not a friendship before we start, it is a relationship that kind of happens as we go along. BMEL22*

> *it is a relationship and it should bring [outcomes]; the researcher should learn from the industry and industry should utilise the knowledge of the researcher. GADL4*

Outcome-driven relationships seemed to be built on the explicit belief that a good relationship enables transactions, thus relationships were linked to performance. Participants described a need to achieve outcomes to sustain relationships. The role attributed to those relationships was relative to the achieved outcomes that were mostly the resources accessed through relationships. This suggests a reinforcing relation in which relationships lead to outcomes, and then transactions support the development of relationships:

> *if you get that personal relationship right the successes will come from that. BQLD8*

When relationships enabled transactions, participants indicated that changes in the formality of relationships could occur, for example in the form of alliances or contracts. Formality was then seen as a successful outcome that kept nurturing the relationship:

> *In a social networking sense only a collaboration in business is all about eventually coming out with some kind of business relationships, so that usually results in some kind of transactions and ultimately will come down to some kind of contractual arrangement or legal agreement. BMEL30*

There was a mix of insights into how transactions drove relationships. Some participants identified business outcomes as the main focus of relationships, regardless of personal relationships:

> *Every business is a relationship business, it doesn't matter whether you are in IT or you are an engineer or you are in marketing, it is a relationship business. BSYD38*

Others recognised the value of personal relationships beyond the business outcome and differentiated business and personal relationships. In this case, expectations seemed to be linked to personal values rather than to resources, and this will be further explored in the next section:

> *Business is a 100% by personal relationship. There is no business without a good underlying personal relationship, that is true... and the more I see this the more I realise that, you just don't have business without that. It is really that simple I think. InSYD36*

Other participants indicated that personal relationships could enhance the formal business relationships (where an outcome is expected), such as in the case of an investor–investee relationship. In this situation, expectations included both business profit and the willingness to transfer personal values and expertise. Mentoring or coaching relationships at a professional and personal level influenced mindset and values:

> *it is not just investment it is money and mentoring, so you mentor companies, you go on the board of companies and that sort of things. RADL40*

In conclusion, outcome-driven relationships were based on clear opportunities to access and exchange tangible resources like capital, contacts, technical knowledge and the like. Achieving specific outcomes reinforced relationship building and on occasions fostered a

change in the formality of relationships. Relationships could also be based on personal values which could support the development of business relationships. In general, findings suggest that industry actors have a transactional thinking mindset that guides individual choices to interact and develop relationships during technological change.

4.3.3.2.2. Collective value

Participants indicated that, beyond business transactions, relationships were also built around the need to develop a collective vision that serves as a basis for consolidating industry groups. The creation of a collective mindset is founded on social processes and individual actions. Participants acknowledged the importance of social processes to enhance the feeling of belonging to a group and in this way supporting the development of relationships, as shown in the Theme "Elements and influences":

> *it's three times a year the meeting and meet the who is who in the building*
> *environment at a top level, so there is a huge value to that. IaSYD35*

Social processes enhance knowledge sharing and create an understanding of the technology to contribute to the collective mindset. Participants described the collective mindset as developed around common technical knowledge that facilitated understanding for collective goal setting:

> *we are having physical demonstrations saying what CLT is because people have*
> *never seen it. GADL7*

Social processes also facilitated nurturing elements of relationships such as trust, as presented in the Theme "Elements and influences". Social capital elements influenced individual actions, such as business decisions, that in turn supported collective mindset development and industry group consolidation:

> *that has a big influence on us investing in it because we have a confidence in that*
> *person, doesn't mean necessarily everything in that company is any better than*
> *another one but the fact that you know someone, and trust them is an important*
> *component of that. RADL40*

In relation to individual actions, participants perceived that actions occurring within a collective created a context of support that enabled synergies among actors. This supportive context leveraged new actions from other industry actors which in turn cultivated the collective mindset and contributed to the collective belonging:

> *put that together with good leadership someone who help go and get the money*
> *and that help a positive environment to work, and at the end of the day that is the*
> *most important thing. RADL40*

This suggests that relationships are used to create opportunities and new conditions in the industry context, as will be further explored in the Theme "Dealing with unknowables".

Collective mindset influenced collective action and enabled new conditions for business opportunities. Thus, a collective mindset was perceived as a collective value that differed from the individual benefits and business outcomes recognised in relationships. For example, participants described a collective confidence and responsibility among industry actors during the uncertainty of technological change:

> *the clean tech people are networking and trying to work together and trying to*
> *survive together. BMEL22*

This suggests that industry actors trust both individuals and the industry as a collective to overcome challenges, as will be further explored in the Theme "Dealing with unknowables".

Participants also attributed to the collective mindset the role of fostering interactions, relationships and actions. New interactions were constantly formed across multiple actors which enabled opportunities for collaborating and developing business:

> *that allows us to plug ourselves in quite nicely whether I am talking to other*
> *investors or partners in the US or Hong Kong or Singapore the model, the way we*
> *interact, the social interactions, now are quite consistent, which makes business*
> *very easy. InADL32*

This embedded support seemed to be used to create momentum, which will be explored in the Theme "Reaching horizons". Results suggest that joint efforts and collaborations reflect the existent collective abilities and industry capacity to support technological change.

In conclusion, relationships based on personal values enabled the consolidation of groups of individuals with embedded synergistic value. Social processes nurtured collectives that further supported the development of an understanding of the new technologies. A collective vision also influenced trust, identity and a shared mindset among industry actors. A collective mindset enabled actions and interactions to create new conditions and opportunities in the industry context. This potential to create new conditions and opportunities for businesses suggest that relationships play a role in facilitating transitions, by guiding individual actions and interactions and consolidating new collective mindsets. This is referred to here as transitional thinking in industry actors that supports technological change.

4.3.3.2.3. Spill-overs

Relationships can be used in the dissemination and integration of personal values in the industry context. This suggests that relationships have a multiplier effect that support the integration of individual values into the collective. Participants indicated that personal values could be communicated to create and influence organisational and industry culture:

> *One of the good things about ASBEC is that its representatives are honourable.*
> *IaSYD35*

> *there are lots of good honest people in the industry. BSYD14*

Participants described the use of relationships to disseminate individual successes into a collective, and in this way, nurture an enabling context. This supports the common understanding of "success breeds success", when someone's success fosters success for others by attracting interests and resources to a specific context. However, participants

recognised that relationships could also disseminate difficulties or problems and influence the context negatively:

> *once you get one customer you get similar customers as well and it follows in. BSYD17*

> *there comes the time where a person can be so ineffective or destructive that you can't afford to try to fix it. InADL32*

Relationships are also a point of reference to identify who is who in the industry. Participants used their contacts as a signal for reputation; this is, on person's reputation built another's credibility simply because of the relationship between them:

> *They would have an impact in the process indirectly because we can say, for example if an investor comes in and says who is interested, I can ring the guys in P&G, Glaxo, mining sites, they all would say that they all like it, no body has spoken yet but they all said they will. BMEL22*

This reflected the participants' beliefs that reputation and credibility are transferable among individuals, as described in the Theme "Elements and influences".

Thus, participants described how they extended their business networks. New contacts were seen as both outcomes of an existing relationship and as new opportunities to expand relationships. The overlapping of different contacts across business networks allowed individuals to be present simultaneously in different industry groups and, in that way, contribute to industry recognition through consolidating the collective identity, as seen in the Theme "Elements and influences":

> *who really wants this technology so that their lives get better as well, they will put something in to work that nobody else will, it is a success. So, they want us to be a success so they can be a success so we all win. BMEL22*

> *you have this group together and because I am part of this group, we are getting all these contacts, we are getting more opportunities. BQLD10*

In conclusion, participants indicated that they use relationships as a spill-over mechanism to communicate their values and to expand their business networks. In both cases, relationships influenced organisational and industry culture and supported technological change by means of recognition of new technologies.

4.3.3.2.4. Conclusion "Role of relations"

The Theme "Role of relationships" presented how industry actors described the use of relationships in three ways. First, relationships were used to access resources and achieve business outcomes. This suggests that industry actors' motivations to engage are outcome-driven, which reflect a transactional thinking. Second, relationships were used to create a collective mindset that sets the basis for industry consolidation in technological change. Collective mindset supported the understanding and acceptance of new technologies and enabled the creation of new conditions in the industry context. Lastly, relationships were used as a spill-over mechanism to integrate personal values into a collective vision of the industry. Both success and problems could also be spread through relationships. Social capital elements, such as reputation, credibility and networks, were transferred and nurtured through social processes and relationships.

To summarise, Theme 4 illustrates that:

- outcome-driven relationships are based on clear opportunities to access and exchange tangible resources that reinforced relationship building

- relationships based on personal values enabled the formation of a collective mindset that guide actions and interactions to create new conditions and opportunities in the industry context

- use relationships as a spill-over mechanism to communicate their values and to expand their business networks

4.3.3.3. Theme: New organisations

This section examines how relationships are perceived specifically in the context of an organisation. Results suggest that some organisational characteristics influence the development of social capital during technological change, and that relationships are used to adapt and enable organisational change. To explore this idea, three aggregate concepts were identified (as shown in Figure 4.16) which contribute to an understanding of how social capital is used in an industry context during technological change.
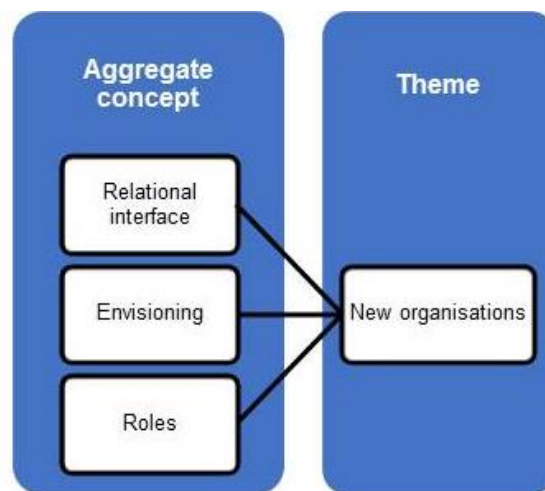
Figure 4.16. Theme *New organisations*

4.3.3.3.1. Relational interface

Participants recognised that characteristics of both the organisation and the surrounding context influenced and could be influenced by business relationships. Results suggest that relationships in an organisational context can be used to align these characteristics by developing an understanding of the conditions of technological change. Participants suggested that organisations could modify the organisational identity in relation to the industry context through an ongoing negotiation of individual, organisational and industry characteristics. Consequently, results suggest that an organisation that uses business relationships to align itself with the industry context acts as an interface for technological change.

Cultural differences are a recognised aspect of the industry context that need to align with the organisational culture. The industry context provides a cultural and social environment that needs to be understood by individuals in organisations. This environment influenced the identity of organisations and individuals. Implicitly, individuals accepted and embedded the social characteristics from the context:

> *You have to be I guess for the industry and technology based industries someone*
>
> *that you feel has a high degree of integrity. RADL40*

Participants stated that some aspects of the industry culture affected relationships negatively. Common behaviours of individuals in specific sectors were recognised as established stereotypes that relate to negative values to those sectors. For example, honesty and integrity were associated negatively with sectors such as waste, and positively to biotechnology. Such stereotypes influenced the willingness to interact and the way interaction occurred:

> *you can't... science has got to be based on facts and so forth and you don't want*
>
> *people twisting the rules so it is very high levels of integrity. RADL40*

> *I am sure most of them are honest but there is certainly a perception that a lot of*
>
> *people involved in the waste sector are anecdotally crocks. InSYD36*

Country-specific cultural traditions guided individual actions and patterns of behaviour. Such cultural aspects were rooted in individual perceptions and mindsets and may have influenced relationships by bringing together different perspectives. This contributed to the collective identity and mindset and challenged the accepted behaviours in the industry:

> *So, when I came here, from my experience when I was dealing with SME in*
>
> *Germany they always try to be a step ahead always; that is a German thing …*
>
> *when I come to a business here, you realise that once the business is successful*
>
> *with the products many of them just stop thinking what is the next step and that*
>
> *sort of stuff. GADL4*

An understanding of the existent cultural differences in an industry supports the acceptance of social agreements, such as standards, monitoring tools, rating systems, legal systems and the like. These social agreements provide an industry with a structure within which to operate. Referred to here as industry systems, they play a role in reinforcing reliability between organisations. Participants indicated the need to align with industry systems and the industry culture to develop their business:

> *In Australia, we rely heavily in contracts, over there you might start with the*
>
> *contract but if something is not working you've got to be very flexible. GMEL33*

The development and adoption of industry systems were described to coevolve together with technological change. As technology change, systems like standards, control tools, rating systems and legal systems were developed and implemented, and its adoption in turn facilitated the development and acceptance of technology. The theme "Technological transitions" showed how language is involved in this coevolution:

> *the building sector it is commercial but its resistant regulation to force it to become*
>
> *more energy efficient. GADL7*

Industry systems were perceived to have a double role. First, the adoption of industry systems by an organisation could support its credibility in the industry context, thus influencing relationships and the resources accessed through them:

> *they refuse to have legal agreements with us and we won't allow them to take*
>
> *control of any product until those legal agreements are signed. BSYD12*

Second, adopting new industry systems was seen as an opportunity to explore new ways of doing businesses, and thus influenced which and how relationships were developed. For example, trade agreements fostered new interactions that pursued business and technological opportunities:

> *we should do a lot more transfer between Australian and particularly with cultures*
>
> *that we have trade agreements in place. InADL32*

Industry systems were also derived from government initiatives and implemented through policies. Simultaneously, policies responded to a need to have an appropriately regulatory framework for a technology.

> *embedding new standards, codifying new standards through regulation. TALKS*

There is a complementarity between industry systems and policies to support technological change, as shown in the Theme "Conflicting and competing industry context".

Within the organisation, participants described characteristics that influenced relationships, including the nature of the organisation, the roles and positions of individuals, the technical knowledge and skills, and the managerial practices. These characteristics were seen as part of an embedded supportive framework that supported the development of relationships.

The nature of an organisation refers to its type, size and structure, and how those affect relationships by influencing common understandings and worth, as shown in the Theme 'Elements and influences'. Results suggest that the nature of organisations influence the way industry actors respond and relate to others within and between organisations:

> *we can certainly show them some work and that gives them and idea of what mind set we are in and what approach to project deliver is. GADL7*

Therefore, social skills seemed to be managed differently in each organisation and by each individual actor. Participants indicated that the engagement in inter-organisational relationships was influenced by the size and structure of the organisations involved. For example, relationships between small and big firms changed with their internal structures and cultures and the benefits perceived and expected by organisational actors:

> *I guess large company and small company are very different places so that dictates a fair bit where they are at and how they interact with others. GADL21*

Participants' insights reflect that the type of organisation informs the social norms, which in turn influences social processes, interactions and the dialogues actors engage in. For example, government organisations were perceived to accept less social activities that involve personal engagement:

> *actually, if you invited someone from the utility business to go to dinner and drinks*
> *particularly if it is a government utility they often say no... Hospitality does not*
> *always fit with that environment. InSYD36*

Another organisational characteristic that participants referred to as influencing relationships was the position held by an individual in an organisation. Position seemed to affect the perceived value of a relationship through the values associated with the position, and in turn influenced the decision on who to interact with and how:

> *I have colleagues that do more lobbying in the hierarchy, for example my CEO.*
> *BSYD16*

Participants indicated that industry actors held multiple positions along their professional career. Each position involves different levels of individual participation in social processes and represents multiple roles simultaneously. Participants reported that the benefits of holding multiple positions were the enhanced understanding of the industry by bringing multiple perspectives and expertise together, and the possibility of expanding connections and relationships.

> *if you are anywhere between a graduate and a senior engineer, where your work is*
> *to do the work and no so much business development, then those networks*
> *functions are good. BSYD38*

A significant element of organisations that influences relationships is the strategic approach of organisations. Participants acknowledged that their business objectives guided the type and formality of relationships and collaborations they engaged in. Results suggest that participants hold an instrumental understanding of relationships that prioritises tangible benefits, for example, resource access, as presented in the Theme

'Role of relations". This instrumental view informed how to develop relationships, behaviours and decisions, and implied the need to identify who to engage with and how, and the ability to adjust the form of engagement according to the situation:

> *the end result is "I want to sell this thing to you", how are you going to find the way*
> *to doing this? BSYD17*

Participants' description of their way to manage inter-organisational relationships seemed to be rooted in the strategic proposition of the organisation. Participants indicated the possibility of developing business models that included the value of relationships according to the technological needs in the industry context:

> *it is quite a mature dialogue that goes when small businesses are trying to grow to*
> *say 'hey it is not really the same as working together'. Whereas in academia they*
> *are more touchy about collaboration and that is because they are competing for*
> *these funds. BMEL26*

> *the reason why we have been so careful about who we choose to partner with to*
> *go into different areas is because relationships are key part of our business.*
> *BMEL27*

Managerial practices facilitated long-term relationships by supporting an actor's ability to foresee relational assets needed for technology development and commercialisation. Managerial practices were described by participants as informing how to manage evolving business models that aligned changes in structure, performance, relationships and technology:

> *situation went pretty well because there was a good performance management*
> *process in place. InQLD31*

Organisational nature, an individual's position in the organisation, and the strategic vision co-evolve with organisational knowledge. Results suggest that organisational knowledge influenced relationships. Participants perceived organisational knowledge was evident in

successful outcomes and such success acted as a signal of organisational capabilities that influenced actors' interests in fostering relationships. Success seemed to be evident in sales, awards and similar, and strengthened organisational reputation and credibility.

Technical knowledge was perceived to offer a platform for interactions as organisations interact with each other based on their technology, as shown in the Theme "Technological transitions". Participants suggested that technical knowledge required mutual expertise and understanding to complement knowledge and create synergies:

> *in 2006 we did the first break through which I then went with to some of my*
> *previous clients. BSYD11*

Participants indicated that knowledge about the industry context, contextual knowledge, informed industry actors about the benefits of relationships that could be expected and the possible changes in the formality of the relationship:

> *what we try to do is we know that we want to work with a certain company.*
> *BSYD38*

> *at some point you may need some strategic alliances with your competitors to*
> *make things better overall, rather than trying to compete and making it hard for*
> *each other. BQLD10*

Results suggest a co-evolution of contextual knowledge and relationships that enables organisations to adapt to and influence the industry context. Contextual and technical knowledge resided both in the individual and the organisation to guide how to use existing resources, capabilities and expertise in uncertain situations:

> *If it wasn't for our previous experiences with international marketing I think we had*
> *struggled a lot more. BWA18*

In conclusion, relationships enabled the organisation to align the individual, organisational and industry context during technological change. In this alignment, both industry and organisational characteristics played a key role, and could be influenced by strategically

managing intra- and inter-organisational relationships. Thus, it is possible to understand an organisation as an interface of continuously changing relationships that adapt and contribute to technological change.

4.3.3.3.2. Envisioning change

Results suggest that participants acknowledge two ways in which organisations interact with the context of technological change: first, complying and adapting to the context, and second, creating change in the context to be able to introduce the new technologies. Organisations move between adaptability and the ability to enable change. This section explores how participants described the use of relationships towards those aims in an organisation.

Adapt to change. Participants referred to the ability of organisations to adapt to current conditions of technological change to sustain their businesses. This adaptability was seen in how technologies adjust to different industry conditions to achieve acceptance. To do that, participants suggested adjustments of business models, managerial practices and communication of the technology. This adjustment influenced interactions and the development of relationships under technological change:

> *But they are now also in the US they are looking at how they expand into new*
>
> *markets and we are trying to reposition away from being a clean tech energy*
>
> *efficiency company. InADL32*

Adaptability was described in terms of organisational capabilities to identify signals in the industry context. Participants reported that they needed to identify signals from international markets, investors and other actors so that they could pursue opportunities to innovate and position their technologies.

> *the industry worldwide looks very bright; our strategy is to develop the technology*
>
> *here, export it overseas. BSYD11*

> *we are innovative in that space and that creates economic opportunities for us to*
>
> *explore. GADL7*

Another element of adaptability was described as the ability to use resources and competencies to adapt to changes. Participants indicated that they used their existing knowledge and skills to access new and expert knowledge and to foster new opportunities.

> *I did lot of international businesses, each industry is different, you can't just adapt, take your experience and put it in the next business; this is totally different, so you never stop learning at the end. BSYD14*

Enable change. Participants also referred to the ability of organisations to influence the existing industry conditions to position their technologies. To do that, organisations could support professional development by fostering strategic relationships. Participants reported using both formal (training) and informal (sharing experiences) mechanisms to develop skills and knowledge in their organisations. Social skills especially, were reported to be developed through cumulative experiences of individuals within a collective:

> *We don't specifically train anybody on how to manage these relationships, it is more like an informal learning, "as you go" kind of thing. BMEL22*

> *the staff members that are coming through they will be introduced to do it (relationships) and try to get to the next level after that when the next level moves on. BQLD8*

Organisational capabilities to enable change were described as stemming from the managerial skills of individuals. However, participants perceived that actors with scientific backgrounds lacked commercial and business skills. In a context of technological change, technical knowledge needs to be complemented with managerial skills. Thus, the actor leading technology development and commercialisation influenced managerial decisions that would further influence technological change:

> *Because what happens is you go into these things and you don't know how to run a company or what the pathways to commercialise something. BMEL26*

Among those managerial skills, participants suggested that identification and matching of actors was required to incorporate the value of strategic relationships into the organisation. Implicitly, this involved the ability to simultaneously manage multiple relationships to bring different benefits and opportunities to the organisation:

> it has been important to find local people that helps building those relationships.
> RMEL25

> I am not sure what word to use but the more they can deal with the people in their
> industry the more specific the learnings and connections are. GMEL33

Participants indicated that organisational capabilities were evident in individuals creating new connections and supporting industry actors to transform technological and market needs into opportunities. Implicitly, this capability suggests that actors could assume different and multiple roles in an industry setting:

> what we are doing is creating connections for local clean tech innovators with
> clean tech innovators in the States. GADL7

> actually, empirically looking at themselves and see what they need help with, even
> if we know what they might need help with they are not necessarily open to that.
> IaADL5

Enabling change is also rooted in an actor's ability to influence individual understanding and perception. Participants recognised the need to influence existing mindsets and paradigms in the individual, organisation and industry to allow technological changes to develop:

> once you got them feel that you are doing things that is not correct for them you've
> lost them probably and it is very hard to come back. RADL40

Changes in individual attitude and perceptions were complemented with the development of individual skills and organisational capabilities. Results suggest that there is a co-evolution between individual mindsets and organisational values through organisational

practices. Individual actions influenced organisational practices that in turn allowed changes to become established:

> *sometimes when I visit a company the thing I think is that they don't need a*
> *research project, they need to get a business advisor who opens their mind, it is a*
> *change management thing. GADL4*

Participants suggested that the adoption of technologies relied on social dynamics to enable change in the technology paradigm. Technology implementation was guided by individuals' perceptions of the technology, which was rooted in their attitude and willingness to try something new. Participants described the use of relationships to influence individual attitude and perception to support technological change:

> *You can't say that solar panel are disruptive technology because the technology is*
> *already there, what is disruptive is the way it is overcoming traditional xx based, a*
> *network organised energy infrastructure. IaSYD13*

> *plugging into innovators and their mind set of that entrepreneurial spirit; something*
> *about what we do that try to change their mind sets by demonstrating and through*
> *that connections and networks. GADL7*

<u>Versatile relations</u>. Results suggest that social capital enables organisations to operate between adapting and enabling change. The dynamics of the different social capital elements mentioned in previous sections co-evolve with industry dynamics and systems:

> *by the time your relationship is strong enough to actually launch into a serious*
> *business partnership the market that you thought you may have has now shifted.*
> *InSYD36*

The constant interplay between industry dynamics and organisational decisions influenced the way relationships were valued and managed. Participants recognised that changes in relationships occurred due to the industry conditions and in alignment with the commercial objectives for the technologies, as shown in the Theme "Conflicting and competing industry context":

>*On the surface they might be seen as competitors but when you actually look*
>
>*down to where the niches are they are actually potentially collaborators. GADL21*

Changes in relationships were also described as occurring according to the process of technology development and commercialisation. Participants indicated the need to align relationships with the characteristics of the process and to adjust the organisations accordingly:

>*it works very well to make the initial connection and for the people to get along but*
>
>*for an association to become a collaboration and the economic output there is a*
>
>*long way to go between that initial level of interest to actually doing something*
>
>*together, actually working together. BMEL30*

An example of organisational adjustment regarding relationships is staff turnover. Individuals who leave an organisation affect the development of social capital elements, such as trust and reputation, and disturb the development of relationships. Therefore, staff turnover was perceived on occasion as a threat to an organisation's relational bonds:

>*big companies do need contracts because they can turn around "she doesn't work*
>
>*here anymore." BMEL26*

However, participants also referred to an implicit capability to rebuild the interpersonal bonds affected by the staff turnover, which reflects organisational ability to adapt to changes:

>*the ones that are gone they have been replaced by people who can repair the*
>
>*trust. The decision making in the organisation it is perhaps driven more by people*
>
>*coming out of the industry and I hope they deliver their objectives. RMEL25*

Results indicate an interesting contrast of the implications of organisational practices, such as staff turnover, on industry and inter-organisational relationships. While staff turnover was described as deterring organisational social capital, it was also recognised as beneficial to the industry because of its ability to facilitate an exchange and

combination of resources. Individuals moving across organisations represent the potential to enhance knowledge sharing and recombine organisational capabilities. Staff turnover allowed skills to be transferred across industries, and to be adapted and complemented. In this way, it was seen as an opportunity to create a collective resource, that in turn supported technological change. Staff turnover facilitated the consolidation of a collective expertise that was perceived as a valuable resource to the industry. This suggests that understanding staff turnover as a collective resource requires a value assessment beyond the organisational boundaries, in a broader sense of worth, as suggested in the Theme 'Elements and influences'. Thus, the value of managerial practices and industry resources is a constitutive part of a collective that is assessed in a continuous cycle, rather than a focus on the immediate and tangible benefits perceived by an individual organisation:

> *a lot of people know other people because they move from business, they move from one company to another company where they grow business and then move out, or there is a venture capitalist in the industry or there is a legal industry, it is all intertwined. BSYD37*

> *building solar panels or whatever but the basic skills there are not dissimilar to what you get in construction and really it is just customising the capability to the industry. IaSYD34*

The ability to transfer, adapt and develop new skills was recognised as a core capability for technological change for organisations both individually and collectively. In this process, participants stated that industry conditions could facilitate the formation of new or different relationships and therefore nurture the development of social skills:

> *You work with government differently than you work with universities than you work with consultants than you work with construction. InSYD37*

> *key people changes from scientist to business developers. TALKS*

The formation of new and different inter-organisational relationships was perceived to require an alignment of organisational values, business objectives and organisational

capabilities, in accordance with individual expectations and industry conditions. This alignment strengthened the role of each organisation within the collective and facilitated envisioning new opportunities. New social assets fostered new roles for organisations and individual actors in the industry:

> *we find that the major water companies we are dealing with are looking for new ideas and new technology, something that sets them aside from their competition, so they are quite open to an approach and to a discussion about what we might have, and we have a very good reception from those companies. BSYD12*

Results suggest that forming new relationships reflects a synchronisation of multiple understandings that create synergies for collective action. Collective habits of interaction and cooperation amongst actors fostered conditions in the industry to create new business opportunities and empowered individuals to pursue them:

> *for example, there is a couple of good industry associations and there is a couple of very good government programs and as part of that they are very very open to working together and learning from each other, and I think that is a very good thing and not all industry sectors are like that. GMEL33*

For example, there is a recognised synergy between small and big firms. Participants acknowledged the strengths of those collaborations in terms of technology development. Small firms tend to focus on R&D while big firms foster commercial opportunities. This complementarity reflects an alignment of multiple and diverse agendas coexisting in a continuous synchronisation and negotiation in the industry:

> *Big companies might not innovate but want to get innovation from someone else; this someone else can be the SMEs. RADL2*

> *what they are trying to achieve is different to what you are trying to achieve, so there are different cultures, different ways of working, different timeframes, different priorities, so you need to understand that. InSYD37*

there is a big hurdle for an individual entrepreneur to success with a different idea;

the entrepreneur has to be aligned with what the big company wants and

overcome a long bureaucracy process. RADL2

In conclusion, organisations hold the ability to both adapt to changes and to create new conditions. To operate in these two approaches to change, relationships were used differently and had multiple interplays with the characteristics of the organisation and the industry. Changes emerged from individual perceptions and were interpreted differently by industry actors. Changes also had different effects on individuals, organisations and the industry context. Results suggest that such differences can be aligned by means of relationships towards supporting technological change. Organisations and their inter-organisational relationships support technological change by envisioning opportunities derived from the continuous alignment of elements.

4.3.3.3.3. Roles

Organisations rely on multiple industry actors to support their operations. An actor can be either a person or an organisation in the industry. Participants reported that specific actors supported the development of relationships in different ways, which suggests that specific functions are assumed by an actor in the collective, referred to here as 'roles'. Participants referred to three different types of functions assumed by actors – connector, facilitator and bridging – to facilitate individual action and technological opportunities, as shown in Figure 4.17. They could operate at an interpersonal level via an actor who acts as intermediate between individuals' relationships, and at inter-organisational level by organisations that act as a mechanism to facilitate interactions.
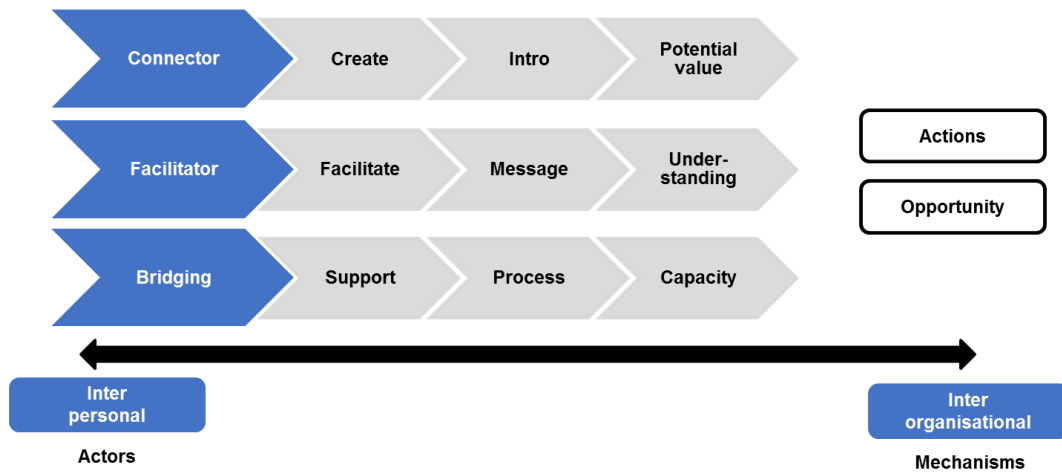
Figure 4.17. Roles of actors

Connector. The connector role was described as an actor who focused on making introductions. The perceived value resided in knowing industry actors and how to approach them. This role was rooted in the ability to align interests, motivations and needs of different industry actors to enable potential business opportunities. Participants often referred to this role as a "broker" – someone who was able to create opportunities by connecting industry actors and facilitating interactions:

> *My job is to work in the broad supply chain in the clean energy sector, so wind,*
>
> *solar, all those areas. The ultimate objective is to connect people to create*
>
> *opportunities to strength industry. IaSYD34*

Social capital elements such as an actor's reputation and credibility facilitated the connector role. For example, the government's reputation, credibility and visibility acted as 'pulling power' to connect industry actors and create opportunities for new actions. Participants perceived the government as a legitimate actor which enhanced trust and facilitated new connections. Individuals from government and recognised institutions could act as connectors, based on the recognition and visibility of the organisation and its support programs:

> *as a government department, we actually have the pulling power to get the*
>
> *decision makers alone to our events and out meetings. GMEL33*

163

part of that is because we have a visibility across a number of sectors so we can

join the dots when there is an industry silo but also because generally

governments are trusted partners, so you could share information with

government. GADL7

Participants also recognised this role in industry associations. These organisations have the ability to link business organisations and act as an inter-organisational intermediary:

there are forums for people in the building industry to work together and

communicate what is going on and to talk to government about policy. InSYD37

The value of connectors was described as a potential value embedded in new relationships. However, due to the complex and long-term process of building relationships, and the predominant focus on tangible business outcomes by industry actors, the potential value of relationships was perceived to be uncertain and difficult to assess. This uncertain value will be further explored in the Theme "Dealing with unknowables".

We can see opportunities for people to collaborate and add value together, so they

may not know each other. GADL7

Facilitator. The facilitator role was described as an actor who mediated between actors to support relationship development. A facilitator understands both sides and helps transmit the message and adapt the language:

There is a couple of... companies I helped bringing them to the table. GADL21

Participants recognised the ability of facilitators to adapt technical and business jargon and perceived that the value resided in technical and contextual knowledge to interpret and communicate the message between actors:

some products are more technical that unless you are a specialist I wouldn't

understand, so they have to be able to connect with me in a way that I can

understand and then from there we can work on even simplifying more so that

> *people from my network from overseas with English as a second language can*
>
> *understand before they can connect with anyone really. GMEL33*

This also included the ability to look for new information and transfer and use it to support relationship building.

> *When I said, I made the data available I basically downloaded a translator and*
>
> *made it easier to comprehend but I am not changing any numbers. BSYD16*

Participants perceived that a facilitator role mainly focused on interpersonal relationships, which involved overcoming difficulties and building common understandings. It is seen in consultancy and advisory positions.

Bridging. Someone who held a bridging role was described as an actor who supported social processes. Participants referred to these people as "champions" and "leaders" who held the ability to attract industry actors together and create social processes that facilitated the opportunity to interact. A champion is an actor who backs-up, supports and provides references for industry actors. Leaders create signals to incentivise collective action and enrich the collective through fostering understanding and motivations. Champions and leaders were perceived to recognise and transmit a collective value that was beyond mere business transaction. They transmitted personal values and visions and influenced the mindset of industry actors:

> *Because of the guy who is in our little society who is also high up to be able to say*
>
> *"we need to do this". They do help when they can and again it comes back to*
>
> *having a champion, somebody who says, "this is worth doing" there is no obvious*
>
> *benefit straight away but they would benefit. BMEL22*

> *one of the missions of energy farmers is about farmers getting involved in the*
>
> *bioenergy industry and we want to be a pathway for that. BWA19*

Participants recognised this bridging role in specific actors in the clean technology industry, and described the benefits of this person could bring to the organisation, such as

providing exposure, enabling new business opportunities and constantly attracting multiple industry actors:

> *I got involved with John's competition because I hope that through the exposure*
>
> *that I get there that would bring new business. BMEL30*

This recognised role fulfilled the identified need to foster relationships and develop momentum in an industry experiencing technological change:

> *he does a brilliant job, he is the only person in Australia at the end doing what*
>
> *should be done more at the end. Everybody appreciates him and he is really true,*
>
> *he is the only incubator in Australia sharing information. BSYD14*

This will be further explored in the Theme "Reaching horizons".

Participants also recognised that this bridging role could be performed by diverse professional profiles such as advocacy, lobbying, regulatory and procurement. However, it was reported that a clear definition of responsibilities for the organisations performing these activities is required. Clear responsibilities and abilities facilitate creating collective understanding and action:

> *so you have a state government which includes all of the state government utility*
>
> *like SA water; you have the commonwealth government that works on things like*
>
> *the Murray River and some of the other policy things they do. IaADL5*

Big companies were recognised as influencing collective action by strengthening or diminishing business opportunities for others. For example, direct investments and new ventures enriched the environment for small and emergent organisations. This type of company also had an indirect mechanism to support technological change. Through signalling benefits that fostered interest in the industry, big companies promoted new technologies, educated the general public and supported market niches and sponsorships:

Our main competitors are maybe around 100 times bigger than we are. But I think that is also good because they spend a lot of money on education, to make people aware of energy savings and all these things, so they are also premium customers to us at the end. We wouldn't be where we are without them at the end, they don't know it. BSYD14

In conclusion, specific industry actors supported technological change by fostering relationships in different ways. Results suggest three recognised roles had a direct influence on relationship development. Some elements of social capital supported those roles and influenced the industry context.

4.3.3.3.4. Conclusion "New organisations"

This theme presented how actors in organisations perceived and used relationships during technological change. Relationships allowed them to align industry, organisational and individual characteristics in such a way that organisations were perceived as an interface of signals and negotiations of understanding. Perceiving an organisation as an interface allowed actors to approach change in two ways: adapting to it and enabling it. For both approaches, different organisational characteristics, capabilities and resources could be managed differently and aligned to relationships. Organisations relied on different types of industry actors to nurture relationships and manage change. Actors played different roles, such as connector, facilitator and bridging roles. These roles supported the development of mutual understandings and collective actions.

To summarise, Theme 6 illustrates that:

- organisational characteristics support and influence relationship building

- organisations adapt to and enable change through managing relationships

- individual and organisational actors assume different roles to support relationship building

4.3.3.4. Conclusion Relational Influences

The above section helped address the question of how industry actors understand social capital during technological change. It did so by presenting an analysis of the role and value of relationships for individuals, organisations and industry as a collective. First, results led to the identification of trust, identity and worth as the three constitutive elements of social capital in technological change. Participants considered these elements to be relevant for allowing social capital to develop in an interplay with contextual aspects of the organisation and the industry. Second, once social capital elements and influences were identified, the analysis focused on the identification of how relationships were used by industry actors. This analysis identified that relationships are used in mainly three ways during technological change: for transactions, to foster collective values, and for spill-over of messages. These functions of relationships can occur simultaneously in alignment with the industry context. Third, the last section explored how relationships occur in an organisation. The focus was on the organisation because it is considered here to be the core of collective action during technological change. The analysis shows that relationships can play a key role as an interface with the industry conditions to establish new technologies. Simultaneously, organisational characteristics support relationships and can have a strategic role in their development.

4.3.4. Emerging themes: temporal influences

Answers to the three research sub-questions explored in the previous sections seek to address the overall research question: How does social capital influence technological change in industry contexts? Up till now, results suggest a tripartite analysis that includes the industry context, the technologies themselves, and the social dynamics, which corresponds to and addresses the three research questions identified in the literature. These three aspects provide a view of how social capital occurs in an industry that experiences technological change, and identifies the unique elements and interplays that nurture professional and business relationships and how those relationships influence the organisational and industry contexts.

Participants also revealed new insights that contribute to an understanding of social capital during technological change but which did not align directly with the three formulated research sub-questions. These new insights focus on considerations about future conditions that are either desired or expected by industry actors. In the following sections, these insights are presented in three themes. The theme "Reaching horizons" refers to the potential to nurture the industry context in which business opportunities are more reachable. The theme "Creating futures" presents participants' insights into how individuals achieve changes in their mindset and behaviours that are reflected in new actions and relationships and enable technological change. The theme "Dealing with unknowables" presents the recognised uncertainty embedded in the conception of the future of the industry and how social capital is used to face uncertainty.

In the next section, these three themes are analysed and integrated to address the overall research question.

4.3.4.1. Theme: Reaching horizons

This theme presents how participants referred to elements of social capital to enable new conditions in an industry context. Those elements were described as enabling new context conditions and nurturing momentum to materialise technological opportunities and achieve technological change, as shown in Figure 4.18. This discussion addresses the research question, "How does social capital influence technological change in industry contexts?".
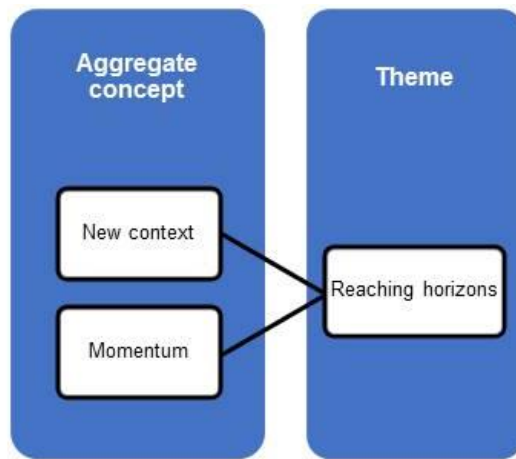
Figure 4.18. Theme *Reaching horizons*

4.3.4.1.1. New context

Participants recognised that new technologies both enabled and demanded the appearance of new conditions in the industry context. These new conditions are referred to here as the "new" context and is described in two ways, as shown in Figure 4.19. First, the recognition of new technologies as part of the industry context. Second, the consolidation of an enabling environment for sourcing business opportunities. In the next section, recognition of technologies and sources of opportunities are described.
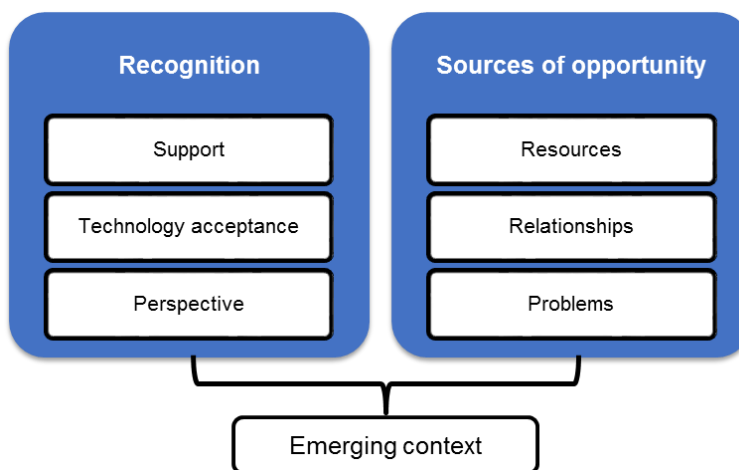
Figure 4.19. New context

Recognition. Results suggest that organisations in a technological change context lack perspective of the industry dynamics in which market needs are still unclear. Participants described the struggle of small and new enterprises in dealing with the confusing dynamics and supporting mechanisms of the industry. This was reflected in the lack of common culture and vision that would constitute the basis of a consolidated industry. As a result, opportunities to interact, get involved and share experiences were difficult to identify:

> *Probably everyone is leaving clean tech because there is no encouragement to be*
> *clean tech in Australia. BMEL22*

> *Small businesses don't think about industry at all, they are not interested in*
> *industry. InSYD37*

> *I don't think the industry is big enough yet for people to look at the whole industry,*
> *without making sense they cannot explore slides of the market to have any*
> *opportunity, the industry is still so young. IaWA24*

There was also a lack of opportunities and abilities to communicate the value of clean technologies. Actors in the traditional industries lacked an understanding of the new technologies, which limited their willingness to accept these new technologies within the current industry. Due to the diversity of technologies and sectors of application, participants suggested that more communication and explanations about clean technology are needed to understand the variety of value propositions appearing in the industry:

> *It doesn't mean anything, it doesn't, I would go what do you really do? What is your*
> *market, who are you selling to, why does it make sense? Clean tech is a nice*
> *phrase at the moment and even for government, and financial support for things*
> *that are labelled clean tech so people dress themselves up as clean tech trying to*
> *attract support so I don't think is an industry. InSYD37*

The understanding of clean technologies was described to be limited by traditional technologies and existing actors, as shown in the Theme "Conflicting and competing

industry context". Participants suggested that the adoption and incorporation of new technologies depended on a change in the traditional paradigm of industry actors. This change could be enabled by a better understanding of the value of new technologies by existing actors in traditional industries, complemented by a supportive environment for new organisations:

> *we found that initially we were talking to companies who were providing a holistic solution for waste water treatment in the metropolitan space, the last thing they want to know about is a low-cost solution like Biogill. BSYD12*

Results indicate that technology development per se does not trigger changes in the industry context. The multiple and diverse technologies that already exist require a social context that enable changes to occur.

When referring to the technologies, participants recognised that actors in the traditional industries have established expectations that set a benchmark for what is expected of new technologies. Acceptance of new technologies was linked to the expectation of improvement performance, for example efficiency and cost reduction. Clean technologies were then regarded as an opportunity to improve existing attributes of technologies to enable access to new markets. Participants suggested that an integration of new technologies with the existing technological paradigm could enable the development of commercial opportunities. This technology integration affects traditional industries and challenges the existing technological paradigm:

> *I think the challenge would be in the clean tech industry to – and when I say clean tech is bioenergy – to really get up to speed and have products that can be integrated quite easily in the farming systems, but it is very early days in terms of that pathway. BWA19*

However, it was also perceived as an opportunity to adopt the existing conditions to improve new technologies that would foster a new technological paradigm. Technologies hold the potential to challenge the status quo of an industry, as presented in the Theme

"Technological transitions". This may occur through the integration of improved technologies into traditional industries which enables changes in traditional paradigms. The willingness and ability of industry actors to adopt the new technology support the technological transition of traditional industries.

In the case of clean technologies, participants recognised that interaction was facilitated by the small number of industry actors in the group. Interaction, however, required resources such as time and skills that small enterprises might not have developed by the time technologies were launched in the market. Therefore, relationships were limited and this affected positioning the technologies in the industry. To face this issue, participants stated that small organisations worked towards both developing capabilities and acquiring of resources in a continuously reinforcing manner:

> *in terms of industry that the clean tech industry is a small industry so it is easy to get in contact with many people. BSYD14*

> *Usually they are in different businesses very focused on what they are doing in their business so they don't have time usually to communicate with each other. On occasion, some of them would talk to each other about where to go for investment but tends not to be a lot of communication between start-up companies. InSYD36*

Sources of opportunity. Participants recognised that industry actors could take actions to enrich conditions in the industry context towards facilitating business opportunities. Such an enriched environment acted as an enabling context that offered different sources of opportunities emerging from organisational resources, relationships and context conditions.

Business opportunities were perceived to come from existing resources in the industry, such as technologies and the technical knowledge, expertise and capabilities of the organisation and the individual. To source business opportunities for existing resources presumed a solid base of contextual knowledge to develop specific actions, either individual or collaborative, for developing the opportunity:

> *For an opportunity to exists it has got to be something happening, so your project*
>
> *and a need. IaSYD34*

Participants stated that a business opportunity also emerged from the alignment between the technological development and a market need. Participants indicated that complementarity between the technology and commercial opportunity could be supported by conditions in the industry context.

> *there is research needed to do that so there may be a need for an ARC linkage*
>
> *project with government assistance, with commercial entities as well and that could*
>
> *lead to commercial outcomes that people could set up their businesses here to*
>
> *commercialise. GADL7*

Participants recognised relationships as a source of business opportunities. Informal and intermittent contacts were perceived to bring benefits. These benefits, that were perceived to be initially uncertain, could be transformed into new opportunities when aligned to the appropriate conditions of the industry context. In this sense, relationships were seen as a way to access business opportunities by means of the recognised synergy of interactions that supported technology recognition and commercial opportunity identification:

> *if I look at inside the companies we have invested we often see people in those*
>
> *companies that we have known for some time; people that have been CEOs in*
>
> *other companies for a while, CFOs, or engineering stuff... and we bring them back*
>
> *into subsequent companies. InSYD36*

Within the new context, participants perceived uncertain benefits, such as passing on wisdom and paying back to society to encourage new mindsets in industry actors. This reinforced social capital elements such as relationships and reputation which in turn established the basis for new opportunities to interact and develop business:

> *how are you going to pass your wisdom without sounding that you are trying to*
>
> *teach them or you are being the xx that is the way you have to bring them along*
>
> *with you. RADL40*

Opportunities were also perceived to come from existing challenges faced by industry actors. The traditional industry context presented participants with an opportunity to engage and discuss challenges and industry conditions. The discussion of current and common issues was perceived as a way to develop common understandings and build social capital, and at the same time identify actions:

> *in the clean tech sector because everyone is facing the same challenges that gives*
>
> *them a common issue to rally around. InADL32*

The engagement of industry actors around industry challenges contributed to consolidating the industry culture through non-confrontational open conversations in which participants created a narrative around the technologies and the industry context. These social processes supported the development of collective social skills and other capabilities important to face challenges and difficult periods, characteristic of technological change. The opportunities to face common issues and difficulties was recognised as a way of nurturing interactions and building community. This was based on common motivations that encouraged collective actions aimed towards seeing the industry thrive:

> *getting to know these people and talking to them and finding what their problems*
>
> *are and them working with them. RMEL23*

Participants indicated that understanding problems and common needs helped them to develop capabilities to raise awareness, identify issues, build criteria and contextual knowledge, and address problems from a collective perspective.

In conclusion, the acceptance and adoption of new technologies were based on organisational capabilities that influenced context conditions through interactions and consolidation of collectives in the industry. This involved the recognition of the technology by means of communicating its value and its integration with the existing technologies. Additionally, new context conditions emerged from the actors' ability to develop business opportunities from existing resources, relationships and context conditions. For the new

context, relationships could support emerging new conditions when they were not linked to tangible business outcomes, but rather to personal values and common beliefs.

4.3.4.1.2. Momentum

Participants referred to appropriate conditions in the industry context that, when aligned, enabled changes in existing technological paradigms. This alignment of conditions and elements in a specific period is referred to here as momentum. In this momentum, industry, organisational and individual factors can be aligned to materialise business opportunities.

Participants indicated that industry conditions related to industry culture affected momentum. Culture informed conditions such as the environment and social process in which interactions occur, the way relationships evolved and the possibility of accessing benefits and transactions:

> *It can be quite difficult to talk to them until you meet them somewhere else. BQLD8*

> *China on the other hand, business get done over dinner. InSYD36*

> *the relationships are very good in that respect but until you can demonstrate the*
> *benefits those relationships don't go to sales. BWA19*

Participants also referred to industry conditions of economic growth that affected interactions. Slow economic development and industry contraction diminished the participation of actors and the development of new interactions. Existing actors struggled to stay in the industry and maintain relationships. Those industry conditions also affected the role of actors who stayed or entered the industry:

> *It doesn't have that rapid growth and because of that it doesn't attract the same*
> *people. BMEL26*

Participants revealed that iterative collective efforts to engage and develop common understanding could nurture momentum. Simultaneously, skills were strengthened which reinforced efforts and momentum. Commitment and support from government and other

organisations were also recognised as contributing to the momentum towards creating an environment that enables business opportunities for new technologies. Momentum is perceived to occur, industry capacity and industry culture can be developed:

> *We are putting a lot of money here, a lot of effort and time and this is the way we are helping industry and research to get together, so it is a structural thing rather than just money. GADL7*

Participants indicated that involvement and participation in social processes supported the development of industry capacity. Interactions were seen as an opportunity to develop a common identity, as presented in the Theme "Elements and influences", and contextual knowledge of the industry. Thus, social processes that enabled actors' involvement allowed the dissemination of knowledge about industry actors, their roles and the factors influencing them:

> *we are creating the opportunity but there is a lot of cultural training that need to happen as well. GADL7*

Social processes that supported capacity building were described as, for example, training for social skills, networking and expertise development. These social processes towards industry capacity incentivised collective action and interaction that further nurtured momentum. Participants recognised that a collective effort by industry leaders helped to develop a common culture from multiple and diverse perspectives and values of industry actors through relationships and collaborations:

> *the work we do here is helping the Australian companies identify what is in it for them and helping them sell themselves overseas in a way that is more about what can you do for the overseas company. GMEL33*

> *I think we also have a role in helping companies become export ready, so a lot of that can be around capacity building, supporting training whereas that is delivered through government or other parties, supporting collaborations between university and industry. GADL21*

Participants recognised that the expectations and interactions of industry actors affected organisational social capital. The reputation of an organisation and interactions derived thereof served as tacit and constant feedback that participants used to adjust their business propositions, managerial practices and relationships, as shown in the Theme "New Organisations":

> *I don't think business relationship yield fruits immediately. I think that occasionally*
> *things will fall into place. InSYD36*

> *Typically, our deals take anything from a year or two to even three years to*
> *crystallise from initial contact to investment. These things take time and time and*
> *patience… InSYD36*

Results suggest that momentum implies an alignment of timely decisions and actions among industry actors, which requires an organisational capability to pursue objectives and relationships over long periods.

Participants also described momentum as the synergistic interplay between social capital and industry context, where relationships develop the context, and vice versa the context facilitates interactions, relationships and collective consolidation:

> *It is government who can afford the money and the time to help these companies*
> *communicate with each other; it's bigger companies that use smaller companies*
> *for ideas and research in the future; it is investors who invest in them. InSYD37*

In conclusion, social capital played a role in the perception of future conditions and the actions taken towards those conditions. First, relationships supported the identification of needs and conditions important for establishing new technologies and challenging the existing industry paradigm. Secondly, social capital elements, social processes, organisational characteristics and relationships were aligned to enrich the conditions and characteristic of the industry context that facilitated new business opportunities.

4.3.4.1.3. Conclusion "Reaching horizons"

The theme "Reaching horizons" presented how organisations pursuing the adoption of new technologies could influence the existing industry context to introduce new conditions that foster technological change. Organisational capabilities played a key role in managing relationships to communicate and position technologies and to influence existing mindsets. In addition, relationships facilitated open conversations that enabled the exploration of new opportunities. In this way, social capital was used to understand and influence the existing context and to enhance the opportunities to develop and position new technologies. Thus, organisations could nurture momentum through managing relationships towards technological needs.

To summarise, Theme 5 illustrates that:

- challenges are present in an industry context of technological change

- relationships are seen as a way to create opportunities and an enabling environment

- iteration of commitment, effort, and participation creates momentum and builds capacity.

4.3.4.2. Theme: Creating futures

Results suggest that influencing the existing industry context and creating new conditions is possible due to collective actions and organisational capabilities that in turn are rooted in individual actions. Thus, individual mindset, and the ability to reflect on previous situations as well as foresee are recognised as core elements required to purse the context conditions needed for technological change. The theme "Creating futures" presents participants' insights into how social capital allows individual and collective reflection and anticipation to shape desired futures. This section presents the two aggregate concepts that analyse how social capital supports technological change by informing future actions, as shown in Figure 4.20.

179
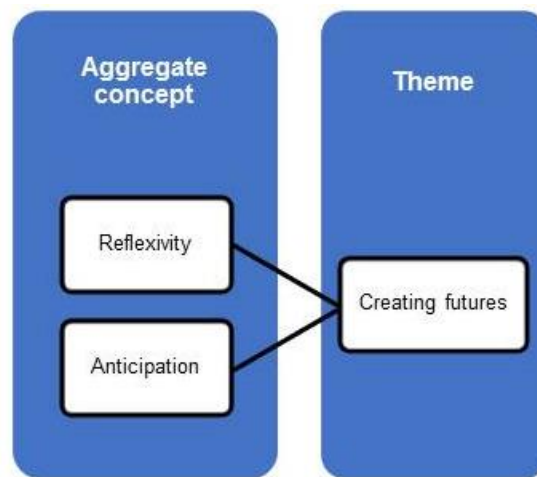
Figure 4.20. Theme *Creating futures*

4.3.4.2.1. Reflection

Participants indicated that industry actors held the ability to retrospectively analyse actions, consequences, intentions and expectations, which is referred to here as reflection. Insights on how this occur showed that reflection was an individual attribute that could be used in social processes to assess previously shared experiences to develop collective awareness for technological change:

> *It is a combination of looking at what people have done before and how they work*
>
> *with other people and so forth. BQLD9*

Reflection was described as an ability to assess individual experiences and actions that lead to different learnings and opportunities. Reflection involves the recognition of the situation, the capabilities and resources used and the contextual characteristics present. Learning was perceived to occur after reflection if iterative actions and subsequent reflection processes informed adjustment of individual action. This reflective learning seemed to involve transferability of skills in organisations to inform individual action:

> *we have to make a lot of decisions and you never know whether is the right*
>
> *decision. You only learn in the future, afterwards, if it was a right decision. So, if*
>
> *you ask me in few years' time I can tell you what I learn. BSYD14*

Participants recognised that technological change involved multiple actors working together on identifying the resources, competencies and results of individual actions and relationships. This collective reflection could be translated into business success when organisational learning occurs:

> until they (companies) are prepared to do that we find it extremely difficult to take
> the opportunity to the next level. InQLD31

Therefore, collective reflection is the ability to recognise ones' and others' learnings. Participants indicated that organisations needed to be aware of how organisational capabilities and knowledge could be communicated in an industry collective and how to integrate other capabilities to facilitate and enhance collective learning. Also, reflection involved awareness of consequences and results, either expected or unexpected to inform actions and interactions. Awareness and reflection were a collective capability that occurred in an iterative and continuous manner to adjust new actions:

> even the companies that did it understood what worked and they continue to try to
> operate that way, but I don't think industry wide was necessarily an appreciation of
> what really make that project work. IaADL5

Participants' responses suggest a lack of reflective analysis and awareness by some industry actors. For example, lack of awareness of contextual knowledge about industry bodies affected the consolidation of new technologies as part of the industry by interfering with interactions between industry actors:

> for example, in Dexxes there are green building foundations. I don't know what
> they are, there are associations of people in the building industry that are involved
> in the environmental... and I don't know who or where they are but there are. I
> don't know if there are in clean tech. InSYD37

The disengagement between actors seemed to be influenced by the unawareness of the context. Results identify that unawareness and lack of contextual knowledge are linked to specific business interests. Big companies lacked interest in interacting due to their

perception of having enough resources, while small companies lacked the resources to devote into knowing the context. Other specialised industry actors (i.e., researchers and investors), seemed to limit interest in exploring the context further and engaging in new interactions:

> *I think if you run a start-up company you are very very focused, your time is very*
> *valuable you are all about building a product, looking after the customer, you have*
> *no time to have conversations. InSYD37*

> *The water industry in Australia is very conservative and I think up to now, I don't*
> *think clean tech has been in the agenda very much. I'm hoping it will change in*
> *these couple of years. InSYD36*

Participants recognised that reflection was related to the feeling of belonging to a common industry group, in this case clean technology. A common identity fostered motivation to reflect on and gain awareness of the industry context:

> *I wouldn't call myself in the water industry, I would say that I was interested in*
> *water research. RMEL23*

> *business on average they are not good at thinking about collaborating with people*
> *that are outside the sphere of influence or interest. BMEL30*

Another significant element that was described was the awareness of participants' own skills to facilitate interactions. By exploring interactions that focused on awareness of strengths, weakness, context conditions and previous knowledge, industry actors could identify business opportunities:

> *it might give you the opportunity to find new businesses around these types of*
> *conversations. GADL4*

> *they do not know the right questions to be asking. IaADL5*

In conclusion, participants' insights indicated that reflection on actions and consequences was supported by the ability to develop collective awareness in relationships. Such

awareness focused on the industry conditions, organisational capabilities and decisions and individual actions, interactions and learnings. Awareness and reflection supported technological change by enabling industry actors to influence individual mindsets and actions by means of sharing learnings from past experiences. This is possible due to the spill-over function of relationships presented in the Theme "Role of relations" that allows values and messages to be transmitted.

4.3.4.2.2. Anticipation

Results suggest that reflective analysis is complemented by the ability of industry actors to foresee opportunities based on desired actions and required conditions. While reflection means retrospective analysis, anticipation refers to an ability to prospectively analyse and foresee. Anticipation was described as the development of sufficient and appropriate criteria to perceive current situations and industry signals that inform future individual actions. Participants stated that when industry signals were scarce, anticipation involved the ability to prepare and identify future needs to achieve their own expectations by being aware of current conditions, modifying individual responses and initiatives, and influencing other actions:

> *So, we actually try to consciously think what is the value propositions of those*
> *different organisations as partners of the CRC. RMEL25*

This anticipative attitude was perceived as a propensity to look for new things and initiate action towards fostering new things to happen. It was described as an individual motivation to take initiative and foster action:

> *if they are not wanting to grow to change, willingness to learn even knowing the*
> *right things wouldn't help them. IaADL5*

Participants described an individual attitude of being open and willing to accept different situations. Thus, anticipation involved having an open mind to foresee consequences of one's and other's actions. It also involved the ability to overcome frustration when there

was a difference between expectations and tangible results, and to see current situations as an opportunity to create new things:

> *You never know what is happening, it could be a disaster tomorrow or someone*
> *knocking on your door tomorrow and making an offer that is wow! you never*
> *thought about that, you really never know. BSYD14*

> *that is a contradiction but I am happy with the contradiction. TALKS*

> *It is an innovating thinking that makes it easier to come to an agreement. GADL4*

Results suggest that personal attitudes and abilities can be communicated and disseminated to create organisational culture through relationships, as presented in the Theme "Role of relations". In this way, organisations, by cultivating social capital, developed the ability to adjust different perspectives and visions to organisational practices. Constant adjustment of expectations between what was happening and what was foreseeable required communication and negotiation of perceptions. Sharing and negotiating perceptions raised awareness about the current situation and alternative actions according to contextual signals:

> *it is getting people together who don't necessarily have to be the one who does*
> *those different roles but have to respect and understand them and that is when it*
> *works best. RADL40*

> *because if you don't know what they want out of the projects then you are going to*
> *find very hard to get what you want. BSYD38*

Participants suggested that individual attitudes towards organisational culture had implications on business objectives and organisational routines. Awareness of such cultural influences could inform individual decisions on involvement, engagement and commitment with other industry actors. Collective awareness of social norms facilitated anticipating responses and contributing to collective understanding:

Some people like to go to work from 9 to 5 and go home; most people won't be part of the industry, those people who want to go to work from 9 to 5 they are not. BQLD8

If new entrants would do it only for the money they wouldn't last. BQLD8

Results suggest that being able to make a connection between anticipation and reflection was an individual ability. The identification of previous outcomes supported the identification of potential opportunities. This ability to combine awareness of past experiences and future objectives informed new opportunities, interactions and actions:

I think it is exciting and I think there are a lot of opportunities there. GADL21

Participants' insights indicated ambiguity surrounding future expectations of the industry. Some participants were positive, others had a negative perception and others recognised the lack of awareness. Those perceptions informed the actions taken by industry actors on business decisions and engagement:

there is definitely potential for the industry here. RADL2

I think the near future is going to be quite difficult for the space we are working in clean tech. BWA19

I don't think clean tech is known largely in Australia and a lot of people are not aware of it; it is a challenge for lots of people knowing about it. BQLD8

In conclusion, anticipation was understood to be an individual attribute to foresee actions and consequences in different contexts and opportunities. Interactions and relationships influenced this prospective analysis by enhancing the collective understanding of the changing context and supporting the development of a collective mindset. Relationships acted as a spill-over of signals, perceptions and personal values that enabled the anticipatory thinking.

4.3.4.2.3. Conclusion "Creating futures"

The theme "Creating futures" presented how industry actors combined retrospective and prospective analysis. Retrospective (reflection) and prospective (anticipation) analysis constituted the ability to enable changes to create new futures by means of relationships. Reflection was based on individual retrospection to support the development of common ground and the creation of new knowledge. Reflection and understanding facilitated managing the ambiguity and uncertainty of attitude towards technological change. Anticipation was understood to be based on the ability to foresee opportunities and consequences. Combining retrospective and prospective analysis enabled individual learnings and common ground for knowledge sharing. Additionally, individual anticipation reinforced and created motivations to enable new opportunities. Social capital enabled anticipation by spreading values and knowledge, as seen in the Theme "Role of relations".

To summarise, Theme 7 illustrates that:

- enabling changes in the context is fostered through new and different actions

- the realisation of those actions is based on the ability to reflect on previous experiences and existent perspectives, and it can also be combined with an ability to foresee opportunities and potential influences from the context to inform new actions

- individual abilities seem to be transferred to the organisation in the form of communicated awareness and collective reflection, and these can facilitate decisions and new actions.

4.3.4.3. Theme: Dealing with unknowables

This theme presents the findings related to the understanding of relationships as a way to overcome difficulties, transform existing contextual aspects into elements for opportunities, and transform potential value into future benefits. These insights reflect the industry actors' future orientation and the way that future-thinking operates in each individual and influences social capital. This future-oriented perspective gains relevance in

the context of technological change, in which uncertainty and ambiguity are common characteristics of the industry.

The next sections present how resilience, serendipity and uncertain value are related to social capital based on the results, as shown in Figure 4.21. This section contributes to answering the overall research question on how social capital influences technological change.
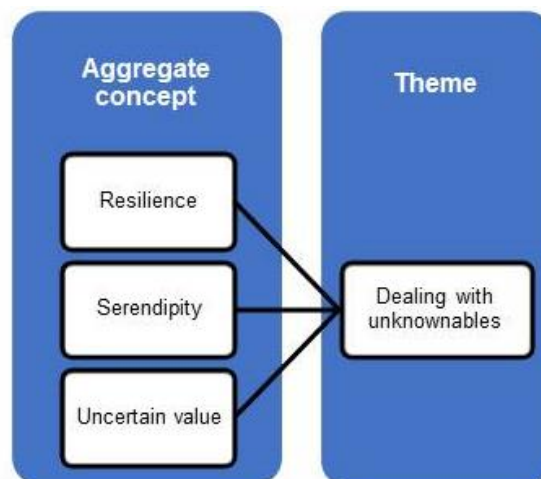
Figure 4.21. Theme *Dealing with unknowables*

4.3.4.3.1. Resilience

Results indicate that business relationships can have negative influences. Participants recognised the link between business relationships and organisational performance, thus factors affecting business success affect relationships. Participants perceived that, on occasion, the breakdown of relationships was related to underperformance of business objectives:

> *The relationship often goes back when things don't go well. InQLD31*

The challenge of organisations to identify business opportunities and expectations of other industry actors was recognised as limiting relationships that are driven by transactions and business outcomes. Also, lack of alignment of organisational practices (business

model, managerial practices) with inter-organisational relationships affected both business performance and the relationships:

> *they are struggling to rise capital because there is a discrepancy between the risk profile and where company is at, so that is what is blocking the relationship at the moment. InSYD15*

> *your first procurement option would not be exactly the right solution but with working together it will mean that you get there. IaADL5*

Personal expectations were perceived to affect relationships due to the pressure put on relationships. Expectations that were difficult to fulfil became the breaking point of a relationship, regardless of the perceived benefits. On some occasions, participants perceived the need to compromise their own expectations to maintain relationships:

> *relationships often break down because there is an expectation that you kind of support no matter what the outcome. InQLD31*

There was a perception that industry actors found it difficult to overcome problems in relationships. Participants reported that broken relationships were hard to recover due to the significant difficulties involved in rebuilding the relationship. This was especially evident when social capital elements such as trust were interlinked to tangible outcomes and transactions that were not reached, as identified in Theme 2:

> *once you got them feeling that you are doing things that are not correct for them you've lost them probably and it is very hard to come back. RADL40*

Results suggest that repairing relationship is possible. The ability to recover and move a relationship forward after facing issues is referred to here as resilience of relationships. Relationships were understood as an ongoing and reciprocal effort to solve problems. Participants indicated that such efforts were based on the ability to identify and align others' initiatives and expectations to build resilience, that is, to find a way to maintain and repair relationships:

> *you need to come up with the arguments of each other and you need to take the*
>
> *problems, you need to listen to the opposite person. GADL4*

Participants stated that resilience could be present in either context conditions or individual initiatives to face individual decisions. Individual initiatives occurred especially when relationships faced difficult times and followed a challenging process to overcome barriers. In this case, resilience was evident through the ability to make difficult decisions to pursue common goals:

> *if a relationship breaks in that sense you need to table it, and that can hurt, can be*
>
> *hard, can be uncomfortable. GALD4*

> *if it doesn't work out, you have to cut ties and that is not a nice thing to do.*
>
> *RADL40*

Contextual conditions were perceived as a barrier when they limited the expected development of relationships and business outcomes. In this case, resilience was described as the actions taken to mitigate and manage contextual conditions and pressures:

> *we don't have time, we just don't have time to [waste], if there is any bad [issue] I*
>
> *deal with it or someone else deal with indirectly. BSY12*

In both cases, individual and contextual factors, participants indicated an embedded ability of individuals to foresee consequences, to gain awareness and to undertake retrospective analysis, as presented in the Theme "Creating futures":

> *have a very structured plan before you drop the ball on people. Because in the*
>
> *moment you drop the ball on people... RADL40*

Another aspect of resilience to overcome problems and repair relationships was described as the openness and understanding of industry actors to adjust their expectations rather than compromise or impose their expectations:

> *People get in the way if negotiation or communication, if you are stuck in that, if it*
>
> *is not working then you need to find ways. InSYD37*

The need to overcome problems to maintain relationships was perceived to be implicitly driven by transactions and the resources invested in the relationship. The motivation to solve issues was guided by the expectation of a business outcome. Therefore, the need and expectation to achieve a business outcome guided organisations to build resilience to maintain relationships. For example, the time and effort invested in developing business relationship seemed to be enough motivation to keep trying and take initiative to solve issues until reaching the desired outcome:

> *of course, you approach ten companies and just one company will talk to you but it*
>
> *is just never giving up, you just continue. BSYD14*

> *if it takes two years to take an order you don't want to lose it because of a small*
>
> *thing. BSYD17*

Participants indicated the need to demonstrate that problems in relationships can still provide benefits. They also recognised the implicit assumption that continuous effort and persistence to recover and keep building relationships would lead to business opportunities. There was an expectation of a successful outcome after iterative trials to build a relationship:

> *Certainly I would give it another go, it is not the process of dealing with X the*
>
> *process of getting them to understand what we are doing and find those people*
>
> *within the organisation." BQLD9*

However, participants also indicated that expectation beyond business outcomes were present. These expectations were related to the common motivation of "doing the right thing" that is embedded in the environmental aspect of clean technologies, as presented in the Theme "Role of relations". This moral motivation incentivised actions and efforts to maintain relationships through difficult times. More meaningful business activities facilitated the consolidation of collective support. Participants acknowledged that personal

relationships with a moral meaning (beyond transactions) nurtured the collective ground and helped overcome difficult times:

> *Business relationships in lots of industries are about what can I get out of this,*
> *whereas the business relationships in clean tech is what can I give out to this.*
> *BQLD8*

For an industry facing multiple challenges due to technological change, resilience provided the industry with collective support. Social capital was perceived to play a role in keeping industry actors together during difficult times by means of the help and support available to the collective. Participants recognised the need for the constant and reiterative reassurance coming from relationships:

> *you know when things go wrong and you need help here or there. BMEL26*

> *if they don't have good strong backing don't bother, because it is going to be too*
> *hard, it really is. BSYD12*

> *you spend an enormous amount of time constantly just going back and reassuring*
> *everybody to keep them on board because people in those organisations change.*
> *RMEL25*

Overcoming the challenges posed by technological change was based on individual experience and attributes. Participants saw that individual persistence and recovery was maintained through relationships and reinforced the development of social capital:

> *I think the long-term business relationships that exist today would be the ones that*
> *survive and take advantage of, once we do get into the political [scene] in*
> *Australia, that might take another year or two, we would have a number of long-*
> *term business partnerships and hopefully those are the ones that take off.*
> *InSYD36*

In conclusion, the ability to overcome challenges was perceived as an individual attribute that could be nurtured in the organisation and industry context by means of relationships.

This ability is referred to as resilience and involves the identification of negative influences on relationships and the understanding of the rationales for solving problems. Relationships allowed participants to share and consolidate moral meanings and played a key role in maintaining and disseminating resilience.

4.3.4.3.2. Serendipity

Participants reported that opportunities emerge from unexpected sources. This is referred to here as serendipity. Results suggest that industry actors managed the serendipity embedded in technological change in two ways. They transformed unexpected outcomes into opportunities and enabled conditions for unexpected things to happen:

> *To me it is the happy coincidence of event which are in turn over time picked up by*
> *reasonable drivers and for whatever reason are embraced. IaSYD13*

Managing serendipity was perceived to be linked to awareness and retrospective analysis of industry actors, as presented in the Theme "Creating futures", to identify and foster the appropriate context conditions to nurture occasions for new things to happen. Results suggest that industry actors simultaneously identified expected and unexpected consequences and translated them into new situations to create opportunities:

> *I don't think they realise that but it actually makes me better at my job. BSYD16*

> *there is certainly an interest but whether it translates into action is going to be of*
> *interest over the next 12 to 18 months. IaADL5*

Results suggest that awareness was the key attribute for accessing unnoticed, unexplored and incipient opportunities. Awareness seemed to be the ground on which to create common understanding that enabled the identification and creation of opportunities. Participants described the importance of building common ground around the technology across industry actors to forge new opportunities:

> *we are looking at the sector as there is a good opportunity for growth and there is*
> *a need for a platform that helps that. InSYD15*

In conclusion, business opportunities could emerge from the awareness and interpretation of random events, rather than just from a sequential progression. Expertise and knowledge synergised to align a set of circumstances for the development of opportunities. Thus, serendipity suggests that the uncertain value of random circumstances, resources and capabilities could be managed through relationships. In this way, new industry conditions are a serendipitous opportunity based on knowledge, technology and relationships.

4.3.4.3.3. Uncertain value of relationships

Participants perceived uncertainty as a common characteristic of technological change, that is, the uncertain value of their actions and relationships.

Participants perceived relationships as a source of unexpected opportunities. The first contact when trying to establish a relationship was perceived as the most important step due to the potential benefits that could be explored and pursued during the development of the relationship. Thus, the value of social processes was acknowledged as they constituted the basis of interaction and engagement that could lead to opportunities:

> *It is very important in the start being a lot of business basically just a chat,*
> *exchange the cards and that could lead to something more significant after that.*
> *IaSYD34*

> *they might find themselves sitting next to a fellow CEO in a conference. IaSYD35*

Participants understood relationships to be an enabler of unexpected opportunities, as holders of potential value, and as a multiplier of effects by expanding contacts and interactions, as described in the spill-over role of relationships. This understanding of relationships reflected their belief that industry actors had an implicit perspective of the future. Thus, social capital seemed to enable different value than the tangible benefits and transactions achieved through relationships:

and say now we talk to this person so that is a lot of stuff comes out that might not

be useful now, it might be useful in the future and provides the resource and you

can call and talk to. IaSYD34

The uncertain value of relationships was evident in the potential to create new things. Participants saw interactions as a way to develop and establish technology through creating understanding and common motivations. Technology was used as a platform for bringing people together and enabling opportunities, as presented in the Theme "technological transitions":

It is a piece of technology and if we can agree on those terms and we can work out

a relationship we can work pretty well. BMEL26

Participants noted that the value of relationships was uncertain due to the unexpected and intangible benefits of social processes. This uncertain value was described as the influence of relationships on mindsets, the creation of new ideas and new knowledge, and the encouragement of new interactions:

something about what we do that try to change their mind sets by demonstrating

and through that connections and networks. GADL7

but some companies they are not there... I guess they are busy but they don't see

the value in collaborating whereas others do. GADL21

Social processes were perceived to create a favourable context in which to facilitate opportunities. For example, working together was the basis of business opportunities. Recognising the uncertain value of relationships was linked to the ability to enable opportunities from social processes:

to innovate we need to pass that, we need to start getting to know each other

better, working closer together. GADL7

If you go down to the coffee shop people are talking about the latest events.

InSYD37

Participants suggested that uncertain value was rooted in the ability to continuously assess the value of relationships, as presented in the Theme "Elements and influences" regarding worth. Social capital could be used to signal organisational capabilities and successful performance. In this way, relationships influenced the willingness to interact and collaborate for new opportunities:

> if we get an investor that comes in and we say look at all the people who believe in
> us then those relationships will be worthwhile. BMEL22

In conclusion, relationships held an uncertain value as the opportunities and benefits they could bring were not initially clear to industry actors. The uncertain value of relationships could be translated into a potential value when certain elements of social capital and the industry were identified. The potential value of relationships reflected a focus on the future by industry actors. This focus required awareness and ability that complemented the use of relationships for transactions.

4.3.4.3.4. Conclusion "Dealing with unknowables"

The above section contributed to responding to the overall research question on how social capital influences technological change. It did so by presenting how a future-focused mindset of industry actors influenced their understanding and use of social capital in technological change. Firstly, this understanding involved the identification of negative influences on relationship and the ability to overcome such challenges. Thus, resilience was presented as an individual attribute to move past difficulties, but an attribute that could also be transferred to the organisation and the industry. This transfer of resilience is possible through social capital. Secondly, awareness of random contextual conditions and elements, together with the ability to align actions, interactions and resources, could translate a normal condition into a potential opportunity. This was referred to here as serendipity and involves social capital to achieve both awareness and alignment. Finally, results suggest that interactions and relationships hold a potential value that is difficult to assess beforehand. This potential value is rooted in iterative interactions facilitated by social processes that influence mindsets and actions to explore and achieve the unknown

value. This section showed how resilience, serendipity and uncertain value are rooted in a future mindset and allow actors to use social capital to manage the uncertainty and unknown conditions created by technological change.

To summarise, Theme 8 illustrates that:

- in the process of enabling opportunities to create new futures, industry actors face uncertainty and unknown circumstances

- industry actors identify the need to deal with such uncertainty and the ability to do so

- resilience, serendipity and the ability to assess uncertain value are identified.

4.4. Summary

Chapter 4 presented the data analysis guided by the three research sub-questions regarding contextual, technological and relational aspects of social capital in technological change. Results also revealed an unexpected theme: a future-oriented perspective of industry actors. Overall, findings suggest multiple interdependencies between the different aspects of social capital and technological change in industry contexts.

The previous sections presented a complete description of each theme and how it addresses the research questions, as summarised in Table 4.8. Throughout the analysis, it was evident that the relation between research question and themes was not as linear and direct as the table presents. However, to facilitate the analysis, the themes were organised into the research sub-questions.

Table 4.8. Summary of themes

Aspect	Research sub-question	Themes
Contextual aspect	How does the industry context influence social capital?	Conflicting and competing industry
Technological aspect	How does the adoption of technologies influence social capital?	Technological transitions
Relational aspect	How is social capital understood and used in a context of technological change?	Elements and influences Role of relations New organisations
Emerging aspect	Future-oriented perspectives	Reaching horizons Creating futures Dealing with unknowables

The analysis of the contextual aspects allowed the researcher to identify and understand how a perception of the industry context influences social capital. It was found that ambiguity was caused mainly by government instability during technological change and poses challenges to relationships, which in turn affects the adoption of new technologies. Additionally, traditional industries that experience technological change play a contradictory role in the transition. On one hand, traditional industries limit the adoption of new technologies that compete with the established ones, but on the other hand, they contribute to renewing social capital elements such as reputation, credibility, identity and networks.

The analysis of the technological aspects allowed the researcher to identify the adoption of new technologies as a motive to develop social interactions in various ways. Findings suggest that technology influences social capital elements such as narratives and identity. This interplay between social capital elements around technology have an influence on technological change. Moreover, the multiple applications of similar technologies across different industries nurture elements such as reputation, trust, identity and worth to facilitate technological change.

The analysis of relational aspects showed how participants created meaning from interactions and how that was reflected on management social capital in technological change. Results suggest that trust, identity and worth, as elements of social capital, interact with factors of the organisation and the industry. These elements and their interconnections allow for the exploration of how industry actors use social capital. It was found that social capital is used mainly in two ways: 1) for transactions and access to resources, and 2) for fostering collective action and dissemination of values, motivations and beliefs. These uses occur simultaneously and as a response to contextual and technological aspects. Thus, social capital acts as an interface to align individual actions, organisational attributes and industry conditions. Thus, industry actors can influence the context of technological change by means of social capital.

Finally, emerging themes contributed to addressing the overall research question of how social capital influences technological change. These findings indicate that a time-focus mindset is present in industry actors. This time perception includes a future-focus that encourages the identification of new actions and interactions needed to achieve desired conditions in an industry context. It is possible that industry actors use social capital to influence contextual conditions to create momentum in which new opportunities are fostered and facilitated. Results suggest that an individual ability to reflect and anticipate is needed to enable future conditions and to guide social capital towards those conditions. In addition to that, social capital can be managed to face the uncertainty and unknown conditions posed by technological change. This can be achieved by means of resilience and serendipity. Consequently, social capital is understood as an opportunity to influence industry conditions and existing paradigms to create new futures.

In conclusion, the nexus between social capital and technological change is a complex interplay informed by individual, organisational and industry elements, and responds to individual interests in technology and business development. Within this complex scenario, some elements and interconnections have been identified as contributing to the understanding of how social capital influences the industry context to support technological change.

5. DISCUSSION: THE INFLUENCE OF SOCIAL CAPITAL IN TECHNOLOGICAL CHANGE

They are limited by transactional thinking. BMEL30

5.1. Introduction

Chapter 4 presented in detail the process of analysis and the findings that led to the development of eight themes, that were further analysed to address the three research sub-questions: 1) how does the industry context influence social capital, 2) how does the adoption of technologies influence social capital and, 3) how is social capital understood and used by industry actors? During this analysis, themes that could potentially contribute to the overall research question but that could not be allocated to one of the three research sub-questions were also considered for further analysis. Altogether, the themes addressed the overall research question: "How does social capital influence technological change in industry contexts?".

This chapter presents the conceptual analysis of the themes. The themes are integrated into a holistic model of the role and influence of social capital in technological change, contributing to extant research. The different components of this holistic model are introduced in the following sections. Section 5.2 addresses the three research sub-questions by identifying specific influences. Each sub-question will be presented in a separate sub-section, and include a graphical representation of the results. Section 5.3 then focuses on the main findings of this research (temporal influences) and describes in detail the perception of time that underlies the understanding and use of social capital through a pragmatist lens. Following this, Section 5.4 presents two different roles attributed to social capital (transactional and transitional) based on the influences previously mentioned and, specifically, the perception of time by industry actors. Section 5.5 concludes the chapter.

5.2. Influences of social capital in technological change

This research shows that there are four influences in the relationship between social capital and technological change. The contextual, technological and relational influences address the three research sub-questions and are presented within this section, while the temporal influence constitutes a new finding and is presented in the next section. Table 5.1 provides an overview of how the influences address the research sub-questions.

Table 5.1. Influence of social capital in technological change

Type of influence	Research sub-questions
Contextual influences	How does the industry context influence social capital?
Technological influences	How does the adoption of technologies influence social capital?
Relational influences	How is social capital understood and used by industry actors?
Temporal influences	Emerging influences

5.2.1. Contextual influences of social capital and technological change

This section addresses the sub-question, "How does the industry context influence social capital?". Contextual influence refers to how changes that occur in the context due to the adoption of new technologies affect social capital. The researcher posits that there is a reciprocal influence between the uncertain context and social capital, contributing to an understanding of how these changes occur.

The thesis confirms prior research stating that technological change occurs through dynamic interactions with multiple elements and their contexts (Nelson & Winter, 1982). The resulting changes in the context have been described as multidimensional which suggest that changes occurring at niche contexts trigger changes on the macro patterns of development (Geels & Schot, 2007). Context conditions inform industry actors on how to engage under the changing conditions of technology adoption within different timeframes. Industry actors are informed and change their intention to interact and the content of their interaction based on the context and technologies, adjusting the role of social capital.

Exploring how the context influences social capital, this research suggests that a) ambiguity and uncertainty in the industry context, and b) a lock-in effect, both challenge the way industry actors use their social capital. As a result, changes occur in terms of who they interact with, what new interactions they make, and the depth of the interactions.

Ambiguity and uncertainty in the industry context affect the conditions for technology diffusion and adoption by influencing social capital. Scholars have shown that during technological change, the perceptions of actors and their social interactions are influenced by a broader context and the changes that occur within that context (Geels & Schot, 2007). Ambiguity and uncertainty arise due to the multiple and diverse pieces of information emitted by different industry actors, perceived as contradictory signals. These contradictory signals are likely to influence social capital during technological change through affecting the motivations, perceptions and actions of industry actors, especially those actors fostering new technologies. Ambiguity and uncertainty influence actors' interests and shape interactions and relationships according to the perceived opportunities to access resources and transactions.

In an ambiguous and uncertain industry context, industry actors adjust expectations and actions. The observed social phenomena suggests that a complex dynamic arises from individual actions in constant interaction with the multiple context components (Eidelson, 1997). New actions occur as a response to individual perceptions of experiences in a continuous cycle of adjustment between intended and unexpected consequences. The resulting situation is the outcome of individual actions in an interplay with the ambiguous context. Individual expectations influence the development of common ground and understandings to create a collective experience within the uncertain context (Fang, Duffy, & Shaw, 2011).

The *lock-in effect* is caused by stable conditions and the established resources and capabilities in the industry context in which new technologies are being adopted (Ruttan, 1997). This lock-in effect seems to limit technology adoption, as industry actors entering

the industry have to compete with established technologies by integrating existing and new resources. Simultaneously, it facilitates knowledge sharing and legitimation of new technologies and actors, due to the existing social structures and established systems of meaning.

Figure 5.1 shows how contextual aspects influence social capital through uncertainty, ambiguity and lock-in, and are influenced by social capital by individual action and multiple interactions.
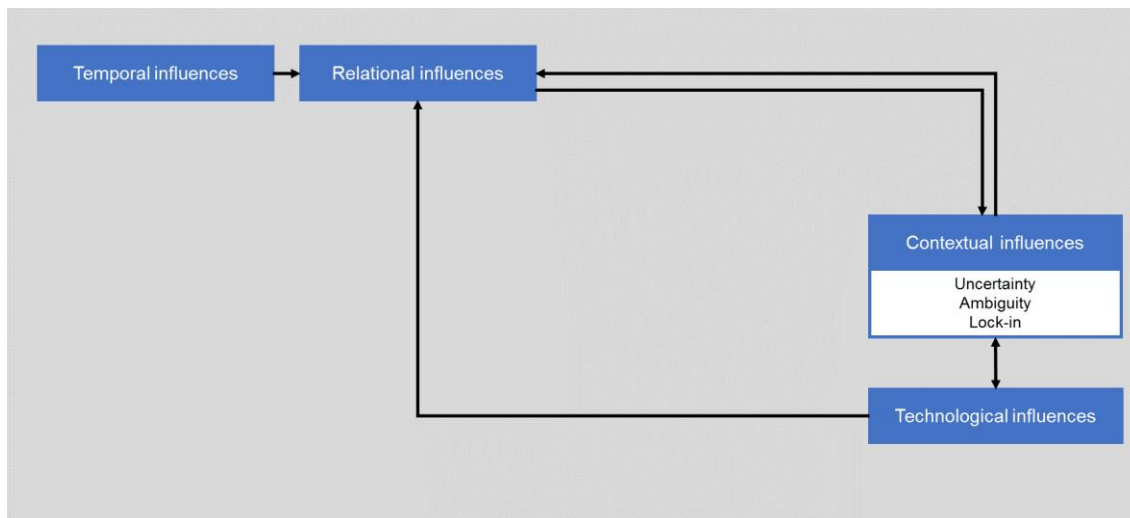
Figure 5.1. Contextual influences

The industry context influences social capital through informing actors' perceptions and actions. The industry context can support technology adoption when the existing social relation provides support to individual actors through existing resources support network expansion, knowledge sharing and translation of skills and capabilities.

5.2.2. Technological influences of social capital and technological change

This section addresses the sub-question, "How does the adoption of new technologies influence social capital?". Technological influences refer to how the adoption of new technologies in an industry context affect social capital through the *narratives* used and the *identities* developed by industry actors around the *use and value of technologies*. This

research contributes to the literature on social capital by incorporating the influences of these elements into the complex dynamic of technological change.

The diverse ways in which actors *use technology* across various sectors influence the specific *narratives* used by industry actors in each industry context. The type of language and the narratives that are predominantly used by industry actors during technological change influence identity, personal values and social bonds according to the diverse uses given to the technology. The language used by industry actors is developed around the new technologies and reflects an understanding of the use and acceptance of technology. Changes in language suggest changes in the acceptance that in turn reflect a shift in the technological paradigm.

Narratives and language influence the way technology is understood and communicated, and how common understanding and shared ground are built around technology, which further influences the development of a common vision of the industry. Social capital supports the process of consolidating collective understanding, shared language and shared values around the technology (Clegg et al., 2007), and thus, the acceptance of new ways of doing things in an industry context – this is, new technological paradigms (Geels, 2004). A shared and recognised language supports building common understandings that cultivate recognised contexts.

Additionally, the application of technologies supports the development of shared and multiple *identities*. In terms of identity, a common understanding of the *value of technology* and the perceived business opportunities shape the feeling of belonging to an industry. The multiple understandings coexisting in the industry context influence the development of a shared identity around technologies. Multiple identities can be an opportunity for the individual actor to develop interactions and relationships and enter different sectors and markets. The multiple applications of technologies enable the existence of multiple identities due to the sectors in which technologies are used. The multiple identities

generate a feeling of a fragmented industry and a lack of recognition. However, they also support knowledge sharing, expansion of networks and access to resources.

Technology and social capital are interconnected and influence technological change. Felt (2015) indicates that the multiple changes taking place during technological change are perceived as "happening in different places at the same time" (p. 14), reflecting the contextuality and temporality of social dynamics. This perception of "simultaneity" (Felt, 2015, p. 14) represents a challenge to developing shared experiences, shared visions and thus a shared identity. The industry actors' multiple understandings of technologies and the changes triggered by them influence individual perceptions and inform how to manage social capital elements, such as individual and organisational identity and the narratives they construct.

Figure 5.2 shows how technological aspects such as value and use of technology influence social capital in terms of narratives and identity of industry actors.
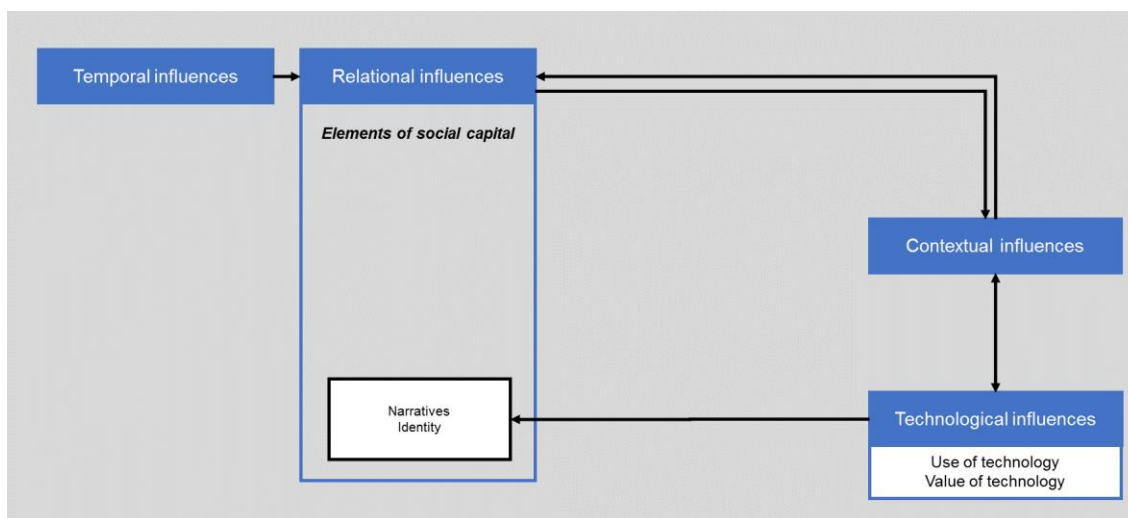
Figure 5.2. Technological influences

5.2.3. Relational influences of social capital and technological change

This section addresses the sub-question, "How is social capital understood and used by industry actors?". The relational influences correspond to the changes in social capital elements that allow industry actors to manage relationships during technological change.

Social capital research has revealed that relationships are complex social processes that involve multiple elements (Nahapiet & Ghoshal, 1998). This research shows that two forms each of both trust and worth coexist, and industry actors shift between the two forms of trust according to their perception of the context and the technology. This dynamic and continuous adjustment is evident through the pragmatist view of social capital in which the cycle of reflexion-action suggests an implicit co-evolution of the meaning and consequences of trust (Elkjaer & Simpson, 2011), as will be presented in section 5.3.

In the case of *trust*, this research reveals two forms of trust occurring among industry actors during technological change: resource and relational. *Resource trust* is referred to in the literature as "calculative" (McKnight, Cummings, & Chervany, 1998, p. 473) trust that represents a rational choice based on costs and benefits, and refers to opportunistic behaviour (Rousseau, cited in Zheng, 2010) and certainty of being rewarded (Leana & van Buren, 1999). This form corresponds to a RBV of trust affecting relationships that lead to a measurable outcome. *Relational trust* is known in the literature as "social" (Lee & Law, 2017, p. 12) or "resilient" trust (Ring & Van de Ven, A. H., 1992) and represents an overall confidence in people and institutions that is based on experience and beliefs, and does not pursue a specific interest (Leana & van Buren, 1999). This social form of trust reflects a pragmatist view as a foundational process of relationships (Smyth, Gustafsson, & Ganskau, 2010).

In terms of *worth*, the literature suggests that the value each actor obtains from relationships occurs through the access to valuable resources that contribute to competitive advantage (Dyer & Singh, 1998; Ireland et al., 2002). However, this research suggests that the identification of the benefits of relationships is a continuous assessment of motivations and the ability to interact, rather than the assessment of a specific tangible outcome. The continuous assessment of motivations, perceived value and interactions constitutes worth, that is manifested in two forms in industry actors in technological change: business and moral.

Business worth suggests that the benefits are assessed by industry actors through the tangible outcomes obtained from interactions with other industry actors that influence the wiliness to interact and develop relationships. This is in line with the literature that suggests that relationships are valued according to the performed activity and the obtained outcome (Arregle et al., 2007). An interest in specific business transactions and outcomes influences the willingness to interact, which reflect the common agreement that "social capital is productive" (Coleman, 1988, p. S98).

Moral worth suggests an interest in mitigating environmental impact that drives social connections based on morals and personal values. Personal motivations are rooted in individual values and rationales which allow them to assess the benefits perceived in relationships. This contributes to the view that social capital is based on the identification of relationship-specific values and the enhancer effect of those values within a social system (Cots, 2011).

Figure 5.3 shows how the relational aspects such as trust and worth guide the use of social capital to influence contextual aspects in technological change.
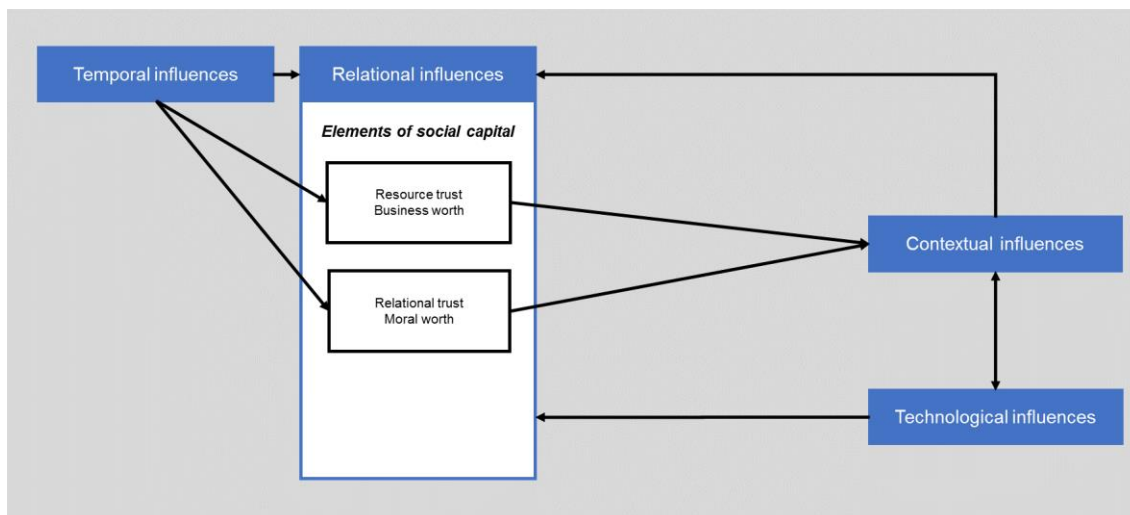
Figure 5.3. Relational influences

5.2.4. Summary

The previous section presented a conceptual analysis of the findings addressing the research question, "How does social capital influence technological change in industry contexts?", by first addressing the three research sub-questions. The evidence provided in the analysis was presented, in terms of the influences of the different aspects previously identified, and constitute the components of a holistic model, as shown in Figure 5.4.
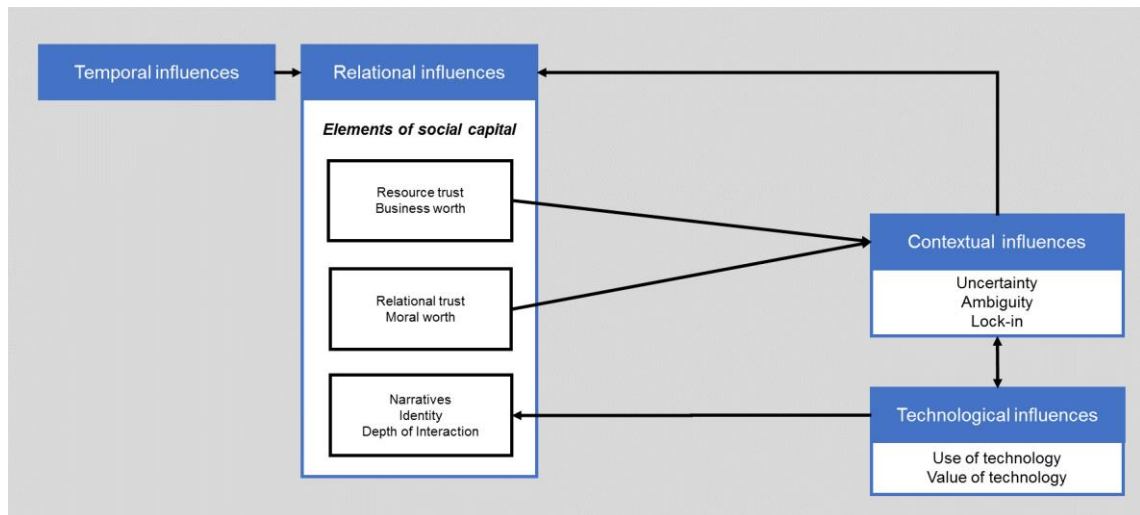
Figure 5.4. Overview of contextual, technological and relational influences

Addressing the first sub-question, "How does the industry context influence social capital?", resulted in the identification of *ambiguity, uncertainty* and *lock-in* as the contextual aspects influencing industry actors' perceptions and actions towards social interactions.

Analysis of the second sub-question, "How does the adoption of technologies influence social capital?", led to the identification of changes in the *narratives* used and the *identities* developed by industry actors, according to the *use and value of technologies* in industry contexts. Further, adjustments and evolution of narratives and identity suggest changes in the common understanding of use and value of technology that in turn reflect a shift in the technological paradigm.

Addressing the third and last sub-question, "How is social capital understood and used by industry actors?", resulted in the identification of changes in the understanding of *trust* and *worth* by industry actors, according to the industry context. These changes allow different and simultaneous uses of social capital to support technological change.

The contextual, technological and relational aspects have been previously identified in the literature; however, the intricacies of their occurrence and interconnections have been lacking. This thesis contributes to the literature by identifying how these aspects are interconnected and can be integrated into a model of the influences on technological change.

5.3. Temporal influences and perception of time

This section presents the new influence found during the analysis – social capital and technological change. Temporal influence refers to the perception of time, mainly present and future, that guides industry actors' use of social capital in technological change. By adding the temporal influence to the nexus between social relation and the adoption of new technologies, this thesis proposes an extended view of technological change in which the influence of social capital is shaped by the temporal perception of industry actors.

Section 5.3.1 presents an overview of how pragmatism allowed the identification of the temporal aspect influencing social capital. Following this, the present and future perception of time are explained in sections 5.3.2 and 5.3.3, respectively. Section 5.3.4 provides an overall view of the four influences that constitute the model.

5.3.1. Pragmatism and the perception of time

A pragmatist view of social capital reveals a temporal perception implicit in the understanding of social capital by industry actors. The temporal influence has been identified using pragmatism through the lenses of inter-subjectivity and reflexivity, as presented in Chapter 3.

Pragmatism proposes a continuum between experience–reflexion and intention–consequence (Elkjaer & Simpson, 2011) that implicitly reflects an existing concern of individuals about the before, now and then. Motivation informs both experience and perception of the lived experience (interactions) and the consequences. At the same time, the individual and inter-subjective experiences inform motivation and perception (Joas, 1990).

This research shows that industry actors perceive time in mainly two different ways, and these perceptions affect their use of social capital. The inter-subjectivity of pragmatism allowed the researcher to identify a present perception of time (set timeframe), while reflexivity enabled the researcher to identify a future perception (open timeframe), as shown in Figure 5.5. This temporality of social capital is not linear as represented. However, the linear representation helps with understanding the correspondence between time perception and social capital.
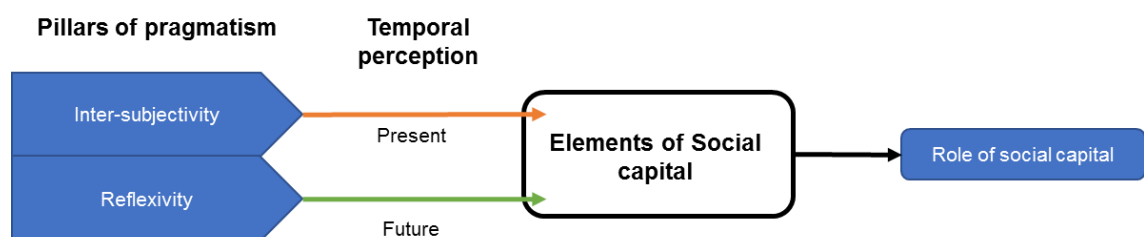
Figure 5.5. Pragmatist view of social capital

First, inter-subjectivity refers to the interactions among actors which occur during the process of meaning-making through shared experiences (Joas, 1990). The present perception of time is identified through the inter-subjective meaning of experiences and actions occurring in the present among industry actors in technological change. Social capital is an inter-subjective phenomenon that exists based on current interactions among individuals. This interaction brings diversity of intentions and expectations into the process of building a common understanding linked to business outcomes and technological opportunities (Maurer et al., 2011; Maurer & Ebers, 2006). The heterogeneity of

expectations and initial understandings suggest that building a shared view involves multiple iterations of negotiating meaning in a recursive manner according to the current situation. Thus, industry actors perceive a present timeframe that is linked to the business outcomes expected from relationships.

Second, the reflexivity of pragmatism suggests a continuous process of identifying intentions, expectations and consequences by the individual and the collective (Elkjaer & Simpson, 2011). Social capital is then nurtured through a reflexive process of intentions and consequences that informs mutual understanding and collective action. The occurrence of expected and unexpected consequences informs shared understandings and collective views in a process of identification and assessment of future actions based on actors' intentions and perceptions. Thus, social capital allows an awareness of signals from others' actions and consequences. This awareness suggests that industry actors perceive an open timeframe that is future-oriented, enables new intentions and future actions, and does not focus on specific objectives from relationships.

Consequently, a pragmatist view supports the temporality of social capital. Extant research shows that, "the shorter the time frame of any engagement exercise, the less people can conceive of their potential capacity to form a thought collective, to develop a group identity or to experiment with different modes of valuing issues at stake" (Felt, 2015, pp. 7–8). Social capital thus facilitates the integration of temporal perceptions by industry actors in negotiating meaning for technological change.

The temporal perception identified in this research builds on Felt's research (2015) that suggests that there is an "impact of specific temporal structures on both how we see the world and how we imagine its development" (Felt, 2015, pp. 10–11). The analysis indicates that multiple perceptions of time coexist during technological change that lead to "temporal inconsistencies" (Giesen, 2004, p. 28) among actors facing uncertainty.

Figure 5.6 summarises the temporal influences and the connection to the relational, contextual and technological influences presented in the sections above. The next sections detail the present and future perceptions of time identified in this research.
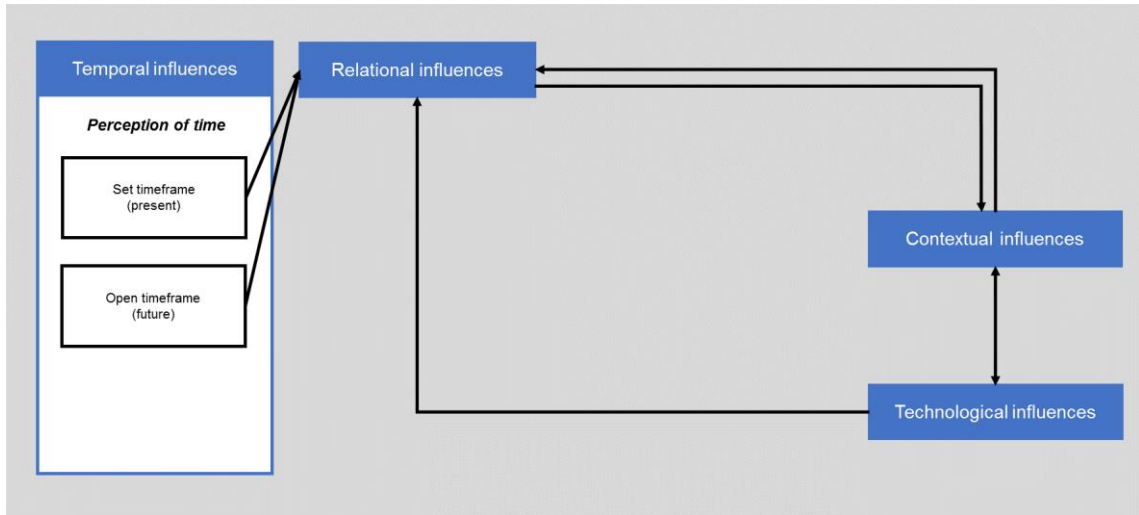
Figure 5.6. Temporal influences

5.3.2. Present perception of time

This research suggests a present perception of time embedded in individual's minds when specific goals and tangible outcomes are expected from relationships. Intentions are framed within this temporal perception in which action takes place. Actions follow and reflect specific set-term goals in a context that is temporally perceived as stable.

This temporal perspective corresponds to a "clock time" (Felt, 2015, p. 6) perception in which time is seen to provide a framework for planning, regulation and execution of actions to achieve objectives in set amounts of time (Felt, 2015). Industry actors use social capital to achieve specific aims in a set timeframe which facilitates different and current interactions and exchanges between actors, context and technology towards specific and immediate goals.

A present perception of time guides industry actors to use trust and worth for resource exchange, as described in section 5.2.3. Trust is used as a resource that allows access to other resources and interactions that are developed based on the worth of business

objectives. This use of social capital corresponds to the RBV previously identified in the literature.

Social capital is then used to achieve such objectives in the set timeframe, which is the basis of the *transactional role of social capital* presented in section 5.4.

5.3.3. Future perception of time

This research suggests that, in addition to the present perception of time, there is also a future perception of time (beyond the current moment) by industry actors, that is not linked to specific outcomes and allows for reflection on past experiences and awareness of intentions to inform new actions. This reflexivity implies attention to experiences and potential consequences to reveal intentions guiding future action. It brings together previous and current experiences under a future perception that enables social capital to play a role in future industry contexts.

A future timeframe guides industry actors to develop interactions and relationships based on a moral worth given by personal values, beliefs and intentions. This moral connection allows actors to develop meaningful trust that is not linked to business outcomes (relational trust as described in section 5.2.3). This aligns with Gersick's (1994) suggestion that actors' "choice of temporal milestones determines the duration of momentum periods and the timing of opportunities for transitional change" (p.13).

Thus, social capital facilitates prospective action based on its anticipatory character, deeper beliefs and reflections. A future-oriented perception gains importance in an uncertain and constantly changing context, as it enables awareness of intentions and consequences to influence the context through social dynamics. This broader perception of time enables individuals to "colonize the future" (Giddens, 1996, p. 370) through "participatory exercises" (Felt, 2015, p. 11). These participatory exercises reflect the implicit use of social capital for negotiating meanings, creating understandings and fostering collective action towards a collective negotiated future.

212

Consequently, the future temporal perspective enables a different use of relationships and provides the basis for the *transitional role of social capital* in technological change presented in section 5.4.

5.3.4. Summary

The previous sections presented the temporal aspect identified as a new finding in this research. This temporal aspect constitutes a new type of influence in the interplay between social capital and technological change.

The temporality of social capital suggests that the "ways in which time is scripted in innovation as well as how temporalities matter" to guide action (Felt, 2015, p. 4). The different temporal perceptions that inform industry actors' objectives and experiences pose a challenge to negotiating common ground and building collective imaginaries. This challenge indicates how industry actors can manage relationships to build common meanings according to their interests, experiences and context conditions.

This research shows that social capital is linked to an individual's time perception mainly in two ways: present and future. A present temporal perspective of social capital supports the view of relationships as essential resources that have a transactional purpose in technological change. This view corresponds to the RBV of social capital, as explained in section 5.4.1. A future temporal perspective of social capital supports the view of relationships as opportunities to create new meanings that have a transitional purpose in technological change. This view corresponds to the pragmatist view of social capital, as explained in section 5.4.2.

Temporal influences are interconnected with the relational influences presented in Section 5.2. These relational influences affect the context and, through the context, technology. In turn, these technological influences affect some elements of social capital, as shown in Figure 5.7.
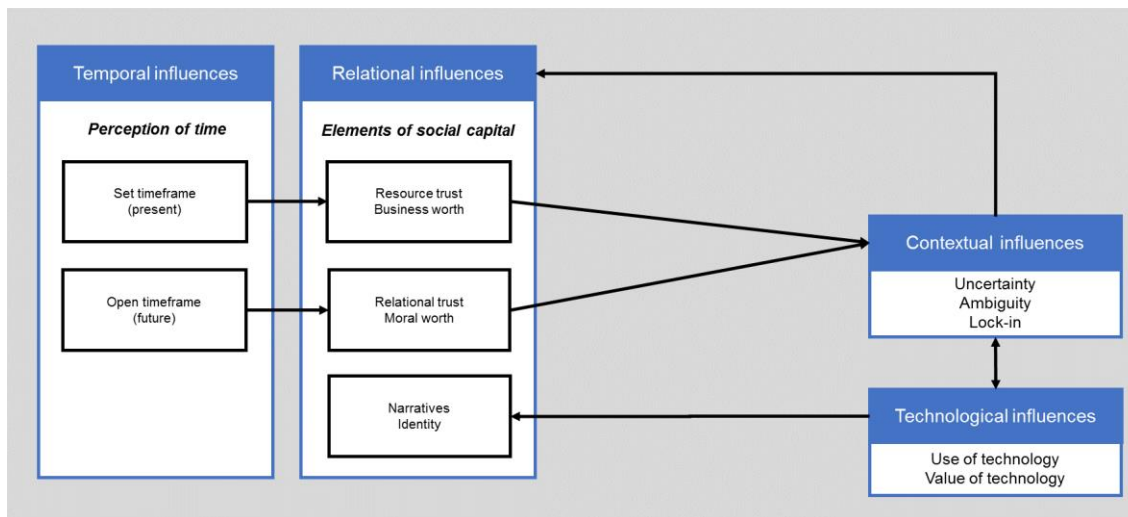
Figure 5.7. Overview of contextual, technological, relational and temporal influences

The identification of the embedded temporal perception guiding the understanding and use of social capital reveals that industry actors are likely to attribute two roles to social capital during technological change: transactional and transitional. The following sections detail these two roles based on the analysis of the multiple influences presented in previous sections.

5.4. The roles of social capital in technological change

The different ways in which industry actors use their relationships and embedded social attributes reflect a role attributed to social capital. Relationships have been predominantly defined from a resource perspective, suggesting a *transactional role* of social capital, evident in the access to resources for achieving competitive advantage and economic performance (Burt, 2000; Dyer & Singh, 1998; Nahapiet & Ghoshal, 1998).

However, the analysis of social capital through the lenses of inter-subjectivity and reflexivity reveals that social capital can be attributed a *transitional role* in addition to the transactional role. In line with the pragmatist approach, social capital is "firmly rooted in people's capacities to realise their interests" (Lappé & Du Bois, 1997) which reflects the implicit and central role of perceptions in defining the use of social capital.

The next sections detail the two main roles attributed by industry actors to social capital that influence the change triggered by the adoption of new technologies, as shown in Figure 5.8. The actions needed to face technological change are partly based on the different perceptions of time that guide the use of social capital to a) adapt to, and b) create changes in the industry context.
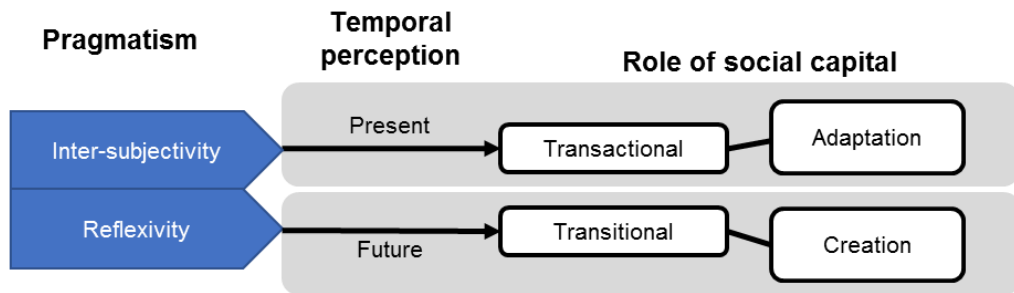
Figure 5.8. Pragmatism and the role of social capital

This research suggests two roles of social capital in technological change that build on the influences previously identified, as presented in Figure 5.9. Temporal and technological influences affect different elements of social capital that further guide the uses of social capital and the different roles. These roles influence the industry context and, in this way, social capital influences technological change, explained in the next sections 5.4.1 and 5.4.2.
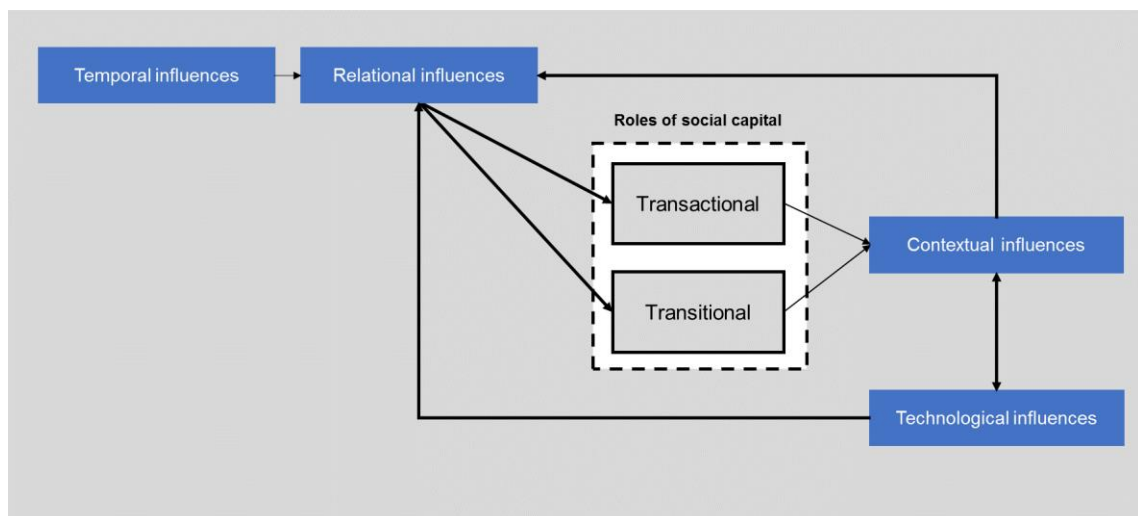
Figure 5.9. Roles and influences of social capital

5.4.1. Transactional role of social capital

By confirming the transactional role of social capital, this thesis confirms and extends the existing understanding of social capital used for the purpose of accessing and exchanging resources (Nielsen & Chisholm, 2009). Thus, the role of social capital resides in individual transactions that occur through relationships when industry actors have clear and short-term expectations and outcomes.

First, this research confirms the RBV of social capital through the transactional role, in which a) the long-term development of social capital has been recognised (path dependence), b) the difficulty in identifying whether and how social capital is created has been indicated (causal ambiguity), and, c) the difficulty in transferring social capital between individuals has been identified (tacit complexity) (Barney, 2001).

The RBV suggests that path dependency, causal ambiguity and tacit complexity make social capital an intangible resource useful to outperform other firms by means of its unique contribution to competitive advantage. By using RBV, scholars have explained the ability of firms to utilise heterogeneous resources (Barney, 1991; Peteraf, 1993) which indicates that social capital can be used to access external and valuable resources. This role also suggests a reinforcing relation between relationships and outcomes which confirms the resources and path dependency theory (Penrose, 2009). Thus, the RBV of social capital has suggested that resources and capabilities contribute to firm performance (Barney, 2001).

Building on the influences presented in section 6.3, this research extends the predominant RBV of social capital, that is based on industry actors' interests in pursuing immediate goals, in two ways: 1) by identifying that relationships are managed within a set timeframe, which is referred to here as the present temporal perception, and 2) by identifying the contextual and technological influences that occur in relationships.

The transactional role is based on the specific interests driving relationships, that is, access to resources (infrastructure, inputs, knowledge and information) or to opportunities

(investment, profit, integration), and suggests that the development and maintenance of relationships is linked to the successful access to valuable resources and depends on the outcomes achieved.

The results contribute to an understanding of the implicit contextual nature of social capital stated in the literature, and reveal explicitly the contextual influences. Such influences are based on the industry actors' multiple perceptions of complex and ambiguous signals from the industry context. Perception of complexity and ambiguity influence the social capital elements such as trust, narratives and shared representations, collective identity and collective mindset, that inform their multiple actions (Adler & Kwon, 2002; Elkjaer & Simpson, 2011). Ambiguity and uncertainty affect actors' perception of other actors which affects trust, reputation and credibility and in turn the relationships and business opportunities pursued by industry actors.

This research builds on Geel's work (2002) that suggests that technology adoption reinforces context complexity due to diverse actions from multiple actors in terms of policies, regulations, incentives and similar that are related to the technology. Research on context complexity becomes relevant due to the uncertainty introduced by the perceived contradictory signals and the challenge to interpret them to inform actors' actions.

Thus, this research extends the theory of social capital by revealing that the role attributed to social capital is relative to the perception of contextual and technological aspects by industry actors, hence multiple perceptions inform actions in different ways. This contribution is aligned with Gretzinger and Royer (2013) who posit that the value of actors' interactions and interdependencies and their context contributes to action by means of transactions.

5.4.2. Transitional role of social capital

"…new concepts for unknown lands…"
(Deleuze 1997, cited in Semetsky, 2006, xxi)

By proposing the transitional role of social capital, this thesis extends the existing understanding of the use of relationships beyond the RBV (Robison et al., 2002). It contributes to both technological change and social capital literature in two ways: 1) by identifying the existence of a future-oriented timeframe in the mindset of the actors, which is referred to here as the future temporal perception, and 2) by identifying the contextual and technological influences that occur in relationships.

First, the research proposes that there is an inherent perception of a future timeframe shaping the use of relationships in which anticipation is then enacted. The transitional role is rooted in "shared representations, interpretations, and systems of meaning among parties" (Nahapiet & Ghoshal, 1998, p. 244) that interact for a future benefit. The cycle of reflection-action allows industry actors to explore a future conception of action to create new value (Joas, 1990). This future conception is understood through the lens of pragmatism, which reveals anticipation embedded in social capital (Zaheer, Albert, & Zaheer, 1999). Anticipation inherently embeds a future perception of time which influences an alternative use of social capital during technological change.

Under the uncertainty of establishing new technologies, a deeper engagement between industry actors occurs through a reflection-action cycle to create new actions. A future perception enables industry actors to interact in this deeper way and to enact new actions that influence context conditions. In this way, the role of social capital goes beyond the access and exchange of resources to influence motives towards new actions, and therefore the context of technological change.

Second, existing theory suggests that the social context of an industry represents an opportunity to create and renegotiate new meanings (Aldrich & Fiol, 1994). Complementing this statement, this research proposes that social capital enables industry actors to identify and interpret signals from the industry context to create collective

understanding. The ability to identify and interpret ambiguous signals and translate them into relational actions reflects the anticipatory elements present in social relations. The multiple and constant rearrangement of trust and worth, and narratives and identity, has been identified as interacting with an actor's perception of time and the signals perceived from the context.

Despite context ambiguity, an actor's engagement occurs through values and ideas, more than resources, therefore "the presence of social capital in the firm also allows it to create new resources rather than simply deploy existing ones" (Nielsen & Chisholm, 2009, p. 18). Thus, a transitional role of social capital provides an understanding of the ability of relationships to support an industry to not only survive and adapt to the context complexity, but also to thrive during technological change by creating the conditions for subsequent transitional periods.

This research suggests that transitional social capital is manifested in two ways. First, social interactions provide industry actors with *resilience,* defined as the ability to change according to the challenges of the context to create and restore action. This ability is based on a collective confidence developed during social processes and engagement. Second, social interactions provide industry actors with *serendipity,* defined as the ability to transform potential benefits embedded in uncertain industry contexts. Both resilience and serendipity are manifestations of a new role attributed to social capital in technological change, further explained in the next two sections.

5.4.2.1. Resilience

Technological change can be perceived as a disturbing period in which new conditions are triggered and influence the overall context (Brown & Eisenhardt, 1997). This research indicates that industry actors make use of their social capital to face disturbances and changing conditions. Extant research has shown that social capital enhances social adaptive capabilities and the coordination and collaborations of actors to contribute to successful action (Drakaki & Tzionas, 2017). These adaptive capabilities suggest a

resilient function in addition to the social control, social action, and social support functions identified in the literature (Portes, 1998).

This research follows Cavallo and Ireland's (2014) perception of resilience as a "bounce forward" (p. 186) and as an ability to generate action under uncertainty, unpredictability and turbulence. Resilience is defined in this research as the ability of social interactions to move to new forms that restore action through collective confidence and engagement. In the literature, resilience means to recover, reorganise and readapt after changes and disturbances (Gibson & Tarrant, 2010). The concept has been applied to organisations' responses to turbulence by means of their ability to overcome disturbing events and to adapt to new conditions (Bhamra, Dani, & Burnard, 2011).

Social capital enables industry actors to move forward and adjust relationships and their elements according to context conditions and changing expectations. Thus, industry actors use social capital to face contextual complexities and move towards the desired state. This research confirms existing theory stating that social capital plays a role in reducing uncertainties faced by actors and thus promotes adoption of new technologies (Lee & Law, 2017). The use of social capital in facing disturbances is referred to here as transitional social capital and it is evident through the resilience of social interactions.

However, research is lacking with regard to the process of resilience. It is still not known how this is important to social capital. This research finds that social capital in the context of technological change serves as the basis of resilience as it allows industry actors to explore a deeper meaning of relationships that is also connected to the perception of time. In this way, a future time perspective allows a deeper connection based on morals and beliefs which provides resilience to relationships by means of collective support. Such morals and beliefs are related to the technology being established. This is evident in the case of clean technologies, in which industry actors regard the technologies as having an impact beyond the business profitability.

Social capital elements are then used in multiple forms, be it a *transaction* through social norms and social exchanges, or a *transition* via the opportunity to bring multiple perspectives together around the new technologies. The synergy of meaningful relationships form the basis of morals and personal beliefs that enable industry actors to move forward during disturbed times. Consequently, social capital plays a key role in the transitions of technology.

5.4.2.2. Serendipity

Technological change brings uncertainty and ambiguity into the context that challenges the active engagement among industry actors when benefits are difficult to perceive. Social capital manifested through shared representations, visions and common ground, acts as a reservoir of values and beliefs that hold the potential to foster collective actions. This research evidences the role of social relations in assessing the diversity and heterogeneity of values and beliefs which represent a potential for creating new social actions. This is referred to here as serendipity and contributes to the transitional role in technological change.

Cunha, Clegg, and Mendonça (2010) refer to serendipity as an accidental finding that is valuable *a posteriori* based on "effort and luck joined by alertness and flexibility" (Denrell et al, cited in Cunha et al., 2010, p. 320). The ambiguous signals from the complex context of technological change are "filtered" in the social milieu and re-interpreted according to inner motivations and expectations of multiple industry actors. During this process, the interactions and actions are maintained in the industry community until uncertainty is transformed into a potential opportunity to generate action.

Through their relationships industry actors nurture their ability to assess uncertainty based on the negotiation of different meanings. This research shows that actors acknowledge the importance of uncertainty to inform future actions, and this importance goes beyond resource access and specific business outcomes. Awareness of uncertainty in individuals and their social groups is facilitated by social capital elements such as shared narratives and identity.

Serendipity, as a manifestation of transitional social capital, enables potential technological and business opportunities through maintaining interactions, especially transferring beliefs and values through narratives and stories to support meaning-making during transition times. Felt (2015) indicates the importance of the "stories told" (p. 17) to recreate identities and collective imaginaries. Social capital plays a transitional role in maintaining the conversation around uncertainty until new actions are created.

In this way, individuals use social capital to foster new industry contexts by enabling necessary conditions for potential opportunities. Opportunity has been identified to be bounded to serendipity (Chetty & Agndal, 2007; Dew, 2009; Graebner, 2004). Even though value and opportunity are not predictable, awareness reflects an ability to identify signals and translate a fortuitous discovery into a valuable opportunity though specific actions.

Social capital is then a source of serendipitous action as relationships hold the potential to create and explore unexpected opportunities. Graebner (2004) shows the serendipitous value in technology acquisitions in the "windfalls that were not anticipated" (Graebner, 2004, p. 752) and embedded in new strategies and new understanding of technologies.

This research indicates that industry actors use social capital to cultivate occasions to create the appropriate conditions in the context and to foster motivations in individuals to enhance serendipitous opportunities for technological change. Relationships and interactions enable opportunities in social processes to foster new actions to influence the context conditions. Conversely, the resulting conditions in the context incentivise new interactions and actions; this momentum is nurtured through iterative engagement. Graebner (2004) recognises that actions by specific actors in the organisation (i.e., leaders taking strategic actions in acquisitions) are needed to maintain momentum.

The pragmatist view identifies that industry actors create prospective actions through collective negotiations and meaning-making based on reflection, knowledge and experience. Prospective actions and serendipitous opportunities are then grounded in the

iterative negotiation of meanings and the willingness to create new meanings through social interactions.

5.5. Model development

Bringing together the influences and roles presented in the previous sections, this chapter concludes with presenting the holistic model of social capital and technological change. The model proposes an integration of the multiple aspects that are intertwined and represent reciprocal and ambiguous influences between social capital and technological change. Leading ideas, that could potentially guide further research, are developed for the different components of the model.

The model integrates and presents the three main findings of this research, as shown in Figure 5.10. First, the model *integrates the influences* – contextual, technological and relational – that occur during technological change. Second, the model *incorporates temporal influences* on the role of social capital in technological change, in addition to the three influences previously identified. Third, the model *proposes two main roles* attributed to social capital by industry actors in technological change: transactional and transitional.
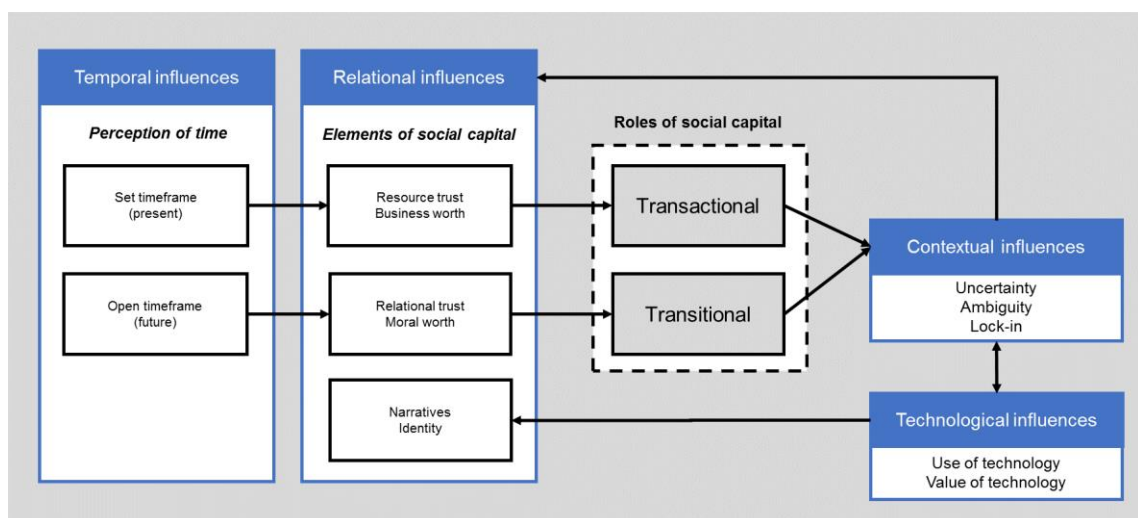
Figure 5.10. Holistic model of social capital and technological change

Integrating the influences. The research proposes an interplay of contextual, technological and relational influences on multiple expressions of social capital, in terms of trust, worth,

narratives and identity. The industry context influences social capital through informing actors' perceptions and actions. The *ambiguity and uncertainty* present in the industry context affect industry actors' *trust and worth* in relationships and potential business opportunities. *Lock-in* effect provides a framework for individual actors through existing resources that influence social capital in terms of *trust and worth* for network expansion, knowledge sharing and translation of skills and capabilities. The technological context, specifically the diverse ways in which actors *use technology* across various sectors, influences social capital in terms of the specific *narratives* used by industry actors and the development of shared and multiple *identities* in each industry context around the technologies. These interplays are guided by actors' interest and expectations of outcomes and allow industry actors to use social capital in various ways.

Leading idea 1: Ambiguity, uncertainty and lock-in are industry context conditions that influence *trust and worth* of social capital.

Leading idea 2: The different use of and value attributed to technology by industry actors influence social capital in terms of narratives and identity.

Leading idea 3: Resource trust and relational trust coexist to guide different uses of social capital.

Leading idea 4: Business worth and moral worth of relationships coexist to guide different uses of social capital.

Incorporating the temporal influence. The contextual, technological and relational aspects are furthermore influenced by a perception of time by industry actors, mainly present and future perception. These different perceptions of time embedded in the mindsets of industry actors are evident in their actions and seem to influence the use of social capital in a transactional or a transitional way. Social capital thus facilitates the integration of temporal perceptions by industry actors in negotiating meanings and collective action for technological change.

Leading idea 5: A perception of time by industry actors influences the use of social capital to foster technological change.

Actors' expectations appear to be set in a specific timeframe with specific goals and tangible outcomes expected from relationships, suggesting a *present perception of time*. This present perception of time guides industry actors to use trust and worth for resource exchange. Social capital is then used to foster current interactions and exchanges between actors, context and technology towards the achievement of specific and immediate goals in a present timeframe, which is the basis of the transactional role of social capital.

Leading idea 6: A present perception of time by industry actors acts as the basis for a transactional use of social capital to foster technological change.

Industry actors' expectations that are not linked to specific outcomes and, rather, allow for reflection on past experiences and awareness of intentions to inform new actions suggest a *future perception of time*. A future timeframe guides industry actors to develop interactions and relationships based on a moral worth given by personal values, beliefs and intentions. This future temporal perspective enables a different use of relationships that provides the basis for the transitional role of social capital in technological change.

Leading idea 7: A future perception of time by industry actors acts as the basis for a transitional use of social capital to foster technological change.

Proposing two roles of social capital. The interplay and integration of the multiple influences on the use of relationships allow the identification of two main roles of social

225

capital in a changing industry context. A *transactional role* confirms the RBV of social capital, in which resource exchange guides the use of relationships. Industry actors aim to achieve short-term outcomes by using different elements of social capital, which reflects a focus on the transaction of strategic resources. Therefore, a set and clear perspective of time and objectives inform the use of social capital.

A *transitional role* extends RBV through the pragmatist view to understand relationships as enablers of contextual change. Industry actors engage in a cycle of experience-reflection-action that suggests the existence of a broader perception of time, including past experiences and future intentions beyond the focus on current specific business outcomes. This transitional role of social capital suggests that new contexts can be created according to the technology and the context.

Leading idea 8: Industry actors attribute social capital a transactional social capital that provides them with the ability to exchange resources.

Leading idea 9: Industry actors attribute social capital a transitional role that provides them with the ability to create new actions.

Transitional social capital involves a different understanding of trust, worth, narratives and identity that enable industry actors to develop *resilience* and *serendipity*. Resilience allows actors to overcome disruptions by means of social interactions, while serendipity enables actors to explore and create opportunities from the uncertain value of new technologies, actions and meanings by means of social interactions. Together, resilience and serendipity enable contextual changes and new industry conditions for technologies.

Leading idea 10: A transitional role of social capital nurtures resilience, understood as the ability to restore action.

Leading idea 11: A transitional role nurtures serendipity, understood as the ability to assess uncertainty and translate it into new action.

Consequently, contextual, technological, relational and temporal influences are intertwined to guide the use of social capital. The two proposed roles of social capital enable industry actors to manage technological change in two ways: a) to adapt to existing conditions, and b) to enable new conditions for technology adoption.

Leading idea 12: A transactional role of social capital allows managing technological change through adapting actions, interactions and resources to the existing context conditions for new technology adoption.

Leading idea 13: A transitional role of social capital allows managing technological change through creating new actions and interactions that enable new context conditions for new technology adoption.

The model provides the basis of the contribution of this research to extend theory on technological change and social capital. It does so by clearly identifying the interplay between the four different aspects involved. Additionally, the interplay among influences reveal two specific forms in which relationships can be used to manage technological change.

5.6. Summary

As the discussion has shown, this research identified four influences and two roles of social capital in the search for an enhanced understanding of, "How does social capital influence technological change in industry contexts?". This discussion presented 1) social

capital and the contextual, technological and relational influences, 2) a pragmatist and temporal influence, 3) social capital transactional and transitional roles and technological change, and 4) how influences and roles are integrated in a holistic model.

First, this research identified that the social capital elements of trust, worth, narratives and identity play a key role and interact with the uncertainty, ambiguity and lock-in conditions of the industry context, and the use and value of technologies. Extant research using RBV has revealed that social capital elements are considered relational resources that can be used to create organisational advantage.

Second, the pragmatist underpinnings of this investigation allowed the identification of the temporal influences that contribute to the identification of how time perceptions guide actors' use of social capital. This research concludes that the perception of time is the main influence when using and managing relationships. The multiple uses suggest that perceptions guide the role attributed to social capital to manage technological change.

Third, actors' perceptions attribute mainly two roles to social capital in managing technological change: transactional and transitional. The *transactional role,* based on resource exchange, allows industry actors to adapt to the contextual conditions and perform under such characteristics. In this way, social capital supports technological change. The *transitional role,* based mainly on moral connections, enables industry actors to overcome challenges and create new conditions. Both roles can coexist in an industry context and enable new conditions for technological change.

Fourth, the model integrates the differences occurring in an industry context and how the interplay of these influences constitutes the basis for the two main roles of social capital proposed here. Additionally, the conceptual analysis led to the identification of leading ideas that suggests scope for further exploration.

In conclusion, these influences and roles together provide the conceptual basis for the contribution to theory and practice, which will be presented in the next and final chapter.

6. CONCLUSION

6.1. Summary of the thesis

The journey undertaken in this research explored, both from a theoretical and empirical stance, the question of how social capital influences the uncertainty and change caused by the adoption of new technologies in industry contexts.

The theoretical investigation presented in Chapter 2 provided a conceptual framework based on the literature streams of technological change and social capital. Literature on technological change presented the multiple contextual factors shaping technological transitions, while literature on social capital outlined an understanding of the social phenomena occurring in an industry context. The conceptual framework was then composed of three aspects that were identified to shape relationships and technology adoption and led to the development of the following research sub-questions: a) how does the industry context influence social capital, b) how does the adoption of technologies influence social capital, and c) how is social capital understood and used by industry actors? These research sub-questions guided the subsequent empirical investigation into the understanding of how the social phenomena influence technological transitions.

To conduct the empirical investigation, a research design was developed (as presented in Chapter 3). The research design has a reflective character of inquiry by following pragmatism as the philosophical view, and a qualitative explorative research methodology aligned to the social phenomena of interest. This empirical investigation continued with the analysis and interpretation of the evidence, as presented in Chapter 4. Data analysis led to the development of eight themes that revealed the main findings and addressed the three research sub-questions.

A conceptual analysis of the findings followed, as presented in Chapter 5. This analysis identified the contextual, technological, relational and temporal influences that guide the

two proposed roles of social capital. These influences and roles were integrated in a holistic model that constitutes the basis to extend the theory of social capital and technological change.

This final chapter presents the contribution to the literature streams of technological change and social capital in section 6.2, the contribution to practice and managerial implications in section 6.3, as well as limitations and further research, in sections 6.4 and 6.5 respectively. The chapter concludes with final remarks.

6.2. Contribution to theory

The research addresses two gaps identified in the technological change and social capital literatures. First, within the literature on technological change, there is a lack of specific exploration of the social attributes influencing changes. Second, within social capital there is a lack of specific analysis of the changing context dynamics and technology on relationships and how they support the process of change. By addressing these issues, this research contributes to an understanding of how social relations occur in changing contexts due to technological transitions.

As discussed in Chapter 5, this thesis proposes the interplay of four influences: context, technology, relations, and the perception of time. This interplay is analysed in this section through the lenses of the literature gaps previously mentioned, and the contribution to both literature streams is presented in the following two sections.

First, this research proposes that the contextuality and temporality of relationships contribute to the ongoing debate in social capital literature on how a changing context and technology influence relationships. It does so by identifying the *contextual, technological, relational and temporal influences* and their interplay through the lens of pragmatism. Specifically, the identification of *time perceptions* as an enabler of different roles of social capital within the changing industry context contributes to current literature.

Second, this research proposes that <u>two roles of social capital</u> contribute to an understanding of the social attributes influencing <u>technological change</u>. The interplay of the four influences guide the use of social capital by industry actors which suggests that *transactional and transitional* roles coexist in the changing and uncertain industry context.

6.2.1. Contextuality and temporality of relationships in social capital literature

To answer the question, "How does social capital influence technological change?", this research adopted a pragmatist stance to extend the existing RBV of social capital (Nielsen & Chisholm, 2009). A pragmatist analysis of social capital in changing industry contexts, as suggested by Farr (2004), revealed the <u>contextuality and temporality of relationships</u>. Thus, this research argues that social capital has broader implications, beyond facilitating resource exchange and transactions for competitive advantage (Nahapiet & Ghoshal, 1998). In short, the evidence for the thesis argues that in the context of the research, social capital has two primary roles: transactional and transitional. Taken together, these roles enable technology to be adopted by industry in a consistent way, and therefore contributes to the change process.

The alternative view of social capital, enabled by the lens of pragmatism, reminds us to take into account the dynamism and complexity of the context (Woolcock, 1998) and the timing (Felt, 2015) in social capital. This research suggests the contextuality and temporality of social capital through the intertwined and reciprocal feedback between shared meanings and representations occurring among the actors, the context and the technology.

This research contributes to the understanding of the *contextuality* of social capital by identifying that ambiguity, uncertainty and lock-in effect challenge and shape the perceptions and interactions of industry actors. This builds on Geel's work (2004, 2005; 2007), that states that context complexity is due to the diverse actions from multiple actors in terms of policies, regulations, incentives that are specifically related to the technology. In this way, the contribution explicitly focuses on how the context complexity in technology adoption becomes relevant and can be potentially addressed.

This research also contributes to the understanding of the *temporality* of social capital. It confirms that situatedness and multiple perceptions of time play a role in the engagement of industry actors during technological change (Felt, 2015). The intertwinement of past, present and future becomes relevant when creating action towards specific and desirable future states related to specific contexts and actors. The contribution emerges from the time perspective and the interplay with the other influences that reveal that industry actors use social capital elements such as trust, worth, narratives and identity in diverse ways.

Consequently, this research suggests that the debate on social capital, that has been predominantly guided by a RBV, can be broadened from a causality approach (source-outcome) to a temporal and contextual view that supports and enables actors' actions under uncertainty. This contribution is aligned with Gretzinger and Royer (2013) who posit that the value of social capital on interactions and interdependencies of actors and their context contribute to action. Thus, the role of social capital resides not only in the networks and resources within, but also in the continuous assessment and negotiation of individual and collective cognitive frameworks.

6.2.2. Roles of social capital in technological change literature

To answer the question, "How does social capital influence technological change?", this research integrated the literature streams of technological change and social capital. Thus, this research contributes to both streams by differentiating the transactional and transitional roles of social capital. These roles contend that an actor's understanding of the industry context and the value and use of technologies guides the use of relationships in a changing and uncertain industry context.

The transactional role confirms the existing RBV of social capital used for creating and maintaining competitive advantage. The thesis' contribution lies in the specific use of elements such as trust, worth, narratives and identity, as resources to achieve specific business objectives. These business objectives correspond to a present perception of time.

The transitional role builds on Felt (2015) by suggesting that relationships enable industry actors "to develop anticipatory and more adaptive forms of governance as well as to connect public participation explicitly with the realm of making techno scientific futures" (Felt, 2015, p. 5). This role extends the RBV of social capital by attributing relationships with the potential to forge resilience and to transform context conditions towards the desired and required technological context (Lappé & Du Bois, 1997).

Consequently, the interplay of contextual, technological, relational and temporal influences guides industry actors to use relationships in various ways. These different uses suggest that social capital can have transactional and transitional roles during periods of technological transition.

This research proposes that the two roles constitute a way of managing technological change. A transactional role supports the RBV to develop competitive advantage (Barney, 2001; Nahapiet & Ghoshal, 1998) through using social capital as a resource. As such, social capital plays a role in managing access to resources to adapt to existing context conditions of ambiguity and uncertainty. A transitional role of social capital contributes to resilience and serendipity, which reflects the anticipatory nature of relationships (Farr, 2004) to support technological change. Moreover, social capital plays a role in managing technological change through creating new actions that support the adoption of new technologies by enabling new context conditions.

In summary, this research contributes to the *social capital literature* by suggesting an alternative view beyond the RBV. The pragmatist view indicates that changes in the multiple expressions of social capital, in terms of trust, worth, narratives and identity, constitute the main influences that interplay with the context, the technology and the time perception in technological change. In addition, this research contributes to the *technological change literature* by incorporating the previously stated contribution to social capital in a holistic model that suggests how to manage technological change by means of the two proposed roles of social capital. These roles include the transactional role to adapt

to existing conditions, and the transitional role to create new actions to enable new context conditions.

6.3. Contribution to practice

In addition to the theoretical contributions presented in the previous section, several practical contributions and managerial implications will now be put forward. These can be applied to industry actors (for example, individual professionals or organisations) involved in the diffusion and adoption of new technologies. The researcher is particularly interested in linking the influences and time perspectives previously identified to organisational dynamics and organisational strategy to improve today's management practice. Due to the diversity of the actors included in addition to the explorative nature of this research, the contribution to practice in this thesis is presented in terms of general directions to manage technological change rather than concrete actions for specific type of industry actors.

The proposed roles of social capital, as the overarching finding of this research, suggest that professional and business relationships can be managed by individuals and organisations to face uncertainty and unknown conditions triggered by technological change. Social capital is understood as an opportunity to influence industry conditions and existing paradigms to create new futures. The identification of a time perception as a key factor determining action suggests that managing technological change should consider multiple scenarios according to the timeframe of business objectives followed by industry actors.

Thus, this research highlights the possibility of managing technological change by using relationships to constantly shift between adapting to existing conditions and creating new collective action to modify industry contexts. Hence, organisations can be aware of the time perception when making decisions on the use of relationships for supporting technology diffusion. Industry actors can use social processes, such as informal activities

and industry events, to raise awareness of the timeframe of other actors and of the general conditions of the context and the technologies.

According to the perception of time and the business objectives, industry actors can better define their decision-making processes, including relationship management. Industry actors can direct their strategic actions towards adapting to existing conditions of ambiguity, uncertainty and lock-in. In this case, actors can foster technology diffusion and adoption by managing social capital towards the achievement of specific business objectives within a limited timeframe. Thus, industry actors can focus on the development of resource trust (expecting a specific outcome) that facilitates accessing transactions. Efforts can be made towards formalising relationships in which worth is focused on the output, while minimising engagement in social processes, and communicating the technical and commercial value of the technology. For this, social capital elements such as narratives can emphasise the technical knowledge in the specific sector of application.

Another plausible scenario for industry actors is to create new collective actions that enable new context conditions. In this case, individuals and organisations can foster technology diffusion and adoption by combining relational trust (not pursuing a specific goal, but trusting in value deriving from the relationship). Strategic actions would focus on interpersonal engagement to explore a new value of technologies beyond the commercial. For this, industry actors can manage the narratives used to communicate their beliefs and explore new opportunities, thus contributing to the building of a common ground and vision. This scenario also implies that fostering the use of different and multiple identities can support and enhance the entrance into new sectors and industry contexts, which in turn facilitates knowledge sharing, network expansion and access to resources across sectors, and ultimately the conditions/*context* for technology diffusion and adoption.

Hence, industry actors can influence the process of technology adoption by fostering resilient and serendipitous relationships to create and exploit potential technological opportunities. Resilience can overcome the breakdown of relationships related to

underperformance of business objectives through the use of narratives and alignment of organisational practices with personal intentions and meanings. As a result, collective action can be nurtured by moral motivations that incentivise actions and efforts to maintain relationships through difficult times. Relationships with a moral meaning (beyond transactions) nurture the collective ground and build resilience. Managing serendipity can be achieved through raising individual awareness and retrospective analysis in industry actors. For this, the value of social processes needs to be acknowledged as it constitutes the basis of interaction and engagement that could lead to new and unexpected opportunities. Social processes can be developed in an organisation to create a favourable context that facilitates opportunities. For example, programs and incentives to work together informally can foster willingness to interact and collaborate for new opportunities.

At an individual level, the implications include developing capabilities to raise timeframe awareness and retrospective analysis in the decision-making process, the use of language and technical jargon according to industry contexts, and the early signal identification to adjust narratives and identify characteristics, among others. Individual actors face a new challenge in managing both roles of social capital, in other words maintain the accrued value from transactions while influencing the context and preparing it for new value creation. Consequently, this thesis suggests that social capital can contribute to the manageability of contextual and technological factors in various ways. Organisations could benefit from managing their social relations with two purposes, access to resources and creation of new contexts, and in doing so, relationships can contribute to managing uncertainty and supporting technological change.

6.4. Limitations

Integrating literature on technological change and social capital, and investigating the intersection of these two fields in the Australian clean technology sector using a pragmatist perspective, enabled the researcher to gain significant insights into the

phenomenon, and ultimately to make contributions to both theory and practice. The results and contributions, however, need to be considered in the light of some limitations.

First, and foremost, it needs to be recognised that the results of this research are limited to the subject under study, namely the clean technology sector in Australia. The main objective of this thesis was to contribute to the development of new knowledge rather than ensure that the results were applicable to other research contexts, be them industries or countries. In other words, the generalisation of the results was not the goal of this qualitative research (Riege, 2003) , as opposed to most quantitative research. While the clean technology industry was purposely selected to build an exemplary case (Eisenhardt, 1989) the results are not necessarily applicable in other, even similar, contexts.

Second, this thesis used social capital as the theoretical frame to understand the social phenomena occurring during technology adoption in an industry. Despite the wider recognition of social capital as a robust theory to explore the role and attributes of relationships (Adler & Kwon, 2002; Portes, 1998), other theoretical frameworks could be used to guide new research. This is especially important due to the complexity of the social aspect that involves multiple and dynamic elements. Due to that complexity, some elements and their interaction could have been overlooked in this analysis and findings.

Third, the results are limited to one specific point of time in technological change. Interviewees' responses were based on their current situation and past experiences in the industry. Compared to research that investigates a subject at multiple points of time, for example, through a longitudinal study (Bryman, 2012), this thesis has focused on only one point of time which can limit the stability of the results over time in technological change. It also needs to be recognised that the research was applied to clean technologies in the Australian industry context in general, and that the industry was not classified into different stages of industry development (Fredin, 2012; Gustafsson, Jääskeläinen, Maula, & Uotila, 2015), so that the results might not be valid specific stages of the industry.

Lastly, the data gathering of this research might have been influenced by an interviewer (or researcher) bias and a social desirability bias. While both ethical obligations (Rosenthal, 1994) and instructions (Phillips, McAuliff, Kovera, & Cutler, 1999) assist with avoiding such bias, qualitative researchers need to be aware of their likely existence, especially when data is gathered through in-person interviewers (Blount, Evans, Birch, Warren, & Norton, 2002). The term "interviewer bias" refers to a variety of biases referring to an interviewer's ability to influence respondents' answers, either in the process of data collection, recording or interpretation (Pannucci & Wilkins, 2010). Given that this research investigated social relations between industry actors in detail, interviewee answers might have been influenced by the interviewees' desired need for social acceptance. Additionally, one limitation is based on the confirmatory bias which unconsciously leading the interviewer to confirm what is believed rather than investigating all possibilities in detail (Nickerson, 1998).

6.5. Further research

Based on the findings, leading ideas and limitations identified in this research, various directions for future research are proposed.

Further research could be done to transfer the research findings to other contexts. The explorative results and, specifically, the leading ideas derived, can be applied to other industry contexts (Bryman, 2012). Similarly, research can look to generalise the findings of this thesis so that they can be statistically tested in order to evaluate the results' applicability to other conditions (Miles & Huberman, 1984). It has been stated that the success of new technologies demand organisational efforts in multiple and global business (Nair & Paulose, 2014). Exploring the international context of new technologies, especially in the global professional networks that support knowledge transfer and resource exchange, can shed light into social capital for technology application at a local and international context (Chetty & Söderqvist, 2013). This can include other industry or technology sectors, other countries and cultures, as well as organisational settings.

Further research could investigate the phenomenon at various points of time during the industry development lifecycle or technological change (Peltoniemi, 2011). Potentially, the role and influence of social capital in technological change might differ in specific phases of the industry or technological development, thus presenting new research questions to be addressed.

With respect to further investigating key results of this research, further research could focus on a deeper exploration of each of the contextual, technological, relational and temporal influences proposed. For example, the interplay of narratives and identity, and trust and worth with other individual, organisational and industry attributes and conditions.

The time perspective in the context of social capital and technological change, in particular, could be the focus of further research (Zaheer et al., 1999). For example, in addition to the present and future time perspective that has been put forward in this research, future research could focus on past perceptions as a third perspective, and also investigate the interplay between these three perspectives. These perspectives may then be researched in different organisational and industry contexts in order to find further influencing aspects and the interplay with the contextual, technological, relational aspects previously proposed here.

The time perspective could be incorporated to well-stablished organisational conceptual frameworks such as dynamic capabilities (Teece et al., 1997) and organisational ambidexterity (O'Reilly & Tushman, 2004), or to strategic management literature on strategic flexibility (Evans, 1991) and decision making (Eisenhardt & Zbaracki, 1992). By bringing the influence of the time perspective of the individual actor, organisational studies could benefit in the understanding of cognitive elements of managerial practices, especially when linked to technological advancements. This could be related to research on the transitional role of social capital, specifically on the operationalisation of resilience and serendipity.

Another field of research related to the individual actor could be the focus on the cognitive elements of social capital in role models, champions and leaders during the appearance of new technologies and innovation (Hollen, Van Den Bosch, Frans A. J., & Volberda, 2013). Understanding these cognitive social elements can contribute to the strategic positioning of both individuals and organisations in leading the social capital in an industry, and therefore managing the establishment of new and multiple technologies.

Future research might also be conducted to extend the results and the developed model by including additional stakeholders (Freeman, 2010), such as society and consumers as key players in the process of technology adoption (Malerba, 2007). Especially in the case of clean technologies, consumer acceptance is a driver of adoption and market development (Negro et al., 2012; Roper & Tapinos, 2016).

Finally, further research could explore new roles of social capital in technological change by using other philosophical and theoretical perspectives to analyse technological change beyond and/or in addition to pragmatism and social capital. Process and relational ontologies (Langley & Tsoukas, 2010) that incorporate time and anticipation perspectives could contribute to an understanding of other aspects of technological change, such as policy scenarios for cutting edge technologies, co-creating processes of new technologies, social value and impact of technologies, among others. The different understandings of such conditions might enable various roles of social relations that can guide technological change.

6.6. Final remarks

This research investigated the role and influence of social capital in managing technological change in industry contexts. Incorporating technological change and social capital literature, investigating the topic in the context of clean technologies and using a pragmatist perspective has created a unique opportunity for this thesis, leading to significant insights. However, it needs to be recognised that technological change is a complex phenomenon, and that, despite the recognised importance, our understanding of

this type of change, especially from a social capital perspective, is still in its infancy. Thus, further research at the intersection of these two research fields is required to better understand and manage technological change in the future. The comprehensive, explorative research undertaken in this research attempted to provide a specific and significant piece of knowledge to further open up the "black box" (Bijker et al., 2012, xliii) in which the reciprocal relation between people and technology remains. The results provide a starting point for future research, and will hopefully contribute to developing a research stream dedicated to the intersection of social relations in technological change.

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APPENDICES

Appendix A: Participant Information Sheet

Small talk, big business: a social capital's contribution to business development in an emerging high-technology industry.

Investigator: Lina Landinez, Wk: 08 8303 2211, Mobile: 0404 190 887, Business School, The University of Adelaide, SA.

This project explores the dynamics of social capital and its influence on business interactions in the clean technology industry, as an example of an emergent high-technology industry. Particularly, this project will identify the role of social capital on industry development in the Australian context. This research will provide a significant contribution to understanding business and industry interactions as main drivers of competitive advantage. Outcomes of this research will inform practitioners and decision-makers in the clean technology industry of the dynamics of business interactions.

Participants are invited to take part in an interview with the investigator. Participants will be asked about their opinion of the role of business interactions and networking practices in industry development, based on their experiences and their current professional roles. A semi structured interview will focus on the participant's experience in developing and maintaining business interactions.

The interview will be one hour approx., and will be digitally recorded following provision of a confidentiality agreement to warrantee the participant and their organisation identity remains private. No names of individuals or organisations will be used or revealed throughout the research project or in the presentation of its final results. Participants will be invited to suggest names of other potential interviewees for this project following a technique known as 'snowball sampling'. A consent form will be provided for participants to assure of confidentiality and consent of the digital recording procedure.

This study has been cleared by one of the human ethics committees of the University of Adelaide in accordance with the National Health and Medical Research Council's guidelines. You are free to discuss your participation in this study with project staff (contact details as above). If you would like to speak to an officer of the University not involved in the study, you may contact the Ethics Secretary, Human Research Ethics Committee, **Ms Sabine Schreiber** on 08 8303 6028.

The University of Adelaide - Human Research Ethics Committee (HREC)

This document is for people who are participants in a research project.

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS

PROCEDURE

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project Title:	A social capital's contribution to business development in an emerging high-technology industry.
Approval Number:	HP-2013-081

The Human Research Ethics Committee monitors all the research projects which it has approved. The committee considers it important that people participating in approved projects have an independent and confidential reporting mechanism which they can use if they have any worries or complaints about that research.

This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research (see

http://www.nhmrc.gov.au/publications/synopses/e72syn.htm)

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

Name:	Dr Lisa J Daniel
	Lina Landinez, PhD Student
Phone:	+61 08 8313 2211

2. If you wish to discuss with an independent person matters related to:

- making a complaint, or

- raising concerns on the conduct of the project, or

- the University policy on research involving human participants, or

- your rights as a participant,

contact the Human Research Ethics Committee's Secretariat on phone (08) 8313

6028 or by email to hrec@adelaide.edu.au

Appendix B: Consent Form

1. I have read the attached Information Sheet and agree to take part in the following research project:

      Title: A social capital contribution to business development in an emerging high-tech industry.

      Ethics Approval Number: HP-2013-081

2. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

3. Although I understand the purpose of the research project it has also been explained that involvement may not be of any benefit to me.

4. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

5. I understand that I am free to withdraw from the project at any time.

6. I agree to the interview being audio/video recorded.   Yes ☐ No ☐

7. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

Participant to complete:

Name: _____ Signature: _____ Date: _____

Researcher/Witness to complete:

I have described the nature of the research to

(print name of participant)

and in my opinion she/he understood the explanation.

Signature: _____ Position:_____ Date: _____

Appendix C: Interview guide

Business interactions are recognised to play an important role in the development of an industry. Understanding how these business interactions inform business development is a key aspect for any organisation. Your participation in this doctoral research will contribute to revealing how to better support constructive business interactions in a technology intensive industry.

The questions below focus on your experience in the clean technology industry and how you perceive inter-personal and business networks operate. Please keep in mind that the value of this interview lies in your experience in this field, and there are no right or wrong answers. I am interested in your personal and valuable opinion.

Personal information

    a. Professional expertise (background, years of experience, etc.)
    b. What was your path into clean tech?
    c. What does your organisation do? (Sector, role in the value network, years, etc.)

Context

I'm interested to know your opinion on the characteristics and state of the industry. Since your organisation was involved, I'd like to hear your insights.

- How would you personally/professionally describe the industry?
- How would you describe, based on your experience, the business interactions of the industry?
- From your experience, how do you think the industry as a whole supports its business interaction and networks?

Challenges and success

I'm interested in how business interactions contribute to the industry. In particular, I'm interested in how business interactions are perceived during difficult and/or successful periods.

- In your opinion, are there common elements or conducive influences that bring the industry together? What are they? How are they transmitted and nurtured?

- How does the diversity (difference) of business perspectives influence the industry as a whole?
- From your experience, have you noticed changes in the characteristics of business interactions, industry culture, or any other social aspect over the period of time that you have been involved in clean tech? Can you describe the changes?

Actions and next steps

Finally, I'm interested in how your organisation perceives the future of the industry. In particular, I'm interested in how business interactions can contribute to developing the industry community.

- Can you give me an example of a successful collective work/achievement in this industry? What do you think made that possible? Why did it work?
- In a similar way, can you recall a non-successful event? Why do you think it happened? What do you think you/others learnt from that?
- What do you think is the contribution of your organisation to the industry development?
- Can you foresee any new activities you can develop?

Appendix D: Second order codes and aggregate concepts

Second order codes	Aggregate concepts
Have social skills	Anticipation
Modify understanding and perception	Anticipation
Ability to identify and adapt to opportunities	Anticipation
Change of individual values needed for organisational change	Anticipation
Role changes with the context	Anticipation
Versatility of relationship according to contextual factors	Anticipation
Ability to develop skills	Anticipation
Social skills and management skills	Anticipation
Ability to read signals from the market	Anticipation
Need a change in mindset to have a new paradigm	Anticipation
Transfer and adapt existing skills of a different industry	Anticipation
Ability to develop relationships in an industry	Anticipation
Ability to use systems	Anticipation
Ability to adapt knowledge and use it	Anticipation
Changes in relationship according to context	Anticipation
Using different social skills according to the situation	Anticipation
Ambiguity of trust	Dual trust
Trust transformed into tangible resources	Dual trust
Carry over or path dependence of trust and reputation	Dual trust
Reinforcing between trust and norm	Dual trust
Trust for business development	Dual trust
Attitude and awareness towards future	Envisioning change
Awareness of influences of culture in organisations	Envisioning change
Ambiguity on believing the future of the industry	Envisioning change
Anticipate consequences	Envisioning change
Expectation on the external context	Envisioning change
Understanding the context changes lead to innovation	Traditional Industry
Ability to adapt to context	Traditional Industry
Previous experience for business development	Traditional Industry
Cleantech as a part, extension or integrated into to traditional industries	Traditional Industry
Competing with traditional technologies and traditional industries	Traditional Industry
Cut back funding	Traditional Industry
Government support to traditional industries	Traditional Industry
Dominant culture, conservative, difficult to modify	Traditional Industry
People moving from traditional industries to new ones	Traditional Industry
CT display characteristics of emerging industry	Traditional Industry
As an emerging industry, it demands more understanding	Traditional Industry
Traditional industries affect perceived value of CT	Traditional Industry
Traditional industries difficult to adapt or change	Traditional Industry
Existing networks from traditional sectors	Traditional Industry

Transversal services support industry development	Traditional Industry
Influence of traditional media	Traditional Industry
Personal commitments and family background determine business opportunity	Conflicting support
Industry activities varied according to the context	Conflicting support
Context as a facilitator of interactions	Conflicting support
International (global) context determines business opportunities	Conflicting support
Diverse ways government supports industry development	Conflicting support
Other support different from money is needed	Conflicting support
Government programs encouraging interaction	Conflicting support
Ambiguous role of IP in tech dev	Conflicting support
Other country's conditions enable business opportunity	Conflicting support
Regulations creating industry development	Conflicting support
Market creates relationships	Conflicting support
Regulatory framework limits industry action	Conflicting support
Need of enough resources to support going backwards	Conflicting support
Small VC market affects industry development	Conflicting support
Context facilitates relationships	Conflicting support
Contacts generated from the context. Opportunities coming from them	Conflicting support
External pressure drives individual action and collective behaviour	Conflicting support
Government impede development	Conflicting support
Policy driving technology development	Conflicting support
Market push, after government incentives	Conflicting support
Experience gives understanding and criteria	Experience
Experience as a signal of credibility that opens up opportunities	Experience
Multiple experience, ability to bring it all together	Experience
Learning from experience	Experience
Experience facilitates understanding	Experience
Working together creates shared experiences and understandings	Experience
Shared experiences facilitate understanding	Experience
Difficulty to create shared experiences	Experience
Share experiences influences transactions	Experience
Position and expertise signal reputation and enable action	Experience
Identity and credibility linked to a position	Identity
Feeling of belonging from shared values, motivations.	Identity
Influences to build up identity	Identity
Belong to multiple associations simultaneously	Identity
Political interest interferes with decisions for industry	Introduced uncertainty
Government changes create uncertainty	Introduced uncertainty
Government priorities affects industry relationships	Introduced uncertainty
Need to match political message and actions to business opportunities	Introduced uncertainty
Dynamic context	Introduced uncertainty
Signals are ambiguous and evolving. Ability to read them to influence perception and action	Introduced uncertainty
Changes in government influence roles and expectations	Introduced uncertainty

Negative perception of government	Introduced uncertainty
Ambiguous messages from government	Introduced uncertainty
Industry cycles affect relationships	Introduced uncertainty
External factors deter process	Introduced uncertainty
Context and external factor affect interactions and transactions	Introduced uncertainty
Correspondence between personal motivations and org characteristics	Alignment
Mix and complement personalities influence work	Alignment
Empathy facilitates action	Alignment
Alignment and understanding create collective action	Alignment
Aligned expectations and understanding facilitates action	Alignment
Integrate organisation strategy or practices	Alignment
Alignment of individual and organisational values	Alignment
Incongruence within government	Alignment
Continuous adjustment of agendas	Alignment
Correspondence between industry culture and type of relationships	Alignment
Complementarity of big and small companies for industry development	Alignment
Divergence of expectations between investors and companies	Alignment
Match individual and organisational expectations with culture	Alignment
Evolution of expectations	Alignment
Build capacity	Momentum
Inter-organisational interactions form culture	Momentum
Right timing for decisions and actions	Momentum
Diversity in an organisation	Multiple and diverse perspective
Others' perception is diverse	Multiple and diverse perspective
Diverse actions towards the same goal	Multiple and diverse perspective
Multiple organisations in an industry	Multiple and diverse perspective
Combination of skills, strengths, experience	Multiple and diverse perspective
Multiple perspectives, backgrounds, personalities to form understanding	Multiple and diverse perspective
Multiple ways to share and exchange resources	Multiple and diverse perspective
Diversity of actors due to diversity of technology	Multiple and diverse perspective
Multiple technologies, multiple products	Multiple and diverse perspective
Diversity in motivations, values and outcomes according to role, position, sector	Multiple and diverse perspective
Multiple rules and systems coexisting in an industry	Multiple and diverse perspective
Recognise multiple differences coexisting	Multiple and diverse perspective
Multiple types of relationships coexisting simultaneously	Multiple and diverse perspective

Different interpretations, multiple ways to reach agreement	Multiple and diverse perspective
Need to communicate personal values	Technology language and narratives
Understanding and common grounds emerge from industry concept (or name)	Narratives
Narrative affects reputation	Technology language and narratives
Understand and interpret the message	Technology language and narratives
Understanding of industry concept affects industry development	Technology language and narratives
Iterative process to get the message across and build understanding	Technology language and narratives
Overuse of the term 'clean technology'	Technology language and narratives
Broad meaning, diverse value based in action	Technology language and narratives
Name changes as industry evolves	Technology language and narratives
Lack of consensus on what cleantech is	Technology language and narratives
Varied used of the term based on perceived benefits	Technology language and narratives
Confusion caused by name easily changed	Technology language and narratives
Success stories influence perception and industry development	Technology language and narratives
Technology development does not respond to an industry concept	Technology language and narratives
Industry concept influences agendas and systems	Technology language and narratives
Communicate the values behind the message	Technology language and narratives
Technical message vs value proposition	Technology language and narratives
Adapt the message according to the context or situation	Technology language and narratives
Cultural narratives influence the message and interpretation	Technology language and narratives
Languages affecting the message	Technology language and narratives
Ability to tell the story, gain credibility	Technology language and narratives
Spread the world, tell the story	Technology language and narratives
Collective value needs to be communicated. Tell the story	Technology language and narratives
Stereotypes	Negatives
Negative perceptions influence decision and action	Negatives
Response to stressful situations	Negatives
Diversity of perspectives and interpretations cause problems in relationships	Negatives
Negative effects of individual action	Negatives

Intangible elements are the source of problems in relationships	Negatives
Negatives of relationships	Negatives
Sources of business opportunity	New context
Intangible benefits of knowledge sharing	New context
Persona vs position. Some values are associated with some positions	Relational interface
Coherence between reputation, managerial practices and context	Relational interface
Understand the organisational context	Relational interface
Size and type of organisation	Relational interface
Way to relate according to size and type of organisation	Relational interface
Business objective and value proposition	Relational interface
Operational costs affect collective dynamic	Relational interface
Management of relationships	Relational interface
Business practices support relationships	Relational interface
Staff turnover affects relationships	Relational interface
Importance of the position for relationships	Relational interface
Multiple positions and roles in one person	Relational interface
Social expressions are catalysed through organisations and influence perceptions and decisions	Relational interface
Systems reinforce reliability	Relational interface
Systems respond and are aligned to organisations	Relational interface
Complementarity of systems and policy as a basis of the ecosystem	Relational interface
Systems evolve and facilitate industry development	Relational interface
Industry culture shaping systems	Relational interface
Business success support relationship building	Relational interface
Dialogue changes with nature of company	Relational interface
Match organisational factors influence relationships	Relational interface
Organisational success as a signal foster relationships and influence perception	Relational interface
Organisational characteristics create or solve difficulties	Relational interface
Perceived value influence interactions	Worth
Perceived value and commercial opportunity are different	Worth
Organisational value of relationships	Worth
Recognise other's value	Worth
Difference between perceived value and real one	Worth
Perceived value of industry associations	Worth
Perceived value of relationships drives motivations to interact	Worth
Different perception of value proposition influence relationships	Worth
Differential value of connections	Worth
Collective learning for business development	Reflection
Retrospective learning	Reflection
Learn from international references	Reflection
Lack of reflective analysis. Unawareness of the situation	Reflection
Learn from others	Reflection
Skills for learning	Reflection
Reflexivity leads to different types of learning and opportunities. Ability to reflect.	Reflection

Change relationships based on learnings	Reflection
Relationships support organisational practices	Relationships
Expectations affect relationships	Relationships
Relationships form organisational culture	Relationships
Relationships support business development	Relationships
Iterative process to build up relationships	Relationships
Relationships allow transactions	Relationships
Type of relationships in early stages	Relationships
Personal relationships in industry	Relationships
Formal relationships as signals facilitates actions	Relationships
Survive industry cycles. Based on experience. Collective	Resilience
Difficulties in the business affect relationships	Resilience
Need to maintain relationships beyond problems	Resilience
Flexibility and ongoing effort to fix problems	Resilience
Solve problems	Resilience
Breakdown of relationships	Resilience
Relationship maintain people together through difficult times	Resilience
Broken relationships are hard to recover	Resilience
Keep trying. Keep building relationships in unsuccessful moments	Resilience
One strong personality can lead an organisation (culture)	Roles
Facilitator role	Roles
Champions and leaders	Roles
Role of organisation as a bridging actor	Roles
Connector role	Roles
Multiple roles of organisation	Roles
Role of the collective	Roles
Role of big companies	Roles
Sponsors as supporters of industry development	Roles
Recognised role and value of John	Roles
Serendipity	Serendipity
New opportunities by chance as a combination of multiple factors	Serendipity
Coexistence of expected and unexpected consequences	Serendipity
Understanding the message enables new opportunities	Serendipity
Ability to deal with unexpected outcomes	Serendipity
Spread personal values to create a culture	Spillover
Personal willingness enables action	Spillover
Success as a signal of continuity	Spillover
Multiplier effect of actors and relationship	Spillover
Organisational culture influences external relationships	Spillover
Internal strengths and capabilities create reputation	Spillover
Public perception builds industry recognition	Spillover
What people bring to industry culture	Spillover
Inertia of networks	Spillover

One outcome leads to another. Ongoing expectation	Spillover
Synergistic effects of intangible elements of relationships	Collective value
Shared value	Collective value
Common vision as a driver of collective action	Collective value
Shared responsibilities	Collective value
Associations as a collective voice	Collective value
Mutually generated elements create collective action	Collective value
Iterative collective actions maintain vision, values, agendas	Collective value
Individual beliefs and mindset form collective goal	Collective value
Linkages between org create industry development	Collective value
Small companies lack perspective as an industry	Collective value
Collective mindset	Collective value
Collective ongoing effort to go through difficult times	Collective value
Collective ability	Collective value
Synergies of individual actions	Collective value
Synergy of collectives	Collective value
Collective confidence link to a person (leader)	Collective value
Collective awareness of value of relationships	Collective value
Transactional thinking affect perception	Transactions
Expected tangible outcomes of relationships	Transactions
Identity (being part of an industry) driven by transactional thinking: it is driven by the perceived value/gains	Transactions
Transaction required for a relationship	Transactions
Outputs are more than money	Transactions
Specific outcome driving relationship	Transactions
Networking without a transaction expectation	Transactions
Knowledge based relationships	Transactions
Common problems bring people together	Uncertain value
Problems as an opportunity to engage, to discuss	Uncertain value
Uncertain value and outcomes of R&D	Uncertain value
Uncertain value of relationships. Social benefits	Uncertain value
First contact is the most important step in a relationship. Uncertain value	Uncertain value
Relationships enables the creation of new things	Uncertain value
Attitude and awareness towards uncertainty	Uncertain value
Relationships are a source of unexpected opportunities. Uncertain value	Uncertain value
Uncertain value of informal activities	Uncertain value
Ongoing reassessment value of relationships	Uncertain value
Technology as a way of belonging	Versatility of tech
Need of a change in perception to introduce a new technology	Versatility of tech
Cleantech sits across multiple sectors	Versatility of tech
Multiple technologies and multiple applications	Versatility of tech
Diversity of sectors causes lack of identity as an industry	Versatility of tech
Continue New tech drives industry development	Versatility of tech
Struggle to develop and stablish a technology in a market	Versatility of tech

Type of relationship change with technology development	Versatility of tech
Technology quality builds credibility	Versatility of tech
Relationship need qaulity technology to be reinforced	Versatility of tech
Level of innovation affects acceptance	Versatility of tech

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