

# **LEVERAGING SOCIAL CAPITAL FOR KNOWLEDGE DEVELOPMENT IN CLUSTERS**

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## **ABSTRACT**

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This doctoral thesis explores how social capital is leveraged for the transfer, sharing and spillover of knowledge (knowledge development) to achieve competitive advantage in clusters. The rationale behind this research is that, paradoxically, in a time of information technology and high labour mobility, location still matters for firms. Clusters - a term describing the spatial agglomeration of firms and institutions of one particular industry - can be the source of advantages for those firms located within the cluster as well as for the entire region. This research contributes to a body of literature devoted to explaining how the advantages of clustering come about.

A resource based perspective on clusters is adopted, focussing on the interplay of the two intangible resources social capital and knowledge. In exploring the research problem of how social capital is leveraged for the development of knowledge in clusters, this project unveils 1) the drivers of social capital for knowledge development and 2) the role of different cluster actors in the development of knowledge.

A qualitative methodology is employed to empirically investigate the research questions. A case study explores an Australian biotechnology cluster, with semi-structured interviews as a method of data collection. Addressing the drivers of social capital, results revealed that different dimensions of social capital drive knowledge development in distinct ways. Specifically, interpersonal relationships between cluster members and informal interaction, which are manifestations of different social capital dimensions, are identified to be the main drivers for knowledge development. In addition, several indirect factors affect knowledge development, through their impact on those interpersonal relationships and informal interaction. Regarding the cluster actors involved in the development of knowledge, results highlight the importance of facilitating actors, which assume the role of a broker of social capital between cluster members.

From a theoretical perspective, this research makes a valuable contribution by showing that the overlap of the three theoretical streams knowledge, social capital and clusters can be drawn on to explain how competitive advantage is created in clusters. Specifically, findings highlight the distinct impact of different social capital dimensions on knowledge development. Furthermore, this research has implications for practitioners and cluster policy makers as findings suggest how social capital is best managed to foster prosperity of the cluster.



## DECLARATION

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I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Lisa Neale, 7/4/2016

Signature

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The final thesis draft was professionally edited by Dr Dana Thomsen (University of Adelaide) for language, completeness and consistency.

## GLOSSARY

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**Cluster actor:** firms and institutions located in, or associated with the cluster.

**Cluster firms:** privately owned, for profit entities that operate in the cluster and contribute to the cluster's main product. Include both horizontal and vertical actors.

**Cluster:** a spatial agglomeration of firms and institutions of one particular industry.

**Competitive advantage:** in the field of strategic management, it refers to an advantage that a firm has over other firms, which can be used to generate greater profits.

**Contract research laboratory:** specificity of the investigated cluster; university facility or research institution that is contracted by cluster management to provide services, facilities or equipment to cluster firms.

**Drivers of social capital for knowledge development:** a process or mechanism by which social capital impacts on knowledge and knowledge development to achieve competitive advantage.

**Firm/institution spanning relationship:** a relationship between two individuals associated with different firms or institutions.

**Horizontal actor:** supply the main product or service; are considered the core of the cluster. One of three actor categories of the value adding web framework.

**Interpersonal relationship:** a relationship between two individuals.

**Knowledge based view of clusters:** complements the resource based view of cluster. Assumes that close geographic proximity between cluster actors gives fosters knowledge exchange, spill-overs and transfer and implies that the most valuable resource for competitive advantage in clusters is knowledge.

**Knowledge based view of the firm:** complements the resource based view of the firm. Implies that the most valuable resource for competitive advantage is knowledge.

**Knowledge development:** a summary term describing various activities that relate to knowledge in clusters. For the purpose of this research, knowledge development refers to the collectivity of knowledge spill overs, knowledge transfer and new knowledge generation.

**Lateral actor:** a cluster actor not involved in the production of the cluster's main product, supporting other cluster actors by providing expertise, policy instruments and strategic oversight. One of three actor categories of the value adding web framework.

**Relational view of the firm:** complements the resource based view. Implies that relationships are of inherent value and can be leveraged for competitive advantage, i.e. relational rents.

**Remote actors:** firms that are not located in, or associated with the cluster; not cluster firms.

**Resource based view of clusters:** application of the resource based view of the firm to clusters. This perspective assumes that through the leverage of cluster specific resources

and capabilities that are not available to remote firms, cluster firms are presented with the opportunity to sustainably outperform other firms, i.e. realise competitive advantage.

**Resource based view of the firm:** a strategic management perspective that assumes that different firms have heterogeneous resources bases and distinctive capabilities, which, when leveraged effectively, can lead to sustainable competitive advantage.

**Social capital:** the sum of the actual and potential resources embedded within, available through and derived from the network of relationships possessed by an individual or social unit. Inherent in the relational view.

**Value adding web:** conceptualises clusters as a web made of the links between horizontal, vertical and lateral actors which are located in close geographic proximity, operating in one industry, whereas the relationships between the actors differ in strength of the link and quality (interdependencies). Assumes a resource oriented perspective on clusters.

**Vertical actor:** supply inputs to, or take product from, horizontal actors. One of three actor categories of the value adding web framework.

## **(1) INTRODUCTION**

---

‘No man is an island’ is an expression commonly used to emphasise that everyone is connected to their surroundings and cannot exist in isolation. This notion is not only applicable to people, but has shown its relevance to organisations. Industrial clusters – a term commonly referring to a spatial agglomeration of firms and institutions of one particular industry according to the definition provided by the OECD (2015) - have taken central stage in economic literature over the past three decades. Industrial clusters of all shapes and sizes can be found around the world. As a consequence, cluster policy has now become an integral part of many country and state governments’ agendas to strengthen the local economy, usually taking the form of substantial financial incentives and funding, in order to encourage firms to settle in one location.

Spatial clustering of firms is a phenomenon that encompasses a wide variety of industries. For example, the south of Germany hosts numerous automotive clusters. Coal/steel clusters shape the landscape in Germany’s west. In addition to ‘traditional’ manufacturing industries, clusters have also evolved around wine, media and transportation (OECD, 2007). A large part of cluster policy, however, is targeted at research and development (R&D) intensive industries, i.e. high technology (Steffen, 2012). As a consequence, new high technology clusters are emerging frequently and can be found all over the globe. The most prominent example of such a high technology cluster is the information technology (IT) cluster of Silicon Valley in California which has not only progressed the region, but shaped the competitive landscape for IT and computer related products world-wide (Robson & Rawnsley, 2001). Another example of a high technology cluster is the biotechnology cluster in and around Cambridge, UK (Casper, 2007). Widespread interest in the cluster phenomenon is due to the fact that location matters. Locating close to each other can create benefits for single firms in the form of performance advantages, such as

increased innovation output and higher sales and profits that can be realised over firms operating in isolation (Camisón, 2003; Jenkins & Tallman, 2010). At the macro level, clusters foster economic development of entire regions (Brown et al., 2010; Porter, 1998b, 2000). These advantages to firms and regions seem paradoxical given that in a time of information technology and high labour mobility location should no longer be relevant. It comes as no surprise that much research has been devoted to explaining why and how clusters can provide advantages to firms and regions, and why some clusters are more successful than others. Not only are findings of such cluster studies interesting for scholars, they also have significant implications for practitioners, such as policy makers or managers who may seek ways to increase competitiveness of their region or firm, respectively. This research joins and contributes to the body of literature exploring how benefits created through clustering come about.

### **1.1. Research problem and research questions**

One theoretical perspective addressing how the benefits of clustering are created is the resource based view (RBV) of clusters. This perspective assumes that through the leverage of cluster specific resources and capabilities not available to remote firms, cluster firms are presented with the opportunity to sustainably outperform other firms, i.e. realise competitive advantage<sup>1</sup> (de Oliveira Wilk & Fensterseifer, 2003; Hervás-Oliver & Albors-Garrigós, 2007). With the RBV of clusters as an underlying assumption, it is well established in the literature that many competitive advantages of clustering, if not all, are created through the leverage of knowledge resources (Malmberg & Power, 2005). Furthermore, there is general agreement that social capital, a concept implying that relationships are inherently valuable and can be considered a ‘resource’ in their own right, is embedded in the relationships of cluster actors and can be leveraged for the

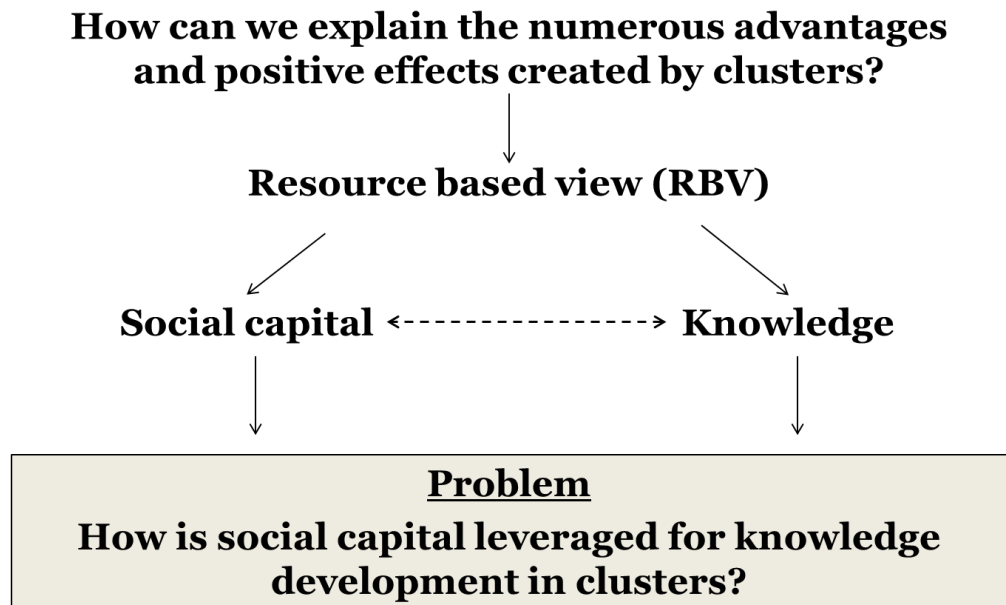
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<sup>1</sup> Competitive advantage in the context of a resource based perspective refers to the outperformance of competitors by means of a value creating strategy (Barney, 1991)

transfer, sharing and spill over of knowledge. For the purpose of this research, the collection of those activities is termed ‘knowledge development’. A focus on knowledge and social capital in clusters is interesting for scholars and practitioners as it can explain why close geographic proximity provides benefits in the form of competitive advantage and, hence, why clusters exist. However, while numerous studies offer sound theoretical explanations as to whether knowledge can be developed for advantage in clusters (Basant, 2002; Howells, 2002; Tallman, Jenkins, Henry & Pinch, 2004), and whether social capital is important for this process (Vejzagic–Ramhorst, Ketikidis & Huggins, 2012) (to both, the answer is a definite yes), the question of how that occurs has received considerably less attention. Hence, this research addresses the following research problem:

**How is social capital leveraged for knowledge development in clusters?**

This research problem and how it relates to its theoretical underpinnings is illustrated in Figure 1.



*Figure 1 - How the research problem is derived from the theoretical underpinnings*

In order to explore this research problem, the ‘how’ question is apportioned into asking ‘what’ (the drivers) and ‘who’ (the actors). Hence, two research questions guide this research in order to explore the problem.

The first research question takes into account that the presence of a resource alone cannot lead to competitive advantage. Regardless of whether in the context of clusters or of single firms, it is an underlying assumption of the resource based perspective that individuals, firms or other entities need to be able to put resources to work in a unique way in order to achieve competitive advantage. In the absence of effective leverage, resources would simply be idle, existing casually without providing significant benefits to the possessors (Teece, 2009). In the context of social capital, the process of effective leverage is under-researched (Kwon & Adler, 2014). Smith (2005, p. 2) suggests that “access [to social capital] does not equal mobilisation”. In order to explore how resources, including social capital, can be leveraged dynamics resulting from the associations, interactions, relationships and exchanges among those participating in cluster activities, considered here to be the drivers of social capital, need to be unveiled. This leads to the first research question which explores the drivers of social capital for knowledge development that result from the leverage of social capital. The first research question asks:

*What are the drivers of social capital for knowledge development in clusters?*

The second research question addresses the initiators of suggested drivers for knowledge development. According to Lorenzen (1997, p. 801), “social capital consists of social relations among agents”. Thus, the second research question addresses who is involved. Social capital is intrinsic in relationships (Dudwick, Kuehnast, Jones & Woolcock, 2006; Nahapiet & Ghoshal, 1998), therefore, the actors in whose relationships social capital is inherent play an important role in its creation. Minimal research exists regarding the actors involved in social capital, especially not in the context of clusters (Kwon & Adler,



2014). Whereas the first research question addresses the problem of how social capital is leveraged for knowledge development in clusters, the second research question addressing the actors frames the context of this process. An integral issue in addressing the research problem is to identify who is involved and the nature of their involvement. Hence, the second research question asks:

*Which actors are involved in the development of knowledge in clusters and what are their respective roles?*

## **1.2. Clusters, knowledge and social capital**

Addressing the research problem of how social capital is leveraged for knowledge development in clusters contributes to the existing extensive body of literature investigating why and how close geographic proximity can create advantages. The underlying theoretical approach adopted in this research is the RBV of clusters. The RBV of clusters has emerged as an important stream of cluster research extending the ‘traditional’ RBV of the firm to a cluster setting (see Barney, 1991; Peteraf, 1993, who are considered the major proponents of the RBV). The RBV of the cluster suggests that clusters create and contain resources and capabilities not available to remote firms, hence offering cluster firms the opportunity for competitive advantage through the leverage of those resources (de Oliveira Wilk & Fensterseifer, 2003; Hervás-Oliver & Albers-Garrigós, 2007).

Along with the emergence and successes of high technology clusters around the globe over past decades, there has been a shift towards a knowledge based view (KBV) of clusters which describes clusters as “venues of enhanced knowledge creation” (Arikan, 2009, p. 658). The KBV of clusters, a logical extension of the RBV of clusters, acknowledges that the most valuable resource in terms of competitive advantage is knowledge. Hence, the KBV implies that the benefits of clustering are predominantly

achieved through leverage of cluster-specific knowledge resources (Arikan, 2009; Malmberg & Maskell, 2002; Malmberg & Power, 2005; Tallman et al., 2004). The underlying rationale of the KBV of clusters is that close geographic proximity gives rise to cluster-specific knowledge activities. These are the generation of cluster-specific knowledge to which only cluster firms have access (Jenkins & Tallman, 2010), as well as knowledge exchange, sharing and spill overs between those involved in cluster activities (Malmberg & Power, 2005). Through such activities cluster actors extend the pool of knowledge available to them, combine knowledge from different sources within the cluster and leverage this knowledge for the realisation of competitive advantage (Hervás-Oliver & Albors-Garrigós, 2007).

Knowledge is closely tied to social capital and in order to fully understand the KBV of clusters the concept of social capital needs to be considered (Valdaliso, Elola, Aranguren & Lopez, 2011). Social capital is considered to be “the sum of the actual and potential resources embedded within, available through and derived from the network of relationships possessed by an individual or social unit” (Nahapiet & Ghoshal, 1998 p. 243). The social capital concept emphasises the notion that social networks and relationships are inherently valuable and can be considered intangible resources in their own right as they potentially contribute to competitive advantage (Inkpen & Tsang, 2005). Social capital is rooted in the relational view, which is an extension of the RBV of the firm. The relational view implies that valuable resources can be derived from relationships. Social capital, being derived from such relationships, is considered an intangible relational resource (Dyer & Singh, 1998; Tura & Harmaakorpi, 2005). Furthermore, the relational view recognises that knowledge as a resource and knowledge development are inherently social in nature (Dyer & Nobeoka, 2002).

Social capital is inherent in the KBV of clusters as a distinguishing feature of clusters is the relationships among cluster actors (Valdaliso et al., 2011). Social capital in a cluster

setting plays an important role in the development of cluster knowledge and through its impact on knowledge is a major contributor to competitive advantage (Inkpen & Tsang 2005; Eisingerich et al. 2010). Indeed, there is empirical evidence supporting the notion that social capital is a major ‘carrier’ of knowledge, fostering knowledge development in a cluster setting (Vejzagic–Ramhorst et al., 2012).

### **1.3. The overlap and shortcomings of current research**

In order to address the research problem and to investigate the research questions, three areas of literature were consulted – cluster theory, knowledge and social capital. Of particular importance with respect to the research problem are the following points which present the overlaps of the three theoretical streams:

- It is well established that social capital and knowledge are closely interlinked and that social capital is a conduit for knowledge development (Dyer & Nobeoka, 2002).
- The KBV of clusters implies that the leverage of cluster specific knowledge resources is the major contributor to advantages in clusters (Hervás-Oliver & Albors-Garrigós, 2007; Malmberg & Power, 2005).
- Social capital is inherently present in a cluster setting, embedded in the relationships of those involved in cluster activities (Vejzagic–Ramhorst, Huggins & Ketikidis, 2009).

Figure 2, below, shows how the research problem emerged from the overlap of three theoretical streams. The application of knowledge and social capital to a cluster context, assuming a resource based approach, constitutes a conceptual framework in its own right which, to date, is under-researched and constitutes the research ‘gap’. While it can be derived from relevant literature that social capital is leveraged for knowledge development in clusters, how this happens remains unexplored and this shortcoming constitutes the motivation for this research.

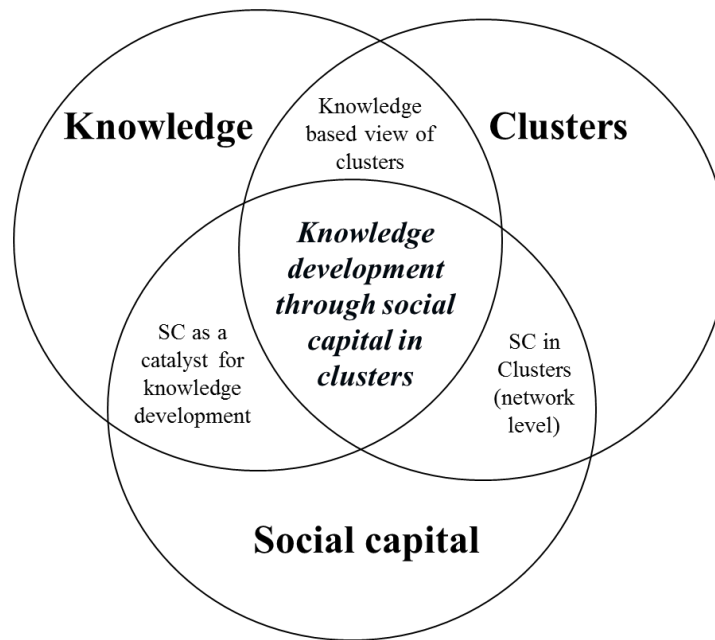


Figure 2 – The three theoretical streams and their overlap

#### 1.4. Contribution and significance

Addressing the overlap of the three theoretical streams of clusters, knowledge and social capital constitutes a theoretical contribution. It is clear that both the social capital concept and the KBV of the firm and of the cluster have received considerable attention and scholars acknowledge that social capital as a catalyst for knowledge can be drawn on to explain cluster competitive advantage (Arikan, 2009; Pinch, Henry, Jenkins & Tallman, 2003; Valdaliso et al., 2011; Vejzagic–Ramhorst et al., 2012). However, this research considers how the relational view can be applied to clusters, and more specifically, how social capital, a relational resource, can contribute to knowledge development. In doing so, this research logically extends the RBV and KBV of clusters because it unveils the underlying dynamics of social capital, rather than merely focussing on the outcomes. Further, this research contributes to a better understanding as to how knowledge and social capital contribute towards such goals as competitive advantage. Such aspects of advantageous positioning are recognised as part of the benefit of clusters and explain why clusters are an established means of regional economic development and hence why they

exist in the first place. Consequently, the importance of clusters as a tool for economic development adds to the significance and contribution of this research

The outcomes of this research also inform practitioners. Social capital is a valuable intangible resource, yet even though it is understood to contribute to the development of knowledge and ultimately to competitive advantage, many practitioners do not have a thorough understanding of how it can actively be leveraged. This is due to the inherent ‘fuzziness’ surrounding the concept, involving definitional ambiguity and lack of universally accepted operationalisation frameworks (Vejsagic–Ramhorst et al., 2012). Nevertheless, the need to manage social capital actively and effectively in order for it to be beneficial is undisputed (Luthans & Youssef, 2004). By exploring how social capital is leveraged this research achieves a level of constructive operationalisation of the relational dynamics therein. Managerial implications can be drawn as research results show managers how social capital is supported and thus how it can be put to work, with a particular focus on the cluster context. In this way, those in charge of managing cluster firms or associated institutions can undertake focused cultivation of their relationships for the development of unique knowledge capabilities toward sustained competitive advantage and strategic capabilities of their organisation. Furthermore, results also bear high relevance to policy makers as cluster policy has emerged as a popular instrument for regional development.

### **1.5. Methodological considerations**

The methodology and associated methods for this research are discussed in-depth in Chapter 4, but a brief overview is provided here. This research employed qualitative case study methodology. Current perspectives on knowledge in clusters are inadequate in explaining how social capital is leveraged for knowledge development. Hence, the research process was inductive in nature, such that rather than testing existing theories in deductive quantitative research methods, this research generated new theoretical

understanding. It is therefore appropriate that a qualitative approach was employed (Eisenhardt, 1989). Specifically, phenomenological hermeneutics was the informing methodology. Phenomenological hermeneutics is an inductive and theory building approach which considers existing theory as a starting point (Ajjawi & Higgs, 2007). Regarding the method of data collection, Yin (2009) suggests that the case study method is a useful approach when a project attempts to address 'how' and 'why' questions. Further, case studies are appropriate to study processes that are social in nature and based on relationships. Hence, the case study method was deemed most appropriate for addressing the research problem.

Consistent with a focus on knowledge, cases were drawn from a high technology industry. The biotechnology (biotech) industry was chosen because, as a dynamic and knowledge intensive industry where knowledge is a crucial resource (OECD, 2009), it represents an exemplary case for studies aiming to analyse knowledge and its effects (Eisenhardt, 1989). Consequently, an Australian biotechnology cluster was selected for investigation. In order to contribute meaningful data to this research, participants needed to be involved in the development of knowledge at the cluster level, implying involvement in firm spanning activities. Such firm spanning activities are most likely tasks of middle or upper level managers, hence it was those people who were invited to participate. A total of 25 individuals from 20 different cluster firms and associated institutions were interviewed. Data was analysed simultaneously and the interview process was completed once saturation was reached, as evidenced by replication and redundancy of themes (Bowen, 2008).

Data was collected using semi-structured, in-depth interviews, either physically on-site or via telephone. In doing so, the researcher was able to follow up on themes and issues during the interview which is necessary for exploratory research (Laverly, 2008).

Consistent with the semi-structured approach, interview questions were used as a guide

and follow up questions were derived during interviews ensuring relevant topics were covered. Initial questions were derived from the theoretical frameworks. Interviews were digitally recorded with participant consent. The data analysis process involved transcription of audio recordings, followed by coding using NVivo 10 qualitative software. Coding was conducted with consideration of key issues identified in the literature and allowed for emergent themes arising from interviews, offering new and unanticipated insights into the knowledge development process in clusters. Consistent with case study methodology, identified themes and issues were analysed using content analysis, a technique used for analysing texts in the context of qualitative studies. Subsequently, data was interpreted in light of existing theory.

#### **1.6. Limitations**

In reading and interpreting the results and conclusions drawn from this research, numerous methodological limitations require consideration. One such limitation regarding the method of data collection is the investigation of a single case rather than multiple cases. A single case study enabled the researcher to conduct an in-depth analysis of the investigated cluster, however transferability to other clusters may be compromised. Another factor limiting transferability is the nature of the selected cluster. This research focussed on an Australian biotechnology cluster. Hence, results may not be transferable to other countries or industries, or to clusters that are lacking those distinct features. Another methodological limitation was the fact that results were based on the accounts of interviewees. Hence, this research relied on participants to be truthful and honest, which is difficult to control. In order to tackle those limitations, numerous measures and techniques were employed to ensure soundness of the methodology. Furthermore, an in-depth discussion as to why the methodology was chosen despite its limitation was included in this thesis.

## **1.7. Summary**

The purpose of this chapter was to introduce the research, describe the thesis structure and explain the motivation for the project. Clusters provide firms and regions with the opportunity to realise competitive advantage and, as a consequence, cluster initiatives have become a popular instrument of public policy. This research contributes to a substantial body of literature by explaining why and how clusters create competitive advantage. This research takes a resource based perspective on clusters with particular focus on two intangible resources - knowledge and social capital. While it is evident that social capital is leveraged for the development of knowledge for competitive advantage, how this happens remains unexplored. This shortcoming constitutes the project's underlying research problem. Based on this research problem, two research questions were derived. Research question one asks 'What are the drivers of social capital for knowledge development in clusters?' informing the process of how social capital is leveraged. Research question two asks 'Which actors are involved in the development of knowledge in clusters and what are their respective roles?' establishing the 'who', i.e. those between whom the processes and mechanisms of knowledge development take place.

Literature on clusters, knowledge and social capital informed this research. A particular focus is on the RBV and KBV of clusters and on the inherent link of knowledge and social capital. In terms of theoretical relevance, this research contributes by providing a processual viewpoint on social capital and knowledge, i.e. showing the dynamics rather than focussing on outcomes. Results also inform practitioners in that, by revealing drivers and actors involved in the leverage of social capital, they provide an indication of how social capital, a highly intangible resource, can actively be managed and leveraged for competitive advantage. An in-depth case study, together with semi-structured interviews, was employed to collect data in one Australian biotechnology cluster.



## **1.8. Structure of the thesis**

The thesis is structured as seven chapters. This chapter introduced the research and explained why this research was undertaken. Initially, an introduction to cluster, social capital and knowledge theory was provided to explain the research context. Then, the research problem guiding this project was explained and from this the research questions were derived. Furthermore, this chapter outlined the current perspectives in the literature and associated shortcomings, research design and set out the structure of the thesis.

The remainder of the thesis proceeds as follows. The second chapter provides an in-depth discussion of relevant literature informing the research problem and questions and illustrates the shortcomings of current theory this thesis addresses. Consistent with the underlying theoretical framework, literature on cluster theory, knowledge and social capital are reviewed. Even though all three theoretical streams are reviewed in their own right, a particular focus is on their overlap. Hence, the literature review includes discussion of KBV of clusters and the inherent link between knowledge and social capital. The literature review explains why a major shortcoming of current research lies in the overlap of the three theoretical streams clusters, knowledge and social capital, constituting the theoretical motivation for this project.

After discussing the literature and highlighting current shortcomings, the analytical framework is developed in the third chapter where five propositions are derived. Consistent with the two research questions querying the drivers of social capital and actors involved, literature on the dynamics of social capital and cluster actors is drawn upon. Specifically, the dimensions of social capital as a driver of knowledge development is consulted to develop propositions one, two and three, and the cluster actor categorisation of the value adding web framework is consulted to develop propositions four and five.

The thesis then proceeds with a discussion of research design in chapter four. With reference to relevant literature on methodological issues, research methodology and methods are detailed and justified along with the data analysis and interpretation process. Chapter four also includes discussion of the philosophical underpinnings of this research which informed research design. Furthermore, the chapter introduces the Australian biotechnology cluster selected for this case study, including a discussion of relevant actors associated with this cluster.

In chapter five, results of data analysis process are presented. Consistent with the research questions which informed the analysis process, this chapter is structured according to data relating to the drivers of social capital that drive knowledge development, followed by data informing who the actors are and their respective roles.

In chapter six, results of the analysis process are interpreted in the light of the five propositions. The chapter is structured according to the propositions, starting with the propositions relating to the drivers of social capital, followed by the propositions relating to actors. Some emerging results which do not relate to the propositions are also considered.

Chapter seven concludes the thesis, including a summary of the key findings, a synopsis of the contributions for theory and practice, suggestions for future research direction and a discussion of study limitations.

## **(2) LITERATURE REVIEW**

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This chapter presents a review and discussion of the literature relevant to this research. Contemporary research is critically evaluated in terms of how it informs this project's research problem and questions. The current shortcomings of the literature are revealed in the following theoretical discussion together with an analysis of how this research addresses them. The three broad theoretical areas that inform this research are: 1) clusters, 2) knowledge and 3) social capital. Given that this research is concerned with value creation and realisation of competitive advantage, these three fields are evaluated and discussed from a resource based perspective. The three areas are synthesised to provide the conceptual framework. Literature was selected and identified through the key words 'clusters', 'social capital' and 'knowledge', and any combination of those key words. Furthermore, the work of key authors of any of the three fields was consulted. A particular focus was on newer literature (post 2005) that dealt with a resource based perspective of the cluster.

The structure of this chapter is as follows: first, literature on clusters is reviewed with a particular focus on explaining how the literature explains cluster competitive advantage, drawing on the RBV of clusters. Second, knowledge is discussed with a particular focus on literature viewing knowledge as a resource for competitive advantage, eventually synthesising this theoretical area with cluster theory by introducing the KBV of clusters. Third, literature exploring the relational view and social capital is reviewed concentrating on the theoretical discussion which considers how social capital can be leveraged for knowledge development. Finally, drawing on perspectives in the literature to help advance a theoretical framework for the thesis, the social capital concept is synthesised with cluster knowledge and the KBV of clusters and shortcomings of current literature and research are identified.

## **2.1. What is a cluster? Differing views**

The first of three areas of literature that informs this research is the cluster concept. The starting point to any study focussing on clusters is conceptualisation of the term ‘cluster’, as the concept is still ‘fuzzy’ and subject to definitional ambiguity (Vejsagic–Ramhorst et al., 2009). However, finding an appropriate terminology is complicated as there is no general agreement amongst scholars and practitioners on what constitutes a cluster. The following discussion provides an overview of the cluster literature to date and places the concept in the context of this research.

The study of localisation of economic activities and close proximity as a driver of certain economic benefits has a long history and its underlying principles date back to the late 19<sup>th</sup> century. British economist Alfred Marshall (1890) presented the idea that clustered firms can benefit from positive externalities and economies of scale. In the early 20<sup>th</sup> century, other scholars supported the notion that geographic proximity can produce advantages for firms (Christaller, 1933; Weber, 1909). Early scholarly writings on the then called ‘agglomeration economics’ likewise focussed on increased economic efficiency through externalities such as economies of scale, e.g. by means of labour market pooling and input sharing (Andersson et al., 2004). Later work on clusters increasingly emphasised the link between clusters and innovation output through knowledge spill overs and knowledge transfer, seeing clusters as regional innovation systems (Malmberg & Maskell, 1997, 2002). Another stream of cluster research emerged in the 1990s and concentrated on increased competitiveness and the concomitant resulting competitive advantage of cluster firms, with a particular focus on local factors and resources that contribute to this advantage (Porter, 1996, 2000). This theoretical perspective of clusters has received a lot of attention and Michael Porter’s text ‘The Competitive Advantage of Nations’ (1990) was considered a major breakthrough for development of the cluster concept. Whereas in the early 1990s US development policy

was pushing diversification, Porter (1990) advocated specialisation and established the term ‘industrial cluster’ emphasising that in addition to a firm’s internal factors certain external factors can boost a firm’s competitiveness (Andersson et al., 2004).

Porter’s (1990) diamond model describes factors that are specific to location. The diamond model was developed to describe why industries in some nations have an advantage over the same industries in other countries. A few years later the underlying premise of the model was applied to firms located in close proximity to one another in order to describe why those firms were able to achieve competitive advantages over other firms. The notion that firms’ proximity to one another can contribute to competitive advantage became the underlying premise of cluster theory. In his 1998 book *On Competition*, Porter (1998a, p. 199), as one of the first cluster authors, included a chapter on industrial clusters, one of the first theoretical elaborations and definition of clusters that is still frequently cited today. For example, it was used by the OECD (2007), as follows:

*“A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities”.*

To date, the above definition is still one of the most frequently cited in cluster literature. This is not only due to the academic fame of the author, but also because it was one of the first cluster definitions to be published and has influenced many succeeding cluster scholars (Steffen, 2012). Nevertheless, a review of current cluster literature reveals that Porter’s (1998b) definition is one of many and it has been criticised for being too simplistic (Tully & Berkeley, 2004). Many scholars have provided differing ideas of what constitutes a cluster resulting in ongoing debate (Malmberg & Power, 2005). Table 1 lists

definitions not developed from Porter's. (based on Brown et al., 2007a). These definitions have input from numerous authors and were created from various research contexts.

*Table 1 - Definitions of 'clusters' based on Brown et al. (2007) and Steffen (2012) and extended, in chronological order*

<b>Author and year</b>	<b>Definition</b>
Czamanski and Ablas (1979, p. 62):	“In what follows ‘cluster’ means a subset of industries of the economy connected by flows of goods and services stronger than those linking them to the other sectors of the national economy. The concept is thus devoid of any spatial connotation”.
Rosenfeld (1997, p. 4):	“A ‘cluster’ is very simply used to represent concentrations of firms that are able to produce synergy because of their geographic proximity and interdependence, even though their scale of employment may not be pronounced or prominent”.
Baptista and Swann (1998, p. 525):	“A geographical cluster is defined here as a strong collection of related companies located in a small geographical area, sometimes centred on a strong part of a country’s science base”.
Feser and Bergman (2000, p. 3):	“We use the term ‘industrial cluster’ in the same generic sense as Czamanski and Ablas (1979) to refer to a specific constellation of linked firms, but prefer ‘regional cluster’ to connote the presence of such an industrial cluster in some specific spatial context”.
Waits (2000, p. 37):	“These industry clusters are geographical concentrations of competitive firms in related industries that do business with each other and that share needs for common talent, technology, and infrastructure”.
Bresnahan, Gambardella & Saxenian (2001, p. 836):	“We define a regional cluster simply as a spatial and sectoral concentration of firms; and we measure success by the ability of the cluster as a whole to grow, typically through the expansion of entrepreneurial start-ups”.

Cooke (2001, p. 24)	“Clusters are geographically proximate firms in vertical and horizontal relationships, involving a localised enterprise support infrastructure with shared developmental vision for business growth, based on competition and cooperation in a specific market field”.
Maskell (2001, p. 930):	“The proposition put forward here simply suggests that the cluster exists because of locational economies that are largely independent of the internal degree of interaction. The sole requirement is that many firms undertaking similar activities are placed in circumstances by co-locating where they can monitor each other constantly, closely, and almost without efforts or costs”.
Brown et al. (2007a, p. 20):	“A cluster is a value adding web constituted by a connection of horizontal, vertical and lateral value adding activities contributed by different actors in proximity to one another which all act in relation to a specific sector. The actors have relationships characterised by interdependencies of different strength and quality that define the boundaries”.
Exposito-Langa and Molina-Morales (2010, p. 1976):	“A cluster can be understood as a network of inter-organisational relationships between different entities such as customers, competitors, suppliers, support organizations, local institutions and others. In these clusters, geographical proximity and a strong feeling of belonging are primary elements facilitating strong relationships, based on values such as trust and reciprocity among others”.



Given that each definition listed above has merit within its own context, the list of definitions shows that clusters can take many forms. However, a review of the definitions in Table 1 also reveals common key characteristics that an agglomeration of firms must possess in order to be considered a cluster, namely a) linkages of various types between firms and b) the potential to realise certain advantages from those linkages (Steffen, 2012, p. 7).

As evident from Table 1, most scholars consider geographic proximity as a necessary requirement of a cluster. Geographic proximity is frequently considered to be the single most important feature that sets clusters apart from other network types (OECD, 2007). Notably, there is no specification as to how close firms have to be to one another in order to be considered 'proximate'. Porter (1998a, p. 188) acknowledges that close geographic proximity is not the most striking defining feature of clusters as "the geographic scope of a cluster can range from a single city or state to a country or even a network of neighbouring countries".

Even though most scholars consider geographic proximity to be a necessary defining feature, it is generally proposed that geographic proximity alone is not sufficient to define a cluster. Given the large spectrum of what can be considered 'close', geographic proximity alone would make it difficult to identify clusters in practice (Andersson et al., 2004). Andersson et al. (2004, p. 10) provide a cluster conceptualisation framework that is not exclusively dependent on geographic proximity. Referring to what constitutes a cluster, they note that "a clinically precise definition is hardly meaningful given the richness and diversity of relevant literature". Instead, these authors propose that clusters be categorised according to common elements and specify three main types of clusters: industrial clusters, regional clusters and knowledge based clusters. According to Steffen (2012), each of the cluster definitions shown in Table 1 can be categorised as one of those types. First, in line with Porter's (1998a) definition, Andersson et al. (2004, p. 31) suggest

that *industrial clusters* are characterised by competitiveness within a sector and are “composed of all the actors, resources and activities that come together to develop, produce and market various types of goods”. Acknowledging that geographic proximity is not a requirement to define a cluster, the authors go on to suggest that industrial clusters are “normally not spatially confined to an area” (Andersson et al., 2004, p. 31). Notably, this is a solitary view and most authors do not agree with the notion that clusters can be defined without a geographic component, as evident in Table 1. Hence, Andersson et al.’s (2004, p. 31) other two definitions of a cluster acknowledge co-location. The success of a *regional or localised cluster*, is based on close geographic proximity of firms and associated institutions and is considered “a spatial agglomeration of similar and related economic activity that forms the basis of a local milieu that may facilitate knowledge spill over”. Commonly, a regional cluster is made up of small to medium enterprises (Andersson et al., 2004, p. 31). Lastly, the authors describe *knowledge based clusters*. This type is a spatially confined cluster, but unlike regional clusters, the focus is more on innovation and technical progress. Competitive advantage creation in knowledge based clusters is due to geographic proximity impacting “greatly on the creation, acquisition, accumulation and utilisation of knowledge” (Andersson et al., 2004, p. 32). Referring to those three cluster categorisations, this research investigates knowledge based clusters. The focus on knowledge based clusters is consistent with the underlying research problem and research questions which are concerned with knowledge development activities, as specified in Andersson et al.’s (2004) definition of this cluster type.

To avoid confusion for the reader, it should be noted that in the literature the term ‘cluster’ is sometimes used interchangeably with ‘industrial districts’ or ‘network’. However, inherent differences exist between the three terms. While all clusters can be considered networks, not all networks are clusters as networks do not need to be geographically concentrated (OECD, 2007). ‘Industrial district’ is a term introduced by

Marshall (1890, in Markusen (1999)) which traditionally refers to an agglomeration of small to medium sized firms, usually in manufacturing (Markusen, 1996). Even though it is undisputed that the industrial districts concept is a precedent of modern cluster theory, contemporary clusters are not necessarily comprised of small to medium enterprises or manufacturing firms. This research explicitly focuses on clusters, not networks or industrial districts. Another synonym for cluster found in the literature is 'geographic cluster'. This term is analogous to 'cluster' and emphasises a cluster's geographic dimension.

## **2.2. Why do clusters exist? - The benefits of clustering**

That clusters exist constitutes a unique research topic that has received a lot of recent attention by scholars. In a world where fast means of travel are available and ICT technologies enable efficient communication world-wide, it seems counterintuitive that clusters have not become extinct (Porter, 2000). Notably, the contrary can be observed. Firms choose to locate close to each other and are encouraged to do so by governments which provide funding and develop cluster policies. The most logical answer as to why clusters exist is that there are advantages that can be realised by firms that cluster over remote firms.

As a first step to address why and how clusters create advantages, it is useful to specify those advantages and the major beneficiaries. There is empirical evidence that clusters produce benefits to the cluster as a whole and the region or nation (Porter, 1998b, 2000). Traditionally, cluster studies have focused on positive externalities created when firms in one industry are locating close to one another. Accordingly, clusters create positive externalities in the Marshallian<sup>2</sup> sense, including external economies of scale, labour

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<sup>2</sup> According to Alfred Marshall, economies of scale can be external to the firm and benefit all firms in one area. As the output of firms in one geographical area increases, the average costs for the single firm decreases. This is due to the specialisation of single firms.

market pooling and increased diversity (Fensterseifer & Rastoin, 2010). With the emergence of knowledge based economies, the focus shifted away from input factors to output, i.e. productivity (Porter, 1998a). Huggins (2008) specifies three ways of how clusters create benefits for the entire region: increased productivity of firms located in the cluster, increased innovation activity and pace of innovation, and stimulation of the “formation of new businesses, expanding and strengthening the cluster itself”.

In addition to the region and the cluster as a whole, the single firm is likewise an important benefactor of competitive advantage created through clustering. According to Fensterseifer and Rastoin (2010), the aforementioned benefits available to the cluster as a whole can also be leveraged by cluster firms to increase productivity of the single firm. Using their distinct capabilities, some firms may be more effective in leveraging opportunities provided by the cluster environment. Therefore, it is possible that a single firm can realise competitive advantages over fellow cluster firms resulting in performance differences of firms located in one cluster (Brown et al., 2010).

### **2.3. A resource based view of clusters**

The interesting question that practitioners and policy makers may ask before deriving an appropriate policy framework, and that many scholars have attempted to address, is how competitive advantage through clustering can be explained and how value creation in clusters emerges. A valuable systematic approach to understand how cluster benefits arise has emerged recently. This approach involves a resource based view of clusters, an approach adopted in this study.

The RBV of clusters is a logical extension of the RBV of the firm. As opposed to the industrial organisation view (Porter, 1981), the RBV of the firm shifts the focus away from industry factors to consider the internal environment of the firm as the major driver of competitive advantage, i.e. a superiority that allows a firm to outperform competitors

(Barney, 1991; Porter, 1979). The underlying premise of the RBV is that different firms have heterogeneous resource bases and distinctive capabilities. Those distinct sets of firm resources become the basis for organisational competitive advantage through realisation 'rents' which refers to the benefits created through resources (Peteraf, 1993; Wernerfelt, 1984). According to the RBV of the firm, resources can be financial, physical, human or organisational, but can also be in the form of a specific skill or capability. Furthermore, resources can be either tangible or intangible in nature (Barney, 1991). Competitive advantage, from a resource based perspective, is defined as a firm being able to leverage a resource to perform certain activities better or/and cheaper than competitors (Collis & Montgomery, 2005).

The basic assumptions of the RBV have been complemented by ideas of other authors with the ultimate purpose to better explain what attributes a resource requires to achieve competitive advantage. In one of the most frequently cited frameworks, Barney (1991) provides a tool for assessing whether a resource can lead to sustainable competitive advantage, or in other words, whether a resource can be considered 'strategic'. In order to be strategic, a resource needs to be valuable to the firm, rare, inimitable, non-substitutable and exploitable. Taking the initials of those five attributes, the framework is referred to as 'VRINE'. Resources that meet all five VRINE criteria tend to be intangible in nature, rather than tangible. Hence, an important implication of the VRINE framework is that intangible resources are most important for competitive advantage (Barney, 1991).

Further characteristics that make a resource strategic are path dependency and causal ambiguity (Collis & Montgomery, 2005). From the VRINE framework, Teece and Pisano (1994) derived the strategic capabilities view which addresses how competitive advantage through resources can be sustained in dynamic and uncertain environments, taking a more dynamic perspective. According to the strategic capabilities view, "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" is a precondition for sustained competitive advantage (Teece,

Pisano & Shuen, 1997, p. 516). Therefore, the strategic capabilities view implies that resources alone are insufficient to provide firms with competitive advantage as how firms manage resources is equally important.

The RBV of the firm, together with the strategic capabilities view, has been applied to clusters to explain how benefits of clustering arise. Similar to the RBV of the firm, the RBV of clusters shifts the focus to resources and capabilities of the cluster. Analysis of the unique set of resources and capabilities of a cluster aims to explain cluster performance, just as analysis of resources and capabilities of the firm explains firm performance (Hervás-Oliver & Albors-Garrigós, 2007). The RBV of clusters is an alternative perspective to Porter's diamond model, hence, is in contrast to the notion that it is industry and locational (i.e. external) factors that determine cluster success. Rather, according to the RBV, it is the unique combination of resources in clusters that can be leveraged by the region, cluster or single firm for competitive advantage (Brown et al., 2010).

An important distinction between the RBV of clusters and the RBV of the firm is that the latter analyses resources held by the single firm only. The RBV of clusters considers resources held by individual cluster firms, but also that resources can be held and leveraged jointly by two or more firms in a network. This complicates identification and assessment of those resources' strategic value given that multiple levels of resources need to be considered (Brown et al., 2010; Brown et al., 2007a). This complication is evident in one of the earliest resource-oriented studies on clusters where de Oliveira Wilk and Fensterseifer (2003) identify shared resources valuable for competitive advantage in a cluster. While their study is useful as one of the first to acknowledge that the RBV is applicable to clusters, Brown et al. (2010, p. 13) consider this first approach a "starting point" only. The major criticism is that de Oliveira Wilk and Fensterseifer (2003) do not specify the level of investigated resources, i.e. whether derived from or possessed by a

cluster firm, from two or more cluster firms or the cluster as a whole. Consequently, to account for cluster resources not necessarily being possessed by a single firm, Brown et al. (2007a) derived a conceptualisation framework for resources in a cluster by considering three resource levels: firm, context and relational. Accordingly, three types of resources, firm specific resources, context specific resources and relational resources, are identified.

Firm level resources in the context of clusters maintain their importance for competitive advantage and the VRINE framework and strategic capabilities framework can be used to analyse resources. According to Fensterseifer and Rastoin (2010), cluster firms can combine firm level resources with cluster level resources, hence creating a new, firm-unique resource that can be used to outperform other firms. The notion that firm level resources maintain their importance in a cluster context implies that certain cluster firms can be more successful than others. Nevertheless, that firms located in clusters can have advantages over remote firms (i.e. firms not located in a cluster) suggests existence of resources on other levels available to cluster firms.

Context-specific resources are concerned with the region in which the cluster is located and include regional, industry specific and institutional resources (Brown et al., 2010). Regional resources include type of area, natural resources and infrastructure that can benefit firms (Steffen, 2012). Industry specific resources are concerned with industry attractiveness. A framework useful for the analysis of such resources is Porter's (1979) competitive forces framework which assesses industry attractiveness by investigating factors shaping industry rivalry. As regional resources are constrained to location they are exclusively accessible by cluster firms, providing them with an advantage over remote firms. For the purpose of this research, a third level of resources is of major importance and the focus of this study, namely resources located on the relational level of the cluster.

Relational level resources in the cluster context are defined as “joint activities and the quality and strength of relationships between the horizontal, vertical and lateral actors in a cluster” (Brown et al., 2010, p. 21). In other words, resources are embedded in, and created by, relationships amongst cluster actors. The particular importance of relational level resources to this research derives from resources being valuable assets and contributors to knowledge development activities in clusters leading to competitive advantage (Brown et al., 2010, p. 21; Tallman et al., 2004). Hence, the resource oriented view on clustering of this research focuses on relational level resources to assess how competitive advantage is created in clusters.

Importantly, for the purpose of this research, competitive advantage created through clustering is taken as a given. The RBV of clusters informs the underlying assumption of this research that firms in clusters realise competitive advantages over remote firms through leverage of cluster specific resources. Hence, this research does not assess whether or not competitive advantages are created, describe what such competitive advantages look like, or measure competitive advantage by means of proxies. Rather, the focus is on the drivers and actors through which competitive advantage is created, and more specifically, on social capital and knowledge as drivers of competitive advantage. This is a valid approach considering a large body of empirical research and conceptual papers have shown that clusters can create competitive advantage. The nature of competitive advantage, such as increased innovation and higher profitability, has been presented by numerous authors in the context of many studies (Bathelt, Malmberg & Maskell, 2004; Brown et al., 2010; Brown et al., 2008; Hervás-Oliver, 2012; Jenkins & Tallman, 2010; Porter, 1998b; Steffen, 2012; Tallman et al., 2004). The focus of this research is the ‘how’.



### ***2.3.1. The role of the single cluster firm and the value adding web framework***

As this research is concerned with understanding competitive advantage creation through knowledge and social capital, it is necessary to specify who realises this competitive advantage and to form an understanding of why the focus on this particular level over others is justified. It is clear from the preceding literature that competitive advantages in clusters can be realised by cluster firms, the cluster as a whole, the entire region and nation. This is due to clusters being multilevel entities encompassing the firm level, relational and the cluster as a whole. Therefore, researchers can use the firm, cluster, region and even the nation as a unit of analysis.

Brown et al. (2007a) state that a major gap in cluster literature is that the role of single firms in clusters has received little attention. This is a significant shortcoming because the advantages realised by the single firm are crucial for clusters. Specifically, that single firms can benefit from clustering is a conduit for cluster existence because “only if there really are advantages and only if competitive advantages can be realised by the single firms is it worthwhile to stay in the region and to (financially) participate in so-called cluster activities, as they may be offered by economic developers” (Steffen, 2012, p. 18). In other words, if firms did not expect advantages they would not choose to co-locate. A focus on the single firm rather than on the cluster as a whole is reflected in Brown et al.’s (2007a) conceptualisation of clusters as a ‘value adding web’. This analytical framework shifts the focus from the cluster level to the single firm and its role as creator of value and beneficiary of competitive advantage created through cluster specific resources. The underlying assumption of the value adding web is that a cluster is constituted of a series of linkages between different firms, institutions and other cluster actors. As a consequence of the existence of value adding webs, firms in clusters influence each other directly and indirectly. The linkages between cluster actors are characterised by interdependencies of various strengths and qualities. Furthermore, an essential underlying assumption of the framework is that those involved in cluster value creation can be

categorised as horizontal actors (firms engaging in the main activities of the cluster, producing the main product), vertical actors (suppliers and distributors of horizontal actors) or lateral actors (external firms, agencies and institutions) (Brown et al., 2010). The value adding web perspective can be considered for the study of value creation in clusters and is particularly useful for the purpose of this research in several ways, as described below:

- The value adding web assumes a resource based perspective on clusters, considering resources on various levels of the cluster as relevant to the creation of competitive advantage. The two other main concepts informing this research are social capital and knowledge which are assumed to be such resources
- The value adding web framework places particular emphasis on linkages between the firms and the webs around them. Social capital, by definition, is embedded in such linkages. Furthermore, the concept can be used to illustrate that these linkages are potential channels for knowledge development

This research adopts the value adding web perspective and a focus on the single firm as ‘value creator’ and beneficiary of competitive advantage through resources. For the purpose of exploring how social capital is leveraged for knowledge development in clusters the cluster firm is the relevant unit of analysis and the cluster is the informing context. This perspective is reflected in methodology and data collection.

#### **2.4. Knowledge and the knowledge based view of clusters**

The second of three areas of literature informing this research is knowledge. While the previous section addressed clusters, this section discusses the theoretical underpinnings of knowledge as a resource for competitive advantage in clusters. The KBV of clusters logically extends the RBV of clusters as it implies cluster-specific knowledge is the main contributor to cluster advantages. In order to address this view and its implications for

this research, knowledge typologies are first considered, followed by a discussion of how literature views knowledge as an intangible resource for competitive advantage.

#### ***2.4.1. Different ways to systematise knowledge***

Within the realm of the RBV, knowledge is considered a valuable intangible resource (Grant, 1996). However, studying and observing knowledge in practice proves difficult as knowledge is intangible, requiring relevant contextual insights for appropriate interpretation. Knowledge has been explored from different perspectives by a large number of authors and researchers from different fields, from sociology to economics to business studies. Hence, different systematisations of knowledge usually correspond to a field, theory or school of thought in order to be better understood and appropriated.

A common and useful way to systematise knowledge has been to develop typologies of knowledge, with different typologies applicable to different contexts. Authors have described knowledge in terms of its dimensions to account for knowledge as a concept being multi-dimensional rather than uni-dimensional. In most frameworks, two or three knowledge dimensions are derived and contrasted to depict knowledge typologies in a simplified and easy to apply way. For example, two important knowledge dimensions are ‘tacit’ vs ‘explicit’ (Polanyi, 1966) to philosophically address what constitutes ‘knowing’ in general. Also, ‘radical’ vs ‘incremental’ knowledge are used in the context of innovation (Freeman, 1998; Mansfield, 1968), while ‘individual’ vs ‘collective’ are ways of considering knowledge at organisational or employee level (Weick & Roberts, 1993; Zander & Kogut, 1995). Alternatively, there is also ‘component’ vs ‘architectural’ knowledge used in the narrow context of product development (Henderson & Clark, 1990) and in networks and clusters (Tallman et al., 2004) making it particularly relevant to this research. Table 2, below, lists the most important knowledge typologies and provides a brief explanation of the context in which they are used.

Table 2 - Most important knowledge typologies

<b>Authors</b>	<b>Typologies of knowledge</b>	<b>Context</b>	<b>Builds on/linked to</b>
Polanyi (1966)	<b>Tacit knowledge</b> 'we know more than we can tell', personal knowledge, rooted in experiences and individual perception <b>Explicit</b> Know-how, skills	Knowledge in general Philosophical, epistemological work	
Mansfield (1968) Freeman (1998)	<b>Incremental</b> Minor changes to existing product <b>Radical</b> Completely new product	Innovation and product development	
Henderson and Clark (1990)	<b>Component Knowledge</b> Understanding of one part of the product <b>Architectural Knowledge</b> Understanding of the product as a system	Narrow technical understanding in the context of product development	Incremental and radical innovation by Mansfield (1968) Tacit and explicit knowledge by Nonaka (1994)
Nonaka (1994)	<b>Tacit knowledge (in organisations)</b> Impossible to verbalise Transfer by means of personal contact and learning Can be held by individual as well as collectively <b>Explicit or codified (in organisations)</b> Can be verbalised, transferred easily	Knowledge management in organisations RBV considering knowledge to be a resource; explanation of competitive advantage	Tacit and explicit by Polanyi (1966)
Garud and Nayyar (1994) Winter (1998)	<b>Simple</b> Can be described by little information <b>Complex</b> Larger amount of information is necessary	Evaluation of knowledge in terms of transformative capacity and intertemporal knowledge transfer	
Garud and Nayyar (1994) Winter (1998)	<b>Independent</b> Discreet; can be described in itself <b>Systemic</b> Embedded in a larger system, needs to be described in relation to other variables	Evaluation of knowledge in terms of transformative capacity and intertemporal knowledge transfer	

<b>Authors</b>	<b>Typologies of knowledge</b>	<b>Context</b>	<b>Builds on/linked to</b>
Zander and Kogut (1995)	<p><b>Individual</b> Sum of individual competencies, information and knowledge</p> <p><b>Collective</b> Organising principles, routines and practices, widely diffused through organisation</p>	Organisational level knowledge	
Matusik and Hill (1998)	<p><b>Private</b> Unique to firm; can be a source of competitive advantage Unique routines, documentations, trade secrets Architectural and component knowledge are both private</p> <p><b>Public</b> Publicly available Public Good Best practices</p>	Competitive advantage creation Resource based perspectives	Tacit and explicit knowledge by Nonaka (1994) Collective vs individual knowledge by Zander and Kogut (1995)
Tallman et al. (2004)	<p><b>Component Knowledge</b> Stocks and flows of knowledge in clusters</p> <p><b>Architectural Knowledge</b> Mainly flows of knowledge, relates to the system, also the cluster, as a whole. Is quasi-private to cluster members</p>	Inter-firm and network level and industrial clusters	Component and architectural knowledge by Matusik and Hill (1998)

As indicated in Table 2, many knowledge typologies are interlinked or build on each other. Therefore, it is important to note that typologies are not mutually exclusive, rather they can be seen as complementary to provide a full picture of knowledge and help account for the multi-faceted nature and complex concept of knowledge. No typology has more merit than others in itself. As shown in the third column of Table 2, the appropriateness of the frameworks depends on context. Not all knowledge typologies listed are relevant to this research. Table 2 shows that there are many ways of considering knowledge and any universality is hypothetical. These frameworks are generally accepted and the classification used in research depends on the context.

The selection of an appropriate knowledge framework is crucial for any study dealing with knowledge in order to provide a context for readers, narrow the scope of literature and derive appropriate research questions, propositions and methodology. For the purpose of this research, two typologies listed in Table 2 are of particular importance. This research draws on the tacit/explicit knowledge typology (Polanyi, 1966) and the architectural/component knowledge typology in a cluster setting (Tallman et al., 2004). These two knowledge typologies require consideration because the tacit/explicit and architectural/component knowledge frameworks explain how knowledge contributes to competitive advantage with the latter framework being specifically relevant in a cluster setting.

#### **2.4.2. *Tacit/explicit knowledge***

The tacit/explicit framework is one of the most frequently used knowledge typology frameworks, especially in the context of knowledge as a resource for competitive advantage. Furthermore, as evident from Table 2, other typologies of knowledge often incorporate this framework as it is broad and applicable in many contexts. The distinction between tacit and explicit knowledge is based on the work of Polanyi (1966), the first author to explain, and emphasise the importance of, a tacit dimension of knowledge. In

doing so, this author criticised the then dominating positivist account of knowledge which considered knowledge exclusively comprised of skills and know how. This ‘know how’ type of knowledge, according to Polanyi (1966) is only one of two possible dimensions and is analogous to what he termed ‘explicit knowledge’. Explicit knowledge relates to documented knowledge that can be easily expressed and written or encoded and therefore can be transmitted between people and firms by means of day-to-day communication, including phone calls, emails and memorandums. However, tacit knowledge cannot be easily articulated because, in Polanyi’s (1966; p4) words, “we know more than we can tell”. Where explicit knowledge can be stored in written form, in the case of tacit knowledge individuals are the repositories (Grant, 1997). Know how, as opposed to ‘know what’, and knowledge acquired from personal experiences is tacit in nature. Consequently, this discreet knowledge type is acquired through individual learning and personal experiences (Lam, 2000).

#### ***2.4.3. The knowledge based view of the firm***

The dichotomy of tacit/explicit knowledge has received considerable attention particularly in the context of knowledge as a strategic resource for competitive advantage. Nonaka (1994), along with many scholars following his ideas (Conner & Prahalad, 1996; DeNisi, Hitt & Jackson, 2003; Grant, 1996), sees knowledge as the heart of the organisation and the major contributor to competitive advantage in firms and, therefore, a major determinant for performance differences between firms. Conner and Prahalad (1996, p. 447) assert that knowledge as a strategic resource is “the essence of the resource based perspective” implying that knowledge is the most valuable strategic resource. This is particularly the case for tacit knowledge. Revisiting the KBV of the firm, it is evident that tacit knowledge possesses the characteristics of a strategic resource. It is highly intangible in nature and, thus, inimitable, rare, difficult to transfer and non-substitutable (Barney, 1991). Therefore, tacit knowledge can provide the firm with competitive advantage over other firms if leveraged effectively. In contrast, explicit knowledge does

not meet those criteria. Per definition, explicit knowledge can be easily transmitted, codified and stored on tangible media. Its potential to create competitive advantage is therefore limited (Collins & Hitt, 2006).

Another theoretical framework emphasising the importance of tacit knowledge combines the tacit/explicit with the individual/collective knowledge typologies (Spender, 1996). Individual level knowledge describes the sum of individual competencies in a firm, while collective knowledge refers to the organising principles, routines and practices widely diffused throughout an organisation (Kogut & Zander, 1992). Based on this individual/collective typology, Spender (1996) created a matrix identifying individual/explicit, individual/tacit, social/explicit and social/tacit knowledge dimensions of knowledge. According to Spender (1996), individual knowledge resides with the individual either in tacit or explicit form. Social/explicit knowledge represents a body of often technical knowledge shared and accessed by organisation members. Social/tacit knowledge is most important to an organisation's advantage. Social/tacit knowledge is fundamentally embedded in the firm and even though firm members may not even be conscious of its existence it is accessed and sustained through their interaction (Nahapiet & Ghoshal, 1998). Spender (1996, p. 52) identifies social/tacit knowledge as "strategically significant" emphasising that knowledge becomes a strategic asset through being tacit and simultaneously being embedded in a collective. Social/tacit knowledge, while being hidden from individual actors, is accessible and sustained through interaction (Choo & Bontis, 2002, p. 677). The combination shows that a social aspect makes tacit knowledge all the more valuable for competitive advantage. Therefore, Spender's (1996) combination framework is relevant to this research as it considers the social aspect of knowledge. Specifically, the framework states that tacit knowledge embedded in a collective is most conducive to competitive advantage. Hence, Spender's (1996) conceptualisation of tacit knowledge informs this research because it emphasises that



knowledge embedded in a collective (the cluster) can be leveraged for competitive advantage through social resources.

#### ***2.4.4. The knowledge based view of clusters***

The literature discussed above about knowledge as a resource and contributor to competitive advantage has been applied to clusters in order to explain cluster advantages. The KBV of clusters represents a confluence of various streams of research, namely the KBV of the firm, and implicitly the RBV of the firm and RBV of clusters. Proponents of the KBV of clusters conceptualise clusters as “venues of enhanced knowledge creation” (Arikan, 2009, p. 658) arguing that the major determinant of cluster competitive advantage is knowledge generated and exchanged within clusters. The underlying premise of the KBV of clusters is the notion that geographic proximity fosters inter-firm knowledge related interactions (i.e. knowledge development) and increases and improves the single firm’s knowledge creation effort. Consistent with the RBV and KBV of the firm, the cluster firm can subsequently leverage knowledge available in clusters for competitive advantage (Arikan, 2009).

Prior to the emergence of cluster literature, it was acknowledged that knowledge development activities across firm or institution boundaries are crucial for firm performance and competitive advantage (Collins & Hitt, 2006). This notion has been found true for many types of networks, including multinational firms with subsidiaries, strategic alliances and informal networks (Kostova & Roth, 2003). Consistent with the RBV and KBV of the firm, inter-firm knowledge development enables competitive advantage by granting firms access to idiosyncratic resources not in their possession. Similarly, the ability of a firm to leverage its capacity to participate in inter-firm knowledge development can be seen as a strategic capability in the Teece (2009) sense, granting a competitive advantage over firms without this capability (Grant, 1996; Kogut & Zander, 1992). Explicit knowledge can transcend firm boundaries easily by means of

written communication. However, Collins and Hitt (2006) note that any kind of inter-firm collaboration is motivated by tacit knowledge exchange because increased access to explicit knowledge would not enable creation of competitive advantage. Hence, without tacit knowledge exchange such collaborations would not eventuate because firms would have no incentive to do so as there would be no resultant value or benefit.

In the context of clusters, the effectiveness and frequency of inter-firm knowledge development activities is enhanced by geographic proximity. This notion is the underlying basis of the KBV of clusters. Being located close to one another, cluster firms have more frequent opportunities to exchange knowledge. Furthermore, knowledge can spill over from one firm to another (Bathelt et al., 2004). The value created through knowledge exchange arises through the heterogeneity of knowledge bases of the actors involved. Close proximity enables a firm to ‘access’ other firms’ knowledge resources, thus extending the resource base at the single firm’s disposal (Bathelt et al., 2004). According to the RBV, firms in clusters possess firm-level resources which in the context of the KBV is the firm’s knowledge base. After accessing knowledge located in the cluster, firms can subsequently combine new knowledge with firm-level knowledge resources to enhance the knowledge base in a way that remote firms could not achieve. The enhanced firm knowledge base can subsequently be leveraged for competitive advantage. With this in mind, the KBV of clusters can explain performance differences between firms located in a cluster. Nevertheless, the combined knowledge of firms can also be disseminated throughout the cluster and made available to other firms which benefits the cluster as a whole setting it apart from other clusters and setting cluster firms apart from remote firms (Arikan, 2009; Lawson & Lorenz, 1999). Enhancement of the single firm’s knowledge base for single firm’s competitive advantage is crucial to this research considering that the unit of analysis is the single firm.

Inter-firm knowledge development activities can be without intention and ‘just happen’, i.e. knowledge spill over due to geographic proximity, as firms engage in day to day activities. However, inter-firm knowledge development activities can be explicit and intended, i.e. with firms engaging in activities to foster knowledge development.

Referring to deliberate activities to foster knowledge development, Hervás-Oliver (2012) criticises contemporary research on cluster knowledge development as skewed towards involuntary, unintended and informal transfers while overlooking that firms may engage in exchanges in a pecuniary way. Consequently, this author calls for inclusion of formalised and explicit knowledge exchange mechanisms when researching the KBV of clusters. Considering this shortcoming, this research investigates knowledge development activities both deliberate (knowledge sharing and exchange) and unintended (spill overs).

#### ***2.4.5. The relevance of the tacit/explicit typology in clusters***

Consistent with the KBV of the firm, tacit knowledge is important for creation of competitive advantage. In addition to the high potential of tacit knowledge to be of strategic value and create competitive advantage, the more explicit and codified the knowledge the less ‘space sensitive’ it tends to be (Bathelt et al., 2004, p. 32). It follows that knowledge development activities relating to explicit knowledge are not enhanced by close geographic proximity. Therefore, cluster advantages would not be derived, or only to a limited extent, from the development of explicit knowledge. It is the geographic proximity of cluster firms that fosters development of tacit knowledge. While cluster firms can develop explicit knowledge with remote firms, tacit knowledge tends to be confined to cluster boundaries (Bathelt et al., 2004).

The tacit/explicit framework is useful to understand the theoretical underpinnings behind the KBV of clusters. Arikan (2009), in explaining the KBV of clusters, uses Nonaka’s (1994) knowledge spiral framework which suggests that knowledge creation in a firm happens by means of a four step process. Specifically, the model states that organisational

knowledge is first acquired at an individual level. In other words, knowledge finds its way into the organisation as tacit knowledge through an individual's learning. When an organisational member learns and understands they subsequently introduce this tacit type of knowledge into the organisation. In the organisation, the individual articulates this knowledge in a tangible form, i.e. written or documented. Eventually, this tacit-turned-explicit knowledge is mixed with the organisation's knowledge base. Organisation members learn by doing, thereby converting knowledge to organisation-specific tacit knowledge (Nonaka, 1994). In reference to clusters, Arikian (2009) states that geographic proximity of two firms can have a positive impact on those firms' knowledge spiral. Specifically, in the first step of the model, one firm can draw tacit knowledge from another firm and convert it to internal tacit knowledge which is subsequently ready to be further amplified and leveraged for competitive advantage. Logically, it seems intuitive that tacit=local and explicit=global, however Bathelt et al. (2004) criticise this idea as simplistic. They argue that the advantages of clustering are created through the unique recombination of both tacit and explicit knowledge stocks produced and contributed by cluster firms. Again, importance of the role of the single firm in the process of advantage creation in terms of knowledge is emphasised. The literature clearly shows that, while tacit knowledge maintains importance, explicit knowledge should not be neglected in terms of competitive advantage. Therefore, this research also considers if, and how, explicit knowledge developed in the cluster may contribute to competitive advantage.

#### ***2.4.6. Cluster knowledge – architectural/component knowledge***

To account for the notion that both tacit and explicit knowledge play a role in the creation of advantages in clusters Tallman et al. (2004) introduced the architectural/component knowledge typology (listed in Table 3). This framework is valuable and constructive in explaining how knowledge can provide competitive advantage to the single cluster firm and to the cluster as a whole. To date, this is the only framework available for conceptualising cluster specific knowledge and for considering how competitive

advantage through such knowledge comes about (Runge, 2014). Originally, the architectural/component knowledge framework was developed for the narrow context of the product development process of a firm (Henderson & Clark, 1990), but has since been extended to analyse the firm as a whole as well as networks, for example communities of practice (Matusik & Hill, 1998; Tallman et al., 2004). Table 3 compares and contrasts the most significant features of component and architectural knowledge types.

Table 3 - Component and architectural knowledge typology in clusters according to Tallman, Jenkins, Henry and Pinch (2004, p. 263)

<b>Component knowledge</b>	<b>Architectural knowledge</b>
<b>General description</b>	
Describes an identifiable element of a body of knowledge and relates to exogenous conditions or laws	Relates to the understanding of a system of knowledge or organisation; it is path dependent and endogenous to the system in which it is embedded
Both tacit and explicit components	Both tacit and explicit components
Relatively mobile	Relatively immobile
<b>In a cluster context</b>	
Available to all members of the cluster through spill overs	Quasi-private to cluster members
The more tacit and systemic, the more slowly it spreads through the cluster	Development at cluster level happens through evolutionary processes as cluster members interact, emphasising the importance of social interaction
Can flow across cluster boundaries	Limits the flows of knowledge across the cluster's boundaries
Can provide competitive advantage to the cluster as a whole, but only short term. Within the cluster, it cannot provide competitive advantage for the single firm as it is public	Can provide competitive advantage to the cluster as well as to cluster firms.

According to the typology presented above (Table 3), component knowledge describes skills and technologies relating to a discreet part of the organisation. Being highly technical, component knowledge is relatively mobile and can be exchanged between organisations that have similar stocks of component knowledge (Tallman et al., 2004). For example, industry specific knowledge manifests itself as component knowledge (Brown et al., 2010, p. 22). Architectural knowledge, on the other hand, relates to the firm, industry or network as an entire system and describes how individual components of

a network or system work together. Even though both architectural and component knowledge have tacit dimensions, component knowledge cannot lead to sustained competitive advantage, neither at firm level, nor cluster level. This is due to both firms and clusters realising short-lived competitive advantage through component knowledge as long as it remains private for the firm and cluster. However, eventually, due to its mobile nature, component knowledge will spill over firm and cluster boundaries making it a public good and eliminating competitive advantage.

Architectural knowledge, on the other hand, is difficult to transfer between cluster firms and near impossible to transfer to others outside the cluster, thus is most valuable for competitive advantage. Tallman et al. (2004) emphasise that in a cluster certain parts of architectural knowledge can be shared between cluster firms explaining cluster level competitive advantage. This is because through architectural knowledge transfer it is possible to “develop an inter-firm or cluster-specific stock of architectural knowledge that will distinguish the cluster from the rest of its industry”. Therefore, Tallman et al. (2004) suggest that architectural knowledge is the key for knowledge based competitive advantage at firm level. Following the logic of the RBV and KBV of clusters, which emphasise the importance of firms combining knowledge resources with existing knowledge stock, this collective stock of architectural knowledge can be used by firms in combination with firm-specific resources, in this case firm specific architectural knowledge, to provide the firm competitive advantage. The framework applying component and architectural knowledge to clusters is extremely valuable for this research as it explains how the single firm in clusters can realise competitive advantages by focussing on cluster specific knowledge types.

#### ***2.4.7. Absorptive capacity and its relevance to the KBV of clusters***

Another related and important concept noted frequently in the context of competitive advantage creation through knowledge is absorptive capacity. In addition to the type of

knowledge, it is absorptive capacity of the firm that determines whether knowledge can be used for competitive advantage (Cohen & Levinthal, 1990). The concept of absorptive capacity is of particular importance when examining knowledge in clusters as the framework can further explain the observation that not all firms located in a cluster are equally successful, even if their knowledge stocks are similar and they have access to similar knowledge resources. Hence, the notion of absorptive capacity channels the discussion of competitive advantage away from cluster level to firm level. Absorptive capacity refers to the firm's learning ability, i.e. the extent to which a firm can assimilate, adapt and apply knowledge (Tallman et al., 2004; Zahra & George, 2002). Specifically, Cohen and Levinthal (1990, p. 128) who first described the concept, define absorptive capacity as the "ability of a firm to recognise the value of new external information, assimilate it and apply it to commercial ends". In many studies on knowledge development and knowledge transfer across a firm's boundaries, absorptive capacity is identified as a major determinant of whether those activities can lead to competitive advantage. Consequently, where a firm is lacking absorptive capacity knowledge transfer activities are redundant to the firm as it cannot capitalise on new knowledge (Zahra & George, 2002). Broadly speaking, the relevance of the concept to clusters is that for a firm being part of a cluster is not sufficient to benefit from the many advantages a cluster creates. The firm is responsible for its own success and its absorptive capacity determines this success. Therefore, differences between absorptive capacities of cluster firms can explain performance differences between firms in clusters (Hervás-Oliver, Alborn-Garrigos, de-Miguel & Hidalgo, 2012). Following this logic, co-location per se will not lead to competitive advantage, stepping away from the perception of cluster firms as being a 'homogenous block' and further emphasising the role of the single firm (Hervás-Oliver et al., 2012). The absorptive capacity framework is relevant to this research because it illustrates that competitive advantage can be created by acquiring knowledge from outside the firm's boundaries and this is the underpinning notion of the KBV of clusters.



Dyer and Singh (1998) complemented the absorptive capacity framework by going one step further and proposing that absorptive capacity is partner specific, i.e. knowledge is assimilated from a specific alliance partner. If a firm possesses ‘general’ absorptive capacity the knowledge flow from one firm to another is not as efficient, or even impossible. Dyer and Singh (1998) further posit that partner specific absorptive capacity can be enhanced if those exchanging knowledge ‘get to know each other’ and frequently and trustingly interact. This notion implies that good and trusting relationships foster knowledge development via positive impact on partner-specific absorptive capacity, and ultimately on competitive advantage. This perspective suggests that for effective knowledge transfer (by means of partner specific absorptive capacity) social assets are necessary, further showing a clear link between relational resources and knowledge.

Even though the unit of analysis is the single firm, it should be mentioned that the absorptive capacity theoretical framework has also been applied to entire clusters to explain inter-cluster performance differences. Accordingly, the dynamic growth and competitive advantage of entire clusters depends on the cluster’s absorptive capacity (Giuliani, 2005; Valdaliso et al., 2011). At cluster level, rather than firm level, absorptive capacity refers to the ability of the cluster to “absorb, diffuse and exploit extra-cluster knowledge” (Valdaliso et al., 2011, p. 708). Consequently, according to this theoretical framework, a cluster’s ability to achieve cluster level competitive advantage depends on two aspects: the ability to form linkages to remote firms and institutions to obtain extra-cluster knowledge, and the ability to leverage this knowledge in the cluster, also denoted as the effectiveness of the “intra-cluster knowledge system” (Giuliani, 2005; Valdaliso et al., 2011, p. 708). The latter describes the channels by which knowledge sourced externally is distributed in the cluster and made accessible to cluster firms. While the absorptive capacity of the firm determines the competitive advantage that firms can realise, absorptive capacity of the cluster determines competitive advantage for the cluster over other clusters.

#### **2.4.8. *Tacit knowledge is social***

As this research is concerned with the leverage of social capital for knowledge development, a link between knowledge and social capital is drawn in this section. It is well established in the literature that knowledge is inherently social in nature (Chua, 2006; Kogut & Zander, 1992), a notion acknowledging that knowledge as a resource is best leveraged by means of interpersonal relationships. Spender (1996) argues that knowledge should not be treated as a resource per se, rather he considers it a “process of ongoing social construction” (in Eisenhardt & Santos, 2002, p. 139), emphasising that in the absence of social interaction knowledge would not exist. This holds true for both explicit and tacit knowledge, however the importance of relationship for the leverage of tacit knowledge has been emphasised in the literature. While explicit knowledge, by definition, can be transferred between individuals and institutions easily, regardless of the nature and quality of their relationship, the transfer of tacit knowledge is made possible through relationships. Social relationships serve as pathways to distribute knowledge between individuals and between firms, enabling knowledge transfer and sharing (Nonaka, von Krogh & Voelpel, 2006). Tallman et al. (2004) explain that architectural knowledge, which in a cluster context can provide firms and clusters with competitive advantage, develops through social interaction between cluster actors and further helps to establish relationships amongst individuals. Unlike component knowledge, social interaction is crucial for architectural knowledge to come to existence and to be ‘used’ for competitive advantage (Tallman et al., 2004).

These viewpoints show that knowledge is leveraged through social relationships for competitive advantage, and hence that relationships are a contributor to this advantage. In order to address the research problem of this project which asks how social capital is leveraged for knowledge development in clusters, it is necessary to explore the theoretical framework addressing ‘social relationships’ and how relationships are linked to knowledge. Therefore, the next section reviews the social capital concept.

## **2.5. Social capital – the value of relationships**

Social capital is a concept proposing that value can be derived from relationships, which can be interpersonal or interorganisational, and together with clusters and knowledge is one of the three underlying theoretical frameworks for this research. Empirical studies confirm a causal link between social capital and the benefits it creates in the context of firms, groups of firms, clusters of firms, regions and countries. An explanation as to why social capital can create benefits, especially in the context of clusters, requires consideration of the relational view of the firm.

### ***2.5.1. The relational view: relational resources and relational rents***

The relational view of the firm is a logical extension of, and also complementary to, the RBV of the firm, emphasising that the opportunity of any firm to create competitive advantage not only depends on the resource base held by the firm, but also on its relationships with other firms. Consequently, the relational view investigates joint resources at the relational level (Dyer & Singh, 1998). The value derived from relationships is considered to be a ‘relational resource’ or ‘relational capital’. The sum of all relational resources is considered to be ‘social capital’. Relational resources at the relational level can create competitive advantage by generating relational rents (Dyer & Singh, 1998). According to a definition by the originators of the relational view, Dyer and Singh (1998, p. 662), relational rents are “a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners”. This definition implies that the value of a relational resource lies in the idiosyncrasy of participating partners, creating a new, collective resource that would not exist in the absence of the relationship. According to Dyer and Singh (1998) and Lavie (2006), relational rents derived from relationships can be either common or private in nature. Common relational rents are beneficial to all parties participating in a relationship, whereas private relational rents are realised by one party in the relationship. When

applied to clusters, the distinction between common and private rents explains performance differences of the cluster as a whole compared to other clusters (common relational rents available to all cluster firms), as well as performance differences between cluster firms (through private relational rents realised by single firms). Hence, social networks and relationships can be viewed as valuable intangible resources in their own right as they potentially contribute to competitive advantage if leveraged properly (Dyer & Singh, 1998). Relational resources, as conceptualised by the relational view, meet the criteria of a strategic resource as defined by proponents of the RBV, as they are intangible in nature, path dependent, hard to imitate and, therefore, valuable for competitive advantage (Barney, 1991; Teece & Pisano, 1994). The relational view is one of the frameworks informing this research as it links the value of relationships to the RBV and to competitive advantage.

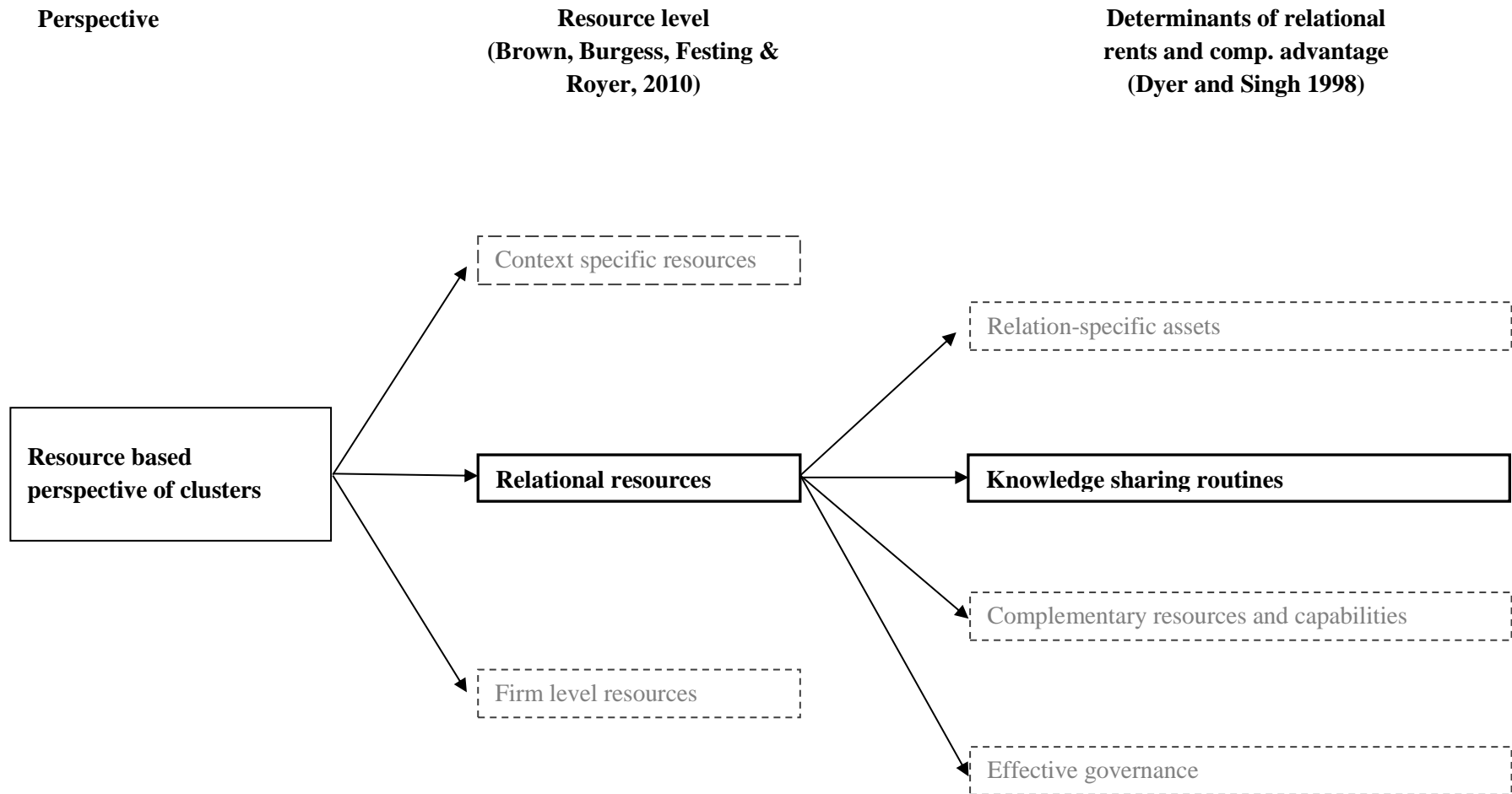
Dyer and Singh (1998) draw a link between relational resources, knowledge and relational rents. Specifically, the authors specify four determinants that need to be present in order for relational rents to be achieved. Those determinants are: 1) relationship specific assets, 2) complementary resources and capabilities, 3) governance mechanisms and, of particular importance for this research, 4) knowledge sharing routines. According to Dyer and Singh (1998), the four determinants can only arise and exist if firms have moved away from purely market based exchange to promote social relationships. An overview of the four determinants is presented in Table 4.

Table 4 - Determinants of relational rents according to Dyer and Singh (1998)

Determinant of relational rent	Sub-processes facilitating relational rents
1. Relation-specific assets	1a. Duration of safeguards
	1b. Volume of inter-firm interactions
2. Knowledge sharing routines	2a. Partner-specific absorptive capacity
	2b. Incentives to encourage transparency and to discourage freeriding
3. Complementary resources and capabilities	3a. Ability to identify and evaluate potential complementarities
	3b. Role of organisational complementarities to access benefits of strategic resource complementarity
4. Governance mechanisms	4a. Ability to employ self-enforcement rather than third-party enforcement governance mechanisms
	4b. Ability to employ informal versus formal self-enforcement governance mechanisms

According to Dyer and Singh (1998), knowledge sharing contributes to relational rents, i.e. competitive advantage through the leverage of social resources. Consistent with Cohen and Levinthal (1990), those engaging in knowledge sharing routines need to possess absorptive capacity in order to leverage knowledge for competitive advantage. Furthermore, knowledge can only be leveraged for relational rents if all relational participants feel motivated and safe to share knowledge (Dyer & Singh, 1998). Dyer and Singh (1998) hence show how and under which conditions relationships can be leveraged for competitive advantage, which is the underlying concept of this research.

This research acknowledges that relationship specific assets, complementary resources and capabilities, as well as governance mechanisms, are major contributors to relational rents and advantages of firms, as specified by Dyer and Singh (1998). However, with the research problem and questions in mind, this research focuses on what Dyer and Singh (1998) term 'knowledge sharing routines' (Table 4) as determinants of competitive advantages through relational resources. An in-depth discussion of the remaining three determinants would be beyond the scope of this research. With reference to the three different resource levels in clusters, and Dyer and Singh's (1998) determinants for relational rents, Figure 3 specifies the focus of this research and links the two theoretical frameworks, with illustrations in faded colour representing concepts that are out of scope for this research.



*Figure 3- Focus of this research and areas out of scope*

Even though the relational view of the firm and the social capital concept are closely linked as both describe the value of interpersonal dynamics there is definitional ambiguity in terms of how the relational view and the concept of social capital relate. Specifically, it is ambiguous whether social capital defines the sum of all relational resources, or whether it is one of many relational resources. When referring to social capital, many authors use it synonymously with ‘a relational resource’ (Flap & Voelker, 2003; Wang, Wang, Huang & Deng, 2012) implying existence of other relational resources that are distinct to social capital. However, neither of those authors explicitly mention other relational resources. Furthermore, it is ambiguous as to whether ‘relational capital’ and ‘social capital’ can be considered synonymous. For example, Capello and Faggian (2005) consider relational capital and social capital to be distinct concepts. According to these authors, social capital “exists wherever society exists, whereas relational capital refers to the (rare) capability of firms exchanging different skills, interacting among different firm actors, trusting with each other and cooperating even at a distance with other complementary organizations” (Capello & Faggian, 2005, p. 77). In this definition the authors imply that social capital is present, but relational capital provides competitive advantage for the firm. However, this is in contrast to the dominant view that social capital has inherent potential to be leveraged for value creation. Alternatively, Collins and Hitt (2006) use the terms ‘relational capital’ and ‘social capital’ synonymously. Similarly, Han, Lee & Yoon (2008) identify trust as a social or relational capital in its own right, implying that facets of social capital dimensions are individually valuable resources. For the purpose of this research, the definition of social capital used is that provided by Nahapiet and Ghoshal (1998, p. 243) who describe it as “the sum of the actual and potential resources embedded within, available through and derived from the network of relationships developed by an individual and social unit”, including all relational resources. In line with the majority of scholars, this is the social capital definition that this research will adopt, hence considering social capital to entail *all* relational resources. Thus, previous literature exploring the effects of relational capital on value creation are considered relevant for this



study, unless the authors explicitly differentiate between social and relational capital. It is clear that a significant gap in research exists to determine how social capital links in with the relational view, but this is beyond the scope of this research.

### ***2.5.2. Defining social capital***

An important contribution to the social capital concept in the context of economics was that of Bourdieu (2008) who analysed relational resources in the context of critical theory of society in general. The rise of social capital research in the context of organisational and economic studies is due, in large, to Granovetter's (1985, 1990) paradigm contesting that economic activity cannot be separated from social activity. This author emphasised the importance of social ties for economic activity and outcome. To date, no universally agreed definition of social capital exists which may be partly due to the inherent 'fuzziness' of the concept itself arising from social capital being intangible, impossible to observe and only measureable in terms of outcomes (Vejzagic–Ramhorst et al., 2012). Table 5 provides an overview of the numerous definitions of social capital found in the literature.

*Table 5 - Definitions of social capital 1986 to current*

<b>Author and year</b>	<b>Social capital definition</b>
Bourdieu (2008, reprint of 1986)	“The aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalised relationships of mutual acquaintance or recognition”.
Coleman (1988, p. 98)	“Social capital is defined by its function. It is not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors-whether persons or corporate actors-within the structure. Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible”.
Putnam (1995, p. 67)	“Features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit”.
Woolcock (1998, p. 153)	“The information, trust, and norms of reciprocity inhering in one’s social networks”.
Nahapiet and Ghoshal (1998, p. 243)	“The sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit. Social capital thus comprises both the network and the assets that may be mobilised through that network”.
Woolcock and Narayan (2000, p. 226)	“Social capital refers to the norms and networks that enable people to act capital collectively”.
Adler and Kwon (2002, p. 18)	“Social capital is the resource available to actors as a function of their location in the structure of their social relations”.
Inkpen and Tsang (2005, p.151)	The aggregate of resources embedded within, available through, and derived from the network of relationships”.
Burt (2009, p. 9)	“Friends, colleagues, and more general contacts through whom you receive opportunities to use your financial and human capital”.
Huber (2009, p. 160)	“[Social capital is defined as] resources embedded in social networks which can be potentially accessed or used by individuals for actions. That is, social capital is about the resources actors are able to mobilise through relationships for certain activities”.

Despite the definitional ambiguity surrounding social capital, Adler and Kwon (2002) explain that the most common definitions and conceptualisations are complementary. A close examination of Table 5 shows that all definitions assume that networks and relationships are of inherent value to those engaging in them. Most definitions imply that social capital, in order to be considered ‘capital’, needs to involve a positive outcome. Bourdieu (1986, reprint in Bourdieu (2008, p. 286)) defines social capital as the “aggregate of the actual or potential resources, which are linked to possession of a durable network of more or less institutionalised relationships of mutual acquaintances and recognition – or in other words, to membership in a group”. This definition emphasises that social capital is a resource which can be leveraged for advantage and its collective nature. Bourdieu (2008, p. 286) considers social capital a “credential” entitling group members to credit, i.e. the possibility to leverage social capital for their advantage. As Coleman (1988) states, social capital by nature creates advantages that would not eventuate in its absence.

In line with Bourdieu (2008), Nahapiet and Ghoshal (1998, p. 243) describe social capital as “the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit”. These authors stress that their definition considers that social capital entails the network itself and resources embedded in the network. With regard to the RBV, by considering social capital as a ‘sum of resources’ Nahapiet and Ghoshal’s (1998) definition implies that social capital can potentially be leveraged for competitive advantage. This research utilises the definition of social capital provided by Nahapiet and Ghoshal (1998). Not only is their framework appropriate to network studies (Parra-Requena, Ruiz-Ortega & Garcia-Villaverde, 2013), but Nahapiet and Ghoshal (2008) also explicitly address the interplay between social capital and knowledge which is relevant to this research.

### *2.5.3. Social capital dimensions*

In addition to providing an unambiguous definition, several attempts have been made to derive taxonomic criteria for social capital in order to apportion and better understand the concept (Sechi, Borri, De Lucia & Celmins, 2011). One criteria frequently used relates to unit of analysis. Social capital can be analysed with a focus on the micro level, meso level or macro level (Chou, 2006). The micro level of social capital relates to individuals and determines how their actions are facilitated by, and how they benefit from, social capital. The meso level focuses on organisations or groups of individuals and how social capital creates mutual benefits (Sechi et al., 2011). The macro level addresses territorial entities and complexes of institutions (Sechi et al., 2011). Elaborating on the macro/meso/micro taxonomy, social capital can be considered to be individual or collective through description of who benefits from the relational rents created. Proponents of the individual view consider social capital to be a private good possessed by individuals leveraging personal relationships (Inkpen & Tsang, 2005). This perspective on social capital is derived from network theory which emphasises the benefits of social capital on the personal level (Burt, 2000). In contrast, the collective perspective sees social capital as an attribute of a “social unit rather than the individual” (Inkpen & Tsang, 2005, p. 150) and as a public rather than a private good with benefits available to the entire group (Bourdieu, 2008; Coleman, 1988). Similarly, Inkpen and Tsang (2005) further distinguish between individual and organisational social capital. According to their framework, individual social capital describes social capital embedded in an individual’s network, whereas organisational social capital describes social capital embedded in an organisation’s network of relationships (Inkpen & Tsang, 2005). In the context of this framework organisational social capital is considered a public good, whereas individual social capital is considered a private good.

Nahapiet and Ghoshal’s (1998) definition of social capital as “the sum of resources embedded within [...] the network of relationships” of an individual or organisation

incorporates private and public as well as the individual and organisational nature of social capital. Therefore, the authors acknowledge that the individual (e.g. employees, managers), organisation (e.g. cluster firms and institutions) and group (the cluster as a whole) contribute to and benefit from social capital in the cluster, even though the unit of analysis for this research is the single firm. Another criterion used to derive a taxonomy of social capital is the division into bonding or bridging social capital (Adler & Kwon, 2002). Bonding social capital is embedded in a network or community and a collective resource of network members. However, bridging social capital connects an actor of a network with external actors that are not part of the network. Putnam (2001a) argues that bonding social capital in a network eventually fosters bridging capital. Hence, strong ties inside a network enable network members to ‘connect’ with outsiders enabling them to draw resources from outside the network. Through the acquisition of resources, bridging social capital fosters growth. The concept of bridging social capital is important for the investigation of clusters because it can be used to describe relationships between firms located in the cluster with remote firms (Molina-Morales & Martínez-Fernández, 2010). In the context of cluster studies, the existence of bonding and bridging social capital shows that social capital and social ties can cross cluster boundaries. This study considers social capital between cluster actors and social capital created through relationships with outsiders. One of the most frequently used taxonomic criteria for social capital is categorisation into dimensions describing the nature of relationships of actors (Sechi et al., 2011) and this is discussed in the following section.

The discussion of social capital shows that, independent of clusters and knowledge, there is ongoing debate regarding how to define and operationalise social capital (Moran, 2005). A first step towards achieving some degree of operationalisation is to view social capital as multidimensional where the dimensions of social capital describe the nature of different relationships between actors (Sechi et al., 2011). As with the definition of social capital, there is no general agreement as to what the dimensions of social capital are and

how to define them. As a consequence, many parallel frameworks exist (Putnam, 1995). Nevertheless, there is consensus amongst scholars that dimensions of social capital should consider both a network level component describing the network configuration and a cognitive component describing informal linkages between actors based on values and trust (Grootaert & Van Bastelaer, 2002 in Sechi et al. (2011, p. 247)). The idea of social capital as dichotomous is based on Granovetter's (1985) description of networks drawing a distinction between structural (network level) and relational (cognitive level) embeddedness<sup>3</sup>.

In keeping with this dichotomy, but developing it further, Nahapiet and Ghoshal (1998) identify three dimensions of social capital, structural, relational and cognitive, where the latter two dimensions are consistent with Granovetter's relational embeddedness. An overview of Nahapiet and Goshal's (1998) dimensions of social capital and their respective facets is provided in Table 6, below.

*Table 6 - Dimensions of social capital according to Nahapiet and Goshal (1998)*

<b>Structural</b>	Network ties
	Network configuration
	Appropriable organisation
<b>Relational</b>	Shared codes and languages
	Shared narratives
<b>Cognitive</b>	Trust
	Norms
	Obligations
	Identification

The social capital framework shown in Table 6 is particularly relevant to this research as it was derived within the realm of how social capital is linked with knowledge. According to Nahapiet and Ghoshal (1998), the structural dimension describes properties of the social network, i.e. the overall pattern of connections that links actors. Specifically, the

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<sup>3</sup> Embeddedness in Granovetter's context refers to the degree by which economic activity is influenced by non-economic institutions. Such non-economic institutions may include social relationships

structural dimension refers to linkage density, connectivity, hierarchy and organisation (Coleman, 1988). In other words, the structural dimension describes “who you reach and how you reach them” (Nahapiet & Ghoshal, 1998, p. 247). The relational dimension of social capital refers to the quality of relationships that people or institutions have with one another, e.g. strength of relationship, friendship, respect and trust. Consistent with other authors’ work, Nahapiet and Ghoshal (1998) include facets such as norms and sanctions, as well as mutual expectations. According to Exposito-Langa and Molina-Morales (2010), the strength of the relational network is the most important facet of this dimension which is defined by emotional intensity and frequency of interaction.

Nahapiet and Ghoshal (1998) were the first to separately identify a third dimension of social capital, the cognitive dimension. Previous work by other authors did not neglect cognitive facets. However, those facets were largely seen as inherent in the relational dimension (Burt, 2009; Granovetter, 1985; Putnam, 1995). The cognitive dimension of social capital describes a shared system of meaning amongst actors in a network, including shared languages and codes. Hence, Nahapiet and Ghoshal (1998) argue that when social capital is analysed in the context of strategy and firm performance, a cognitive dimension should be identified separately as its facets are highly relevant. Further, Nahapiet and Ghoshal (1998) state that in the context of knowledge development, facets of the cognitive dimension are of particular importance as the presence of shared language and shared codes are likely to be important prerequisites for transfer of tacit knowledge in particular. Social capital dimensions are highly relevant to this research, as in order to explore social capital in the context of clusters and knowledge, systematisation of social capital is needed. The dimensions of social capital have been used successfully to achieve specificity for empirical studies, and importantly, in the context of knowledge development (Inkpen & Tsang, 2005). Therefore, this research considered the dimensions of social capital when deriving the research propositions presented in chapter three.

#### ***2.5.4. Interdependencies in relationships***

Another important way to view social capital is through interdependencies. As explained previously, social capital is embedded in, and created through, relationships. However, relationships differ in terms of quality and strength which ultimately has an impact on social capital. The quality and strength of relationships is described by interdependency between parties in the relationship. The potential for social capital to initially be created and how effectively and efficiently it can be leveraged for knowledge development are strongly dependent on the nature of interdependency. Hence, considering the interdependency of a relationship is integral when analysing social capital between two parties (Kostova & Roth, 2003). Interdependencies are a particularly valuable tool to describe and analyse relationships between cluster actors.

Conceptualising interdependencies of relationships is as challenging as conceptualising relational resources, or relationships themselves, due to relationships being inherently intangible. A framework commonly used to describe and capture interdependencies is that developed by Thompson (2003, reprint of 1967). Originally, Thompson's framework was used to analyse relationships of sub-units in a single organisation and has since been applied to describe organisational structure. However, recently the framework was found valuable when applied to the value adding web framework and cluster context to analyse relational resources (Brown et al., 2010). Here, the nature of interdependency describes how control over resources is distributed between actors participating in a relationship. Specifically, it also describes the strength of a relationship where high levels of interdependencies indicate a strong relationship.

Three types of interdependencies were described by Thompson (2003): pooled, sequential and reciprocal. According to Thompson (2003), pooled interdependencies describe a relationship situation in which each party contributes to and benefits from the whole. In other words, even though each party of the relationship contributes to a common



advantage there may be competition for certain pooled resources as parties of the relationship can use them to their advantage. Applied to a cluster context, pooled interdependency arises when cluster actors compete for resources of value, such as skilled labour or customers (Gretzinger & Royer, 2013). Pooled interdependencies are considered to be the loosest form of interdependency. Sequential interdependency describes a situation where the output of one party is the input for another (Thompson, 2003). In the context of clusters, this is a constellation where one cluster actor receives input from another actor. This is most commonly the case between a supplier (vertical cluster actor) which provides input to another firm's (horizontal cluster actor) production process (Gretzinger & Royer, 2013). Reciprocal, or balanced, interdependencies describe a mutual exchange of inputs and outputs between parties. Thus, reciprocal interdependency has elements of pooled and sequential interdependencies. Applied to a cluster context, reciprocal interdependency occurs when there is mutual exchange of inputs and outputs between cluster actors (Gretzinger & Royer, 2013). A fourth type of interdependency proposed by Van de Ven and Ferry (1980) to complement Thompson's (2003) framework is team-oriented interdependency. Team oriented interdependency is similar to reciprocal interdependency in that both actors in a relationship supply each other with inputs and outputs. However, the distinguishing feature of team oriented interdependency is that those activities are undertaken interactively and simultaneously (Brown et al., 2010).

In order to understand how interdependencies can ultimately impact on social capital, the strength of the interdependency has to be considered. According to Thompson's (2003) understanding, 'strength' in this context refers to the extent of joint resources involved in the relationship and who has control over resources. Thompson (2003) states that the higher the importance of joint resources for the relationship, the 'stronger' the relationship and the higher the potential for social capital to be created and be present in the relationship, as well as potential creation of relational rents. This strength is weakest

for pooled interdependencies in the absence of joint resources and increases from sequential and reciprocal to team-oriented interdependencies which is considered the strongest interdependency type (Brown et al., 2010; Steffen, 2012). Strength derives from the fact that parties are dependent not only on resources, but also on the other party's cooperation. Consequently, it is team-oriented interdependencies that have the highest potential for creation of social capital in a relationship.

According to Gretzinger and Royer (2013), interdependencies are a fruitful way to analyse social capital in a cluster setting. In the context of this research, interdependencies are considered to be relevant as, due to correlation with social capital, they are a good way to systematise the highly tacit context and achieve specificity. Therefore, interdependencies were considered when deriving the interview questions and in the data analysis and interpretation process.

#### ***2.5.5. Social capital – not always beneficial***

The main focus of this research is the positive effects of social capital, i.e. how social capital can help create competitive advantage, as evident from the research problem and questions. Nevertheless, it is important to note that recently scholars have argued that social capital is not universally beneficial and can have negative effects. Any study dealing with social capital should at least acknowledge that there can be negative effects since these are an integral part of the social capital concept, specifically with regards to knowledge. Nahapiet and Ghoshal (1998) note that high levels of social capital may restrict firms' access to new knowledge as they can merely source it within their network of strong ties. Further, they assert that norms can be cemented through social capital and subsequently become antagonistic. In the context of clusters, knowledge redundancy, or obsolescence, is a negative effect of social capital. This occurs as firms in clusters source knowledge from each other, but have a tendency to isomorphism in that they have similar, overlapping knowledge bases (Exposito-Langa & Molina-Morales, 2010).

Similarly, Uzzi (1997) found that an intense level of social capital, or ‘overembeddedness’, can hinder the acquisition of knowledge from outside the network, since the strong ties of network members ignore remote firms.

Referring to the negative effects of social capital for knowledge development, Nahapiet and Ghoshal (1998, p. 260), quoting Boland and Tenkasi (1995), assert that “effective organisation requires a constant balancing of potentially opposing forces” implying that practitioners should consider the negative effects. Nevertheless, these authors do not analyse the negative effects of social capital, but conclude that these should be examined in separate studies. This is a valid approach because bringing together social capital dimensions, network analysis and knowledge is inherently complex (Inkpen & Tsang, 2005), thus introducing negative outcomes as an additional variable to consider would not be beneficial. Therefore, while it is important to know that negative effects of social capital exist, it is beyond the scope of this study to examine this phenomenon as the research focus is on how the leverage of social capital contributes to competitive advantage in clusters. Nevertheless, the negative effects of social capital were kept in mind for interpretation of results of this research.

## **2.6. Social capital, knowledge and clusters**

The underlying rationale for this research lies in the overlap of the three theoretical streams of clusters, knowledge and social capital. The following section discusses previous literature on the interplay of social capital and knowledge in clusters and specifies the shortcomings that this research aims to address.

### ***2.6.1. Knowledge is social***

Social capital can be leveraged for competitive advantage through its impact on knowledge. Dyer and Singh (1998) consider knowledge sharing routines to be one of the four determinants of relational rents, thus showing the inherent link between relational

resources, knowledge and competitive advantage. In the context of clusters, social capital is a concept that needs to be considered when discussing the KBV of clusters. The literature generally confirms that social capital is a major ‘catalyst’, or facilitator, of knowledge development inside and outside cluster settings, and many studies confirm that social capital can contribute to competitive advantage through its role as a knowledge facilitator (Chiu, Hsu & Wang, 2006; Yli-Renko, Autio & Sapienza, 2001). Social capital as a catalyst for knowledge development acknowledges that knowledge in itself, and knowledge development activities, are inherently social in nature.

A wealth of research is available addressing the inherent link between social capital and knowledge. Many studies show that social capital is a conduit for activities that we understand to be knowledge development (Maskell & Malmberg, 1999; Molina-Morales & Martínez-Fernández, 2007; Steiner & Hartmann, 2006). For example, social capital serves as a pathway to distribute knowledge between individuals and between firms enabling its development, including transfer and sharing (Lesser, 2000). In addition to knowledge distribution, social capital also facilitates and supports knowledge acquisition (Adler & Kwon, 2002; Sechi et al., 2011).

Social capital is particularly important for development of tacit knowledge. Supporting the idea that social capital impacts on tacit knowledge, rather than explicit knowledge, Collins and Hitt (2006) examined the link between tacit knowledge transfer and social capital for firm level competitive advantage. They found that social capital can help overcome the inherent challenges of tacit knowledge transfer, for example the difficulty to articulate and communicate tacit knowledge and inter-firm and cultural differences. In summary, it is evident that social capital is a driver of knowledge development activities, particularly for tacit knowledge. This idea can be applied to a cluster setting in order to explain how knowledge contributes to competitive advantage.

In one of the most renowned and frequently cited studies on social capital and its impact on knowledge Nahapiet and Ghoshal (1998) propose that, in the context of an organisation, social capital facilitates the generation of new knowledge by positively affecting the conditions necessary for knowledge combination and exchange. These conditions are: access to knowledge, anticipation of value of new knowledge created, motivation to create new knowledge and ability to combine knowledge resources. The authors state that in order for knowledge to be generated all four conditions must be met and that social capital makes knowledge generation possible indirectly by creating and enhancing those conditions. In presenting their argument, Nahapiet and Ghoshal (1998) implicitly assert that social capital also drives knowledge development indirectly by impacting the firm's absorptive capacity, a requirement for their third condition, the ability to combine knowledge resources.

Even though Nahapiet and Ghoshal's (1998) research focuses on organisations rather than networks or clusters, the authors argue that certain collectives that achieve high levels of social capital can realise competitive advantages by leveraging social capital for knowledge development. According to Nahapiet and Ghoshal (1998), organisations are institutional settings and through close relationships of their members they are conducive to create high levels of social capital can be created. Therefore, an entity that is networked has an advantage over markets in terms of knowledge generation, as markets do not display close ties between members (Nahapiet & Ghoshal, 1998). The authors also stress that it is tacit knowledge, rather than explicit knowledge, that is generated and leveraged through social capital. They refer to Spender's (1996) social/tacit and individual/tacit knowledge dimensions to explain that social capital fosters the generation of these two knowledge types making social capital highly relevant to competitive advantage through tacit knowledge. As one of the first papers addressing the inherent link between social capital and knowledge, Nahapiet and Ghoshal's (1998) framework is, to date, also one of the most frequently cited. Since its initial publication in 1998, their work

has been used as the theoretical underpinning for a number of studies that examine social capital in a cluster setting where their underlying ideas have been empirically confirmed (Boari & Presutti, 2004; Inkpen & Tsang, 2005; Tallman et al., 2004). Nahapiet and Goshal's (1998) framework is highly relevant to this research as it shows the link between knowledge and social capital.

### ***2.6.2. Social capital as a driver of knowledge in clusters***

The idea that social capital is an important contributor to competitive advantage in clusters logically extends the RBV of clusters, similar to how the relational view of the firm extends the RBV of the firm. In the initial literature on clusters, Porter (1998a) defined what constitutes a cluster suggesting that relationships are important and concluding that 'social embeddedness' and social ties in clusters are key contributors to cluster success. In other words, social capital is understood to be a distinguishing feature of clusters (Gordon & McCann, 2000). Social capital in cluster settings as a driver of competitive advantage has become established as an important pillar in cluster research.

Although interorganisational and interpersonal relationships in clusters were traditionally analysed from a market-oriented perspective, relational and cognitive aspects of relationships have emerged as an important field of study to explain how cluster advantages develop (Depret & Hamdouch, 2010). The underlying premise of studying social capital in clusters is that the presence of many actors (i.e. firms and institutions) and their relationships with one another are a defining feature of clusters. Clusters are understood to be value adding webs with linkages between firms and institutions which overlap (Brown et al., 2010) where social capital is embedded in any one of those linkages. Geographic proximity fosters close ties between actors which are part of this web, subsequently giving rise to social capital (Molina-Morales & Martínez-Fernández, 2010; Zaheer & McEvily, 1999).

The initiation of social capital takes place in clusters to a larger extent than in other network types where actors are not located geographically close to one another. Hence, clusters have been described as ‘social networks’ (Parra-Requena et al., 2013, p. 160) to account for social capital being a distinguishing feature. Farrell and Knight (2003) propose that clusters are the only real-life examples of social capital in action at the micro level, since the causal relationship between social capital and its outcomes can be readily observed. Thus, clusters are unique ‘test cases’ when the objective is to study the dynamics of social capital. Not surprisingly, a wealth of literature is available analysing social capital in a cluster setting.

The notion that advantages realised by cluster firms and clusters as a whole are, at least partly, due to the presence of social capital is widely supported (Beugelsdijk & Van Schaik, 2005; Cooke, Clifton & Oleaga, 2005; Porter, 1998a). Huber (2009) describes social capital in the context of clusters as a resource embedded in social networks which can potentially be accessed and leveraged by individuals, implying a role in creation of competitive advantage. This is consistent with the RBV of clusters in which social capital is considered a relational level resource created through various relationships amongst cluster actors which can be put to work for competitive advantage (Eisingerich, Bell & Tracey, 2010; Lee, Lee & Pennings, 2001). Foss (1999) argues that the RBV of clusters can benefit from the social capital concept to explain how advantages of clustering arise and calls for further research to bridge and integrate these two streams. Achieving such integration is one of the objectives of this research.

Although social capital is a strategic resource according to the RBV, any resource needs to be leveraged, i.e. ‘put to work’, in order to create competitive advantage (Barney, 1991). Despite social capital being a competitive resource itself, many scholars argue that social capital is particularly useful as a means to access other resources which may otherwise be inaccessible in the absence of social capital, i.e. those held by other cluster

firms or related institutions (Hazleton & Kennan, 2000; Maurer & Ebers, 2006).

Consistent with the idea that knowledge is inherently social, another resource to which social capital enables access is knowledge.

Even though the KBV of clusters and social capital in a cluster setting are considered two discreet streams of research in their own right (Eisingerich et al., 2010), some scholars suggest that social capital would not be of any value to cluster actors if not for its potential for knowledge development. This notion provokes a new perspective on competitive advantage in clusters, namely integration of three fields of research: clusters, knowledge and social capital. The underlying premise of integrating clusters, knowledge and social capital is that the crucial role of social capital for competitive advantage derives from its potential to be leveraged for knowledge development (Huber, 2009; Tura & Harmaakorpi, 2005). The idea that social capital can help cluster actors achieve competitive advantages through knowledge development is consistent with the relational view of the firm which posits that through social capital “alliance partners can generate rents by developing superior inter-firm knowledge-sharing routines” (Dyer & Singh, 1998, p. 665). Such routines eventually enable knowledge development activities, such as knowledge transfer, recombination and creation of specialised knowledge, which result in competitive advantage. Furthermore, Dyer and Singh (1998) specifically name knowledge sharing routines as a determinant for relational rents to be achieved, as discussed previously.

Considering that the interplay between social capital and knowledge is a major contributor to competitive advantage, many conceptual or empirical studies have addressed how this competitive advantage is created. In their empirical investigation, Malmberg and Power (2005) explored what drives knowledge creation in clusters and showing that social interaction, rather than competition and formal knowledge exchange mechanisms, drive this exchange. Maskell and Malmberg (1999) call that social



interaction the social dimension of clusters and conclude they are a major contributor to knowledge exchange. Furthermore, Foss (1999) argues that collective learning of cluster actors, facilitated through social capital, determines competitive advantage in a cluster setting. Another perspective from the literature is that social capital has a positive impact on absorptive capacity of cluster firms, hence facilitating knowledge sharing (Vejzagic–Ramhorst et al., 2012). Similarly, Valdaliso et al. (2011) found that social capital can increase the cluster’s absorptive capacity, so the cluster can benefit from links with other clusters, providing competitive advantage to the firms and cluster as a whole. Burt (2009) asserts that social capital creates value by bridging structural holes<sup>4</sup> in clusters, thus helping firms obtain non-redundant knowledge resulting in brokerage opportunities for cluster firms (Gretzinger & Royer, 2013).

Consistent with the KBV of the firm seeing tacit knowledge as the more valuable resource according to the VRINE framework, the importance of social capital for tacit knowledge in a cluster setting has been stressed (Collins & Hitt, 2006). Furthermore, in referring to the component/architectural knowledge typology in clusters, social capital drives knowledge development of architectural knowledge which, as a strategic resource, is relevant for sustainable competitive advantage creation. This is also evident in the definition of architectural knowledge which implies that architectural knowledge derives from the social system of the cluster (Tallman et al., 2004).

In summary, social capital can be leveraged for knowledge development in clusters and, through its impact on knowledge development, can contribute to the achievement of competitive advantage. Nevertheless, *how* this happens has received considerably less

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<sup>4</sup> The concept of structural holes describes the notion that if network members have very dense connections, the knowledge shared tends to be redundant. Structural holes exist between two networks that each hold non-redundant information.

attention. This presents a significant gap in literature which is discussed in the following section.

### ***2.6.3. Clusters, knowledge and social capital – the overlap***

This research addresses the overlap of three theoretical streams: cluster theory, knowledge and social capital. Previous research on social capital and knowledge have significantly contributed to theory, but simultaneously raised questions to which the answers would be interesting for both theory and practice (Inkpen & Tsang, 2005, p. 146). The fact that social capital is a major catalyst for knowledge development and hence a major contributor to competitive advantage in clusters has been confirmed empirically and the question as to why this is the case has also received some attention. However, the question of how this happens, and how social capital can be leveraged for knowledge development, are to date not fully understood (Huggins, 2008; Inkpen & Tsang, 2005).

Addressing this ‘how’ question and unveiling the dynamics of the leverage of social capital in a cluster setting is made difficult by the fact that research on social capital as a concept faces a number of challenges (Adler & Kwon, 2002). Social capital, being intangible and a result of social interaction, is impossible to observe directly and is therefore hard to capture. As a consequence, rather than focussing on the dynamics behind the leverage of social capital, most studies investigate the outcomes which are easier to observe. This is why the aforementioned shortcomings of research exist despite social capital’s value for competitive advantage being undisputed and its role for knowledge development evident. Looking at outcomes rather than the dynamics behind results, however, is a static perspective on social capital and does not capture the fact that it is an inherently dynamic concept (Maurer & Ebers, 2006). Kwon and Adler (2014) point out the difference between ‘having’ social capital and ‘mobilising’ social capital, with the latter being under-researched (Inkpen & Tsang, 2005; Maurer & Ebers, 2006).

The lack of a framework explaining how social capital ‘works’ in the specific context of clusters can be attributed to the fact that the mechanisms leading to competitive advantage of clustering are not well understood. The RBV of clusters has proven useful to analyse clusters and competitive advantage, however the view is still emerging and under development. Foss (1999) makes particular reference to the RBV of clusters criticising the causal link between relevant resources and competitive advantage as subject to much ambiguity. Similarly, Depret and Hamdouch (2010) observe that a noticeable shortcoming in the literature is insufficient research on the dynamics of clustering. According to these authors, the general conception of clusters in the literature has been static and standardised which they deem too simplistic. Clusters evolve over time and space and these dynamics, to which social capital is a major contributor, need to be considered in order to explain clusters fully and analyse how the advantages of clusters arise. Moreover, there is a lack of empirical research addressing how social capital and knowledge create competitive advantage in clusters. Sechi et al. (2011) and Capello and Faggian (2005) found that investigations of knowledge development through social capital is limited to theory with empirical evidence largely lacking. Therefore, in light of the shortcomings of cluster and social capital literature, many scholars call for greater clarity regarding how social capital influences strategic outcomes of clusters through knowledge (Inkpen & Tsang, 2005; Moran, 2005). This research addresses those aforementioned shortcomings in several ways, as described below.

- 1) This research takes a processual viewpoint on social capital by unveiling the dynamics behind the leverage of social capital
- 2) This research addresses the shortcomings of the RBV of clusters and further develops the view by focusing on leverage of resource social capital rather than on the outcome, and on its interplay with another resource, knowledge
- 3) This research investigates the research problem empirically by undertaking a case study on an Australian biotechnology cluster

#### *2.6.4. Studies with similar objectives*

Even though research, and empirical research in particular, addressing how social capital is leveraged for knowledge in clusters is rare, a small number of studies have, at least partly, addressed this ‘how’ question. However, these previous studies are set within a different context and have different objectives from this research, hence the results do not inform the research problem and questions of this project. Those studies were consulted to derive the propositions for this study, in particular to inform how to systematise social capital for empirical studies. In addition, the results of previous studies further confirm the importance of social capital for knowledge development.

One of the most relevant studies to this research is that of Nahapiet and Goshal (1998) which was one of the first to establish that social capital has an impact on knowledge generation and competitive advantage, and hence is widely cited. Nahapiet and Goshal’s (1998) objective was to examine how social capital impacts knowledge development, an objective similar to the objective of this research. However, the focus of their research was organisations and sub-units, not networks or clusters. Furthermore, the authors exclusively explored knowledge generation, not specifically knowledge development activities including transfer, sharing and spill overs. Lastly, their objective was to identify how the conditions necessary for knowledge development are affected by social capital, hence they did not elaborate on how social capital drives knowledge development. Nevertheless, the findings of Nahapiet and Goshal (1998) are useful to show that the dimensions of social capital need to be considered when examining how it impacts knowledge. In particular, their view that social capital is a multidimensional concept aided development of the propositions of this research.

Another study important to this research, and based on Nahapiet and Ghoshal (1998), is the work of Inkpen and Tsang (2005). Unlike Nahapiet and Ghoshal (1998), this work explores social capital in a cluster setting and addresses how social capital dimensions

affect knowledge development activities. The analysis of Inkpen and Tsang (2005) investigates how social capital affects the conditions necessary for knowledge development, not the dynamics. Using an operationalisation framework similar to Yli-Renko et al. (2001), Inkpen and Tsang (2005) link social capital dimensions with positive outcomes of social capital and posit that a study analysing social capital dynamics should consider the different dimensions of social capital. This substantiation was adopted for this study and propositions were developed based on their conceptualisation of social capital.

## **2.7. Summary**

The previous sections in this chapter presented a discussion of literature on clusters, knowledge and social capital and showed how the overlap of the three theoretical areas provides the basis for this research. The literature suggests that clusters create competitive advantages for firms in the cluster and the RBV of clusters is a good theoretical approach to explain how those advantages arise.

The RBV of clusters is the theoretical underpinning for this research based on the notion that cluster-specific resources are major determinants of competitive advantage. Two of these strategically valuable resources in a cluster setting are knowledge and social capital. Proponents of the KBV of clusters posit that many of the advantages of clustering derive from knowledge development activities in the cluster. Furthermore, the literature suggests that social capital is embedded in relationships between cluster actors and can likewise be leveraged for competitive advantage. Knowledge and social capital are valuable resources in their own right, however, the two are inherently linked with social capital driving activities that leverage knowledge for competitive advantage in a cluster setting. The objective of this research is to unveil how social capital is leveraged for knowledge development in clusters which is a significant shortcoming of current literature.

The role of theory discussed in the literature review is to inform the propositions on the basis on what is known about clusters, knowledge and social capital. Hence, propositions are derived from the literature, which will be shown in the next chapter.

In conclusion, Table 7 below summarises the most relevant literature informing this research. The table is structured according to the three streams of literature that inform this research (clusters, knowledge and social capital), as well as their overlaps, and presents respective authors, findings and contributions in the context of this research.

Table 7- Overview of relevant literature

Author(s)	Finding	Contribution (to this research)
<b>Clusters</b>		
Marshall (1890)	Locating in close geographic proximity creates benefits	First mention of clusters in literature; first author to acknowledge that locating in close geographic proximity can create advantages for the region and for the clustering firms
Porter (1990)	The diamond model describes location factors that contribute to competitive advantage of nations (1990); based on the idea of locational factors contributing to competitive advantage, Porter's later work (1998) explained why firms can benefit from clustering and provided a definition of clusters	In an era when diversification was seen as a major contributor to competitive advantage, this study contributes to this research in that specialisation was suggested as a major determinant for competitive advantage, setting the foundation for modern cluster literature. Furthermore, the definition of what constitutes a cluster from 1998 is still widely cited and used as a reference
Barney (1991),	Strategic resources at the firms' disposal can be leveraged for competitive advantage	Provides the foundation for the RBV of clusters
Maskell and Malmberg (1999), de Oliveira Wilk and Fensterseifer (2003), Hervás-Oliver and Albors-Garrigós (2007)	RBV of clusters – it is through a unique bundle of cluster specific resources that competitive advantages are realised in clusters	Explains how the advantages of clustering come about; offers an alternative to Porter's diamond model (i.e. external factors) in explaining how competitive advantages through clustering develop by shifting the focus to underlying resources

<b>Author(s)</b>	<b>Finding</b>	<b>Contribution (to this research)</b>
Brown et al. (2010); Brown et al. (2007a)	According to the value adding web framework, resources relevant for competitive advantage in clusters can be on three different levels –firm, context and network. Actors in clusters can be categorised as horizontal, vertical and lateral.	The value adding web framework, through the three different levels, helps identify resources in clusters. Furthermore, it shifts the focus away from the cluster as a whole, to the single firm as a contributor and beneficiary of competitive advantage. The categorisation of cluster actors helps in the identification of who in the cluster creates value through which activities
<b>Knowledge</b>		
Polanyi (1966)	Knowledge has a tacit and an explicit dimension	One of the first authors to acknowledge that knowledge is multidimensional. Provides the basis for the KBV of the firm by acknowledging that not all knowledge dimensions are equally conducive to competitive advantage - tacit knowledge is a strategic resource that can lead to competitive advantage.
Nonaka (1994)	The KBV (KBV) of the firm – a logical extension of the RBV of the firm, suggesting that the most important (intangible) resource for competitive advantage is knowledge	Provides the foundation of the KBV of clusters (KBV of clusters)



Author(s)	Finding	Contribution (to this research)
<b><i>Social capital</i></b>		
Dyer and Singh (1998)	The relational view – resources are not only held by single individuals or institutions, but are embedded in the network of relationships (=social capital)	Supplements the RBV by suggesting that inter-firm linkages can be the source of competitive advantage, shifting the focus to the relational level. This is the underlying rationale of the social capital concept. Furthermore, the authors state that knowledge sharing routines are a major determinant for value to be derived from relational resources, emphasising that there is an inherent link between knowledge and social capital
Bourdieu (2008), Coleman (1988), Granovetter (1985)	Relationships, and the network of relationships, can be considered a resource that can be leveraged for competitive advantage. Economic activity cannot be considered separately from social activity.	When investigating resources for competitive advantage, the relational level needs to be considered. Hence, the RBV of clusters requires consideration of cluster relationships
Granovetter (1985)	Social capital is dichotomous and has structural as well as cognitive aspects	Emphasises that social capital is multidimensional and indicates that the dimensions should be considered when attempting to operationalise the concept

<b>Author(s)</b>	<b>Finding</b>	<b>Contribution (to this research)</b>
<b><i>Knowledge and clusters</i></b>		
Tallman et al. (2004)	Apply the knowledge typology 'architectural' and 'component' to clusters in explaining how competitive advantage in clusters comes about	Contributes to the KBV of clusters by explaining that it is architectural knowledge that is a strategic resource and hence contributes to competitive advantage
Maskell and Malmberg (1999), Malmberg and Maskell (2002), Malmberg and Power (2005), Arikian (2009)	Clusters are venues of enhanced knowledge creation, with cluster specific knowledge resources being the reason why clusters create competitive advantage	Findings constitute the KBV of clusters, stating that competitive advantage is created through knowledge resources
<b><i>Knowledge and social capital</i></b>		
DeNisi et al. (2003); Nahapiet and Ghoshal (1998)	Social capital is conducive for the development of knowledge and especially necessary for the development of knowledge of the tacit type	Establishes a link between the two intangible resources social capital and knowledge: implies that knowledge is social in nature and cannot be leveraged or created for competitive advantage in the absence of social capital
<b><i>Knowledge, social capital and clusters</i></b>		
<i>Molina-Morales (2005), Inkpen and Tsang (2005)</i>	Social capital is one of the resources in clusters that contribute to competitive advantage through its impact on knowledge resources	Combines the KBV of clusters and the relational view to explain why competitive advantage is created

### **(3) PROPOSITION DEVELOPMENT**

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In this chapter, the propositions guiding this research are derived from relevant literature. Propositions 1a), b) and c) address the first research question which asks ‘What are the drivers of social capital for knowledge development in clusters?’ Then, the second research question ‘Which actors are involved in the development of knowledge in clusters and what are their respective roles?’ is considered in deriving propositions 2a) and b) from social capital and knowledge theory. In particular, the different dimensions of social capital and their impact on knowledge are discussed.

#### **3.1. Social capital dimensions as drivers of knowledge development**

The first research question addresses the drivers of social capital for knowledge development in clusters. The underlying motivation for this research question was that numerous studies confirm the benefits resulting from social capital through its impact on knowledge (Hauser, Tappeiner & Walde, 2007; Molina-Morales, 2005; Vejzagic–Ramhorst et al., 2012; Yli-Renko et al., 2001) consistent with the widely accepted viewpoint that knowledge is social in nature. Literature suggests that social capital can foster knowledge development by affecting the conditions necessary for knowledge exchange in various ways (Nahapiet & Goshal, 1998; Vejzagic-Ramhorst et al., 2012). However, no existing studies have explained *how* this happens. Consequently, to date, no framework exists specifying the drivers of social capital for knowledge development in clusters.

Finding a starting point to develop propositions to address this question was difficult as there is no theoretical framework available which might provide an indication of what those drivers are. Although the exact drivers are unexplored, it is valid to conclude that those drivers are likely to be influenced by the different dimensions of social capital. In developing the propositions, this research considered literature which suggests that that

different dimensions of social capital have a distinct impact on knowledge and, as a result, should be considered individually rather than combined (Yli-Renko et al., 2001).

The idea that social capital is multidimensional, with different dimensions describing various facets of relationships, is generally acknowledged amongst social capital researchers. Essentially, the idea that the dimensions of social capital should be considered is based on theoretical assertion of the relational view stating that “different social assets [i.e. different ‘kinds’ of social capital] have different effects on relationship outcomes” (Yli-Renko et al., 2001, p. 609). Therefore, the importance of social capital dimensions should be considered in any study exploring social capital empirically. In response to social capital studies that investigate one dimension of social capital to the exclusion of others, Walter, Lechner & Kellermanns (2007) warn that the impact of any social capital dimension on knowledge development needs to be analysed relative to the impact of other dimensions, otherwise results are meaningless. This is because the dimensions of social capital tend to overlap (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). It follows that any study exploring a dimension of social capital requires consideration of the other two dimensions. Hence, a study investigating social capital should consider all three dimensions.

The first suggestion that three dimensions of social capital- the structural, the cognitive and the relational dimension- may each have differing impacts on knowledge related activities was made by Nahapiet and Ghoshal (1998) in their frequently cited paper that established academically that social capital and knowledge are inherently linked.

Nevertheless, despite their argument that all three dimensions of social capital impact the conditions necessary for knowledge generation and should all be considered, they further suggest that each dimension may impact on the conditions necessary in a distinct way.

According to these authors, it may be possible that some dimensions of social capital can inhibit knowledge development activities, whereas others have a positive, fostering

impact. A similar argument was raised by Woolcock (1998) who calls for recognition that different dimensions of social capital support or weaken conditions for social capital, implying that whether the outcome of social capital leveraged as a resource is positive or negative depends on the relevant dimension. Molina-Morales and Martínez-Fernández (2010) likewise propose that the different dimensions of social capital are a starting point for any investigation to understand how the benefits of social capital arise. That the impact of each dimension can be different implies that investigating the overall effect of social capital dimensions on knowledge may not provide a full picture in exploring how social capital 'works'.

Notably, there is a small number of empirical studies available that have clearly distinguished between social capital dimensions in exploration of how social capital impacts on knowledge. Those studies show merit in examining social capital dimensions individually in order to understand the impact of social capital on knowledge development. For example, in a study investigating the impact of social capital on manager performance, Moran (2005) investigated the relational and structural dimensions of social capital and found that each had a positive and distinct impact on managerial performance. In the context of clusters, Molina-Morales and Martínez-Fernández (2010) empirically investigated a Spanish manufacturing cluster and found a positive link between social capital and innovation output. With regards to social capital dimensions, results indicated that while the overall impact of social capital is positive, not all social capital dimensions have an equally strong impact on positive innovation outcomes. According to Molina-Morales and Martínez-Fernández (2010), it is beneficial to study social capital dimensions discreetly when analysing social capital. Another study by Exposito-Langa and Molina-Morales (2010) emphasised the distinct effect of social capital dimensions through studying the negative effects of social capital. The authors found that different social capital dimensions can create knowledge redundancy in clusters and that facets of the relational dimension are the most important contributors to

redundancy. Although this research does not focus on the negative effects of social capital on knowledge, findings emphasise the importance of considering the distinct effects of each dimension on social capital.

A study highly relevant to this research, due to similarity of research objectives, is the empirical work of Yli-Renko et al. (2001) that supports the notion that when exploring the impact of social capital on knowledge development all three dimensions should be investigated distinctly. Albeit not in the particular context of clusters, Yli-Renko et al.'s (2001) study explicitly examines the three different dimensions of social capital (the structural, the relational and the cognitive dimension, based on Nahapiet and Ghoshal (1998) ) and found that each social capital dimension had a distinct role in determining young firms' knowledge acquisition in different ways. In their concluding remarks, making reference to the current state of social capital research, Yli-Renko et al. (2001, p. 609) criticise that the importance of the different dimensions, and therefore the need to investigate them distinctly, has failed to receive sufficient consideration in the literature. The authors contend that "these dimensions are distinct and have differing effects on knowledge acquisition", and hence call for further research focusing on the relative impact of social capital dimensions.

While the aforementioned studies do not have the same objective as this research, i.e. investigating knowledge development in the particular context of clusters, the results and implications of those studies are relevant to this research as they clearly show that one cannot achieve a full picture of social capital and its leverage without considering its dimensions. Furthermore, literature clearly shows that it is beneficial to consider the dimensions of social capital and to study their distinct impact when analysing how social capital is leveraged for knowledge development. Therefore, in deriving the research propositions this research focuses on social capital dimensions whilst exploring the drivers of social capital for knowledge development. To illustrate the merit of this

approach Table 8 provides an overview of the literature focusing on the distinct impact of different dimensions to show it is a valid approach to consider the dimensions of social capital when investigating social capital's impact on knowledge. The table presents the authors, context of the study, relevant dimensions and results.

Table 8 - Dimensions of social capital and their impact on knowledge

<b>Authors</b>	<b>Context/Objective of study</b>	<b>Dimensions</b>	<b>Results</b>
Nahapiet and Ghoshal (1998)	How do different social capital dimensions affect the conditions necessary for new knowledge generation?	<ul style="list-style-type: none"> <li>• Structural dimension</li> <li>• Relational dimension</li> <li>• Cognitive dimension</li> </ul>	All three dimensions affect some of the four conditions necessary for the generation of new knowledge, but the cognitive dimension has been found to affect all three. Structural predominantly affects it indirectly through the other two dimensions
Yli-Renko et al. (2001)	The impact of different social capital dimensions on knowledge acquisition in key customer relationships	<ul style="list-style-type: none"> <li>• Social interaction</li> <li>• Network tie dimension (operationalises the structural dimension)</li> <li>• Relationship quality dimension (operationalises the relational dimension)</li> </ul>	Social interaction and network tie dimensions have a positive association with knowledge acquisition; relationship quality has a negative association
Moran (2005)	The impact of dimensions of social capital on managerial performance	<ul style="list-style-type: none"> <li>• Structural dimension</li> <li>• Relational dimension</li> </ul>	Both social capital dimensions have a positive impact on managerial performance. The structural dimension has a relatively stronger impact on execution-related tasks, whereas the relational dimension has a stronger impact on innovation-related tasks



Authors	Context/Objective of study	Dimensions	Results
Molina-Morales and Martínez-Fernández (2010)	The impact of social capital dimensions on product innovation of firms in clusters	<ul style="list-style-type: none"> <li>• Social interaction</li> <li>• Trust</li> <li>• Shared vision</li> </ul>	All dimensions of social capital have a positive impact on innovation output of firms in a manufacturing cluster, however to a differing degree
Exposito-Langa and Molina-Morales (2010)	The impact of social capital dimensions on knowledge redundancy in clusters	<ul style="list-style-type: none"> <li>• Relational dimension: Strength of ties (a facet of the relational dimension)</li> <li>• Structural dimension (a facet of the structural dimension)</li> </ul>	Whereas strength of ties can result in knowledge redundancy, the degree of structural dispersion is negatively associated with it

In developing the research propositions, this research followed the approach taken by Inkpen and Tsang (2005, p. 146) who address “how social capital dimensions of networks affect the transfer of knowledge between network members”. Their study is conceptual, not empirical, with propositions derived from existing cluster and social capital theory. Inkpen and Tsang (2005) investigated how the three dimensions of social capital specified by Nahapiet and Ghoshal (1998) affect the conditions necessary for knowledge transfer. They specifically explored this in the context of three inter-firm network types and suggested how to operationalise the dimensions in each of those networks. Inkpen and Tsang’s (2005) study is relevant for this research because, along with strategic alliances and intra-corporate networks, they investigate clusters. To date, this is the only study investigating the impact of social capital dimensions on knowledge in a cluster setting. The lack of studies constitutes a significant shortcoming of the literature. Inkpen and Tsang (2005) state that social capital dimensions take specific forms depending on the network type in which they are embedded indicating that studies on other network types may not necessarily be transferable to a cluster context.. As a result, it is proposed that the drivers of social capital for knowledge development arise from the structural, cognitive and relational dimension of social capital, influenced by the typical forms those dimensions take in clusters. Following Inkpen and Tsang (2005) suggestion for future research to examine dimensions distinctly, this research investigates the impact of those three social capital dimensions empirically.

This research considers Inkpen and Tsang’s (2005) social capital systematisation approach over other approaches because it refers specifically to clusters. This is crucial as the relative importance of social capital dimensions varies according to the type of network in which social capital is embedded (Inkpen & Tsang, 2005). Furthermore, their framework is derived from Nahapiet and Goshal’s (1998) study which specifically examines the link between knowledge and social capital by addressing whether social capital has a role in new knowledge generation. The authors state that the facets of each

social capital dimension are those “most related to knowledge transfer” (Inkpen & Tsang, 2005, p. 152). Therefore, this research follows Inkpen and Tsang’s (2005) framework for development of propositions, rather than choosing a social capital systematisation framework that has not been used in a cluster or knowledge context.

### **3.2. Social capital dimensions in the context of clusters**

In keeping with Nahapiet and Goshal’s (1998) three dimensions of social capital, Inkpen and Tsang (2005) specify the typical forms that social capital dimensions take in a cluster and how those dimensions affect the conditions necessary for knowledge transfer (Inkpen & Tsang, 2005, pp. 152, 155). These are presented in Table 9 below.

Table 9 - Typical forms of social capital dimensions in clusters

Dimension	Typical form of dimension	Conditions facilitating knowledge transfer
<b>Structural</b>		
Network ties	Social ties as a foundation for inter-member ties	Proximity to other members
Network configuration	Non-hierarchical and dense networks in a geographical region	Weak ties and boundary spanners to maintain relationships with various cliques
Network stability	Dynamic, with members joining and leaving	Stable personal relationships
<b>Cognitive</b>		
Shared goals	Neither shared nor compatible goals	Interaction logic derived from cooperation
Shared culture	Industry recipe	Norms and rules to govern informal knowledge trading
<b>Relational</b>		
Trust	Process-based personal trust	Commercial transactions embedded in social ties

According to Inkpen and Tsang (2005, p.152), the structural dimension of social capital in a cluster setting refers to the cluster actors' network ties, network configuration and network stability. *Network ties* in clusters are established "as a result of interpersonal relationships developed from informal gatherings". This is consistent with Brown and Hendry (1997) who emphasise the informality of ties between cluster actors. The resulting network ties facilitate knowledge exchange due to the possibility of tacit knowledge and architectural knowledge being exchanged through geographic proximity. Another aspect of the structural dimension of social capital in clusters is *configuration*, describing hierarchy, connectivity and density. Clusters tend to be non-hierarchical and dense networks where actors are 'glued' together by informal casual ties and exchanges. Inkpen and Tsang (2005) suggest that one way the configuration may affect knowledge development in clusters is by fostering the formation of cliques of cluster firms. As a consequence, to establish effective knowledge development activities, firms should maintain boundary spanners which bridge the weak ties between those cliques. In the absence of boundary spanners, knowledge development cannot take place between cliques, hence hindering overall knowledge development of the cluster.

*Network stability* refers to the rate of membership change of membership in networks. Very unstable networks are characterised by a high rate of membership turnover which potentially limits knowledge development through social capital because social capital is lost. Clusters are considered to be unstable "with firms joining and leaving the district continuously" (Inkpen & Tsang, 2005, p. 151). As a consequence, for the KBV of clusters to be valid, there must be mechanisms in place that moderate the impact of this instability and counteract minimal social capital building because otherwise the benefits of clustering through social capital could not eventuate. Specifically, Inkpen and Tsang (2005) suggest that close personal contacts established by individuals due to close geographic proximity may be maintained even if members leave the cluster. This is also a method of boundary spanning, enabling external knowledge to flow in the cluster.

Following the findings of Inkpen and Tsang (2005), it is likely that the structural dimension drives social capital for knowledge development by creating the conditions necessary for knowledge to flow. In particular, these authors suggest that knowledge development is enabled through informality and through establishment of boundary spanners. Therefore, the first proposition of this research is:

*P1a) The development of knowledge in clusters is likely to be driven by the structural dimension of social capital*

Inkpen and Tsang (2005) address the cognitive dimension, analogous to Nahapiet and Ghoshal (1998), which is considered to represent the resources providing shared meaning and understanding. They describe two facets of this dimension, namely shared goals and shared culture amongst cluster actors. They propose that in clusters, due to the complexity of network ties described by the structural dimension, cluster actors can have only few, or no, shared goals or shared vision. This absence, or near absence, of shared goals and visions results in cluster actors lacking in “common understanding and approach to the achievement of network tasks and outcomes” (Inkpen & Tsang, 2005, p. 153). Hence, for cluster actors to engage in firm spanning knowledge development activities despite the lack of a common goal, they need to understand that this type of collaboration can provide them with competitive advantage. This joint understanding is termed ‘interaction logic’ by Inkpen and Tsang (2005) based on Helmsing (2001).

Shared culture in the context of clusters refers to “institutionalised rules and norms that govern appropriate behaviour” (Inkpen & Tsang, 2005, p. 153). Here, Inkpen and Tsang (2005) assert that cluster actors do not share one culture and that a cluster-wide culture does not exist; rather, there are distinct cultures present, varying from firm to firm. The lack of cluster culture and the existence of many different cultures simultaneously prevents cluster actors from willingly sharing knowledge due to “the risk that the receiver

of such knowledge may use it against the interest of the sender” (Inkpen & Tsang, 2005, p. 152). In order to eliminate this risk, the flow of knowledge, albeit informal in nature, should be guided by norms and rules. Those norms and rules can be written down (e.g. in the form of a written down framework or a contract), but can also be tacit in nature and comprise a common language to guide informal knowledge exchange (Helmsing, 2001). In accordance with Spender (1989), Inkpen and Tsang (2005) note that this facet of the cognitive dimension of social capital can take the form of an ‘industry recipe’. An industry recipe can be considered a tacit and implicit rules and norms framework. The rationale is that firms facing similar competitive pressures adopt similar policies, essentially creating a tacit rules and norms framework (Hannan & Freeman, 1977). The existence of such tacit and implicitly understood norms and rules that enable the sharing of intangible between competing firms has been empirically confirmed (Von Hippel, 1987), however not in a cluster context and not in the context of knowledge development through social capital. Given this previous research it is likely that knowledge development through social capital in clusters is governed by written down and/or tacit norms and rules. Hence, it is likely that knowledge development in clusters is driven by the cognitive dimension of social capital. In the absence of common goals amongst firms, the cognitive dimension is likely to drive knowledge development through a written down and/or tacit rules and norms framework. Hence, it is proposed that:

*P1b) The development of knowledge in clusters is likely to be driven by the cognitive dimension of social capital*

Lastly, there is a *relational* dimension of social capital focusing on the outcomes of interactions such as trust, norms and identification (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998). In the context of networks, it is sensible to focus on the facet of trust which has been found to impact on inter-firm knowledge development activities. This idea is backed by literature concluding that trust is a requirement for actor willingness to

share knowledge and other forms of resources (Dyer & Singh, 1998). Inkpen and Tsang (2005) assert that trust can be present in clusters as the relationships between actors are commercial in nature, as opposed to purely market based relationships, commercial transactions have a social and informal component, thus enabling trust to build (Uzzi & Gillespie, 2002). Their rationale is that actors may not be willing to share knowledge resources out of fear that competitors may use those resources against them. Supporting the idea that trust works as a lubricant for knowledge development, Collins and Hitt (2006) suggest that the relational dimension of social capital is the major driver of tacit knowledge development, as trust between partners is considered the most important factor for this process and trust is embedded in the relational dimension. Enabled through the impact of trust and trusting relationships amongst cluster actors, it is likely that the relational dimension of social capital has an impact on knowledge development. Hence, the next research proposition is that:

*P1c) The development of knowledge in clusters is likely to be driven by the relational dimension of social capital*

### **3.3. Involvement of actors**

A second research objective, corresponding with the second research question, is to unveil the actors involved in the development of knowledge through social capital. Inkpen and Tsang (2005) state that for fruitful analysis of social capital and the benefits it creates it is necessary to identify the ‘possessors’ in whose relationships social capital is embedded. In a cluster setting, the possessors are cluster actors, i.e. those involved in cluster activities (Andersson et al., 2004). In order to address the research problem, this research examines the involvement of cluster actors in the development of knowledge through social capital.



### ***3.3.1. How cluster actors are categorised in the literature***

Emphasising the importance of actors for cluster studies, Depret and Hamdouch (2010, p. 2) note that a cluster is a “complex networked entity” structured around actors with “varied organisational or institutional profiles”. This statement illustrates that those participating in cluster activities are frequently complex entities (i.e. people, organisations or institutions) which are likely to operate at multiple levels and in various positions, executing a number of activities influencing, and being influenced by, the cluster environment. It therefore comes as no surprise that a large number of categorisation frameworks for cluster actors have been used by scholars to investigate the cluster context. For example, cluster actors have been categorised as individual and also as industrial (i.e. single firms) and institutional entities (Holmén & Jacobsson, 2000). Although some studies have focussed on cluster actors at the individual level, e.g. engineers (Dahl & Pedersen, 2004) or entrepreneurs (Feldman & Francis, 2006), the focus has usually been on firms producing the main product of the industry in question. Considered to be the “heart of the cluster”, they are commonly drawn on to define cluster boundaries (Steffen, 2012, p. 23).

Attention has shifted away from the ‘heart of the cluster’ firms upon acknowledgement of a large number of other actors equally important in shaping the cluster environment (Andersson et al., 2004; Soelvell, Lindqvist & Ketels, 2003). Therefore, recent categorisation frameworks for cluster actors have emphasised that, in addition to those involved directly in cluster activities, supporting institutions are of major importance to creation of competitive advantage. For example, Exposito-Langa and Molina-Morales (2010) describe clusters as a network of customers, suppliers, support organisations, local institutions and others, implying that each of those are considered cluster actors. Similarly, according to Andersson et al. (2004), based on Soelvell et al. (2003), cluster actors encompass cluster firms, government entities, research communities, financial institutions and institutions for collaborations (IFCs). According to Andersson et al.’s

(2004) categorisation, cluster firms comprise those firms that operate in the core business of the cluster and their suppliers. Firms operating in the core business and their suppliers have traditionally been the focus of cluster studies, to the exclusion of entities that may influence cluster activities while not being involved in the production of the cluster main product. In contrast, Andersson et al.'s (2004) framework shows that other institutions and entities supporting cluster firms have a crucial role in shaping the cluster environment by impacting on the operation of cluster firms, their resources and ultimately on competitive advantage (Andersson et al., 2004). For example, the research community is of major importance. Actors of the research community include universities, research institutes and collaborative research centres whose value is derived from their role as providers of research and research facilities and also from acting as “nodes of entrepreneurship” in clusters, driving innovation (Andersson et al., 2004, p. 24). Furthermore, financial institutions provide financial support to cluster firms, or help them find such support. The role of the government, or associated government institution, is to provide appropriate policy settings to cluster firms which ultimately impacts how cluster firms operate. In addition, IFCs are defined as “formal or informal actors which promote interest in the cluster initiative among the actors involved” (Andersson et al., 2004, p. 24). IFCs are actors which exist exclusively to support cluster actors and foster actor development, without directly being involved in cluster activities. IFCs may also help establish links between cluster firms and other actors (Andersson et al., 2004). In the context of this research, IFCs may be seen as ‘catalysts’ for competitive advantage.

### ***3.3.2. Horizontal, vertical and lateral actors***

An alternative categorisation to that of Andersson et al. (2004) which considers the importance of supporting institutions and firms categorises actors into horizontal, vertical and lateral cluster actors (Brown et al., 2010). This categorisation of cluster actors is based on the perspective of clusters as a collection of overlapping value adding webs from a resource oriented perspective around individual cluster firms, hence emphasising

the importance of the role of the single firm in influencing cluster activities (Brown et al., 2010). This categorisation framework assumes that cluster actors are linked either directly or indirectly by a complex web of relationships in which social capital is embedded. Due to a focus on inter-linkages of cluster actors and social resources embedded in relationships, this research draws on this categorisation framework for cluster actors.

Generally speaking, categorisation of horizontal, lateral and vertical cluster actors includes all actors identified by Andersson et al. (2004) and Soelvell et al. (2003), but they are grouped into horizontal, vertical and lateral actors. Horizontal actors are directly involved in the core activity of the cluster by producing the main products, i.e. analogous to those denoted 'cluster firms' by Andersson et al. (2004) (Brown et al., 2010).

Horizontal actors operate in the same sector, but may have a different focus in terms of what they produce. Therefore, they may not be in immediate competition with one another. In addition to actors directly involved in cluster activities, the crucial role of lateral actors for the creation of competitive advantage is emphasised. In a similar manner to Andersson et al. (2004) and Soelvell et al. (2003), the inclusion of lateral actors in the framework acknowledges that it is not only actors directly involved in cluster activities, but also those in supporting roles that contribute to value adding activities and hence to the competitive advantage of the cluster. Lateral actors support cluster firms by providing "expertise, policy instruments and strategic oversight, as well as the resources brought to bear through institutional oversights" (Brown et al., 2010, p. 16). Similarly, Molina-Morales (2005, p. 81), who uses the term "local institutions" in lieu of lateral actors, describes them as "locally oriented organisations that provide firms in the local area with a host of collective support services". Exposito-Langa and Molina-Morales (2010) stress a role of lateral actors as "repositories for knowledge" suggesting that lateral actors are likely to be of particular importance to this study. Lateral actors can also provide infrastructure (Tallman et al., 2004) or training and education (Andersson et al., 2004). In terms of competitive advantage for the cluster firm, lateral actors are not directly involved

in the creation of such an advantage; rather, they have a facilitator role (Brown et al., 2010, p. 15). Examples of lateral actors include universities, training and research institutions, for example, those providing support by joint research projects and by educating professionals and skilled workers. Universities are important contributors to knowledge development in clusters as they are “knowledge producers”, with university generated knowledge creating positive externalities to cluster firms (Capello & Faggian, 2005, p. 179). Furthermore, the government and its executing bodies establishing and implementing cluster policies are also considered lateral actors as they have an impact on cluster activities via policies. Another type of lateral actor that has received attention in the literature is cluster management as the discrete cluster management authority. Globally, many clusters are run by a separate cluster management. A cluster management organisation is usually established with the explicit purpose to implement cluster policy, coordinate cluster firm activity and manage the cluster as a whole (Terstriep, 2008).

It should be noted that lateral actors are not necessarily located in the cluster in terms of geographic proximity. Although more often than not they are close in terms of geographic distance, they may be located remotely. Depret and Hamdouch (2010, p. 10) emphasise the importance of externally located lateral actors, in terms of geographic proximity and/or industry focus, as clusters are not closed systems; rather, they are open to the outside world and polycentric (Depret & Hamdouch, 2010, p. 2). The importance of lateral actors in cluster studies becomes evident when considering social capital as a resource for competitive advantage.

The idea that lateral actors are important contributors to cluster social capital is consistent with Putnam’s (2001a) taxonomy of bonding and bridging social capital discussed earlier. Putnam (2001b) argues that bridging social capital is embedded in relationships between network actors and outside actors and that social capital can be leveraged by all actors. Applying this framework to clusters, lateral actors take the role of outsiders with whom

cluster firms create bridging social capital. Burt (2009) suggests that local institutions can act as intermediaries between cluster firms and external networks, hence bridging social capital with external networks and providing cluster firms with an additional source of relational resources. The conceptual importance of local institutions is drawn from Burt's (2009) concept of structural holes, where relationships between lateral actors and horizontal or vertical actors bridge those holes between clusters and external actors. In summary, research suggests that lateral actors are important contributors to value creation in clusters. Hence, research exploring competitive advantage in clusters needs to consider lateral actors in addition to actors directly involved in cluster activities in order to gain a complete picture. However, with reference to the development of knowledge through social capital in clusters, the specific role of lateral actors remains largely unexplored (Inkpen & Tsang, 2005).

In addition to horizontal and lateral actors, the value adding web framework specifies vertical actors. Vertical actors support horizontal actors by supplying them with resources, such as knowledge and tangible products, or input to the horizontal actors' production process. They may also act as distributors of horizontal actors' products and services (Brown et al., 2010). It follows that the categorisation of an actor as either horizontal or vertical is determined by their position in the supply chain. The division of cluster firms into horizontal and vertical is a useful tool for analysing clusters in many industries where the difference can be clearly observed and is unambiguous. Importantly though, for many industries the line between horizontal and vertical actors is not always clear. In some industries and sectors, it is difficult to near impossible to pinpoint a firm's exact position in the supply chain since as output of a firm may be considered the main product of the industry, but simultaneously that output may be the input to another firm's production process. Relative to firms in the same industry, a firm can therefore be a supplier, a producer and a customer/buyer at the same time. Although it is uncommon in manufacturing, a 'blurred' supply chain can be observed in high technology industries,

e.g. biotechnology (OECD, 2009). Furthermore, the clear distinction between horizontal and vertical actors is complicated when a degree of vertical integration exists. Hence, it may not be fruitful to distinguish clearly between horizontal and vertical actors. However, this is not problematic given that the purpose of actor categorisation is to “come to an understanding of the cluster industry and further differentiate the supporting and facilitating actors” (Brown et al., 2010, p. 16), emphasising that distinguishing supporting actors from those directly involved is of utmost importance for analysing clusters. This is consistent with Andersson et al. (2004) who emphasise that the distinction between main actors (cluster firms involved in the production of the main product) and supporting actors is crucial in investigating clusters.

In the biotechnology industry, a clear distinction between vertical and horizontal actors is not possible as a boundary between the two is unclear (OECD, 2009). Firms in the investigated cluster supply other firms with goods and services, whilst simultaneously offering their products to the market, hence being a producer of the main good. This is possible because, compared to other industries, the biotechnology industry entails a diverse range of products and services (OECD, 2015; Powell, Koput & Smith-Doerr, 1996). Hence, in line with Andersson et al. (2004), this research considers the division between lateral actors and cluster firms. Cluster firms are considered firms involved in production of the main product, or supply those involved, or both. As a result, ‘cluster firms’ encompass both horizontal and vertical actors, as specified by the value adding web (Brown et al., 2010)

### ***3.3.3. Which actors are involved?***

The previous section discussed categorisation of cluster actors. However, categorisation alone is not sufficient to explore the first research question addressing who is involved in the development of knowledge and the respective roles of those involved. The proposition for consideration is drawn from cluster literature which suggests that actors in

clusters are important to define cluster borders and shape the cluster environment. Specifically, the proposition is drawn from the value adding web framework as this framework is rooted in the RBV of clusters, the underlying approach of this research. To date, the literature has not specified which actors are involved in the development of knowledge through social capital, to what extent each actor is involved relative to others, if some are involved more or less, and why this might be the case. Kwon and Adler (2014, p. 417) attribute this shortcoming to the fact that “because social capital is about relationships, researchers have not paid much attention to the characteristics of the actors involved in the relationships”. Furthermore, the lack of research on actors is at least partly due to the fact that empirical research with the specific objective to investigate the role of social capital for knowledge development in clusters is rare (Vežzagić–Ramhorst et al., 2009).

The few empirical studies investigating social capital in clusters have predominantly mentioned actors directly involved in cluster activities, i.e. cluster firms. In doing so, those studies implicitly confirm that cluster firms are involved in the creation and leverage of social capital (Boari & Presutti, 2004; Cooke et al., 2005; Steiner & Hartmann, 2006). However, empirical studies on knowledge and social capital in clusters have not, or not sufficiently, considered the role of lateral actors (Inkpen & Tsang, 2005). Also considering the lateral actors, a study by Gretzinger and Royer (2013) examined how social capital can create value for cluster firms. Although analysing involvement of various actors was not the major objective of their study, results indicated that both cluster firms and lateral actors were involved in creation and leverage of social capital. The authors conclude by suggesting that further research is necessary to examine the role of knowledge at the relational level of the cluster, highlighting this as a shortcoming of the literature. Based on results of this study it is likely that both cluster firms and lateral actors are involved in the development of knowledge through social capital (Gretzinger &

Royer, 2013). It is, however, still unclear how exactly they are involved, to what extent one actor type may be involved compared to the others, and why that may be the case.

With cluster actors all unambiguously being part of a complex networked entity that constitutes a cluster (Depret & Hamdouch, 2010), and interlinked via the value adding webs surrounding the actors (Brown et al. (2010), it follows that they are likely to all have a role in creating social capital embedded in the network. Involvement in this context means that their actions are a conduit for the leverage of social capital to develop knowledge. This leads to the research propositions that:

*P2a) Cluster firms are likely to be involved in the development of knowledge through social capital.*

*P2b) Lateral actors are likely to be involved in the development of knowledge through social capital.*

It is important to note that the objective corresponding with the five research propositions above is not limited to answering the ‘yes or no’ question as to whether the dimensions of social capital drive knowledge development, and whether specific actors are involved or not. This research seeks to inform understanding about the underlying premise of cluster actor involvement, i.e. which actors are involved in the knowledge development process and to what extent; whether one actor is more involved relative to others; and the reason why such a constellation may be the case. The literature does not provide an answer to such questions. Research propositions P2a) and b) are designed as a ‘starting point’ for exploration of the research question. By keeping the propositions ‘open’, this research develops a concept of how social capital is leveraged for the development of knowledge in clusters, especially in synthesis with the propositions P1a), b) and c) which seek to inform social capital theory by revealing which dimensions are implicated in knowledge development in a cluster context.



### **3.4. Summary**

In this chapter, the research propositions were derived which guide data collection and the interpretation process. First, in accordance with relevant literature on social capital, this research addresses the research question ‘what are the drivers of social capital’ and proposes that structural, relational and cognitive dimensions of social capital are likely to drive knowledge development in clusters. The underlying rationale is that social capital is multi-dimensional in nature, that each dimension is likely to have a distinct impact on knowledge and that the dimensions are likely to take different forms in different networks, including clusters (Inkpen & Tsang, 2005; Yli-Renko et al., 2001).

Furthermore, the actor categorisation framework of the value adding web as a means to distinguish between cluster firms was adopted to develop propositions addressing the research question ‘who is involved’. According to the value adding web, social capital is embedded in the complex web of relationships between actors (Brown et al., 2010).

Therefore, consistent with this theoretical perspective, this research proposes that cluster firms and lateral actors are all involved in development of knowledge. In summary, Figure 4 shows how the propositions relate to the research questions and the research problem, and hence summarises the underlying premise of this research.

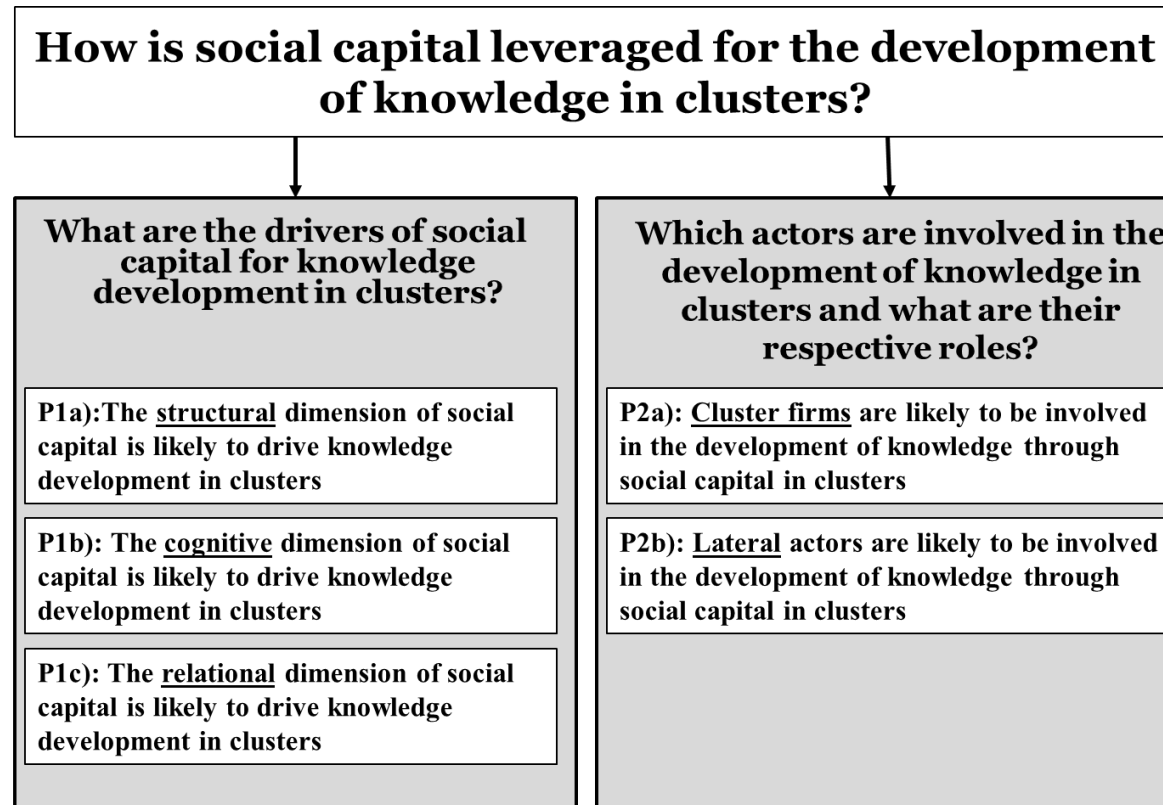


Figure 4 - Research problem, research questions and propositions

## **(4) RESEARCH DESIGN**

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This chapter provides an overview of the research design for this project, detailing how data was collected and analysed, as well as the philosophical underpinnings of this process. First, the research paradigm is discussed, including an explanation as to why specification of the paradigm is important for any empirical research. Second, the process of data collection is detailed, explaining and justifying the collection methods with reference to relevant methodological literature. This section includes an introduction of the investigated cluster. Finally, the analysis and interpretation process is detailed, followed by a discussion of soundness criteria for this qualitative research.

### **4.1. Research Paradigm**

Before selecting appropriate methods of data collection, the research design process requires consideration of epistemological and theoretical perspectives which guide the investigation, i.e. the research paradigm. Research paradigms are basic belief systems providing ontological, epistemological and methodological assumptions (Guba & Lincoln, 1994). Without consideration of paradigms which inform methodology and methods, it is unlikely that data collected will appropriately address the research problem and research questions (Crotty, 1998). The appropriateness of techniques and methods for research is justified by philosophical underpinnings which determine the research context. Therefore, techniques and methods for data collection should not be derived without consideration of the research paradigm. (Morgan & Smircich, 1980). The importance of the research paradigm is based on the widely accepted notion that researchers' philosophical stance and intentions undoubtedly influence the way they undertake research, making it necessary to evaluate the philosophical underpinnings of the methods and methodology in order to fully understand the work. Particularly relevant to this thesis, given the research problem, Mack (2010, p. 6) notes that "[...] how one views the

constructs of social reality and knowledge affects how they will go about uncovering knowledge of relationships among phenomena and social behaviour [...]. It follows that consideration and identification of an appropriate research paradigm is necessary in order to give meaning to the research itself, its outcomes and results.

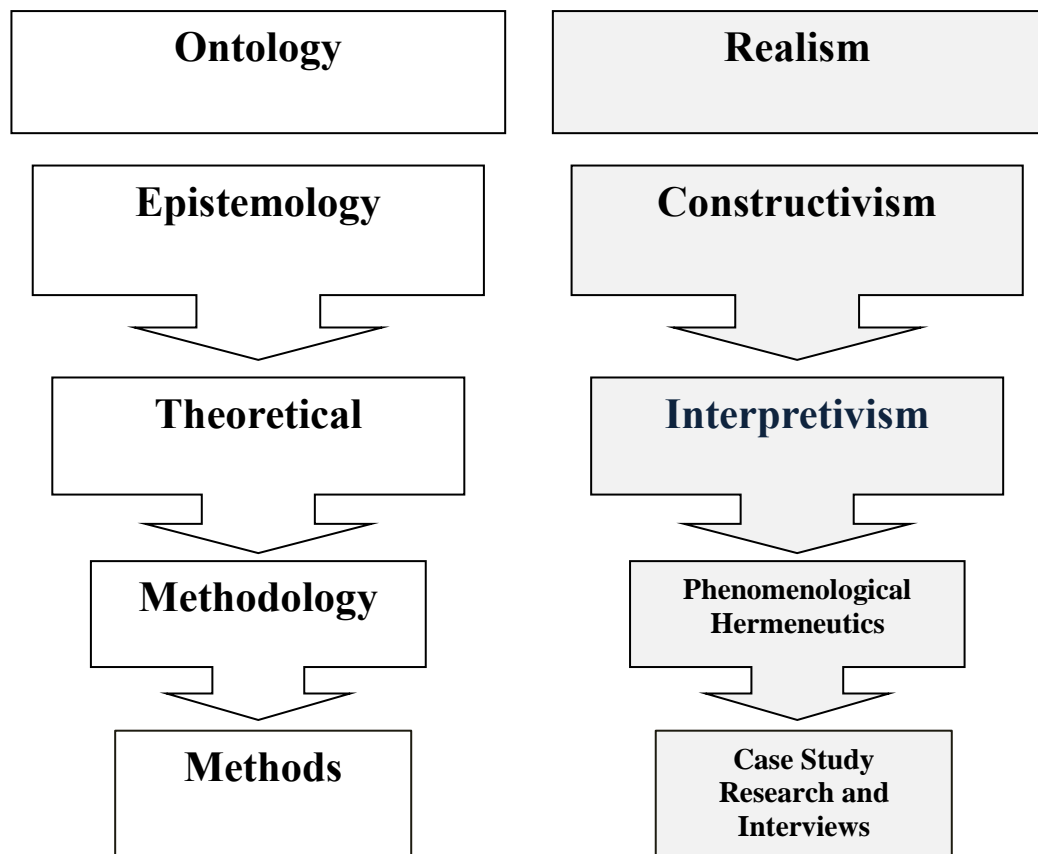
#### ***4.1.1. Selection of an appropriate framework***

Most authors agree that a research paradigm requires consideration of the ontological and epistemological perspective, as well as methodology and methods. A thorough review of the literature on research paradigms revealed that specifying a paradigm is complicated by the fact that there is no consensus or guideline regarding how to apply research paradigms or standardised use of important terms. To date, research paradigms and related concepts have only been loosely explained (Mack, 2010). Bogdan and Biklen (1998, p. 22) suggest literature on paradigms to be “a loose collection of logically related assumptions, concepts or propositions that orient thinking and research”. There are also a few seemingly contradicting statements in the literature which add to the confusion. For example, according to Mir and Watson (2000), constructivism and realism are two opposed epistemological stances, and a researcher can only adopt one of them. In contrast, Crotty (1998) states that realism is an ontological stance and goes hand in hand with constructivism as an epistemological stance. Alternatively, Crotty (1998) argues that realism is an ontological view, constructivism is an epistemological view and positivism and critical theory are elements of the theoretical framework. Healy and Perry (2000) suggest that realism, constructivism, positivism and critical theory are all on the same level and can be considered the “starting point” for the development of a research process, each inherently having the three elements ontology, epistemology and methodology/methods in their stance.

Although there are some major differences in the use of research paradigms by different authors, the basic underlying assumption is generally consistent throughout the majority

of papers and discourses. Existing frameworks provide a continuum ranging from a fully objective philosophy to a highly subjective view that considers reality (and thus research) as being created by subjects and researchers, and therefore available for complete interpretation (Morgan & Smircich, 1980). Given that this philosophical continuum is the underlying assumption of most research paradigm models discussed in literature, it is up to the researcher which framework they choose to adopt, provided they accept the need for a philosophical framework.

This research adopts a framework derived by Crotty (1998) which has gained much recognition and has been cited frequently over the past decade due to its comprehensiveness. According to Crotty (1998), there are four elements to a research paradigm: ontology/epistemology, theoretical perspective, methodology and methods. Epistemology, or addressing ‘how we think about what we think’, is inherent in the theoretical perspective and in the methodology and methods. Therefore, selection of positions and stances taken as the research unfolds should not happen arbitrarily. Rather, a research process needs to follow a logical ‘string’ of philosophical positioning. Figure 5 illustrates the string of four elements adopted for this research on the right relative to Crotty’s (1998) framework shown on the left. The research paradigm adopted for this project has a realism ontology, constructivist epistemology, interpretivist theoretical framework, uses phenomenological hermeneutics as a methodology and case studies as a method of data collection.



*Figure 5 - The research paradigm based on Crotty (1998)*

#### **4.1.2. *Ontology and epistemology***

The ontology guiding this research is realism, and, consistent with a realism ontological perspective, social constructivism is the epistemological stance on which this research is based. Ontology describes how we perceive the nature of existence and the form of reality as such, thus answering the question “what is real?” (Crotty, 1998, p. 10; Guba & Lincoln, 1994). Epistemology is concerned with knowledge, embodying an understanding of what knowing entails (Crotty, 1998). Ontology and epistemology tend to overlap (Mack, 2010) as one is contingent on the other and both need to be ascertained to design research. As Crotty (1998, p. 10) points out, “to talk of the construction of the meaning is to talk of the construction of meaningful reality”. Therefore, in epistemology the ontological view is already implied (Guba & Lincoln, 1994). The realism ontological perspective for this research asserts that there is a probabilistically apprehensible reality outside a person’s mind (Crotty, 1998; Healy & Perry, 2000; Perry, 2001). If reality is

already sufficiently understood, but nevertheless the research problem and the research questions warrant a qualitative methodology, the methodology for a research project may be operationalised within a realism ontological paradigm (Healy & Perry, 2000). Healy and Perry (2000) suggest that for qualitative research in the management sciences, realism is an appropriate paradigm if participant perceptions are studied with the objective to understand the world, as is the case for this research.

Realism as an ontological stance is implied in the constructivist epistemology. This research explores the dynamics behind social capital, and hence seeks to explain mechanisms and processes created by human interactions which facilitate knowledge development. According to Guba and Lincoln (1994, p. 106), “human behaviour, unlike that of objects, cannot be understood without reference to meaning”, therefore implying that ‘what we know’, or our ability to understand human interactions, is not objective. Knowledge is constructed by social relationships and interactions and the way we view the world (Crotty, 1998). Clearly, an objectivist view of the world would be unsuitable for this kind of research as in this case results rely on the accounts of individuals and their view of reality. On the other hand, subjectivism, another epistemological stance that a researcher can assume, would also not have been suitable for this research. In highly subjectivist research ‘outside reality’ does not obstruct the reality constructed by research participants (Crotty, 1998). This research clearly considers external reality as the context of industry and participant relationships is a reciprocal part of their interpretive knowledge creation environment and does not merely interpret results from the reality created by participants.

Social constructivism refers to the notion that the meaning of reality is largely constructed by people, whilst still acknowledging that an objective reality, i.e. one present outside the mind, exists (Crotty, 1998). Literature to date has not unveiled how social capital is leveraged for knowledge development in clusters, yet empirical evidence

suggests that social capital is an important catalyst for knowledge (DeNisi et al., 2003; Nahapiet & Ghoshal, 1998). Hence, existing theory and thus the ‘outside reality’, as specified by Crotty (1998), is an integral part of this research and is considered to help put data collected from respondents into perspective. To inform the questions and propositions, participant accounts and inherently their view of cluster context was drawn on. Therefore, social constructivism is the appropriate epistemological view for this investigation.

#### ***4.1.3. Theoretical perspective***

The epistemological and ontological assumptions warrant an interpretive theoretical perspective because theoretical perspective informs decisions made regarding the evidence collection process (Crotty, 1998). Interpretivism assumes that realities are constructed by individuals, depending on their context and frame of reference, therefore acknowledging that humans are incapable of full objectivity. It also assumes that context needs to be considered (Crotty, 1998). Those assumptions were considered in the derivation of an appropriate methodology for this research.

#### ***4.1.4. Methodology***

The decision as to whether a researcher employs a quantitative or qualitative approach is, in its essence, methodological and needs to fit appropriately with the epistemology and theoretical perspective (Guba & Lincoln, 1994). Therefore, consistent with the nominated paradigm, and in order to explore the research questions, this research employed the qualitative methodology of phenomenological hermeneutics. The overall objective of hermeneutic phenomenological methodology is the development of a rich or dense description of the phenomenon of interest in a particular context setting (Ajjawi & Higgs, 2007, p. 616). Both phenomenology and hermeneutics are methodological approaches in their own right. Phenomenology as a methodology is concerned with mapping the lived experience of participants, therefore suitable for research exploring social phenomena



created by people and their interactions, such as social capital and knowledge.

Phenomenology exclusively considers human interaction as based on participant experiences. It acknowledges that the participant's interpretation of personal experiences is a part of those experiences (Cope, 2005).

Hermeneutics was originally concerned with text interpretation and text understanding (Long, Cunningham & Braithwaite, 2013). Phenomenological hermeneutics adds a phenomenological aspect to text interpretation, i.e. moves hermeneutics from "what it [text or word] says to what it talks about" (Lindseth & Norberg, 2004, p. 146). It is not the "factual, as psychic, social or historical events that need explanation". Rather, phenomenological hermeneutic necessitates a focus on the understandable meaning of lived experiences (Lindseth & Norberg, 2004, p. 146). 'Meaning' in this context refers to what the spoken word implies for the research problem and research questions (Lindseth & Norberg, 2004). In the context of this research, it is not the text, i.e. the interview transcripts that matter, but what the accounts of interviewees imply about social capital and knowledge development.

Phenomenological hermeneutics is an inductive and theory building approach which considers existing theory as a starting point, thus setting it apart from, for example, grounded theory research where theory is created from research data exclusively. Therefore, the use of hermeneutical phenomenology implies that the researcher interprets participant accounts under the light of current theoretical perspectives, thus adding an interpretive element (Crotty, 1998; Lavery, 2008). This notion is consistent with this research as participant accounts need to be understood with reference to current theory on clusters, knowledge and social capital in order to address the research questions. Knowledge, social capital and cluster theory are concepts with which participants may not be explicitly familiar, but that are nevertheless crucial for meaningful analysis. Where phenomenological research would not be guided by propositions or hypotheses,

phenomenological hermeneutics uses propositions to account for existing theory.

Therefore, phenomenological hermeneutics justifies the use of propositions derived from literature to guide the data analysis process for this research.

#### **4.2. Case studies as a method of data collection**

The method employed for the empirical work of this research in order to delineate the participant group was case study research together with semi structured interviews.

According to Gerring (2004, p. 341), a case study is defined as “an intensive study of a single unit”. Phenomenological hermeneutics warrants the use of a method that studies a small sample in-depth and in detail, rather than generalising from a large sample (Gerring, 2004). This is especially the case if the phenomenon of interest is rooted in social interaction and relationships (Denzin & Lincoln, 1994). Furthermore, Yin (2009) and Perry (2001) suggest that case studies are appropriate if the research addresses ‘how’ or ‘why’ questions, thus warranting an in-depth, rather than superficial, inquiry of the phenomenon in question. Therefore, the appropriateness of case studies for this project derives from the research problem, which in this case addresses how social capital is leveraged for knowledge development in clusters.

Linking case studies to the research paradigm, the case study as a method is consistent with the epistemological and ontological stances and theoretical framework of realism, social constructionism and interpretivism (Crotty, 1998). Healy and Perry (2000) suggest that case study research and realism as ontological perspectives go hand in hand because case study research enables collection of data that is observable and ‘created’ by people (e.g. perceptions). Furthermore, case studies have been suggested as appropriate for phenomenological hermeneutics methodology as they enable the researcher to empirically investigate and describe in-depth phenomena while simultaneously considering the context (Ajjawi & Higgs, 2007).

#### ***4.2.1. Number of cases and participants***

To date, there is no general agreement regarding the ideal number of cases for case study research to achieve meaningful insights about the phenomenon in question. Patton (1991) argues that the meaningfulness and insights generated by case study research are rooted in the information-richness of cases, rather than sample size. Eisenhardt (1989) advocates between two and four and up to 10 cases for any given research, but admits there is no ideal number. Perry (2001) suggests between two and 15 cases and emphasises the importance of embedded cases in one ‘big’ case, for example individual firms in one industry, or business units or individuals within one company. Consistent with Perry (2001), one such ‘big case’, i.e. a cluster, was examined in this research, with 20 embedded cases represented by firms and institutions, and 25 participants interviewed across those firms and institutions.

According to Perry (2001), the unit of analysis selected for a case study derives from the research problem and corresponding literature. For this research, firms and institutions as a unit of analysis were selected, with a particular focus on their network of relationships, based on existing theory which has traditionally considered cluster actors to be such firms and institutions (Andersson et al., 2004). The number of 20 embedded cases and 25 participants was not arbitrary. Given time and resource constraints of this research and that in case study research there is no ideal number of samples, new samples were brought to the study until data saturation which is the point of the data set being considered complete as indicated by data replication and redundancy. Saturation usually becomes evident during the coding process when the same ideas are consistently presented by data, with no new themes emerging (Bowen, 2008). For this research, data saturation was reached at 25 interviews.

#### ***4.2.2. Case selection***

Cases were purposefully selected to enable theory development, meaning that selection

was drawn from a population defined by the research problem and research questions (Eisenhardt, 1989). As the research problem includes the following issues: 1) clusters 2) knowledge and 3) social capital, cases needed to be concerned with those. With a focus on clusters, it follows that cases needed to be drawn from one or many clusters. Furthermore, knowledge and knowledge development needed to play a role in the investigated cluster. Knowledge is an intangible resource, a contributor to competitive advantage and an important contributor for firm and cluster success in all industries. However, knowledge is particularly crucial in high technology industries characterised by high levels of innovation activities (Maurer & Ebers, 2006). The biotechnology industry is an industry often cited as a good example of high technology where knowledge is frequently mentioned as the single most important determinant for competitive advantage and social capital is a major contributor to knowledge development (Maurer & Ebers, 2006). Therefore, the biotechnology industry represents an exemplary case for the study of knowledge development and its social implications.

#### ***4.2.3. Description of the investigated case***

The following paragraphs will describe the investigated case, including a description of the industry, the cluster and relevant actors.

##### ***4.2.3.1. The biotechnology industry***

Like most high technology industries, the biotechnology industry is highly knowledge dependent, with knowledge and knowledge-related activities being a major determinant for innovation. Innovation is one of the major determinants of competitive advantage for biotechnology firms, and as a result, their success is often measured in innovation output (Heimeriks & Boschma, 2011). Hence, not surprisingly, the biotechnology industry has been the subject of numerous studies on knowledge as a resource for competitive advantage (Clarke & Turner, 2004; Maurer & Ebers, 2006). Therefore, the biotechnology industry is an appropriate and exemplary case for this study since the phenomenon of

interest to be studied, knowledge, is likely to be more readily observed compared to non-innovation intensive industries (Eisenhardt, 1989). Furthermore, biotechnology companies tend to cluster more often than firms in other industries and there is evidence that those firms benefit to a higher extent from clustering compared to firms in other sectors (Maine, Shapiro & Vining, 2010). Consequently, a vast number of biotechnology clusters of various ‘shapes and sizes’ exist globally making the industry suitable for cluster studies (Breznitz, O’Shea & Allen, 2008).

A clear and unambiguous definition of biotechnology is imperative for the selection of an appropriate case and selection of participants. This research adopted the commonly used statistical definition provided by the OECD. According to the OECD (2015), biotechnology refers to “the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services”. This broad definition is complemented by a list base definition, narrowing what is considered biotechnology. Table 10 provides the list based definition with seven categories, as available from the OECD website and numerous publications (OECD, 2009, 2015).

Table 10 - Seven list-based definitions of biotechnology provided by the OECD

<b>List-based definition of biotechnology</b>	
<b>DNA/RNA</b>	Genomics, pharmacogenomics, gene probes, genetic engineering, DNA/RNA sequencing/synthesis/amplification, gene expression profiling, and use of antisense technology.
<b>Proteins and other molecules</b>	Sequencing/synthesis/engineering of proteins and peptides (including large molecule hormones); improved delivery methods for large molecule drugs; proteomics, protein isolation and purification, signalling, identification of cell receptors.
<b>Cell and tissue culture and engineering</b>	Cell/tissue culture, tissue engineering (including tissue scaffolds and biomedical engineering), cellular fusion, vaccine/immune stimulants, embryo manipulation.
<b>Process biotechnology techniques:</b>	Fermentation using bioreactors, bioprocessing, bioleaching, biopulping, biobleaching, biodesulphurisation, bioremediation, biofiltration and phytoremediation.
<b>Gene and RNA vectors</b>	Gene therapy, viral vectors
<b>Bioinformatics</b>	Construction of databases on genomes, protein sequences; modelling complex biological processes, including systems biology.
<b>Nanobiotechnology</b>	Applies the tools and processes of nano/microfabrication to build devices for studying biosystems and applications in drug delivery, diagnostics etc.

Australia is home to a strong biotechnology industry. Even though a number of single biotechnology firms have been operating in Australia for decades, a strong Australian biotechnology industry started to emerge in the mid-nineties and has since become a major driver for the Australian economy. From the 2000s until present, Australia has experienced a boom in biotechnology, with a steep rise in revenue generated by biotechnology firms, and a large increase in the number of start-ups. Biotechnology is now considered one of the fastest growing industries in the country. After a stall of growth due to the financial crisis in 2009, the industry has regained momentum with revenue, R&D expenses and net income increasing by 24%, 20% and even 231% between 2013 and 2014 (Ernst & Young, 2015). As a result, according to the Scientific American Worldview Scorecard (2015), which ranks countries' biotechnology strengths according to six categories productivity, IP protection, enterprise support, intensity, education/workforce, foundations, and policy and stability, Australia is ranked fourth in the world, up from number ten the previous year. The Australian biotechnology 'boom' has partly been due to the federal government supporting industry and firms through the provision of funds and tax incentives. In addition, state governments have regional programs and policies to develop local biotechnology industries. AusBiotech, Australia's biotechnology industry body, represents Australian biotechnology firms and acts as a broker between firms and the government. As a consequence of those government efforts, in 2014 most Australian capital cities have biotechnology districts (Bergeron & Chan, 2004). Hence, due to its strong biotechnology base, Australia is a suitable country to investigate a biotechnology case.

Notably though, despite its strong growth as evident by financial indicators, there is still room for improvement in the Australian biotechnology sector. Vitale (2004) notes that this is partly due to inconsistent government policies, supporting companies at the early stages, but not during commercialisation. As a result, "Australian researchers are less likely to make appropriate choices with regard to commercialisation (Vitale, 2004, p. 5).

Therefore, commercialisation of Australian biotechnology products is still below potential (Vitale, 2004). Furthermore, being located far from the world's major biotechnology hubs, not sharing a time zone, Australia's biotechnology industry faces the challenge of being connected to the global industry. To aggravate the problem of distance, the biotechnology industry in Australia does not have the right mix of supporting institutions locally, such as universities and research institutes (Gilding, 2008). Such challenges faced by the Australian biotechnology industry are interesting for this research as they raise the question if and how social capital and knowledge are leveraged by Australian biotechnology firms to overcome them.

One Australian biotechnology cluster was investigated in this research. To preserve anonymity of participants involved, the cluster and the state are not identified. The biotechnology industry cluster selected largely reflects the industry in Australia as a whole. Over the past decade, the number of biotechnology firms in the state where the research was conducted has more than doubled. Most of the firms located in the cluster are small to medium sized firms. Various branches of larger multinational biotechnology companies are also present. Furthermore, there is a cluster management organisation in place.

#### 4.2.3.2. Infrastructural characteristics of the investigated cluster

The state biotechnology industry, including lateral actors, is clustered in and around the capital city. As a result, the cluster encompasses the city and surrounding suburbs. However, the vast majority of cluster firms are located within a small area referred to as 'the precinct'. This precinct itself is located in an area of 1 km length and 500 m width, directly adjacent to the city centre. It hosts 126 privately owned companies of which 92 have a biotechnology focus. Originally, the location of the precinct was an industrial area, housing a number of large manufacturing factories. From 1999, the state government started developing the area into a bioscience district due to convenient location close to



the city centre. The precinct is divided into three distinct areas. The eastern part of the precinct hosts the facilities of a large brewery. This section is part of a major infrastructure development plan of the area, but is not part of the biotechnology precinct. The second area is used by one of the state's major universities, which runs a technology and science based research hub on site. Even though this area is predominantly a university campus, there are also about 40 commercial tenants, most of which have a biotechnology focus. The third area of the precinct is the bioscience precinct which is the 'heart' of the cluster as this area comprises most privately owned biotechnology firms located in the cluster. The bioscience precinct is also home to a small number of cafés/restaurants, a few park areas and recreational sites.

A building referred to as the incubator building is located in the precinct. The incubator is a new, state-of-the art facility. Its purpose is to provide laboratory and office space for start-up biotechnology firms in the early stages of operation. In addition, the facility hosts numerous meeting rooms and has surrounding parklands for recreation. As of 2014, there were six tenant firms in the incubator. In 2013, a second building close to the incubator was completed and will soon provide additional space for start-up companies. The incubator and the extension are fully funded by the state government and run by the cluster management organisation.

#### 4.2.3.3. Cluster firms in the investigated cluster

The investigated cluster is comprised of about 120 companies with a biotechnology focus that can be considered vertical or horizontal actors. They can be categorised as such because they produce or provide biotechnology related goods or services, i.e. the 'main good' of the industry. The firms, although all considered biotechnology and part of the cluster, differ significantly in terms of operations. This reflects the definition of 'biotechnology' encompassing numerous fields and activities OECD (2015). Based on

Brown et al.'s (2010) definition, in order to be considered a cluster firm for the purpose of this research, a firm must:

- be a private company and
- have reported activities in one or more of the fields defined as 'biotechnology' (refer to Table 10 above), or
- provide inputs or services to a firm active in those activities, or
- both of the above

The information to categorise firms as 'cluster firm' was obtained by consulting firm websites, the online database provided by cluster management and by contacting the firm directly where there was ambiguity about the focus of operations.

After the process of identifying cluster firms, it became clear that the investigated cluster reflected the diversity of the biotechnology industry in general (OECD, 2009) as it comprised firms operating in fields of diagnostics, pharmaceuticals, agriculture and veterinary sciences, laboratory equipment, medical devices and biotechnology reagents. The majority of cluster firms were small to medium sized businesses with approximately three to 20 full time employees. The six tenant firms in the incubator building, being in the start-up stage of operations, were small with one having only one employee on site. About 10 of the firms in the cluster were divisions of larger national or multinational firms each employing approximately 20-50 employees on site. Participants were selected from this pool of cluster firms.

#### 4.2.3.4. Cluster management

An important lateral actor in the investigated cluster is the cluster management organisation. Cluster management was considered a lateral actor because it provides support to cluster firms rather than being involved in the production of the core product. In terms of the value adding web framework, cluster management organisations are recognised as a lateral actor (Andersson et al., 2004; Gretzinger & Royer, 2013). In the

investigated cluster, the cluster management's supportive function is manifest in its mission stating that the organisation's purpose is to manage, foster and further develop the precinct. Specifically, cluster management provides services, such as business development, finance, infrastructure and marketing assistance, to biotechnology firms. The cluster management organisation in the investigated cluster was founded and incorporated by the state government approximately decade ago and according to its mission statement cluster management seeks to foster growth of the biotechnology industry in the state. As the cluster management organisation clearly has a supporting function in the cluster, it was considered a lateral actor.

#### 4.2.3.5. Contract research laboratories

A distinguishing feature of the investigated cluster is that university laboratories and research institutions across the city and state were contracted by cluster management to provide cluster firms with access to top of the range biotechnology equipment and expertise. Motivation for the initiative was that small to medium sized firms in the cluster rarely have financial capacity to purchase expensive equipment or may lack relevant expertise which may prevent them from reaching their full innovative capacity. As of 2015, 18 laboratories and institutions were part of the initiative, with about 95 employees and AUD \$124 million worth of equipment involved.

The contract research laboratories are usually part of universities and other research institutions and were run by those universities and institutions. Therefore, physically the laboratories are located close to their respective university faculties or institution and spread across the city and surrounding suburbs. Laboratory staff were usually on the pay roll of the relevant university or research institution. In order to acquire contract research laboratory status, laboratory managers must undertake a mentoring program, use contract research laboratory branding and submit an annual review. In return, the laboratories are eligible to apply for and receive substantial funding through cluster management. In

terms of governance, contract research laboratories are managed by a contractor employed by cluster management. The manager reports to cluster management and to the steering committee which is made up of member representative of the major contract research laboratory stakeholders. Furthermore, laboratory managers report to a steering committee.

Contract research laboratories are considered lateral actors as their purpose matches the definition provided by literature which states that lateral actors are those that provide “expertise, policy instruments and strategic oversight, as well as the resources brought to bear through institutional oversights” (Brown et al., 2010, p. 16). Furthermore, contract research laboratories are part of the local academic community which has been recognised as a lateral actor in the literature (Andersson et al., 2004; Brown et al., 2010; Royer et al., 2009). Moreover, even though the laboratories work with cluster firms as part of a contractual agreement, the main activity and purpose is undertaking research for their respective institution, rather than producing the main product of the cluster. This shows that they cannot be categorised as a cluster firm.

#### 4.2.3.6. Universities

Universities in close geographic proximity of cluster firms are traditionally considered lateral cluster actors (Brown et al., 2010). Numerous universities are located in and around the investigated cluster, however, dominant involvement of universities is through the contract research laboratory initiative. Nevertheless, local universities have some limited additional involvement with the cluster. First of all, the universities, especially those nearby, provide education for highly skilled professionals that are subsequently recruited by cluster firms (Steffen, 2012, p. 24). Furthermore, one of the universities maintains a campus in the precinct and owns the majority of land in the area. Hence, it acts as a landlord to biotechnology firms. The university explicitly states that preference is based on a potential tenant’s ability to enter a useful association with the university,

implying that it seeks to establish relationships with the cluster firms and that it expects benefits from those relationships in addition to financial gains from relational rent collected.

#### 4.2.3.7. Government

Another lateral actor recognised in the literature is government (Brown et al., 2007a). In the case of the investigated cluster, state government rather than federal government is involved with the cluster. As mentioned previously, state government is represented through the cluster management organisation. In addition, the government runs a department responsible for innovation, manufacturing and trade in the state. This division is also responsible for cluster development, the overall purpose of which is strengthening of the state's manufacturing sector by means of industry clusters. The division has one employee dedicated to coordinating cluster initiatives in the state. In the investigated cluster, this employee works closely with cluster management.

#### 4.2.3.8. Consultants

Another type of lateral actor recognised in the literature are external consultants (Andersson et al., 2004; Brown et al., 2010). In the state and city, various consulting firms are available which offer consulting services to firms operating in innovation intensive industries, or biotechnology explicitly. Many biotechnology and consulting firms confirmed that consulting services were used regularly in the cluster. Consulting firms are considered lateral actors.

#### ***4.2.4. Selection of suitable interview partners***

After cluster firms and lateral actors were identified in the investigated cluster, potential participants were selected. The objective was to have a participant base comprised of approximately 50% cluster firms and 50% lateral actors, a ratio reflecting presence in the cluster.

Regarding the position of a potential interviewee in their respective organisation, it is important to note that knowledge development affects all levels of an organisation (Coleman, 1988). However, in order to contribute meaningful data given the research problem and questions, participants needed to be involved in development of knowledge at cluster level. This implies that they need to be involved in firm spanning activities. This criterion was most likely to be fulfilled by upper or middle level managers, as lower level staff, e.g. R&D personnel and administrative staff, are less likely to engage with other firms and focus on internal activities according to job description. Hence, individuals with at least some management responsibility were targeted in the participant selection process.

An online database provided by the cluster management organisation listing firms and institutions associated with the cluster, together with a description of the respective products and services offered, was consulted for contact details. Initial contact was made via email, with an attached project summary and request to forward the email within the organisation, especially to the people deemed appropriate to participate in this research. If no answer to an email was received within three weeks follow up phone calls were made. Another important way of contacting and recruiting participants was referrals from those already interviewed. Interviewees subsequently contacted colleagues from other cluster firms that they personally knew and invited them to participate. Table 11 lists participating firms and institutions, including their operational focus and categorisation into cluster firms and lateral actors.

*Table 11 - Composition of research participants*

<b>Categorisation</b>	<b>Number of sub-cases</b>	<b>Number of interviewees</b>
Cluster firm	10	13
Lateral actors	10	12
<i>Consultants</i>	2	2
<i>Cluster management</i>	3	3
<i>Government</i>	1	1
<i>Contract research laboratory</i>	4	6

In total, 96 firms and institutions were contacted and 25 interviewees across 20 firms or institutions participated. Of the 20 firms and institutions, 10 were considered lateral actors and 10 were considered cluster firms. The ratio of 50/50 roughly reflects overall apportionment in the cluster as evident from the online database. Of the 25 interviewees, 13 were cluster firms and 12 were lateral actors. Of the 12 interviewees considered lateral actors, two were consultants, three were associated with cluster management, one was a representative of a government body and six were from contract research laboratories.

#### **4.2.5. Interviews**

Data was collected by means of semi-structured interviews. Given the philosophical underpinnings of this research and methodology, interviews were the most suitable method for data collection. In phenomenological hermeneutics methodology it is imperative that participants provide a detailed account of their experience of the phenomenon in question. Furthermore, it is crucial to have an open exchange and discussion led by the participant rather than by the researcher. Therefore, interviews should not follow a rigid structure, but should instead consist of open-ended questions, giving participants the opportunity to add information as they wish (Laverty, 2008). It follows that structured interviews were not suitable for this research.

According to Denzin and Lincoln (1994), fully unstructured interviews are most appropriate for exploratory research. However, due to time and resource constraints and efficacy in the collection of data, a fully unstructured approach was not suitable. Semi-structured interviews, i.e. open-ended questions with the opportunity to supplement with additional questions during the interview, were conducted to allow the researcher to collect a large amount of data in a short time period (Rowley, 2002).

Appropriate interview questions for a research project should be derived from the theoretical framework (Denzin & Lincoln, 1994). Therefore, consistent with the research problem, questions and propositions of this research, interview questions were derived from cluster and social capital theory addressing vertical/horizontal/lateral actors and structural, relational and cognitive dimensions of social capital based on Nahapiet and Ghoshal (1998), Inkpen and Tsang (2005) and Brown et al. (2010). In order to operationalise the social capital concept for development of interview questions, Inkpen and Tsang's (2005) framework was drawn on as it suggests how social capital dimensions are likely manifest in clusters. Being semi-structured, interview questions were a guide rather than a rigid protocol and in the course of the interview follow up questions were asked and in-depth discussion of topics unfolded. Nevertheless, it was ensured that all predetermined interview questions were asked, and all topics were covered, by means of a checklist used by the researcher. A copy of the interview questions is provided in Appendix I.

With participant permission, interviews were recorded and transcribed. The recording of an interview and transcription by the researcher is a crucial part of phenomenological hermeneutics methodology as "a tape-recorded and transcribed interview text lies closer to speech than to writing, especially if the interviewer herself/himself interprets it" (Lindseth & Norberg, 2004, p. 148). The vast majority of interviews took place on site in



participants' offices and some at a third party location, such as a café or restaurant. Three interviews were conducted via phone or video call. According to a recent study by Irvine, Drew & Sainsbury (2013) that compared effectiveness of semi structured interviews face to face with those conducted via phone, data collection via phone interview is acceptable practice. The potential downfall of a phone interview is lack of face to face contact which may discourage some participants to share information was avoided in two of three phone interviews by using Skype video. Even though it cannot be established with certainty whether the remaining participant was 'holding back' due to the lack of face to face contact, the interview lasted more than an hour and the participant provided detailed information and lengthy answers nevertheless. A total of 1021 minutes (=17 hours and 1 minute) of interview data was collected.

#### **4.3. Content analysis as the informing method of data analysis**

In order to analyse qualitative data obtained from interviews, a thematic investigation was conducted using content analysis. Content analysis is described as “a research method that uses a set of procedures to make valid inferences from text” (Weber, 1990, p. 9). In particular, the method has been proven useful for analysis of unstructured or semi-structured interview transcripts (Burnard, 1991), the latter of which is the source of data for this research. Historically, content analysis was developed from grounded theory research and was originally introduced by Glaser and Strauss (2009, reprint of 1969). Grounded theory is a research methodology that is completely exploratory, with theory generated from data exclusively and not guided by hypothesis and propositions. While the research for this thesis is not completely exploratory, content analysis was adapted as a method of data analysis for this research which was guided by existing theory (Graneheim & Lundman, 2004). Relevant to this research is the ‘directed approach’ to content analysis (Hsieh & Shannon, 2005). Directed content analysis considers existing theoretical frameworks in analysis of data. Content analysis, directed content analysis in particular, are therefore consistent with the methodological framework of this research.

#### ***4.3.1. Coding of themes and issues***

The “heart of content analysis” is the process of coding qualitative data (Ishiyama & Breuning, 2010, p. 490). Coding involves the sorting of “large quantities of text into much fewer content categories” (Hsieh & Shannon, 2005, p. 1285). In the case of interview transcripts, coding involves the categorisation of interview text into relevant categories (Burnard, 1991). In order to deal with a large amount of qualitative material present in interview transcripts of this research the use of qualitative research software was a major advantage. Indeed, Yin (2011) recommends the use of software to handle large amounts of qualitative data that emerges from case study research. Therefore, this research used NVivo 10 qualitative software to code and aid analysis of interview transcripts.

The overall aim of analysing interview transcripts is to identify relevant themes and issues in a “reasonably exhaustive categorisation system” (Burnard, 1991, p. 462). The resulting categories are also referred to as ‘codes’. Achieving a categorisation system requires numerous steps which were followed in this research, as outlined below. As a first step, a list of initial codes and sub-codes were established. Consistent with the directed approach to content analysis, these categories were derived from existing theory in order to purposefully explore the data and inform propositions (Hsieh & Shannon, 2005; Potter & Levine-Donnerstein, 1999). In keeping with the two research questions, this research used ‘actors’ and ‘social capital dimensions’ as initial codes. Each of these codes were assigned numerous sub-codes, also derived from theory, to assist with initial analysis and sorting of data. Another initial main code was characterisation of the interviewee, e.g. biographic information, professional background and so on. Table 12 lists initial a priori codes and sub-codes used in the first round of analysis. It is important to stress that these initial nominal codes were used to initiate analysis. In order to derive empirical richness, the data was allowed to ‘speak for itself’ and emerging themes and issues not proposed by existing theory were considered equally important.

Table 12 - Initial codes for data analysis

<b>1. Interviewee information</b>	
<b>2. Actors</b>	Cluster firms
	Lateral actors
<b>3. Social Capital</b>	Hierarchical levels
	Instability of clusters
	Interactions
	Norms and rules
	Relationships
	Shared culture, goals and interaction logic
	Trust

The second step was coding procedure for interview transcripts. This process largely followed the steps suggested for directed content analysis by Hsieh and Shannon (2005). First, the data analysis process involved reading interview transcripts and allocating quotes and sentences to the aforementioned initial codes. Text that did not fit into a pre-defined category was allocated to additional categories (emergent themes). According to Burnard (1991), the objective of this first ‘read through’ of interview transcripts is to become immersed in the data, however additional steps are necessary to achieve coding of the text. As a second step, codes and sub-codes were refined with consideration to the new codes, or emergent themes, created and relationships between codes were reviewed and refined. If new codes could not be considered sub-codes of either ‘characterisation of interviewee’, ‘actors’ or ‘social capital’, new, free codes were created. Subsequently, the interview transcript was read through a second time to check that relevant text was accounted for in codes. Then, the next interview transcript was read and coded, with codes added and relationships refined if necessary. This process was followed until all interview transcripts were coded. It should be noted that text relevant to more than one category was allocated to all relevant categories.

#### **4.4. Interpretation**

Once interviews were coded interpretation of the data took place. As a first step, theme density assessment through frequency determination was undertaken. Strauss and Corbin

(1990) emphasise that in analysing qualitative data frequency determination can be useful to add soundness to data. Similarly, Hsieh and Shannon (2005) state that even though data obtained from directed content analysis cannot, and should not, be analysed statistically, it may still be useful to examine the prevalence and priority of codes to reveal themes were considered important to interviewees in order to complement qualitative analysis. Therefore, assessment of theme density through frequency determination involved a focus on how often a specific issue was mentioned within and across interviews. If a theme or issue was mentioned by numerous participants, this indicated transferability of this particular issue; if mentioned numerous times in one interview of one firm, this indicated significance. While it cannot substitute the researcher's own work and diligence, NVivo 10 software proved useful for the assessment of theme density, as the software can count words and sentences and create diagrams on the basis thereof.

As a final step of data interpretation, results of analysis and interpretation were compared, contrasted and collectively assessed with respect to how they informed the propositions. This process involved comparing and contrasting observed patterns in the data with theoretical underpinnings (Trochim, 1989; Yin, 2011). This process identified whether the data supports theory, supports or contradicts existing theoretical frameworks, or new themes and issues are prevalent in the data that are unrelated to the theory. Discussing and integrating the results initiated development of a theoretical framework that indicates how social capital influences knowledge development in clusters.

#### **4.5. Soundness criteria**

This research was undertaken to ensure soundness criteria were met. This is important because any research method needs to achieve a certain degree of scientific rigor in order to provide meaningful results. Lincoln and Guba (1985) developed a framework to assess rigor and to ensure trustworthiness of qualitative inquiry in terms of confirmability,

dependability, credibility and transferability. In doing so, Lincoln and Guba (1985) addressed a significant challenge that qualitative researchers are facing in assessing rigor for qualitative methods, case studies in particular, which is challenging due to the ambiguity surrounding criteria and lack of scientific assessment techniques (Riege, 2003, p. 76). Lincoln and Guba's (1985) framework explicitly acknowledges that qualitative research is based on different philosophical underpinnings of quantitative approaches, hence requiring distinct criteria and techniques to assess soundness. As a result, Lincoln and Guba's (1985) criteria has been widely used across many fields of research and over time has been complemented by scholars suggesting specific strategies and techniques to ensure the four criteria proposed are met (Baxter & Jack, 2008; Houghton, Casey, Shaw & Murphy, 2013; Riege, 2003). The framework has been found to be particularly suitable for case study research under the realism paradigm (Riege, 2003) and is appropriate for this research. The overall soundness of this research was determined based on Lincoln and Guba's (1985) four criteria of confirmability, credibility, transferability and dependability. Strategies and techniques employed to ensure rigour in this research are explained below.

#### ***4.5.1. Confirmability***

Confirmability assesses whether the procedures applied to collect data are appropriate to measure the phenomenon of interest and do not reflect characteristics and preferences of the researcher (Yin, 2003). To achieve confirmability, or in other words, "the extent to which conclusions are the most reasonable ones obtained by data" (Riege, 2003, p. 81), the qualitative researcher needs to ensure that "the work's findings are the result of the experiences and ideas of the informants, rather than the characteristics of the researcher" (Shenton, 2004, p. 72). In the context of this research, confirmability implies that conclusions drawn about the leverage of social capital for knowledge development reflect interviewees' experiences and are not biased by opinion, experience or previous knowledge of the researcher.

Unlike in quantitative enquiries, confirmability can be problematic in qualitative research, since methods and procedures employed are designed and conducted by humans (Shenton, 2004). One way to address confirmability is to implement reflexivity, which requires acknowledgement of the researcher's own predisposition to make it visible and understandable to the reader (Houghton et al., 2013). Reflexivity further implies that each decision made by the researcher concerning the research project needs to be recorded (Houghton et al., 2013). This was achieved for this research, as the underlying philosophical assumptions were discussed in detail.

Confirmability in qualitative research can be achieved by recording "as concrete as possible" all steps of the data collection and interpretation process (Riege, 2003, p. 83) to render them comprehensible and reproducible in order to provide a full picture (Riege, 2003; Yin, 2003). To achieve this, each decision made for this research needs to be explained in detail (Houghton et al., 2013). Such an 'audit trail' enables the reader to trace the research process step by step and hence confirm that inferences from data are indeed plausible (Shenton, 2004). For this research, the research design process, including underlying philosophical underpinnings, methodology and methods, were carefully outlined. Part of the audit trail is also the retention of data sources for possible re-analysis in the future, so that the researcher can return to raw data at any time for reassurance (Miles & Huberman, 1994). This research achieved confirmability by explaining in detail how data was collected and analysed. Furthermore, the interview transcripts will be safely retained for five years, as required by university policy. A last step of ensuring confirmability, as stated by Riege (2003), is a plausibility check at the end of the data interpretation process. This technique involves an audit of whether inferences drawn are logical in the light of existing theories. This was achieved for this research, as results were discussed and interpreted in the light of relevant theory.

#### **4.5.2. Dependability**

Dependability refers to the stability of data (Houghton et al., 2013). A qualitative study is considered dependable if other researchers, in carrying out the same study, would come to the same result (Riege, 2003). Hence, dependability is closely related to confirmability, and more often than not, the same techniques and strategies are suggested that simultaneously address both dependability and confirmability (Houghton et al., 2013). Dependability was ensured for this research by following the techniques and strategies aimed at achieving confirmability described above. Specifically, to enable the possibility of further achieving dependability in future studies, methods and procedures of the research process and design should be reported in as much detail as possible to enable other researchers to repeat the study if desired (Merriam, 1998; Shenton, 2004). Accordingly, Chapter 5 of this thesis is devoted to detail and discusses each step of this study.

Whether a qualitative study meets the criteria of dependability is ultimately decided by future researchers (Houghton et al., 2013). However, it should be noted that the exact replication of findings by other researchers is not necessary for the soundness of qualitative inquiry. In clearly distinguishing dependability from the reliability criteria of quantitative research, Merriam (1998, p. 206) notes that “rather than demanding that outsiders get the same results, one wishes outsiders to concur that, given the data collected, the results make sense – they are consistent and dependable”.

#### **4.5.3. Credibility**

Credibility refers to whether findings are internally coherent. In other words, credibility represents how accurately findings reflect reality (Lincoln & Guba, 1985). In the context of this research, credibility assesses whether conclusions drawn about the leverage of social capital for knowledge development indeed reflect what is really ‘happening’ in the investigated cluster.

Lincoln and Guba (1985) advocate prolonged engagement to ensure credibility.

Prolonged engagement requires the researcher to be present on site for data collection to foster participant trust and ensure truthful accounts, i.e. ensures that participants say what they mean (Houghton et al., 2013). This was achieved for this research as the vast majority of interviews (23 of 25) were conducted face to face. Another two interviews were conducted face to face via video conferencing, hence establishing some degree of trust. Furthermore, to ensure credibility, new data should be collected until saturation (Houghton et al., 2013), as was done in this research.

The use of a diversified data base is also significant to achieve credibility (Golafshani, 2003; Shenton, 2004). According to Meyer (2001) diversity helps achieve good substantiation of propositions. One way of achieving diversity is by including diversity in the participant base “because individual viewpoints and experiences can be verified against others and, ultimately, a rich picture of the attitudes, needs or behaviour of those under scrutiny may be constructed based on the contributions of a range of people” (Shenton, 2004, p. 65). For this project, diversity was achieved by consulting 25 individuals from different management levels, firms and institutions. Furthermore, Shenton (2004) proposes iterative questioning during interviews to achieve credibility, involving the use of probe questions to unveil data. Iterative questioning was achieved by the use of semi-structured interviews which enabled the researcher to include additional questions and to further inquire about issues as necessary. Another technique to ensure credibility is to use illustrations and diagrams during data analysis to illustrate ‘cause and effect’ relationships and to constantly revise them as new data is analysed (Miles & Huberman, 1994). This was also done for this research.

Lincoln and Guba (1985) propose peer debriefing to establish credibility. Peer debriefing involves presentation of the data analysis to colleagues not involved in the research on a regular basis to obtain an unbiased opinion on whether inferences drawn from data are



plausible. The data collection and analysis process should also be presented and discussed with peers (Houghton et al., 2013). During the data collection and analysis process, results were discussed with peers and feedback was taken into account for reflection.

Guba (1981) further proposes that in order to achieve credibility, the researcher should be present on site for data collection to foster participants' trust and hence to ensure truthful accounts, i.e. ensures that participants say what they mean. This was achieved for this research as the vast majority of interviews (23 of 25) were held face to face, establishing trust.

#### ***4.5.4. Transferability***

Transferability is concerned with extrapolation of findings beyond the immediate inquiry (Riege, 2003), i.e. the extent to which findings can be applied to other contexts. For this research, transferability relates to the extent to which results would hold true in other biotechnology clusters, clusters in other industries, or knowledge development through social capital outside of a cluster setting.

Whether results of a qualitative study can be applied to other contexts is ultimately up to the judgement of the reader (Houghton et al., 2013; Riege, 2003). In order for such judgement to be made, Houghton et al. (2013) suggests 'thick description'. This implies that the context of the research be described in as much detail as possible, including descriptions of methods, the case itself and "rich and vigorous presentation of findings with appropriate quotations". This was achieved for this research as both the investigated cluster and research design were described in detail. Furthermore, a large number of direct quotes from interviewees are provided in Chapter 5.

In addition, where transferability from one case is limited (Eisenhardt, 1989), multiple embedded cases as one large case (the cluster) allow some degree of transferability

(Meyer, 2001). Thus, this research examined 20 embedded cases with 25 individuals employed in numerous biotechnology firms and institutions located in a cluster. In assessing transferability, it should be kept in mind that in qualitative research transferability has often been perceived as the most problematic criteria. Transferability for qualitative research should not be considered an equivalent concept to external validity of quantitative studies (Riege, 2003). Riege (2003, p. 81) states that while quantitative studies aim to achieve statistical generalisation, in qualitative studies the objective is “analytical generalisation, whereby results are generalised to some broader theory”. Therefore, the term transferability is used in qualitative studies, rather than external validity, to make a clear distinction to generalisability in quantitative research (Guba, 1981). For this research, findings should not be perceived as being directly applicable to other cases. Rather, the focus is on contribution to theory.

#### **4.6. Ethical issues**

As this research involves human subjects, research ethics were considered. This study was cleared by the University of Adelaide Human Research Ethics Committee before data collection commenced. Participants were provided a research information sheet before the interview with information about the research and its objectives. Furthermore, participants were informed that they could withdraw at any time. On the day of the interview, participants were asked to sign a consent form that confirmed they agreed to have the interview recorded. Interviewees were assured regarding confidentiality of data and anonymity.

#### **4.7. Summary**

This chapter detailed the research design of this project, explaining how data was collected and analysed. Given the research problem and the fact that a ‘how’ question is addressed, this research was predominantly exploratory as the exact research problem and questions have not been addressed previously. However, relevant literature and

theoretical frameworks are available to draw on for exploration of the research problem and was therefore considered in the data analysis process. Therefore, an ontological perspective based on realism and an epistemological perspective based on constructivism were adopted as underlying research philosophical paradigm, since these views consider the fact that reality is constructed by humans, but also exists independently. Consistent with this paradigm, case studies, together with semi-structured interviews was adopted to study an Australian biotechnology cluster. Data collected was analysed using content analysis, and subsequently interpreted by comparing results with existing theory, as well as by considering emergent themes and issues. To ensure soundness of the findings, measures specifically derived for qualitative research were taken to ensure confirmability, dependability, credibility and transferability.

## (5) RESULTS

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This chapter presents the empirical work of this dissertation. The data of the case study is analysed and themes and issues are identified to explore how social capital is leveraged for the development of knowledge in clusters:

*RQ1) What are the drivers of social capital for knowledge development in clusters?*

*RQ2) Which actors are involved in the development of knowledge in clusters and what are their respective roles?*

The chapter is structured according to the above research questions, starting with a presentation of themes and issues emerging from data that relates to drivers of social capital for knowledge development. The two dominant drivers for knowledge development were found to be firm spanning, interpersonal relationships and interactions which are discussed first. Subsequently, themes and issues reflecting factors that impact on interpersonal relationships and interactions, hence indirect drivers for the development of knowledge are presented. This is followed by presentation of themes and issues relating to cluster actors and their respective roles in the development of knowledge. Figure 6 below presents an empirical model of the relationships between key themes and issues of the results. Quotes from the interviews are used to illustrate the data and are presented in *italics*. Interviewees are identified in terms of whether they are a lateral actor or are from a cluster firm. More detail about individual interviewees cannot be disclosed due to confidentiality issues. The chapter concludes with a synopsis.

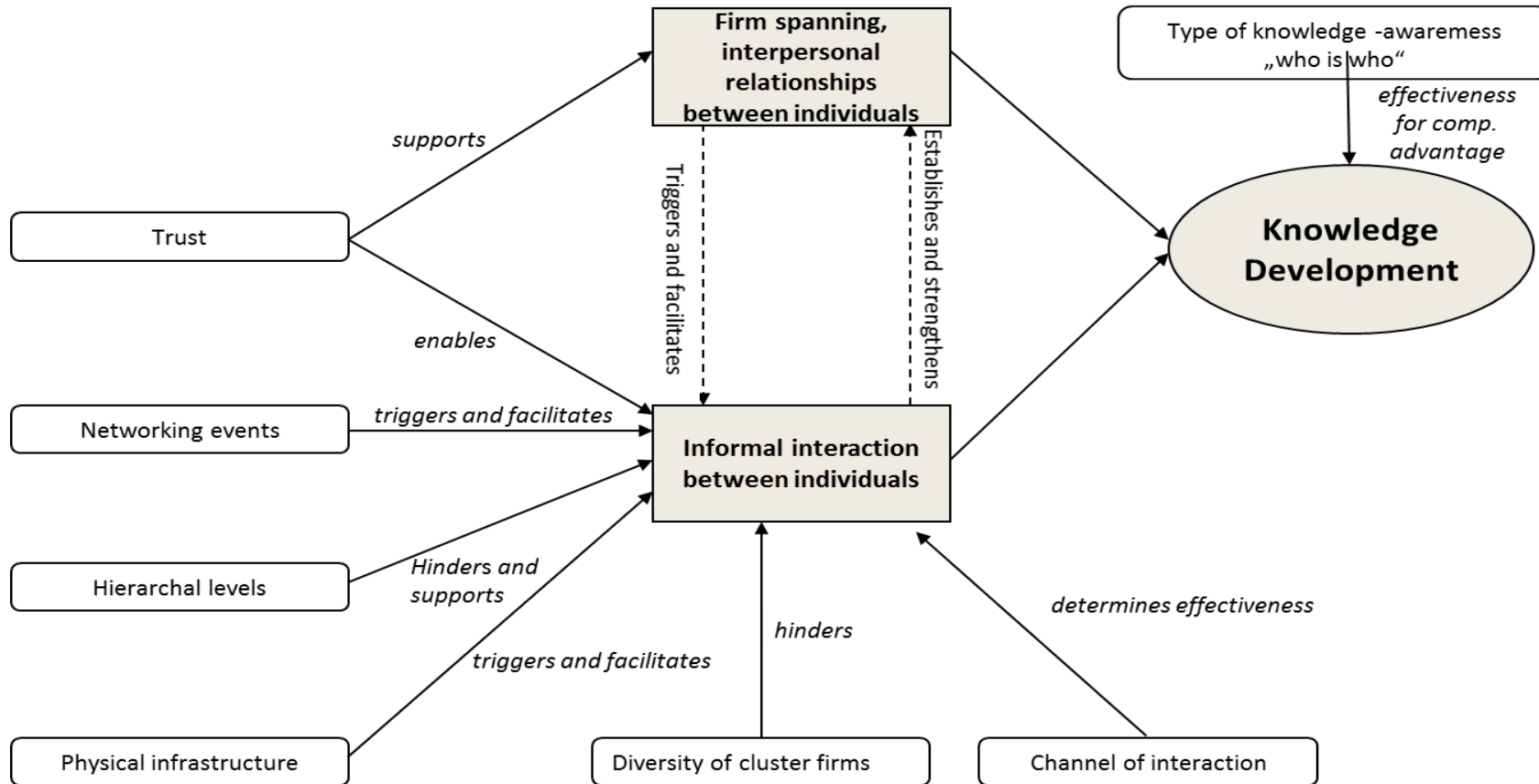


Figure 6 - The drivers of social capital for knowledge development and relevant actors

### **5.1. Interpersonal relationships and how they drive knowledge development**

Data suggested that one of the dominant drivers for knowledge development in the cluster were firm/institution spanning interpersonal relationships between individuals. Results revealed such relationships acted as a ‘pipeline’ for knowledge flow between different cluster firms and institutions. An ‘interpersonal relationship’ was considered by interviewees to be an amicable association between two people, who, as a result of this relationship, get along and are friendly with each other. Interviewees from cluster firms described such relationships along the lines of “*X [person from other cluster firm] and I get along well*”, “*I would say we have a friendly business relationship*” or “*we have a good relationship with [name of manager of cluster firm]*”. The importance of such firm spanning, interpersonal relationships as a driver for knowledge development was derived from the fact that ‘getting along’, or being amicable with each other, acted as a facilitator for knowledge to flow from one individual to another and sometimes was considered a prerequisite for knowledge to be developed or shared between people. This was illustrated by the comment of one interviewee from a cluster firm, noting that “*I think you wouldn’t ring the person to talk to them about something unless you know them, unless you did feel that you could trust them*”. Similarly, another interviewee from a cluster firm felt that interpersonal relationships increase the likelihood of knowledge being shared freely and noted that “*you know you never do a deal or exchange information with someone you don’t like*”. Results clearly showed that the vast majority of interviewees maintained firm/institution spanning interpersonal relationships with individuals from other firms through which they shared knowledge with the other party, or knowledge spill over took place. This meant that in the investigated cluster, interpersonal relationships of various kinds existed across firms, with one interviewee, a consultant, noting that “*the biotech world is a rich source of work, and also for personal relationships*”.

Results also suggested that firm spanning, interpersonal relationships drove knowledge development because when people felt comfortable with each other they were more likely to overcome interpersonal problems that may arise and potentially hinder flow of knowledge. As one interviewee from a cluster firm commented, *“it’s [the transfer of knowledge] based on relationships, I think they are really important. If you’ve got a good relationship with somebody and there is an issue, you are in a better position to overcome that”*, emphasising the fact that an amicable and trusting relationship can help solve problems before they become a barrier to knowledge flow. Supporting this notion, another interviewee from a cluster firm explained that *“apart from their [cluster colleagues’] technical skills, you have to work with people you get along with, that you can solve problems and argue together, and still be in a relationship at the end of the argument”*.

Interestingly, the firm spanning, interpersonal relationships described by interviewees, albeit amicable, were rarely described as deep friendships. Interviewees preferred to keep relationships on a friendly, yet professional level. For example, one interviewee from a cluster firm explained that *“you are happy to sit there and have a coffee and a chat. But it’s not friends, it’s more colleagues”*. Similarly, another interviewee from a cluster firm emphasised that *“a business relationship and friendship sometimes have to be separate”*. A third interviewee from a cluster firm described her interpersonal relationships to be *“friendly business relationships. I keep my necessary distance”*. As a result of interpersonal relationships being kept on a professional level, knowledge development in the cluster was usually not taking place when individuals *“catch up socially”*, e.g. meeting socially on weekends or meeting up for *“after work drinks”*. Supporting the idea that knowledge was developed during professional settings, one interviewee from a cluster firm explicitly commented that with cluster colleagues whom he has a close and amicable interpersonal relationship he did not *“tend to socialise with them outside the work sort of things”*. Such statements imply that a relationship did not have to be a very

close friendship in order to drive knowledge development. Rather, an amicable business relationship with interaction limited to work hours appeared to be sufficient to foster knowledge flow.

Results further revealed that cluster management and consultants were well aware of the strategic value of firm spanning, interpersonal relationships for knowledge development in the cluster and considered active facilitation and fostering of interpersonal relationship between cluster actors as part of their agenda. One interviewee, a consultant, in detailing what his job entails explained that “*one of things I’ve been doing, I’ve been building a network of partners [between firms]*” and that they felt one of their major tasks was to “*get people connected*”.

#### **5.1.1. Stronger relationships**

Even though data clearly suggested that firm spanning, interpersonal relationships in general were drivers for knowledge development, or referring to a term used by some interviewees, “*pipelines*” along which knowledge disseminated in the cluster, results indicated that relationships of different strengths were not equally effective in driving knowledge development. Although individuals rarely entertained relationships considered to be friendships, they felt that some of their “*professional relationships*” were closer and stronger than others. That certain relationships were stronger than others was evident in statements of interviewees who noted that they were closer to a few individuals from other firms and institutions, describing such a strong bond along the lines of “*closer to [name] than to [name]*”, “*more stable*”, “*having a stronger bond*” or “*[name] is the person I speak to most, by far*”, “*I trust [name] most*”. It was notable that interviewees described their stronger relationships more vividly and spent more time talking about these relationships. Regarding the impact of stronger relationships on knowledge development, interviewees stated they were more likely to exchange and develop knowledge with those with which they had a stronger bond. Some interviewees explained



that when they were in need of advice or consultation, they were more likely turn to someone they had a strong connection with before turning to other potential sources. In explaining why he was often consulted for advice, one interviewee from a cluster firm explained that it was because with *“some of them I might have a longer relationship with”*. This was further illustrated by another interviewee from a contract research laboratory, who explained why he preferred to consult a close acquaintance rather than someone he did not know as well *“because some of them had really little understanding of what [interviewee’s organisation] offers in terms of [focus of organisation]. Whereas X had an understanding, so, we have a unique understanding”*. Results also revealed that in many cases, individuals would exclusively turn to those with which they had a strong relationship. One interviewee, from a cluster firm, explained that *“apart from X and X [two people with whom the interviewee had a strong relationship], I didn’t find the other people terribly useful in a biotech sense”*.

Notably though, it was not only the strong relationships between two individuals that were relevant to knowledge development. Many interviewees described strong relationships among groups of people, each consisting of a small number of people from cluster firms (about three to five) who interacted with each other more frequently than with fellow cluster colleagues. This was illustrated by statements of a number of interviewees who, rather than describing their strong relationship with one person, explained they had a close bond to a group of people with whom they caught up frequently as a group, with interviewees across all actors stating that *“Closest, I am with X and X”* or *“[...] some of the guys from Y [cluster firm] would pop in”*. This resulted in intense knowledge development activities within those cliques and less intense knowledge development across cliques, with one interviewee noting that within his clique, *“I think there is more willingness to communicate. With X, who is the director of Y [another cluster firm] – and myself and that sort of level. Also X from Y”*. As a

consequence, in the investigated cluster, knowledge was developed more frequently and more effectively in a relationship characterised by a strong bond between two individuals or members of a clique. This indicated that stronger firm spanning relationships between individuals or among cliques were the most effective “*pipeline*” or “*medium for knowledge*” to be disseminated in the investigated cluster.

### **5.1.2. Networking**

Results show that the interwoven web of interpersonal relationships along which knowledge was developed was not stable. Rather, new firm spanning, interpersonal relationships were established frequently, hence creating new pipelines along which knowledge could potentially flow. One of the major means through which new relationships were established in the cluster was by leveraging existing relationships, a process referred to as “*networking*” by many interviewees. Networking was considered important for knowledge development because increasing an individual’s network of interpersonal relationships added new ‘sources’ of knowledge that cluster actors could tap into. This was emphasised by one interviewee from a cluster firm who stated in terms of efficient development of knowledge “*because of our size, we can’t cover all the bases [of knowledge], networking is really critical and it is key*”. Through networking, individuals in the cluster were made aware of, and became linked to, other individuals who held a particular skill set, knowledge or specific experience, with one interviewee describing such a situation: “*I might say, hey you’ve got to meet so and so just across the room there because he does that sort of stuff if it is a researcher or someone trying to commercialise something. If you happen to know who could be helpful or useful or interested or engaging, you can point it out, call him over, they come, you leave, and they keep talking*”. Similarly, another interviewee from cluster management explained that he often had “*direct contact from people to me [...] asking, can you do this? And so I, it is my function to find out, who in my network is the best person for them to see*”. Yet another

interviewee from a cluster firm described how *“you often get called, with someone saying, so and so from such and such said that I should call you”*.

The process of networking was one of the indirect drivers for knowledge development in the cluster because it helped establish interpersonal relationships which drive knowledge directly. Interviewees were generally aware of the inherent value of networking for knowledge development. As a result of networking as a means to establish new interpersonal relationships and consequently adding new *“pipelines of knowledge”* interviewees of cluster firms and lateral actors alike named networking opportunities as one of the major benefits of being located in the cluster and deliberately sought to network whenever the opportunity presented itself. This could occur through explicitly asking other cluster actors in their current relationship network, as an interviewee from a cluster firm put it, *“do you know anybody who could help me with or has this particular skill set?”*

### ***5.1.3. People moving between firms and institutions***

Results revealed that another important indirect driver of knowledge development in the cluster was mobility of people within the cluster. People leaving a position in one cluster firm/institution and starting to work for another generally *“take their relationships with them”*, i.e. maintaining and nurturing interpersonal relationships with their ex-colleagues after the move. In describing such a relationship, one interviewee from a contract research laboratory explained that *“they might meet when they...if they know each other on a personal level. If it's people that have worked together in the past”*. As a result, relationships that have previously been intra-firm relationships were turned into firm spanning relationships, establishing a pipeline for potential knowledge development between cluster firms.

Results revealed that movement of people between cluster firms happened frequently and that many strong firm spanning relationships in the cluster had come about after one of the parties had moved. As one interviewee from a cluster firm put it, *“yes, I used to work for Y [company] which is in the Z [other company] building. So I meet with those guys regularly still”* or *“X [name of colleague that has moved on to another cluster firm] used to be on our board and I’ve got a strong relationship with him as well”*, while another from a cluster firm explained how he still connected with a former colleague: *“X was formerly a CEO of Y [cluster firm]. And I worked there as an intellectual property advisor. So I knew him. And occasionally I still talk to him”*. Another interviewee from cluster management, in commenting on firm or institution spanning interpersonal relationships, confirmed that such relationships are due to people having worked together in the past and that he was *“aware of those sorts of relationships, and most of the times, they have been pre-existing”*. Interviewees further explained that they often leveraged relationships with ex-colleagues for knowledge development by asking them for specific technical or business advice, with one interviewee from a contract research laboratory noting that when sourcing knowledge that cannot be found within the firm he would first turn to *“someone who’s known, someone you worked with at some stage”*. Similarly, in explaining who he would contact if he needed urgent advice, one interviewee from a contract research laboratory noted that his first contact would be an ex-colleague who *“was our quality manager here. [...]. So that’s a contact. It also gravitates towards someone, to the people who have worked here, I suppose”*.

Notably, results showed that a considerable number of people were shifting from research or academia careers to work in industry, i.e. shifting from research institutions to commercial cluster firms, for example, *“when I worked for Y [firm], I had left Z [hospital] where I had worked for 24 years”*, or *“Well, I know X, he used to work with me in a previous life. A laboratory that we both worked at”*. Those former researchers still maintained relationships with their former institutions and leveraged those relationships

for knowledge development. One interviewee from a cluster firm noted that *“we are still in contact because we spun out of the [university], so we got links back to the [university]. [...] We’ve got X still on our board and we got him for any interaction with the uni. We would ask, could uni help us with this regard, and he would say, yes”*. Hence, people moving between clusters firms and institutions whilst maintaining relationships were major enablers of knowledge development, which was especially significant between research institutions/universities and firms.

In addition to people moving within the cluster, many interviewees described that they maintained interpersonal relationships with ex-colleagues who had left the cluster to work for remote firms or institutions (remote in terms of geographic location and/or outside the biotechnology industry). As a result, such relationships were considered knowledge pipelines connecting the cluster to the *“rest of the world”*. Interviewees described that they would ask now remote individuals for advice, often turning to them before turning to someone locally in the cluster. As one interviewee from a cluster firm noted *“I can call him anytime, to discuss anything. He is on our Singapore board”*. Another interviewee from a contract research laboratory explained how *“my old boss there [remote location] now runs that company, and rang up and asked, can you do this for me?”* As a result, relationships with remote actors drove knowledge development in the cluster and were particularly important for sourcing remote knowledge.

## **5.2. Informal interaction and how it drives knowledge development**

Interpersonal, firm spanning relationships drove knowledge development in the investigated cluster because when leveraged they acted as pipelines along which knowledge was developed. Results also revealed *how* knowledge flows along those pipelines, therefore a second dominant driver of knowledge development was the informal interaction between cluster actors. Interaction referred to a reciprocal communication between two individuals, with interviewees describing interactions along

the lines of *“I talk to X on a regular basis”, “We had a chat”, “I caught up with [...]”* or *“I interacted with X a couple of times”*.

The interesting finding was that not all types of interaction drove knowledge development in the investigated cluster. Results revealed that it was informal, rather than formal, interaction that was the most effective driver for knowledge development. Informal interaction was considered interaction that did not follow an official protocol, was not directed towards a pre-specified objective, or, as one interviewee from a cluster firm put it: *“you can speak to them fairly informally about [specific topic], you know, so it may be work related, but it won’t be specifically trying to address issues”*. Informal interaction was generally perceived to be amicable and relaxed in nature, with one interviewee describing informal interaction as *“that informal part, where people could relax and free wheel and put out crazy ideas, retract, something less threatening”*. Informal interaction usually *“just happens”* when people come together in an informal setting. Examples of informal settings as described by interviewees included *“just sitting and having a coffee”, “just having a chat with”, “having a beer with someone”* or *“we just catch up”*.

Regardless of the setting, informal interaction was most likely to ensue and hence knowledge was most likely to be developed between two individuals if they had an interpersonal relationship. As one interviewee from a cluster firm put it, in terms of development of knowledge, *“I think the social side of things is key...having someone that you know about and pick up the phone and call in a certain situation. It’s probably more about whether you know them, whether you have had a beer with them at a working function, than it is having a formal communication”*. However, even though an existing interpersonal relationship appeared to increase likelihood of informal interaction, it was not an absolutely necessary prerequisite. Even though, according to interviewees, relationships could greatly facilitate initiation of informal interaction and hence the development of knowledge because people felt *“comfortable with each other”*, some interviewees described situations where it was informal interaction with a stranger that

initially built a relationship. For example, one interviewee from a cluster firm commented that *“I think they [opportunities for informal interaction at a networking event] are great. They are good for building that relationship”*. This illustrates that interpersonal relationships and informal interaction were closely interlinked and reinforced one another, fostering development of knowledge.

Interviewees were aware that knowledge generally flows during informal interactions. As a result, most interviewees strongly preferred informal to formal interactions and tried to keep interactions with other individuals from the cluster on an informal level to foster the flow of knowledge. For example, one interviewee from cluster management noted that *“It’s REALLY informal. That’s pretty much how I like to conduct most of my [interactions] [...] That’s me. If I am meeting up, I’d rather do it over a coffee”*

Similarly, another interviewee from a cluster firm explained that *“the informal part [of an event] is the most important part for me”*. A third interviewee from a cluster firm emphasised that he preferred informal interaction over formal interaction because *“there is no communication plan, if you like, formally set up, to interact with the cluster or the precinct [...] I think it is fine the way it is. There is a lot of strength in that informality”*.

Interviewees made it clear that this ‘strength’ of informality related to its effectiveness for knowledge exchange and transfer. As one interviewee from a cluster firm put it, *“I’d say you exchange a lot of information if you get people together to have a glass of wine”*.

Such an exchange of knowledge was possible during informal interactions because people *“are quite comfortable talking to you, and they are hoping that it might help them, because they hope that you might give them some information that they could benefit from”*, as an interviewee from a cluster firm put it. This quote illustrates that informal interactions fostered knowledge transfer and sharing because people tended to be more willing to share knowledge. This is because informality creates a feeling of *“being comfortable”* with each other and hence induces trust. This was further illustrated by another interviewee from a cluster firm, noting that, *“if you enjoy interacting with them*

*[other cluster colleagues], then you are sharing information”*. Furthermore, many interviewees found that informality in interaction enabled development of tacit knowledge, a concept of which many were aware and which they considered particularly valuable. Illustrating this, one interviewee from cluster management described informal interaction as a situation *“where people come in and they talk about it whatever they are doing in the company, but it’s the exchange of tacit information that happens at these functions. Tacit information is valuable because it transfers something that is difficult to transfer otherwise”*.

Results showed that informal interaction drove knowledge development because it gave rise to development of ‘unexpected’ knowledge. Through informal interaction, interviewees found that they sometimes acquired knowledge they did not ask for because more often than not informal conversations take unexpected courses. As one interviewee from a cluster firm put it, during informal conversations *“you can be a bit elastic and flexible with your thoughts”*. Such unexpected knowledge exchange could take the form of information about which fellow cluster colleagues or firms hold specific resources and skills, with one interviewee stating that through informal interaction *“you may not talk about it specifically, but you do get a flavour of who is around, what their skill bases are”*. Unexpected knowledge exchanged also included attitudes or implicit understanding towards sensitive issues including conversations *“like, how do you work with your bank managers, because I got a problem with mine”* or *“seeing what kind of person [another cluster colleague] they are”*, as explained by two interviewees from cluster firms. This illustrates that despite the fact that people did not *“ask for it”* to happen, fruitful knowledge development still ensued without effort and those involved in the interaction found this unexpected knowledge valuable.

Results clearly showed that informal interaction was the most effective channel for knowledge development, particularly for knowledge considered valuable by interviewees.



This was further emphasised by comparing how interviewees described instances of formal interaction. Interviewees explained that they often engaged in interaction with other individuals from the cluster that was coordinated by formal rules and procedures and directed towards an objective specified in advance. As one interviewee from a contract research laboratory stated when describing how he interacted formally with his company's client "*we talk specifically about what they [the client] need and how we can provide it*". This quote illustrates that formal interaction was considered necessary when specific, business related issues have to be discussed, with the discussion being guided by a particular objective that all parties were aware of, hence usually in the setting of a "*previously arranged meeting*" or "*fixed appointments*", e.g. in the context of a supplier-buyer relationship or "*service provision*". Such instances of formal interaction were described by interviewees to be "*rather brief*" e.g. a "*quick phone call*". Besides acknowledging that formal interaction happened and is part of everyday business routine, interviewees did not go into detail when describing formal interactions and mentioned it rather casually. Despite that formal interaction was clearly part of peoples' day to day activities, from the responses of the interviewees it seemed that knowledge was not commonly developed through formal interaction.

Cluster management and consultants were aware of the importance of informality for knowledge development. As a result, they saw it as part of their agenda to foster interaction and informality because they were aware of "*the value [in terms of knowledge development] of being able to facilitate, bringing people together, that's what we do, being able to provide that vehicle*". Similarly, an interviewee from cluster management described his interaction with cluster actors: "*So I go out with them having a cup of coffee in a coffee shop somewhere and I don't say anything for half an hour*", explaining that "*it's [interacting informally] deliberate*". He further emphasised the importance of informal interaction by explaining that the ability to create an informal setting is a requirement for people applying to the company: "*If they can't entertain me, talk about*

*themselves for half an hour, then they will not join my organisation. So the people skill here in an organisation to interact with other people is of highest priority*". Not surprisingly, fostering informal interaction between individuals in the cluster was explicitly part of the strategy to foster knowledge development. A consultant explained that informal interaction was his strategy to approach people in the cluster in order to transfer knowledge to them: *"I'm involved in guerrilla tactics. There is nothing formal about this, no formal program, so I am trying to get something going that has no official sanction. And I've been permitted. I haven't been slapped on the wrist, but I haven't been supported either. It's very informal". There's no program, there are no guidelines*".

Informal interaction was hence 'used' as a strategic tool for practitioners to actively foster knowledge development.

#### **5.2.1. Spontaneous interaction**

Results showed that for an interaction to turn into an informal conversation in the course of which knowledge was developed it should be triggered spontaneously rather than being planned and premeditated. Spontaneous encounters foster informality which fosters the exchange and transfer of knowledge considered valuable by interviewees. One interviewee from a cluster firm described a situation of spontaneous interaction when he had successfully shared knowledge he considered valuable: *"A good example is myself running into these other CEOs, you know often we talk about things without a particular agenda, but you pick up areas of knowledge that hold you in pretty good stead*". Many instances of spontaneous interaction were described by interviewees, which shows that spontaneous encounters are a major driver of knowledge development. An interviewee from a contract research laboratory explained how a spontaneous encounter led to him providing knowledge to the other party: He stated that *"if somebody is with me I can have a little tour of the lab and I can show what we are doing*". Spontaneous interaction in the cluster usually took place after people were *"bumping into each other"*, i.e. meeting in person coincidentally and *"stopping to have a chat"*. Many interviewees had such a

strong preference for spontaneous interaction as opposed to planned interaction stating that they interacted with other people “*mostly ad-hoc*”. For example, an interviewee from a cluster firm explained that he met colleagues from other cluster firms “*pretty much just in the corridors and things like that. So as you walk in in the morning. You have a chat*”. As a result, firm spanning interactions in the cluster was rarely planned ahead, but seemed to happen largely ad hoc.

Cluster management and consultants commented that they recognised the strategic value of people interacting spontaneously for knowledge development, acknowledging that their role was that of a “*support mechanism, to facilitate, to foster interaction I suppose. Because I mean I am not doing the interaction between these people, but you are fostering, you are facilitating situations where people can interact*”. As a consequence, enabling interaction between different cluster actors was part of the agenda for the cluster, commenting that the most valuable knowledge in strategic terms was developed through “*the power of serendipity. It’s the power of serendipity. To create situations where people bump into each other and get to talk*”.

Planned interaction, on the other hand, did not seem to drive knowledge development in the same way because an informal atmosphere rarely ensued. Planned interaction was usually triggered because of an “*issue or a question that needs answering*”, as an interviewee from a contract research laboratory put it, and discussion during such meetings rarely went beyond the particular issue or question. It was evident that cluster actors did not have planned meetings, as an interviewee from a cluster firm put it, to “*just interact for the sake of it*”. Rather, interviewees who recounted formalised meetings stated those meetings were usually brief and the content limited to the particular issue to be discussed, with one interviewee from a cluster firm saying that “*it [content discussed during a formalised meeting] is all business, yeah*”. Therefore, during planned meetings, informal interaction rarely ensued, participants “*stuck to the schedule*” and only limited

information was shared and exchanged. Nevertheless, planned interaction, even though it did not drive knowledge development, was still one of the dominant ways that people interacted in the cluster. Planned interaction usually happened if one firm or contract research laboratory supplied another cluster actor with goods and services. One interviewee from a cluster firm, in explaining why planned meetings are generally initiated, stated that *“we are a supplier of their equipment. It’s a business sort of thing”*. Furthermore, he explained that with the firms to which his firm was a supplier, he had *“fixed appointments. You know. The reps would be part of the calling cycles to try and network with as many people as you can. The sales people would be trying to book meetings with their departments, and their laboratories on a regular basis”*. As a result, in relationships characterised by one organisation supplying input to another, or one firm being the client of another firm, informal interaction rarely ensued and development of knowledge between those two parties was very minor or not evident at all.

### **5.2.2. No relationships and no interactions**

The majority of interviewees described that they maintained a rich network of firm spanning, interpersonal relationships and interacted informally with those with those that they had a relationship with. Notably, there was a small number of interviewees, all from contract research laboratories, who stated that they did not have interpersonal relationships in the cluster and as a result *“little interaction with other firms”*. For these interviewees interaction with cluster firms resulted from transactional relationships, i.e. one firm supplying input to another, with one interviewee noting that *“we probably haven’t done a lot of networking with them [other cluster firms] outside the business side of things”*. As a result of lacking interpersonal relationships interviewees from contract research laboratories did not have much involvement in development of knowledge in the cluster, with one interviewee noting that *“we do not share as much [knowledge] as we probably should”*.

Interviewees with only transactional type relationships were the exception in the investigated cluster. Nevertheless, the accounts of these interviewees were interesting and useful. The underlying reasons of why these individuals do not participate in interpersonal relationships and knowledge development tell us in reverse what factors need to be present for relationships and knowledge development to occur, and hence are useful in addressing the research question regarding the drivers for knowledge development. Results revealed that the reasons for this lack of relationships and interactions are manifold. One contributing factor was that contact with other cluster firms or institutions had not eventuated in the past because there was no specific reason to trigger initial interaction. For example, cluster firms did not “*do business with*” each other, cooperate in joint projects, nor have a similar scope of business. Cluster actors did not initiate interactions or build relationships just for the sake of it. This meant that even though informal interaction can ensue spontaneously and take unexpected turns, an initial triggering factor must be present for interaction to be initiated and for knowledge development to ensue. Illustrating this, one interviewee commented that in order to engage with other individuals, he “*would have to need a very specific reason to doing it*”.

The existence of a relationship between parties was a facilitator for spontaneous, informal interaction. However, some interviewees noted that they were unable to dedicate time to interact or to build relationships due to a busy work schedule, with one interviewee from a contract research laboratory commenting that “*we went to a couple [of meetings] and met some good people. But then I guess time just got away. When the meetings were happening, it wasn't always convenient*”. Infrastructure was also an issue, with cluster actors not physically located in the district having less opportunity to interact and nurture interpersonal relationships. This was particularly the case for contract research laboratories, which are not located in the district, but spread across the city and state, because, as one interviewee from cluster management specified, “*it would be hard to get the face to face contact given that contract research labs are spread out all over the city.*”

*That is an issue. There is limited touchpoints*". As a result, those located further away from the cluster were most likely not to participate in knowledge development at all, with the same interviewee noting that *"we don't share [knowledge] as much as we probably should"*. This indicates that people not participating in knowledge development through interactions and relationships saw a benefit in doing so if they were to make the effort, but could not or did not want to overcome the hurdles.

### **5.3. Factors impacting on interpersonal relationships and interactions**

Results revealed that the main drivers for knowledge development in the cluster were firm spanning, interpersonal relationships which act as pipelines for knowledge flow and leverage of relationships for informal interaction. However, it was apparent from the data that a large number of factors impact on knowledge development facilitating, enabling or hindering the leverage of firm spanning, interpersonal relationships and interactions. Impacting factors further inform the research question which asked “What are the drivers of social capital for knowledge development?” by showing which factors drive knowledge development indirectly. Indirect factors were grouped into eight thematic categories and data informing those indirect factors is presented below.

- Channels of interaction
- Networking events
- Rules and norms
- The role of hierarchical levels
- Physical infrastructure
- Trust
- Diversity of cluster firms
- Types of knowledge

#### ***5.3.1. Channels of interaction***

Results revealed that the channel through which people interacted played an important role for effectiveness of the interaction in terms of knowledge development because informality ensued only through certain channels. In the cluster, face to face contact, phone and email were the channels that individuals used to interact with each other. Notably, people generally preferred face to face interaction to electronic communication due to the type of knowledge that can be exchanged via electronic communication is limited, or as one interviewee from a cluster firm put it, “*email is all right to set up meetings, but to do anything useful, it is face to face*”. Similarly, another interviewee noted that “*email is good for exchanging straight information, but I think to have that bit of added value or to analyse the information in a way to see what it really means, I think*

*this is often done personally rather than electronically*". As a result, when an interaction was necessary and had to be planned, most interviewees tried to organise such face to face meetings when possible, rather than electronic communication, with one interviewee from a cluster firm explaining *"I guess I have a personal preference to meet with people personally and I try and arrange a meeting over a cup of coffee"*.

Results also suggested that interviewees were aware of the effectiveness of face to face communication in terms of knowledge development, with one interviewee explaining that *"I think the best ideas, in my experience, are sometimes the best insights that come from a personal interaction"*. Interviewees understood that, unlike electronic communication, face to face enabled the transfer and exchange of knowledge through *"experiences"*, *"opinion"* or *"understanding"*. For example, one interviewee commented that *"when I said people moving to [the precinct] in the cluster, it's because of knowledge... that's not the knowledge you read in the paper. It's the knowledge that you only get face to face"*. Unlike electronic communication, face to face contact was found to create an informal and trust induced atmosphere which in turn facilitates informal interaction and hence knowledge development. This was illustrated by one interviewee who noted that: *"And particularly if you are going to do stuff, speaking to them and working out whether you can trust them or not and seeing what kind of person they are, this is really important"*. Similarly, another interviewee from a cluster firm found that both personal relationships and trust are built when interacting face to face: *"It [face to face contact] lowers the barriers to communication because you feel comfortable reaching out, because you know the person as a friend"*. Furthermore, interviewees found that face to face contact helped nurture and leverage existing interpersonal relationships which in turn fostered knowledge development. As an interviewee from a cluster firm stated, *"things tend to happen face to face, there is no misunderstandings basically, there may be questions that one asks. It is much better to keep it on a personal level"*. As a consequence of interviewees having a strong preference for informal interaction, face to face interaction



is how much of the knowledge, in particular the type of knowledge considered valuable by interviewees, was developed.

Consultants and cluster management were explicitly aware of the strategic value of face to face contact for knowledge development in the cluster because it helps build relationships. Hence, they considered it part of their agenda to create opportunities for face to face contact to happen between individuals in order to increase competitiveness of the cluster. One interviewee from this group explained that his professional objective was to *“help people come together and share experiences, because this is the only way for it to become meaningful”*, while another said that facilitating face to face interaction and the *“getting together”* of cluster actors was *“one of the many functions we have”*.

### **5.3.2. Networking events**

Results revealed that the vast majority of informal and spontaneous interaction happened when individuals from cluster firms and institutions met face to face at networking events organised by cluster management. Consequently, networking events were found to be a major indirect driver of knowledge development by creating a setting for informal interaction. In the investigated cluster, networking events are organised by cluster management and held at locations in and around the cluster precinct. Events usually start with a formal talk or presentation about biotechnology related topics where *“people sit back and listen”* and conclude with an explicitly informal networking forum where food, beverages and entertainment are provided, and participants are given the opportunity to *“mix and mingle in an informal setting”*.

The informal part of networking events was most important for people, with one interviewee from a contract research laboratory stating *“the informal part is the most important thing to me”*. Similarly, an interviewee from a cluster firm found that *“the reason why we get people to come to those functions is because they want to meet*

*others*". By meeting others in an informal atmosphere, knowledge was developed, or as one interviewee put it: *"I think those [events] were important for knowledge sharing because people's experiences came out"*. However, interviewees of both cluster firms and laboratories explained that they were also interested in presentation topics and an interesting and relevant topic would influence their decision to attend an event, with one interviewee from a cluster firm stating that *"I still get the newsletter, and invites. And I guess I look at them to see if it is of interest to me, and whether there is any benefit for us as an organisation to be there"* or *"if the presentation was immediately relevant for me so that I can comment sensibly, so I would [attend]"*, as an interviewee from a contract research laboratory specified. As a result, opportunities for networking, interacting and hence knowledge development were lost if potential participants were not *"lured"* to attend events through interesting topics. This was consistent with numerous statements during interviews that even though they enjoyed developing knowledge in informal interactions, they would not initiate an interaction *"for the sake of it"*.

With individuals enjoying the opportunity for informal interaction and knowledge development, interviewees generally had a positive attitude towards the events describing them along the lines of *"I used to go and they were terrific"* or *"very effective"*, or a *"useful method"* for knowledge development. Therefore, cluster actors of all categories *"generally try and get to those networking events"* on a regular basis or *"go to all of them. They are all interesting"* The positive attitude and engagement of individuals rendered networking events effective for knowledge development due to the large number of people with different backgrounds meeting in an informal setting.

In addition to providing a forum for informal, face to face interaction, interviewees found that events facilitated knowledge development in the cluster because they were generally considered *"good for building that relationship"* or because *"you meet some good people there"*. Interviewees emphasised that during networking events, they were able to

network with people from other cluster firms and institutions that they would otherwise not have met, or nurture relationships with people that they did not meet face to face on a regular basis to leverage relationships for knowledge development later. This was illustrated by an interviewee from a cluster firm who described his networking experience at a recent event: *“That was great, because you are running into other people from other companies and universities”*. An interviewee from a contract research laboratory commented that *“people you had never met before, you’d have to stand next to them to start talking. That happens a lot. It’s good fun talking to someone that I haven’t seen before”*. More often than not, the networking events were the only opportunity to *“catch up with colleagues that you might not see any other times other than [cluster management’s] networking events”*, as one interviewee from a cluster firm stated. Networking, as discussed earlier, was one way of increasing cluster member’s net of relationships which they leverage for knowledge. Hence, the events were not only crucial for providing a setting for informal interaction, but for building new relationships which could subsequently be leveraged for knowledge development.

The importance of networking events for knowledge development also derived from many cluster actors being located remotely from the precinct. Networking events provided an opportunity to meet with colleagues face to face in an informal setting and hence engage in knowledge development. An interviewee from a cluster firm commented that *“we wouldn’t really meet. Other than maybe at [cluster management] networking forums”* or, as another interviewee from a cluster firm explained, *“it’s just those meetings [that I meet with other people informally]”*.

Notably, even though the feedback regarding networking events was predominantly positive, there were some interviewees who explicitly stated that they *“haven’t been to the cluster meetings in recent times”*, or have not attended at all, with one interviewee explaining: *“[I haven’t been to the events], not that I remember”*. Those interviewees

were predominantly from contract research laboratories which are located further away geographically (i.e. not in the precinct) and hence found it impractical to travel to networking events which were always held in and around the precinct. In order to attend the events they would have to travel and consequently invest time and money, with interviewees stating that *“we are too remote”* or *“sometimes, but not as often as I’d like because I am travelling”*. Such statements indicated that it was the physical distance that prevented people from attending, rather than a negative attitude towards those events. This finding emphasises the importance of close geographical proximity for knowledge development.

### **5.3.3. Rules and norms**

Results further revealed that another factor indirectly impacting on knowledge development in the cluster was the perceived absence of rules and norms that guide interaction. Apart from the explicit IP related cautions that they had to consider as part of their employment contract with their firm or institution, interviewees did not feel that there were any rules or norms, neither written down nor tacit, guiding how they should interact. Interestingly, this perceived freedom from rules and norms was considered conducive to knowledge development. Interviewees explicitly stated that knowledge could be shared freely and openly, and that they felt comfortable doing so, with an interviewee from a cluster firm contesting that *“no there aren’t [any rules that guide interaction and knowledge sharing]. No, not that I’m aware of. I’m quite happy for my people to talk to anybody. This company is an open book basically”*, while another interviewee from a cluster firm explained that *“you can’t breach confidentiality and you can’t breach IP. Other than those things people share pretty freely”*, and a third from a cluster firm detailed that *“obviously if you are working on a confidential project, you need to cover a confidentiality agreement where you discuss not too much. But there is a lot of information that you can exchange around”*.

As a result of a positive attitude towards free knowledge flow, many interviewees stated they were opposed to a rules and policies framework besides IP, because they felt that rules and norms that guide interaction and knowledge development would be a hindrance and that a framework dictating what can be shared and what cannot during interactions would not be beneficial. For example, referring to how knowledge exchange can be actively fostered, an interviewee from cluster management explained that *“it’s the magical serendipity. And that’s how industries are being built. That’s how it happens. There’s only so much you can do from a policy”*, noting that a rigid rules and norms framework would hinder *“serendipity”* from occurring. Interviewees indicated that even if a rules and norms framework was desired, implementing one in the cluster was *“impossible. [...] But a set of rules about how the companies talk to each other requires an organisation to facilitate that. It requires every company to agree to it”*, as detailed by a consultant. This indicated that a rules and policies framework was not desired by cluster actors and would most likely hinder knowledge development.

Interestingly, interviewees did not feel that the one *“written down rule”* that they were bound to follow, intellectual property, had a negative impact on knowledge development. Even though interviewees strongly emphasised that they had to be cautious not to disclose confidential information in interacting with individuals from other firms and institutions, for example explaining that *“all of our staff signed confidentiality agreements”*, it was clear that they did not feel that intellectual property rules had much of an impact on development of knowledge in the cluster, or more so, did not negatively impact on the positive effects of knowledge development. This was due to the type of knowledge usually targeted by IP and confidentiality agreements being technical, written and easily transmitted from one person to another, with one interviewee explaining that *“I think if you wanted to transfer technical knowledge, that would be quite hard because everybody needs to be aware of protecting their intellectual property”*. Examples of technical knowledge that interviewees were cautious about sharing included *“what*

*chemicals to use, how to check that they are working*” or *“you can’t talk about clients”*. However, technical knowledge was not the type of knowledge that interviewees found valuable. In describing the benefits they expected or had experienced during knowledge development with other individuals, interviewees referred to *“experiences”*, *“opinions”*, *“attitudes”* or *“insights”* which is harder to transfer, as a consultant put it: *“Not everything can be covered by agreements, and there has to be good will, and there has to be trust for knowledge that is just out of sight of specific technical things that have to be shared”*. This quote illustrates that it is the *“good will”* of people that is conducive for trust-infused interaction, rendering rules and norms unnecessary.

#### **5.3.4. The role of hierarchical levels**

Results revealed that hierarchical levels had a major impact on with whom people form relationships, and hence on firm spanning, interpersonal relationship ‘pipelines’ along which knowledge flows. Interview data suggested that knowledge in the cluster that was developed across firms and institutions almost exclusively between higher hierarchical levels, i.e. between those holding management positions, because only those at higher levels had relationships with each other and interacted. For example, a CEO of a cluster firm explained that *“[I interact with] the CEOs, CFOs, or the company’s secretaries or members of boards”*. Another interviewee, a CEO of a medium sized biotechnology firm, in discussing how he interacts with other cluster firms and institutions commented that *“it is probably more the highest level one and two. Highest level being board, so that is one, so it’s one and two”*, while another interviewee stated that *“it’s senior management to senior management mainly”*. On the other hand, the interaction of the lower hierarchical levels, which included researchers and/or administrative staff, tended to be more firm or institutional internal, and not firm spanning. As a consultant stated, *“people who are in the support role stay within their company, they don’t often interact”*. Referring to a specific R&D employee, an interviewee from a contract research laboratory noted that *“he [the R&D employee] does a bit of internal networking by talking to people from*

*[interviewee's firm], but he doesn't go out*". These quotes show that firm spanning, interpersonal relationships in the cluster tend to be maintained between the higher levels. Interviewees generally felt that lower levels did not maintain relationships, neither within the firm, nor firm spanning. This resulted in those from higher levels often having minimal interaction with research or administrative staff. A consultant, provided an example of a problem created by lacking relationship interaction between higher levels and R&D personnel: *"I was astounded, one of my senior R&D people, several years ago now, we were having lunch together. And he looked at me. And I had known this guy for years and years, we had worked together for years. And he says to me: X, what do you actually do? He had no idea. I was running the place, he had no idea what I actually do day to day"*. As a result of lower levels not maintaining relationships nor engaging in interaction, therefore *"being isolated"*, they did not contribute much to knowledge development. On the other hand, a higher hierarchical level appeared to be an indirect driver of knowledge development. This showed that the knowledge pipelines in the cluster, made up of firm spanning, interpersonal relationships, were skewed towards higher levels.

That lower levels did not contribute much to knowledge development in the cluster resulted in their knowledge not being shared and made available to other cluster actors. This, in turn, was considered a disadvantage by most interviewees who felt that researchers in particular possessed a rich base of valuable knowledge and experience, with one interviewee from a cluster firm describing R&D personnel as *"all in their early to mid 20s, they are really clever"*. A consultant, detailed the problem of lacking knowledge development between levels, *"if you get a bunch of people from the same level, they tend to stay within the things that are preoccupying them"*. Hence, not surprisingly, most interviewees would prefer if different hierarchical levels between firms and institutions interacted more frequently. In explaining whether he would like to interact more with lower levels, a CEO of a small firm stated: *"Absolutely [...] I think if*

*you are innovating and an entrepreneur, you have to talk to people at every level”.*

Evident from those statements is that the lack of relationships and little interaction between levels, and in particular with lower levels, was not due to people not wishing to interact. Rather, there appeared to be a lack of opportunity to interact with lower levels during day to day activities.

The lack of opportunity for different hierarchical levels to interact emphasises the need for opportunities and motivators for informal interaction to drive knowledge development as people in the cluster did not interact *“for the sake of it”*. One way to overcome the lack of interaction between different hierarchical levels were the networking events. Cluster management and consultants expressed that these events were part of their agenda to bring different levels together in the cluster so knowledge can flow between levels, with one interviewee explaining that *“we do that [bringing different levels together] at our networking functions. They are open to anybody. [...]”*. The networking functions were often considered the only opportunity for higher and lower levels to have contact with each other, with interviewees stating that *“it is really a mixture”* of different hierarchical levels. In particular, informal networking at events was considered by interviewees to be a setting where people of all levels had opportunity to communicate freely. In explaining why he found those events useful, one interviewee noted that interaction was between *“everybody and anybody, from the managing director down to the storeman”*. Similarly, an interviewee from cluster management commented that *“they [people from all levels] will mix and mingle”*. *No, this is where informal events are very important. If there is a social event on, people talk to everybody”*. In addition, some interviewees noted that networking events were a forum when lower level employees (R&D staff in particular) interact with people outside their firm. In explaining how one of his R&D staff interacts one interviewee from a cluster firm explained, *“[name of R&D employee] attends some of the events. Contract research labs are involved in at least one of the networking forums*



*each year, and [he] usually attends that*". These quotes further show the crucial role of networking events in providing a forum for people to develop knowledge.

### **5.3.5. Physical infrastructure**

Physical infrastructure was revealed to be another indirect driver of knowledge development because supportive infrastructure provided opportunity for face to face, spontaneous interaction and hence knowledge development, with one interviewee from a cluster firm explicitly stating that *"the degree of collaboration that happens tends to happen much more on a physical infrastructure basis"*. Specifically, it was evident from interview data that spontaneous, face to face interaction was most likely to ensue with people who located within walking distance in terms of geographic proximity. One interviewee explicitly said that the reason why he interacted with colleagues from other cluster firms was *"because we are fairly close together. Yeah, I think it is nice to have a precinct"*. Similarly, another interviewee from a cluster firm described how he would often interact spontaneously with colleagues from other firms because they were located in close proximity, sharing a building: *"Well an example is that one of the companies we shared a facility with, you have morning tea, you have more interaction there – an informal interaction [...] It is more spontaneous. If we wanted to have morning tea, it just goes"*. Furthermore, close geographic proximity appeared to nurture existing relationships between individuals or between cliques and hence fostered knowledge development along those relationships. For example, one interviewee discussed a strong bond with another individual from a cluster firm explaining that this person's workplace was *"next door to X [interviewee's company] for about five or six years anyway. So we know all the people and it's a personal favour more than anything else [...]. We share [product] deliveries and things like that. So again it's all infrastructure based"*. Similarly, in explaining why he had a particularly close, interaction-fuelled relationship with another cluster member, an interviewee from a cluster firm explained that *"Yeah, I*

would definitely say that that's the case [that we have a close relationship]. There are a few companies that are near us. [...] And we tend to work fairly close together”.

The importance of walking distance geographic proximity for knowledge development was further highlighted by the fact that cluster actors located not in the precinct, i.e. further away than walking distance, generally had low engagement in knowledge development because they were rarely presented with an opportunity to, as one interviewee put it, “*bump into each other*”. This was particularly an issue for the contract research laboratories which were located remotely on site of their respective universities or institutions, with one interviewee commenting: “*We're too remote. I bump into one of the people from [the precinct] in the shopping centre on weekends. If at all*”. As a consequence, interaction between laboratories and cluster firms was generally limited to prearranged and formalised meetings, without face to face contact, i.e. “*a lot of interaction is electronic. Emails flying around all the time. Our clients send information electronically due to the relatively large physical distance between those actors*”. This restriction to non-face to face, non-spontaneous interaction limited the development of knowledge between firms and research laboratories.

Results went on to reveal that close geographic proximity was conducive, but by no means sufficient, to trigger interaction. Interviewees emphasised that infrastructure needed to “*create a forum where folk can mix and mingle*”, with coffee shops and community spots where people can meet and interact informally, “*just catching someone in the general areas, sitting and have a coffee*”, as detailed by an interviewee from a cluster firm, and hence engage in knowledge development. A third interviewee, also from a cluster firm, explained that he exchanges most knowledge with individuals from other cluster firms while having “*a lot of chats at [name of coffee shop] down the street*”. The importance of such areas for interviewees implied that merely being located close

together did not necessarily initiate the “buzz”, of knowledge flow, as it was termed by cluster management.

The importance of supportive infrastructure providing a forum for informal interaction was further highlighted by many interviewees explicitly identifying problems of infrastructure as barriers to knowledge development which prevent spontaneous interaction and “*mixing and mingling*” from happening. The issue mentioned most frequently by interviewees across all actor categorisations was that the precinct area was considered to be old, “*run down*” and “*lacking visual amicability*”, and hence in need of major refurbishments. As one interviewee from a cluster firm stated, the district “*is old [...] The buildings, the labs... There is a fair amount that needs to be done*”. Due to the precinct being run down, roads and buildings were difficult to access by pedestrians or cars, making it hard to get around, with the CEO of a cluster firm providing the following example: “*if you take them [clients] up to the incubator and drive them up to the front door, it’s fine. But just the surroundings are a little bit... I mean I walk people regularly to the incubator. [...] And they are in danger in breaking their ankle on the footpath out there. It’s on a 45-degree angle and there is you know. One of the plates has been destroyed and they can put their foot through. There is some fundamental... I don’t know*”. As a result, individuals from many firms and institutions located in the district did not like to go outside, forfeiting the chance to meet people and interact. In addition to the area being shabby and run down, another problem identified by interviewees was the perceived shortage of community meeting spots where people can meet, interact and develop knowledge, for example cafés or parks. The importance of such spots has been highlighted by interviewees explaining how close physical proximity can be leveraged. However, even though some cafés are located near the precinct, according to interviewees, there were too few, with individuals from some firms having to walk relatively long distances to visit a café, sometimes demotivating them from going in the first place. More often than not, interviewees noted that local cafés had inconvenient

opening hours. As a consultant put it, *“Where are the coffee shops? And these are important. Where are the places that people are going to mix and mingle?”* An interviewee from cluster management explained that *“because of the current structure of [the district], it inhibits those informal interactions. Because there is no, for example, cafeteria where everyone goes at lunchtime and meet”*. Similarly, an interviewee from a cluster firm, in referring to a nearby café that had recently closed down, described that *“while the café was open, we had meetings and, yeah, we’d just sit and maybe have lunch or coffee or whatever, but now it’s a little bit trickier”*. A third interviewee, a consultant, summed up the problem as *“we need some public space”*. As evident from these quotes, the lack of public meeting spots forfeited the chance of interaction, as people from cluster firms and institutions require informal settings to interact and develop knowledge. Interviewees identifying major problems with infrastructure hindering informal interaction highlighted that supportive infrastructure is a prerequisite for informal interaction and hence knowledge development.

Another important feature of the physical infrastructure mentioned many times during interviews was the incubator building. The modern facility provides office and laboratory space for start-up biotechnology firms, as well as conference facilities. Many interviewees felt that the incubator fostered knowledge development between current tenants because the building, hosting community areas and meeting rooms, provides *“an area for common meeting”* and hence spontaneous, face to face and informal interaction. A CEO of a cluster firm located in the incubator building noted that *“what I do enjoy about being in this building is to chat to people ad hoc”*. Another interviewee, also from a cluster firm located in the incubator, explained that tenants *“have discussion happening within that incubator that we contribute to”* and a third further confirmed that *“definitely within the incubator it’s sort of informal communication”*. Furthermore, the building acts as a hub for all cluster actors, with some firms, which are neither current or past tenants, regularly using the building facilities for workshops or conferences. One interviewee

from a cluster firm stated that *“I was there actually last week, but... it wasn't...to visit anyone. We actually use the facility there to run training courses for our own organisation”*. Another interviewee also from a cluster firm detailed that *“I guess our organisation would use the venue 3-4 times a year, so I guess it is regularly”*. The importance for knowledge development that interviewees impute to the incubator further showed that infrastructure needs to provide common meeting spaces so close geographic proximity can be leveraged for knowledge development.

### **5.3.6. Trust**

Results showed that trust, inherent in a relationship and developed during informal interactions, was an indirect driver of, and a prerequisite for, knowledge development. Interviewees of both actor categories considered trust to be a *“lubricant”* which enabled the flow of knowledge through relationships and in interactions. Interviewees felt that without the presence of trust individuals would not be willing to share or exchange knowledge with others, let alone with people from other firms or institutions, with an interviewee from a cluster firm explaining that *“if you trust people and if you like people [...] - then you are sharing information”*. Another interviewee considered the role of trust in developing knowledge with cluster colleagues to be *“absolutely huge”*, while a third interviewee, also from a cluster firm, felt that in the context of knowledge sharing, *“trust is a very big one”*. One of the underlying reasons was that in sharing knowledge trust helped assess whether *“the information you receive is true and honest”*, and hence beneficial and valuable. Notably, trust as a prerequisite for knowledge development was particularly emphasised for knowledge of the non-technical and tacit type, with interviewees stating that without trust, tacit knowledge would not be willingly shared and exchanged in the cluster, or as a consultant suggested, *“there has to be trust for knowledge that is just out of sight of specific technical things that have to be shared”*. This quote illustrates that tacit knowledge was the knowledge type that, according to interviewees, was exchanged during informal interaction and in interpersonal

relationships, and the exchange and acquisition of tacit knowledge was considered a benefit to knowledge development.

Results suggest that trust was most likely to develop during face to face contact, showing why this channel was considered most effective for knowledge development. In this context, one interviewee justified his preference: *“I have a personal preference to meet with people personally [...]. And particularly if you are going to do stuff [...], speaking to them and working out whether you can trust them or not and seeing what kind of person they are is really important”*. Trust was also considered to be an inherent feature of interpersonal relationships, and hence considered to be a major reason why knowledge development was most frequent and effective between two people who maintained an interpersonal relationship. In explaining the relationship of two cluster actors, a consultant shared: *“I’m amazed how those guys trust each other, about quite detailed things, but it’s because they know each other”*. Another interviewee from a contract research laboratory explained that in interacting with people from other cluster firms and institutions, in order for knowledge to be developed between people *“it has to be personal, it has to be trust”*.

Some interviewees noted that it was trust that guided knowledge sharing, thus making rules and norms for knowledge development unnecessary. Rather than adhering to rules and norms, interviewees felt that knowledge could be shared and exchanged as long as the other party could be trusted, with one interviewee from a cluster firm noting that *“you know, if there wasn’t a CVA in place, there certainly was a spoken agreement about what was said about the state in the room [...], which relies on a fair degree of trust”*, whereas another interviewee, a consultant, found that *“there has to be good will, and there has to be trust”*. Another interviewee from a cluster firm found that, in interacting with others, rather than thinking about what is covered by a confidentiality agreement, *“we gotta have trust”*. As discussed previously, the absence of a rules and norms framework appeared to

foster the free flow of knowledge, with interviewees agreeing that rigid rules and norms would hinder knowledge development. This emphasised that trust was an enabler for knowledge development indirectly by rendering rules and norms unnecessary.

Consultants and cluster management emphasised that trust was important for effective “*working together*” as in the absence of trust cluster actors would not be receptive for cluster managements’ and consultants’ agendas, for example to foster a knowledge supporting infrastructure. An interviewee from the cluster noted that “*it’s not the buildings, or physical arrangements that foster trust. It’s more that the trust enables physical things to happen*”. Another interviewee, a consultant, commented “*the precinct, the extension of the precinct actually happened because individuals trusted each other. So I knew X, who was an investor, and she had my trust, and my confidence to see that this is worth me putting time into it*”. As a result, cluster management and consultants emphasised that they were aware of the strategic value of trust, and hence considered building trust amongst people to be part of their objective to provide this “*lubricant*” for knowledge development. One consultant familiar with the social capital concept and its importance for knowledge development noted that in order to foster social capital, trust has to be built: “*Because talking of social capital, the important thing really at the human level is the trust that is absolutely important, and that takes time to build up, it’s a human process*”. These quotes show that building trust was a strategic tool for practitioners to help actively facilitate knowledge development between cluster colleagues.

### **5.3.7. Diversity of cluster firms and institutions**

Another factor impacting indirectly on knowledge development was the diversity of cluster firms and associated institutions. Data showed that high firm diversity of cluster firms may act as a barrier to knowledge development. Specifically, if two firms or institutions had very diverse scopes of operations (in terms of products and services and little overlap of the activities they perform), this may prevent knowledge development

between those firms and institutions. Identifying such a barrier, however, was conducive in informing the research questions because examining hindering factors provided an indication of the underlying dynamics of how knowledge development is driven. The underlying reason as to why product and operational diversity was a barrier to knowledge development was because people from diverse firms and institutions were not motivated to establish relationships or interact as interviewees did not interact simply for the sake of it. Consistent with biotechnology being an industry comprising a large number of fields, many interviewees noted that in the cluster they felt that their own firm's scope of operations was unique, with one interviewee explaining that *"it's not that many here in [the cluster] that we compete against"*, while another interviewee from a cluster firm explained that *"nobody got the same degree of...the same specialisation that we got here"*. In explaining why he did not interact much with colleagues from firms and institutions that did not share the same specialisation, another interviewee also from a cluster firm explained that *"we didn't have the same background. It's funny. Science is funny. As soon as you move out of your discipline"*. Similarly, a third interviewee also from a cluster firm explained why individuals from other firms infrequently initiated interaction with him due to the highly unique and specialised scope of his firm *"was the problem. And lipid biochemists, it's lipids, fats. And not what you would call sexy. It's not... lipids are not sexy"*.

As a result of firms in the cluster not sharing the same scope of operations, many interviewees that did not interact broadly felt that the knowledge base of other firms was not relevant to them, and hence could not be leveraged for their own advantage, thus discouraging interaction. An interviewee from a cluster firm noted that *"the cluster doesn't have the right technical skills to help me develop the technology here"*. As evident from this quote, lack of interaction between cluster firms and institutions with different scopes of activities is due to not seeing the opportunity to exchange knowledge



of the technical type (e.g. skills, technology). However, lack of motivation to initiate interaction resulted in other knowledge types, especially tacit knowledge such as experiences and attitudes, not being exchanged between people either. The lack of exchange of tacit knowledge was considered to be a “*negative side effect*” of cluster diversity, as indicated by many interviewees. Notably, a small number of interviewees whose respective firm or institution had a very unique scope of operations found that the lack of motivation to interact with others arose from “*being different*” to others and cancelled out the advantages arising from being located in the precinct. Accordingly, these interviewees considered moving away, as one interviewee from a cluster firm put it, he “*didn’t see any [advantages] there, other than that there are other scientists located, technology but they weren’t in our area*”.

That diversity of cluster firms hindered interpersonal interactions illustrated the importance of a physical forum where people can get together, meet spontaneously and start interaction in an informal setting. In the absence of such a forum, cluster actors did not see benefits of being proactive and initiating interactions that may result in knowledge development, due to a lack of a specific motivation to do so.

#### ***5.3.8. Types of knowledge***

In analysing interview data, an emerging theme was the type of knowledge developed. Specifically, results clearly showed that the type of knowledge exchanged differed depending on the nature of relationship and interaction, and that some types of knowledge were considered more valuable by interviewees than others for competitive advantage. Generally, technical knowledge was not the dominant type of knowledge developed in the cluster. Interviewees explained that if they needed specific technical advice they were likely to look outside the cluster because many felt that the cluster environment did not provide the skills needed. Interviewees explained that this was particularly due to the aforementioned diversity of cluster firms, with most being highly specialised in their

respective field. As an interviewee from a cluster firm commented, “*My engineering prototyping is done in [different state]*”. As a result, it was apparent that only on very rare occasions would cluster actors look for technical knowledge in the cluster.

Furthermore, interviewees noted that during informal and unplanned interactions when most knowledge development in the cluster happens, technical knowledge was rarely exchanged because “*people just don’t want to talk about work all the time*”, as noted by an interviewee from a contract research laboratory. Furthermore, technical knowledge was considered to be covered by IP agreements, with interviewees of all categories feeling that when interacting, “*you have to be cautious about your IP*”.

Rather than technical knowledge, it was mainly tacit knowledge that appeared to be developed in the cluster. Tacit knowledge was described along the lines of “*attitudes towards*”, “*experiencing [something]*”, “*learning from each other*”, “*how it’s done*” or “*insights*” by interviewees of both actor categories. An interviewee from a cluster firm defined tacit knowledge as “*the skills that they [researchers] gain in the lab, the skills that they gain when they have to do with clients – problem solving abilities and relation to what we actually do in here*”. Such knowledge “*can’t be written down*” and hence, as an interviewee from cluster management termed it, is “*tacit information*”. Consequently, when sharing experiences of knowledge development through relationships and interaction, on many occasions interviewees referred to a specific type of tacit knowledge that was frequently shared and exchanged between individuals, and considered very important and beneficial. Interviewees of both actor categories described “*management issues*” or “*the business side of things*”, which was tacit knowledge related to running their biotechnology firm as managers. Interviewees, even though they now held management positions, mostly had science backgrounds and had not received formal business education or qualifications, with one interviewee from a contract research laboratory commenting “*I think the marketing and the business side wasn’t my area, I was lab based*”. Hence, interviewees found it useful to exchange and share experiences,

attitudes and understanding about management issues with colleagues, with many interviewees having “*spoken to a couple of people for advice about particular aspects of business*”, as noted by an interviewee from a cluster firm. Specifically, interviewees of both actor categories explained that they exchanged knowledge concerning “*funding*”, “*expansion plans*” and “*whether we are setting up a manufacturing plant*”, “*where we will be going in the next five years*”, “*what would be an open service industry*” and “*for some of our clients, where we could use some of the [...] technology*”. In particular, interviewees generally valued the personal experiences and attitudes of those with which they had a close interpersonal relationship and found it “*interesting how they manage their business, what value they are looking for*”, as stated by an interviewee from a contract research laboratory. The account of peers was considered to be more honest, reliable and trustworthy. Since “*the business side of things*” was predominantly about personal experiences, or “*how we do things around here [the organisation]*”, it was not communicated in written form, but required face to face contact. Hence, such experiences were usually shared while “*running in the corridor and say, ok. You know. What do you think of this*”, as noted by an interviewee from a cluster firm.

Another example of tacit knowledge is related to personal attitudes of individuals shared during informal interactions and within the realm of a trusting relationship, e.g. knowledge relating to “*what do you think about this, or you know, would you be able to evaluate that?*”, as noted by an interviewee from a cluster firm. In particular, individuals exchanged and shared attitudes towards the government and government policy making, issues with funding (such as problems obtaining funding, who to approach and how), experiences and attitude towards cluster management and consultants, experiences with, and attitudes towards, research laboratories (or, in the case of research laboratories, problems with cluster firms) and also the value (or lack thereof) of being located in a cluster. Such attitudes and experiences were shared during informal interactions between cluster members with a very close interpersonal relationship where trust was present. As

an interviewee from a contract research laboratory stated, the sharing of attitudes was not perceived as an explicit “*sharing of knowledge*”, but a rather casual exchange where “*we might learn something from each other*”. Two other synonyms for the acquisition of knowledge used by interviewees of both actor categories were to “*realise*” and to “*get it*”.

Another important type of knowledge to which interviewees of both actor categories frequently referred was general awareness of “*who is who*” in the cluster, i.e. where to source specific knowledge, expertise and skills. Interviewees explained that in exchanging knowledge during an informal, face to face interaction, they were often made aware of which firms were present in the cluster and the scope of activity and skill sets of other firms, or in other words, “*just about knowing the expertise of the group*” or “*identify who would have that particular sort of knowledge*”. Interviewees emphasised that they would not have asked for that particular kind of knowledge. Rather, the acquisition of such knowledge was considered “*catching up with people and learn more about what they are doing*”, as detailed by an interviewee from a contract research laboratory. Nevertheless, interviewees found such knowledge valuable because curiously, despite close geographic proximity to other firms and institutions, more often than not interviewees did not know what skills and services were available in the local area, not having “*surface knowledge of the skill set of these [cluster] organisations*”, as one interviewee from a cluster firm stated. In the words of an interviewee from a cluster firm, “*there’s not many people here who know what we are doing*”. Similarly, an interviewee from a contract research laboratory found that, outside the context of informal encounters, “*people aren’t really forthcoming in what they are doing*”.

In light of people not knowing their neighbours in the cluster, gaining this awareness was considered useful. Interviewees found that the awareness opened up the option of finding, accessing and leveraging skills and resources available in the cluster in the future if

needed. For example, an interviewee from a cluster firm noted that through informal interaction with a colleague within the cluster he had gained “*general knowledge of where the expertise lies in the group and you can kind of initiate in some of the common area around*”. Many interviewees emphasised the usefulness of networking events as this type of knowledge could be acquired there. One interviewee from a cluster firm found networking events useful because “*you do get a flavour of who is around, what their skills are, just from a general discussion area, you make connections when you need them*”. This awareness of who is who and where expertise and knowledge was located in the cluster was the knowledge type most frequently mentioned, and most emphatically discussed by interviewees in explaining the value they identify in knowledge development. This highlights the situation of cluster actors being unaware of the knowledge available in the cluster, which was noted as an issue that hindered knowledge development, leading people to look outside rather than inside the cluster for advice.

Awareness of the existence of different types of knowledge, and the fact that some types are considered more valuable by cluster members than others, was an understanding harnessed by cluster management to foster the prosperity of the cluster. During interviews with cluster management, it became clear that interviewees were aware that tacit knowledge, rather than technical knowledge, was perceived as the more valuable knowledge in the cluster and the one that they should focus on developing. Hence cluster management saw it as part of their agenda to foster the exchange of tacit knowledge, with one interviewee explaining that “*tacit information is valuable because it transfers something that is difficult to transfer otherwise. But I call it the glue. It’s the glue in a relationship. That’s why people are together, it’s the glue in the community. When I said people moving in the cluster, it’s because of knowledge*”. Another interviewee from cluster management explained that he was aware of the importance of “*face to face communication*” for tacit knowledge to be exchanged. Hence, it was apparent that cluster

managements' facilitation activities targeted tacit knowledge in order to drive knowledge development in the cluster.

#### **5.4. Cluster firms**

The data showed that cluster firms have a central role in knowledge development in the cluster. Results revealed that cluster firms were the 'hub' for knowledge development in the cluster, meaning that knowledge flowing in the cluster usually 'passes through' a cluster firm. A large part of knowledge development in the cluster was amongst cluster firms to the exclusion of lateral actors, with cluster firms considering themselves to form "*a broader community*" of firms with members that have "*close ties*" with each other. This was also evident in that the majority of close interpersonal relationships described by interviewees from cluster firms were with individuals from other cluster firms, rather than with lateral actors. Furthermore, analysis of interview data revealed that the majority of informal, face to face interactions described by interviewees referred to interaction between two (or a group of) people from other cluster firms. This was because colleagues from other cluster firms were those that "*you are most likely to bump into*" in the precinct or incubator because lateral actors were predominantly located remotely. As a result, a large part of knowledge development in the cluster was driven through interactions and relationships of cluster firms.

Nevertheless, cluster firms interacted with lateral actors and entertained relationships with them. Notably, the involvement of lateral actors in knowledge development was predominantly through interactions and relationships with cluster firms, rather than with other lateral actors. Interviewees from the contract research laboratories explained that they did not maintain relationships with other laboratories, nor interact with other laboratories on a regular basis because "*all the research institutes, all [are] spread out all over the place*", with no opportunity for spontaneous, face to face interaction, as explained by an interviewee from cluster management. However, contract research

laboratories frequently interacted with cluster firms, mainly as part of their purpose to provide cluster firms with equipment, skills and services. Hence, as an interviewee from cluster management stated, *“I think the laboratories do [have a role in knowledge sharing in the cluster], particularly for the smaller companies”*.

Cluster management and consultants interacted frequently with cluster firms. An interviewee from cluster management described the organisation’s inherent purpose as: *“We are more there to interact with the companies [...]. Because that is what we do”*. As a result of interaction being part of their day to day routine, most interactions and relationships described by cluster management and consultants were with colleagues from cluster firms. Interviewees from cluster firms also described that they are actively involved with cluster management and frequently sought interaction to source knowledge from them, i.e. *“get the support services they need”*.

### **5.5. Contract research laboratories**

Due to their affiliation with universities, access to equipment and knowledge, and specialisation in niche fields of biotechnology, contract research laboratories were in possession of highly specialised technical knowledge, with interviewees noting that *“they [the laboratories] have got some really expensive gear that they’ve procured through grants and things like that”*. The laboratories were usually run by highly qualified and experienced individuals considered to be a rich source of tacit knowledge. Many interviewees from cluster firms described that they had often made use of the laboratories’ services for the purpose of accessing equipment and knowledge. This sometimes resulted in the establishment of relationships between certain firms and laboratories, depending on the field of specialisation, *“because it is extremely specialised [...], you tend not so much form alliances, but you form relationships with the laboratories”*. Most of the time, the laboratories interacted with cluster firms in the context of specialised service provision. Due to the remote location of the laboratories,

this was usually done via email or phone and content of such interaction was usually limited to information about service provision.

Cluster firms and interviewees from contract research laboratories rarely described informal, face to face interaction with each other. Furthermore, close interpersonal relationships were rare between cluster firms and contract research laboratories. The few interpersonal relationships between cluster firms and laboratories existed where the parties had previously worked together before one of them had shifted to another firm or institution. Interviewees from cluster firms emphasised that they perceived the laboratories to be a service provider and not a ‘partner’ for knowledge exchange, with one interviewee describing relationships with contract research laboratories as *“we pay them a lot of money to do what they do”*, while a second interviewee emphasised that *“we only need the laboratory for our clinical studies and trial”*. One interviewee, in discussing why he did not interact with contract research laboratories much, asked with a sarcastic undertone *“how deep is your pocket?”* and added that apart from providing equipment *“they weren’t of any help”* to his company. As a result of interactions and relationships between laboratories and cluster firms eventuating from service provision being formalised and not face to face, only technical knowledge was exchanged and limited to the context of a particular project. As laboratories act as a supplier to cluster firms, knowledge development exclusively happens *‘one way’*, with laboratories providing technical knowledge to cluster firms. One interviewee stated, *“I don’t think they deliberately hinder [knowledge exchange], but they don’t share the goodies that they’ve got”*. Apart from obvious financial gain, contract research laboratories did not reap any benefits from interaction with cluster firms, and hence did not identify benefit from being located in the cluster, with one interviewee from the laboratories noting that *“I can’t remember anything specifically coming out of [being located in the cluster]”*. Results showed that, besides service provision, contract research laboratories did not identify other opportunities to interact with other cluster actors. Interviewees from



contract research laboratories suggested that the relatively large geographic distance between the laboratories and other cluster actors, and the precinct in particular, hindered initiation of interaction and prevented establishment of relationships because they did not have the opportunity to “*mix and mingle*” or because, as one interviewee put it, “*there are limited touch points for laboratories. Just the events*”. However, individuals from the contract research laboratories were less likely to attend the networking events previously identified as a setting where much of the knowledge development in the cluster happens. The non-attendance of laboratories was partly due to physical distance, as the events are held in the precinct, with laboratory employees having to make time consuming travel arrangements causing major inconvenience. For example, in explaining why representatives from the laboratories rarely travelled to those events one interviewee stated that “*when there are events, they are not attended as much as it should be, because these events are normally after conventional working hours, and those people have other commitments apart from work, you know family*”. Employees from laboratories were generally not willing to condone those inconveniences because they did not see much benefit in attending the events, with one interviewee explaining “*it is a bit of a contract research laboratories problem, because those networking events have a commercial focus. So, it is not foremost in their mind [...]. You have got to do those things, you know 10 times, nothing might happen, but on the 11<sup>th</sup> time, you might meet someone that is a potential client, but if you didn't go the first 10 times, you wouldn't have eventually gotten to the 11<sup>th</sup>.*”.

Another reason why contract research laboratories did not have a major role in knowledge development is the lack of interaction and relationships between the laboratories. In addition to a relatively large physical distance between the laboratories, “*it is a very diverse group. They run from laboratories that basically do surface analysis, through to ours, which does chemistry*”, as an interviewee from a contract research laboratory explained. Hence, contract research laboratories did not have an initial motivation to

interact or form relationships with each other. Laboratories did not exchange their highly specialised knowledge, neither of the tacit type (experience, attitudes, *“learning from each other”*), nor of the technical type, e.g. who possesses a particular skill set or equipment, or how to use particular equipment. An interviewee from cluster management emphasised that this was indeed a problem and a hurdle to knowledge development, noting that laboratories should *“try to foster relationships between the different universities and research institutions. I mean if an institution or somebody got this gear, really expensive, it is pointless somebody else buying exactly the same gear. If possible... Is it possible to be able to use this instrument? And it is cheaper for everyone”*. The above quotes illustrate that there would be substantial benefits in knowledge development between the laboratories which to date have not been realised due to a lack of relationships and interactions.

## **5.6. Cluster management**

An important role for knowledge development in the investigated cluster fell to cluster management. Notably, cluster management was seldom directly involved in knowledge development. Rather, they were considered to be facilitators of knowledge development in the cluster which reflected the self-image of the cluster management organisation. For example, one interviewee from cluster management commented that *“I guess we see ourselves as a catalyst”*. Cluster management was well aware of the strategic value of knowledge development in order to foster cluster prosperity, commenting that *“they [firms and institutions] are moving to a hub of knowledge and with knowledge comes a competitive advantage and comes security”*. Therefore, in order to foster knowledge development, cluster management felt that one of their major tasks was to *“bring people together”*. This self-image also reflects how other cluster actors saw the role of cluster management, with an individual from a cluster firm commenting that *“[cluster management] can’t make us collaborate, can’t make us to be interested. They can’t make us like each other. It is just going to happen. But they can be the facilitator. A catalyst”*.

Another interviewee acknowledged the role of cluster management for successful knowledge development, commenting that *“it [knowledge development] is certainly facilitated enormously by [cluster management]”*.

Notably, many interviewees found that without the activities of cluster management knowledge development between cluster firms, laboratories and other institutions would not occur because *“somebody has to facilitate it [knowledge development]”*. One interviewee from a cluster firm felt that *“a private company could not do what cluster management does”*. Specifically, interviewees indicated that in the absence of cluster management, networking events which provided the foremost setting for knowledge development through interaction would not take place. A consultant noted that for such events to be organised there needed to be *“someone who will lead the initiative, who has the passion”*. Therefore, interviewees doubted that the firms or laboratories themselves would be proactive and organise such events because *“it would be difficult I think for companies within the incubator and the cluster, for them to be expected to spend the money to put on sessions like the [cluster management] networking sessions”*, as an interviewee from a contract research laboratory suggested. Similarly, another interviewee felt that *“I suppose somebody has got to keep that momentum going of stimulating the meetings between the various businesses”*. As a consequence, another interviewee from a cluster firm explained *“you probably wouldn’t develop those personal relationships if it weren’t for cluster management”*, illustrating that a large part of interactions and relationships in the cluster are due to cluster management facilitation activities.

Even though cluster firms and institutions were rarely proactive in fostering knowledge management, notably there was one regular meeting in the cluster organised through the efforts of firm CEOs. This meeting, however, was not considered effective for knowledge development, unlike networking events organised by cluster management. This regular meeting was intended to be a *“get together”* of firm leaders (CEOs) of selected cluster

firms, arranged by the firms themselves in cooperation with a consultant. Similar to the networking events organised by cluster management, the objective was to “*get selected people to talk to one another*” about current issues in the cluster environment. The CEO of a cluster firm described this meeting as “*some of the leaders from around [company name] and a group of others and myself, we try to meet once a month to sort of get together to see where things are going generally, is there anything that we can influence at the [state] level*”. However, only few interviewees were aware of this meeting, and even fewer had attended. Those who had attended noticed that attendance was low, only few firms participated, issues of their concern were rarely discussed, and the atmosphere was formal with participants not leaving their “*comfort zone*”. Hence, many interviewees did not consider this meeting to be valuable in terms of knowledge development, with a CEO of a cluster firm and an addressee of this meeting commenting that “*I’m not convinced that it has much impact, but we keep connected together, so that’s some bonuses, but not what I would call true bonuses in terms of scientific and knowledge sharing*”. This example reflects the statements of many interviewees who felt that networking activities were most effective if organised top down, further emphasising the importance of cluster management.

The role of cluster management reached beyond setting up opportunities for interaction between individuals. Cluster management also acted as a channel to access knowledge outside the cluster. In referring to the role of cluster management as a ‘middle man’ to establish connections outside the cluster, one interviewee commented: “*So they have that, they have facilitated, not only by setting up networking events, they can facilitate communication just because they are immersed in the industry*”. Specifically, interviewees noted that cluster management establishes connections and links to biotechnology firms and research institutions interstate and overseas with whom cluster firms can subsequently interact and source knowledge. In order to establish such connections cluster management leveraged its own network. As one interviewee

commented, the establishment of connections to remote firms and institutions in the absence of cluster managements' efforts "[...] would happen far less efficiently, because you would be less likely to come in contact with people who work in your specific area of interest".

Cluster management's role in knowledge development was through its responsibility for precinct infrastructure as cluster management considered "a precinct is important in creating a forum where folk can mix and mingle" and to "exchange tacit information". In particular, cluster management are in charge of improving infrastructure in such a way that it provides a convenient setting for firms and institutions to meet and to interact, e.g. by creating "common coffee pots, and the places that people are coming and sharing, perhaps encouraging each other". In order to improve knowledge sharing amongst cluster actors, cluster management felt that they need to consider "not just the knowledge sharing, but the physics. The [development plan] is about addressing the physical in such a way that it facilitates the human interactions". This further emphasises cluster managements' role as an important facilitator of knowledge development indirectly through the creation of supportive physical infrastructure.

Notably, through interactions with other cluster actors, cluster management specifically aimed to create a trustful and informal setting to make people "feel comfortable", to create a trust infused atmosphere and to generate the feeling that cluster management is approachable, with one interviewee from cluster management commenting that "It's my hate passion for my staff sitting here and have other people come to them. The staff who have industry interaction have to be out in industry. That means you go there, you meet them there, you talk to them there, you know". Other cluster actors generally spoke highly of cluster management and acknowledged the value, stating that "[cluster management] as a concept is quite good". Acknowledging the usefulness of cluster management, one interviewee commented that "[cluster management] is giving us guidance on planning

*and things like that. So I think from a task oriented aspect which is more of an operational aspect, it's been quite useful".* As a result of the generally positive attitude towards cluster management, knowledge development was facilitated because individuals from firms and institutions generally tried to be *"building the relationship with [cluster management]"* attending events and being receptive to the services they offered.

Even though cluster management's most important role is that of a facilitator for knowledge development, some interviewees found that they also contribute to knowledge development directly, albeit to a limited extent. For example, cluster management provides some advice to cluster firms on how to run a business, with one interviewee from a cluster firm explaining that *"I have met with [cluster management] a few times. Yes... [...] to see if we can put anything together... to make everyone aware of what [company] has to offer"*. This type of advice from cluster management was considered useful by interviewees because most have a biotechnology background without a business or commerce related qualification.

Another important role of cluster management, as emphasised by cluster firms and cluster management itself, was provision of advice concerning access to funding. The need for funding and lack of funding opportunities was a major issue for all interviewees, from cluster firms as well as those from the contract research laboratories. Hence, a major reason as to why cluster management is usually consulted for advice was based on the fact that *"a lot of companies around this area are really looking for funding, venture capital to keep them going to the next stage"*. Hence, the provision of knowledge about funding issues added to cluster managements' crucial role for knowledge development as a catalyst.

## 5.7. Consultants

Similar to cluster management, consultants' roles in knowledge development was that of facilitators, helping firms and institutions come together to exchange knowledge. When referring to knowledge development, one consultant commented that *"I guess my role is to light the fires and expect others to take the leadership"*, making it clear that he saw himself as a catalyst with the bigger part of knowledge development being the responsibility of firms and laboratories. Also, similar to cluster management, consultants contributed to knowledge development by organising seminars and *"get togethers"*. A CEO of a cluster firm saw the consultants' role as *"[they try] to get people networked"*. Similarly, one consultant specified when describing his role for the cluster that *"a lot of cluster development work is about connecting people. So it will be about being a sounding board and helping them connect with others, and where there is an exemplar that can be of value, I am happy to help. That's the role that I see for myself"*.

Consultants aimed to facilitate knowledge development through organising events, workshops and forums. The purpose of those events organised by consultants was to educate people, or *"capture the mind"* about specific issues, e.g. *"a specific cluster forum around [large company] and around suppliers"*. In order to convey this knowledge and disseminate it throughout the cluster, consultants organised events to educate about clusters in general and spread awareness of the value of being located in a cluster, e.g. *"workshops to help them [cluster actors] think through a potential development of a cluster, and what it is meant for them, what they had to do"*. However, the events were not organised as frequently, and only inviting a limited number of participants, with one consultant noting that *"these workshops are limited to 25 people, so I selected people from government, academia and industry"*. The vast majority of interviewees explained that they had never attended a meeting organised by consultants or even heard of them. Hence, through events, consultants reached only a limited number

of people and significantly less people than cluster management. The role of consultants as facilitators for knowledge development was therefore considerably less significant than that of cluster management.

Apart from organising events, consultants were involved with the cluster through cooperation with cluster management, e.g. helping with development of a supportive physical infrastructure that fosters interaction, with one consultant explaining that *“I put a lot of work in the development of (...) the infrastructure plan”*. Due to close cooperation, consultants often interacted with cluster management rather than with firms or laboratories directly, with one consultant noting that *“Most of our involvement I guess has probably been with [cluster management] [...]. We are predominantly interacting with them [cluster management]. X [name of cluster management staff] is basically the middle man between us and the laboratories and firms”*. This was supported by the fact that many interviewees described that they were at least occasionally involved with cluster management, but only a few recounted interaction with consultants. As a result, consultants’ role for knowledge development in the cluster was supportive and indirect, predominantly through helping cluster management with their activities.

Notably, one consultant who had previously held a management position in one of the cluster firms and had since moved on to a consultancy still maintained close personal relationships with people that he had worked with in the past and leveraged those relationships in his new field of work. According to one interviewee, a CEO of a cluster firm aware of this particular consultant’s activities stated the consultant was *“so well networked into the industry, he tries to make the connections”*. Cluster firms often consulted him for advice because they were aware of him knowing *“the business, the industry from inside out”*. Consequently, many interviewees from cluster firms who had worked with this consultant when he was working in biotechnology described that they had an amicable and trusting relationship with this consultant. This was in clear contrast



to the relationships of firms with other consultants which were formal in nature and not characterised by frequent interaction. Many interviewees did not have any interaction with other consultants at all, with one interviewee emphasising that *“he’s the only one”*. Informal interactions and interpersonal relationships of this particular consultant illustrate the importance of established relationships to leverage knowledge development, i.e. relationships maintained and nurtured for knowledge exchange even after one party moves on.

## **5.8. Universities**

In the investigated cluster, there were a number of local universities in close geographic proximity. Results revealed that their role in knowledge development was minor. Some interviewees from contract research laboratories stated that they had close relationships with other university researchers to which they turn when they need advice. This was because most contract research laboratories were integrated into universities and located on campus with many staff holding an affiliate position at their respective university. Consequently, contract research laboratories sourced most of their technical knowledge from their respective university when they needed advice. Cluster firms, on the other hand, rarely directly interacted with universities. Results revealed that interviewees see contract research laboratories as the interface that connects them with universities, deeming direct contact unnecessary. As one interviewee commented, *“people assume that because we are developing microbiology diagnostics, we are closely associated with the microbiology department at university. But in fact, we only need the laboratory for our clinical studies and trial”*. This shows that universities predominantly disseminated their knowledge to the cluster through contract research laboratories rather than through direct contact with other cluster actors.

Notably, a small number of cluster firms had spun out of universities. Only interviewees from those firms interacted directly with universities. Those interviewees stated that they

still had amicable relationships with individuals from universities and stated that on occasions, when they needed technical advice, they would turn to universities, with one interviewee describing this relationship: *“We are in contact because we spun out of the university, so we got links back to this university. I guess in our highly regulated field, we need to have complete control. If there is anything non-regulated, that’s when we’d come back to universities”*. In light of other cluster firms having minimal interaction with universities, this example further illustrates how previously established relationships (in that case, when the interviewee was still part of the university) can be, and were, leveraged for knowledge development in the cluster.

Universities played an indirect role in knowledge development through supplying the cluster with students or graduates. Many cluster firms frequently recruited new R&D staff from local universities, provided work experience opportunities or employed graduate PhD researchers. One interviewee in charge of recruitment of a cluster firm explained that *“we take students in from a local university, work experiences and some other courses around here”*. According to interviewees, graduates acquire knowledge *“on the job”*, especially the type of knowledge that they cannot acquire through study, only through experience. One interviewee from a contract research laboratory stated that *“we train them up to give them industrial experience that they can take back”*, while another interviewee from a cluster firm noted *“that graduates coming straight out of university may know the basics of what is going on, but actually apply it to a particular area is normally a six months training program, not so much a program, but a six months training on the job before they actually got a handle and what’s the necessary settings”*. Another interviewee from a cluster firm added that after being on the job *“you tend to see that their knowledge base expands exponentially”*. This quote illustrates that while universities mainly transfer technical and theoretical knowledge to the firms via students and graduates, it was predominantly the students that were the benefactors of the relationship between firms and universities because they were exposed to an environment

where they could gain valuable experience. The role of universities (excluding the contract research laboratories) for knowledge development in the cluster can therefore be considered that of a benefactor because they have a large number of firms and institutions in close proximity that “*train their students on the job*”, complementing their academic knowledge with practical experience.

### **5.9. Government**

The government’s role for knowledge development in the investigated cluster was limited. Most interviewees perceived cluster management to be the “*the government’s executing body*”, with one interviewee from a cluster firm commenting on the government’s role, “*I’m assuming [cluster management] has already covered that*”, while another interviewee, also from a cluster firm, indicated that “*I guess cluster management is the voice for the government*”. When cluster actors need to communicate with government they approach cluster management first. As a result, cluster firms and institutions had little interaction or communication with government, with one interviewee from a contract research laboratory noting, “*I don’t deal much with the government*”.

When the government was mentioned during interviews, both cluster firms and contract research laboratories referred to the government’s role in providing funding, with interviewees of both categories explaining “*we are government funded, so we are accountable to the government*” or “*we are probably going to be looking at what sort of R&D benefits or government support could we even get in support of an expansion*”. This illustrates that the government’s major task was perceived as provision of funding, while it did not have a direct role in knowledge development. The government only indirectly impacted on knowledge development in the cluster because it has cluster management as its “*executing body*”.

### 5.10. Remote actors

An emerging result was the fact that remote actors, i.e. actors not affiliated with the cluster and hence, in reference to cluster literature, not considered cluster actors, have a major role in development of knowledge in the cluster. Surprisingly, the role of remote actors appeared to be more significant than that of the government, local universities or consultants. Results revealed that a diverse range of actors, either not located geographically close or not affiliated with biotechnology, were involved in the development of knowledge. Notably, many interviewees stated that they were more likely to source knowledge from external actors with which they have an interpersonal relationship, rather than from within the cluster. For example, in explaining where he would get advice one interviewee from a cluster firm stated that *“I’d go to my tech group first. That’s the way. Tech is the executive connection, in other parts of the world. [...] Obviously if you have a problem you would be dealing with it internally. And then we would always seek external advice. That’s my support network”*. Another interviewee explained that when it comes to sourcing knowledge, rather than looking in the cluster first, his firm *“has pipelines worldwide”* for knowledge that he consulted regularly. Through such pipelines that were maintained by individuals’ interactions and relationships, the cluster was connected to the *“rest of the world”* where knowledge flows in and out. As one interviewee from a cluster firm put it, *“pipelines [are] also pulling in new knowledge, maybe academic institutions, linked to similar knowledge centres in the world”*.

One important reason why individuals from cluster firms and institutions developed knowledge with external actors was due to a close interpersonal relationship with an external actor. One interviewee from a cluster firm explained that knowledge is sought from *“not just the colleagues around here, in terms of business knowledge. A good friend in [other Australian capital city] two good friends in [said city] who are really askew*

*business men. And if I need advice in that particular direction...them*". Another reason, as stated by interviewees, was that remote actors identified by interviewees worked for a diverse range of firms or institutions, in diverse fields, located interstate and across the globe. Cluster firms that were divisions of larger, global firms tended to seek advice from divisions of the same company rather than from the cluster, as one interviewee stated, *"we got our own knowledge base, so we do our own problem solving"*. This was the case even if the knowledge base was located further away, with one interviewee detailing that his cluster firm *"has its own pipelines. We are about 100 people here, but we are part of a global organisation of about 17000 and manufacturing facilities all over the world"*, while another one explained that *"because we are global, in the firm we do quite a lot of information sharing, discussion of results, we split work between here, Chicago and India"*.

When interacting with external actors, interviewees of both actor categories noted that this was mainly done via *"email, phone, video conferencing"* as more often than not external actors were located at large physical distance. As a result, interaction was planned and formalised, and not surprisingly, knowledge exchanged was technical in nature, described by interviewees as *"we sought technical advice"* or *"technical skills"*. A reason as to why cluster members turned to external actors rather than sourcing knowledge locally was that they found on many occasions they could not find the knowledge they needed in the cluster, further emphasising that the diversity of the firms' scopes was hindering knowledge development. One interviewee from a cluster firm explained why he would consult remote actors rather than looking in the cluster, *"so we are making [product]. So there is no one here. We wouldn't compete with anyone here"*. A consultant stated that *"so they actually go remotely (for knowledge development), US and...yeah, and why? They leverage a different network, not realising that the local network has the same capacity"*. This quote suggests that awareness of available skills in the cluster was low. As a consequence, a large part of the opportunity to develop

knowledge locally, leveraging the “*local buzz*” through informal, face to face interactions and relationships for the development of tacit knowledge was not realised because people turned to external sources.

### **5.11. Summary**

This chapter presented data from the case study undertaken for this research. The first part of the chapter presented results corresponding to the first research question “what are the drivers of social capital for knowledge development?”, while the second part presented results with themes and issues corresponding to the second research question “which actors are involved in the development of knowledge in clusters and what are their respective roles?”

Data of this research showed that firm spanning, interpersonal relationships and informal interactions between individuals were the two dominant drivers for knowledge development in the investigated cluster. Interpersonal relationships act as pipelines for knowledge between cluster firms and institutions, whereas informal interaction leverages those interpersonal relationships for knowledge flow. In addition, results revealed a number of factors that drove or hindered knowledge development indirectly through their impact on interpersonal relationships and interaction. Specifically, a face to face channel of interaction, networking events, different hierarchical levels, infrastructure, trust, the absence of rules and policies and the diversity of cluster firms and institutions all impacted on knowledge development, by providing or hindering the opportunity for firm spanning, interpersonal relationships and/or spontaneous, informal interactions. An emerging result was that in addition to tacit knowledge, knowledge regarding the skills of fellow cluster colleagues and knowledge regarding how to run a business were considered to be the most valuable knowledge types.

Regarding roles of cluster actors in knowledge development, it was found that cluster firms had an important role for knowledge development being predominantly involved in the aforementioned interpersonal relationships and informal interactions that drove knowledge development. In contrast, contract research laboratories had minimal contribution to knowledge development, as they had fewer relationships with other cluster actors and limited interaction, especially not of the informal kind. This was due to their remote location, but also because they were perceived to be service providers. Results revealed that cluster management had a crucial role as a facilitator of knowledge development because through networking events and provision of supportive infrastructure a setting for informal interaction between cluster actors was created. The role of consultants was limited to helping cluster management fulfil its agenda. An emerging result was the important role of external actors, identified to be pipelines from and to the cluster leveraged for the flow of knowledge to the cluster from outside. Universities and the government did not play a major role in knowledge development in the investigated cluster, as they had no interaction with other cluster actors. Rather, they were represented by contract research laboratories and cluster management, respectively. The next chapter discusses how those consolidated results inform the propositions and address the research problem.

## **(6) INTERPRETATION**

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The following chapter presents the interpretation of the results with reference to current literature and theories, and in light of the five propositions that were presented in chapter four. First, results are interpreted in terms of proposition 1a), 1b) and 1c) exploring if and how the three dimensions of social capital –structural, cognitive and relational – drive knowledge development in the cluster. Then, results are interpreted in terms of propositions 2a) and 2b) exploring which cluster actors are involved in the leverage of social capital for knowledge development and their respective roles. Finally, two emerging themes, which do not relate to the propositions but nevertheless emerged from results, are identified, interpreted and discussed in light of relevant literature. The first of those emerging results is the distinction between individual and collective social capital in investigating how social capital drives knowledge development. The second emerging result is the importance of the knowledge type ‘knowledge of expertise location’ for competitive advantage. An overview of the findings, structured according to the corresponding propositions and underlying theoretical frameworks are presented in Table 13.



Table 13 - Summary of results interpretation

Corresponding proposition	Underlying theoretical framework	Interpretation/finding
P1a) suggests that the development of knowledge in clusters is likely to be driven by the structural dimension of social capital	Social capital dimensions in clusters (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998), strong and weak ties (Granovetter, 1983)	<p><u>Network ties</u></p> <ul style="list-style-type: none"> <li>• Interpersonal relationships and informal interactions are the major drivers for knowledge development in the cluster</li> <li>• Geographic proximity, in order to support knowledge development, should not exceed walking distance</li> <li>• Geographic proximity alone is not conducive for knowledge development, as it needs to be accompanied by supportive infrastructure</li> </ul> <p><u>Network configuration</u></p> <ul style="list-style-type: none"> <li>• Strong ties exist within cliques, whereas weak ties exist between different cliques</li> <li>• Strong ties exist between members of the same hierarchical level, whereas weak ties exist between levels</li> <li>• Cluster management acts as a boundary spanner in order to leverage the weak ties for knowledge development</li> </ul> <p><u>Network instability</u></p> <ul style="list-style-type: none"> <li>• Clusters are unstable networks. Weak ties with those that have left the cluster can be leveraged for knowledge development</li> </ul>
P1b) suggests that the development of knowledge in clusters is likely to be driven by the cognitive dimension of social capital	Social capital dimensions in clusters (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998), institutionalised rules and norms (Adler & Kwon, 2002; Von Hippel, 1987)	<ul style="list-style-type: none"> <li>• Lack of rules and norms helps development of tacit knowledge and fosters innovation</li> <li>• Trust is a substitute for formal or informal rules and norms, as it guides knowledge development and prevents opportunism in the sharing and exchange of knowledge</li> </ul>

Corresponding proposition	Underlying theoretical framework	Interpretation/finding
P1c) suggests that the development of knowledge in clusters is likely to be driven by the relational dimension of social capital	Social capital dimensions in clusters (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998); trust in relationships and knowledge exchange (Dyer & Singh, 1998; Maskell & Malmberg, 1999; Putnam, 2001b), relational embeddedness (Granovetter, 1985)	<ul style="list-style-type: none"> <li>• Trust is inherent in interpersonal relationships and supports the development of knowledge in the cluster</li> <li>• Trust is necessary for the exchange of strategically valuable tacit knowledge</li> <li>• Trust is particularly present in strong interpersonal relationships that have developed over time through a history of interaction</li> </ul>
P2a) suggests that cluster firms are likely to be involved in the development of knowledge through social capital	Cluster literature on cluster actors (Andersson et al., 2004), value adding web (Brown et al., 2010; Brown et al., 2007a), interdependencies (Thompson, 2003)	<ul style="list-style-type: none"> <li>• Cluster firms leverage their web of relationships with each other and with lateral actors in order to develop knowledge</li> <li>• Relationships of cluster firms are characterised primarily by sequential interdependencies, with little reciprocal or team oriented interdependencies</li> <li>• Cluster firms rarely actively initiate knowledge development. It ‘happens’ or is initiated by cluster management</li> </ul>
P2b) Lateral actors are likely to be involved in the development of knowledge through social capital	Approaches to cluster management (Bode, 2011; Terstriep, 2008), structural holes (Burt, 2009), value adding web (Brown et al., 2010; Brown et al., 2007a), interdependencies (Thompson, 2003)	<ul style="list-style-type: none"> <li>• Cluster management’s role is that of a crucial catalyst without which much knowledge development would not take place</li> <li>• There is merit to the ‘top down’ approach of cluster management</li> <li>• Cluster management creates value by bridging structural holes</li> <li>• Cluster management acts as a broker for relational resources</li> <li>• Albeit being the possessor of valuable knowledge sources, contract research laboratories are not as involved as they could be due to geographic distance to other actors exceeding walking distance</li> <li>• The relationship between contract research laboratories and cluster firms is characterised by sequential interdependencies, resulting in less relational resources</li> </ul>

Corresponding proposition	Underlying theoretical framework	Interpretation/finding
Emerging result: Individual vs collective/organisational social capital	Individual (Burt, 2000) and collective/organisational social capital (Bourdieu, 2008; Coleman, 1988; Kostova & Roth, 2003)	<ul style="list-style-type: none"> <li>• Knowledge development takes place between individuals, through their networks and their social capital</li> <li>• Emphasises the importance of individual social capital in the cluster, with collective or organisational social capital not as important for knowledge development</li> </ul>
Emerging result: Knowledge of expertise location	Tacit knowledge (Polanyi, 1966), knowledge of expertise location (Borgatti & Cross, 2003; Mitchell, Waterhouse, McNeil & Burgess, 2010)	<ul style="list-style-type: none"> <li>• Tacit knowledge is developed for competitive advantage</li> <li>• One of the most important knowledge types is knowledge of expertise location</li> <li>• Knowledge of expertise location motivates cluster members to engage in knowledge development</li> </ul>

## **6.1. The structural dimension of social capital**

Proposition 1a) suggests that

*The development of knowledge in clusters is likely to be driven by the structural dimension of social capital*

This proposition is strongly supported by results, which show that the structural dimension of social capital, describing the pattern and configuration of ties in the cluster (Burt, 2000; Nahapiet & Ghoshal, 1998), is a major driver for knowledge development. Specifically, results indicate that all three facets of the structural dimension of social capital, network ties, network configuration and network stability, are drivers for knowledge development in the cluster. In the following section, results are interpreted with reference to three facets of the structural dimensions of social capital, starting with network ties, followed by network configuration and concluding with network stability.

### **6.1.1. Network ties**

The network ties facet of the structural dimension of social capital describes the specific way network members are 'related', i.e. they specify why they are part of network (Nahapiet & Ghoshal, 1998). According to Inkpen and Tsang (2005), network ties in clusters are connections between cluster actors, established through interpersonal relationships and interactions of individuals, and characterised by the absence of more formalised connections. According to the authors, knowledge is developed along those cluster relationships. This notion is consistent with the data of this research. In the investigated cluster, close interpersonal relationships and informal interactions were the major drivers for knowledge development. In the absence of formal links (i.e. two firms or institutions doing business with each other), firm spanning, interpersonal relationships were the only connections between many firms and institutions in the cluster. It follows

that in the absence of interpersonal relationships, despite being located in a cluster, many firms and institutions may not be connected. As a result, with knowledge being inherently social in nature (Chua, 2006), knowledge development would be less likely to happen in the absence of interpersonal relationships (Inkpen & Tsang, 2005). The structural dimension of social capital hence drives knowledge development through interpersonal and informal connections, which also describe how cluster actors are connected in the case of the cluster explored.

In addition to interpersonal relationships, network ties in clusters take the form of geographic proximity. In other words, geographic proximity is the reason why cluster actors are linked (Inkpen & Tsang, 2005). Hence, in the context of clusters, geographic proximity is considered a facet of the structural dimension of social capital (Inkpen & Tsang, 2005). Even though in the investigated cluster interpersonal relationships were found to be the most important connection between cluster actors in the context of knowledge development, those relationships were enforced and enabled through close geographic proximity of the actors. In terms of knowledge development, the literature suggests a close link between a firm's or institution's location and the extent to which this firm or institution engages in knowledge development in the cluster as "firms occupying more central locations of the precinct have the edge over those located at the periphery" (Inkpen & Tsang, 2005, p. 156).

Data of this research strongly supported the idea of geographic proximity being conducive for knowledge development. In the investigated cluster, firms and institutions located directly in the precinct, rather than at a remote location in the city or state, engaged in knowledge development more frequently than those located in various other locations in the cluster. Firms and institutions in close proximity to the precinct had more opportunities to interact informally and spontaneously, and to nourish interpersonal relationships via face to face interactions. Notably though, data further suggested that

geographic proximity, in order to drive knowledge development in the investigated cluster, should not exceed walking distance. This finding is interesting given that even though the literature emphasises the significance of geographic proximity for knowledge development (Audretsch & Feldman, 2004), there is ongoing debate in cluster research about how to define close geographic proximity with reference to clusters. In the literature, 'geographically close' can be anything ranging from being located in the same building to spanning different countries (Andersson et al., 2004). However, results of this research indicated that cluster actors should be close enough to access each other via a short walk, contrasting literature which states that a cluster can span a couple of hundred kilometres and still be driving knowledge development. This finding gives rise to the conclusion that at least for knowledge-based clusters characterised by a focus on innovation and technical progress (Andersson et al., 2004), knowledge development is fostered if geographic proximity does not exceed walking distance.

While results indicated that geographic proximity not exceeding walking distance fosters knowledge development in clusters, it was revealed that geographic closeness was not sufficient to foster knowledge development. Data of this research clearly showed that supporting infrastructure needs to be present that makes it easy for cluster actors to meet in person and to interact (accessibility, community spots) and therefore leverage geographic proximity for knowledge development. In the absence of supporting infrastructure, geographic proximity alone may not be conducive to knowledge development. This finding is interesting because Inkpen and Tsang (2005) consider geographic proximity as a facet of network configuration that drives knowledge development, without mentioning infrastructure. Furthermore, the importance of a supportive infrastructure is striking because geographic proximity has been considered to be the dominant defining feature of clusters (Porter, 2000; Rosenfeld, 1997; Waits, 2000), with cited studies stressing that it is this close proximity that fosters benefits arising from clustering. However, data from this research suggested that geographic proximity is a

necessary, but not sufficient condition for knowledge development and hence for the benefits of clustering to eventuate. Therefore, in explaining how knowledge is developed in clusters, one ought not consider proximity in isolation, but also explore whether there is supportive infrastructure in place.

In summary, network ties drive knowledge development through interpersonal relationships between individuals and geographic proximity. However, in order for geographic proximity to be leveraged supportive infrastructure is required.

### ***6.1.2. Network configuration***

Network configuration is the second facet of the structural dimension of social capital in the context of clusters. Configuration refers to the pattern of linkages between cluster actors, i.e. how dense and strong those linkages are, how they are distributed, and whether they are hierarchical in nature (Nahapiet & Ghoshal, 1998). Inkpen and Tsang (2005) propose that, in terms of network configuration, clusters are characterised by cliques of cluster firms between whom strong connections exist. In the investigated cluster, firm spanning cliques and partnerships between individuals did exist, and knowledge was developed more frequently and effectively within such cliques, hence supporting that network configuration drives knowledge development.

The formation of cliques and strong relationships in clusters and the fact that knowledge development is more frequent and efficient amongst those cliques and relationships is consistent with Granovetter's (1973) theory of strong and weak ties between members of a network. The strength of ties describes the "combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterise the tie relationships" (Granovetter, 1973, p. 1316). Strong ties in the context of clusters describe strong relationships infused with trust and characterised by frequent interaction (Rowley, Behrens & Krackhardt, 2000). Weak ties are ties not characterised

by trust and frequent interaction, but nevertheless with potential to create value because network members can access additional resources they would not find within their ‘strong ties’ network (Burt, 2009). However, boundary spanners are necessary to leverage weak ties (Inkpen & Tsang, 2005). Interpreting the data of this research with reference to this theory, cliques and strong interpersonal relationships represent strong ties in clusters, whereas weak ties exist between different cliques and between cluster actors that do not have close interpersonal relationships. There is extensive knowledge development along strong ties and less along weak ties because strong ties give rise to frequent informal interaction. Nevertheless, there is untapped potential for knowledge development along weak ties. Leveraging weak ties between cliques and between individuals which do not have a close relationship could potentially add heterogeneity to the knowledge base of cluster actors, because the leverage of weak ties enables new knowledge to develop through combination (Burt, 2009). As evident from results of this research, this rarely happened due to individuals not interacting outside their cliques and close relationships. In the investigated cluster, cluster management took the role of the boundary spanner by organising events to bring together cluster actors that would usually not interact with each other. Indeed Inkpen and Tsang (2005, p. 156) note that “boundary spanning in clusters can take the form of events organised by a professional association”, confirming observations in the investigated cluster. This finding emphasises the importance of a facilitator for knowledge development, as cluster firms and institutions themselves are unable to leverage weak ties for knowledge development.

Another facet of network configuration is the hierarchy, or the absence thereof, of network members (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998). In the context of clusters, ‘hierarchy’ refers to the degree of hierarchical structures between firms and institutions, i.e. whether they exist and whether they are rigid or flexible. Such hierarchies in clusters impact on knowledge development because they impact on the extent of informal interaction (Inkpen and Tsang, 2005). According to Inkpen and Tsang (2005),



clusters are non-hierarchical. Hence, hierarchical structures should not impact on knowledge development. In the investigated cluster this notion held true for the firm level with no hierarchies existing between firms and institutions. The impact of hierarchy on knowledge development at the individual level, however, was strong. At the individual level, hierarchical levels played a significant role for knowledge development. Knowledge tended to be developed between individuals on the same hierarchical level, but minimal knowledge was developed across levels. Individuals from higher hierarchical levels tended to form strong relationships and cliques amongst themselves, at the exclusion of other levels. The lower levels in particular rarely engaged in knowledge development. The fact that hierarchical levels act as a barrier to knowledge development is acknowledged by Grant (1996, p. 118) who states that “hierarchical coordination fails” if knowledge is transferred in a network, especially if “a major part of which [knowledge] is tacit”.

The weak ties/strong ties theoretical framework can be drawn on to interpret this result. Weak ties exist between different hierarchical levels, whereas strong ties exist among members of one level. In the investigated cluster, weak ties between hierarchies remained idle, i.e. they were not leveraged for knowledge development. Interviewees were aware that weak ties between higher levels and lower levels bear potential in terms of knowledge development, often expressing regret that there was little interaction between them. This lack of interaction was attributed to a lack of opportunities. To leverage weak ties cluster management again acted as a boundary spanner by bringing together all levels at events, or by providing infrastructure where they can mix and mingle. This further emphasises the importance of cluster management as a catalyst, or in terms of theories, as a ‘boundary spanner’ to bridge weak ties (Granovetter, 1983).

In summary, the network configuration facet of the structural dimension of social capital drives knowledge development because strong bonds between individuals and cliques act

as pipelines for knowledge development. It also drives knowledge development by leveraging weak ties, with the help of boundary spanners, i.e. cluster management. Such boundary spanning activities through cluster management also help overcome the impact of hierarchical levels which act as a barrier to knowledge development.

### **6.1.3. Network stability**

Network stability is a third facet of the structural dimension of social capital and it refers to the extent membership of actors in a network is stable or dynamic (Nahapiet & Ghoshal, 1998). In the investigated cluster, network membership was dynamic in that it was highly unstable. At the firm level, new firms joined the cluster frequently with the incubator building explicitly aiming to attract new firms. Furthermore, cluster firms and institutions periodically terminated their operations and moved out of the cluster. However, the dynamic nature of cluster membership was even more significant at the individual level with people moving frequently between cluster firms and institutions, or leaving the cluster and the industry completely.

The outcome of this high level of dynamism was positive in terms of knowledge development. Specifically, in the investigated cluster, knowledge continued to be developed with those that had left the cluster. Indeed it is established in the literature that cluster actors are able to transform potentially negative effects of network instability, i.e. the disintegration of strong connections and the resulting loss of opportunities to interact, into positive outcomes because network instability “extends the network beyond the district” (Inkpen & Tsang, 2005, p. 157). In fact, in the investigated cluster, individuals tended to maintain strong relationships with individuals who had left the cluster enabling the exchange of tacit knowledge across cluster borders. As a consequence, individuals were able to draw new knowledge from other firms and institutions outside the cluster. This is consistent with Inkpen and Tsang (2005) who suggest that network instability may

result in access to new available sources of knowledge. In other words, network instability can create knowledge pipelines to external actors (Maskell, 2014).

The idea of knowledge pipelines between cluster actors and external actors is, again, consistent with Granovetter's (1983) notion of the inherent value of weak ties. In theoretical terms, those leaving the immediate geographic area of the cluster are effectively rendering strong relationships into weaker relationships, or in other words, strong ties into weak ties (Granovetter, 1983), eliminating opportunities for frequent informal interaction. However, against expectations, and unlike weak ties within the cluster environment, the overall effect of high dynamism was positive. Therefore, in the case of network instability, the resulting weak ties were successfully leveraged by cluster actors. According to Granovetter (1983), weak ties act as bridges that reach beyond the immediate network, allowing access to new resources that one would not be able to tap into within one's network of strong ties. Competitive advantage in the cluster can therefore be created because weak ties allow access to new knowledge (Tallman et al., 2004). Subsequently, once new knowledge is 'drawn' into the cluster using weak ties as pipelines, it can subsequently be combined with knowledge already present in the cluster and possessed by cluster actors.

According to Nahapiet and Goshal (1998), one of the ways that social capital impacts on knowledge development is by fostering creation of new knowledge through a combination of different knowledge sources. Through their connection with external actors, cluster actors have a more diverse base of knowledge at their disposal which can be used for competitive advantage (Jenkins & Tallman, 2010; Maskell, 2014). In this context, Maskell (2014, p. 1) notes that "even the most successful local clusters were unable to continue to thrive in splendid isolation", implying that the establishment of knowledge pipelines to the remote world is a necessity for clusters to be successful. This is consistent with Schumpeter (1934), according to whom creation of new knowledge

through combination is a conduit for creation of competitive advantage and for economic development in general. The idea of pipelines to external actors explains how the network stability facet of the structural dimension of social capital, specifically its instability, is a driver of knowledge development. However, it is the instability of relationships that drives knowledge through creation and subsequent leverage of weak ties.

What is interesting and striking about knowledge pipelines to external actors is that weak ties to remote actors were successfully leveraged for knowledge development, in clear contrast to weak ties within the cluster environment. Within the cluster, the lack of interpersonal relationships between different cliques or different hierarchies can be considered weak ties (Granovetter, 1983; Inkpen & Tsang, 2005) not leveraged for knowledge development. Data suggested that this was due to lack of interpersonal relationships and no evolving informal interaction. On the other hand, weak ties to external actors appeared to be conducive for knowledge development because individuals leveraged their close bonds with those that had left. This finding further emphasises the importance of interpersonal relationships for knowledge development, as opposed to other ways that actors could be connected (e.g. formal agreements between firms). In theoretical terms, this finding supports the notion that in clusters the structural dimension of social capital is represented through interpersonal relationships resulting in informal interaction which drives knowledge development (Brown & Hendry, 1997; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998).

## **6.2. The cognitive dimension of social capital**

Proposition 1b) suggests that

*The development of knowledge in clusters is likely to be driven by the cognitive dimension of social capital*

The cognitive dimension of social capital describes the extent of shared meaning and understanding in a network (Nahapiet & Ghoshal, 1998). The cognitive dimension in the context of clusters is suggested to manifest itself as a shared interaction logic or as written down or tacit norms and rules, both of which are proposed to drive knowledge development (Inkpen and Tsang, 2005). In discussing the cognitive dimension of social capital and its impact on knowledge development in clusters, Inkpen and Tsang (2005) suggest that clusters are characterised by a lack of common goals towards which cluster actors work and by a lack of common culture which are likely to inhibit motivation for actors to cooperate, interact and develop knowledge. As a consequence, Inkpen and Tsang (2005) suggest that cluster actors ought to overcome the lack of common goals and common culture in order to develop knowledge. Therefore, to motivate cluster actors to develop knowledge, cluster actors must share an ‘interaction logic’, or in other words “must recognise that cooperation and knowledge sharing can enhance their competitive position” (Inkpen & Tsang, 2005, p. 157). Furthermore, to make up for lack of common culture, clusters are proposed to have rules and norms in place, either in the form of a written down agreement or tacit and informal in nature, guiding development of knowledge (Inkpen and Tsang, 2005).

Consistent with the literature, cluster actors in the investigated cluster did not share or work towards common goals. Rather, they pursued their own firm’s or institution’s strategic direction, with interviewees confirming that common goals were indeed not the main motivator for cluster actors to engage in knowledge development. However, data also indicated a strong awareness among cluster actors that knowledge development was beneficial for themselves and for the cluster as a whole. Cluster actors were conscious that their relationships and interactions can be leveraged for knowledge development, and felt committed and motivated to engage with each other. Hence, an interaction logic was present in the investigated cluster and was a major driver of knowledge development. It was this interaction logic that motivated individuals to attend events and maintain

relationships with remote actors, even though doing so may be difficult and inconvenient at times. Consistent with the literature, results of this research emphasise that the prospect of accessing new sources of knowledge which can be leveraged for competitive advantage helps overcome such difficulties and inconveniences (Helmsing, 2001; Inkpen & Tsang, 2005). Hence, the cognitive dimension of social capital drives knowledge development through the presence of an interaction logic.

Although the presence of interaction logic as a motivator for knowledge development was evident, the results did not support the proposition that knowledge development was guided by written down or tacit rules and norms to address the lack of common culture (Inkpen & Tsang, 2005; Spender, 1989). Tacit rules and norms can manifest themselves as an industry recipe. Industry recipe is a concept rooted in organisational ecology theory which implies that organisations operating in the same environment with a similar focus are likely to adopt a similar policy framework (Hannan & Freeman, 1977). Neither a rules and norms framework nor an industry recipe were perceived by interviewees to be present in the investigated cluster. Knowledge development was not guided by any written down rules and policies, with the exception of IP. Data showed that individuals from cluster firms and institutions generally felt that it was the absence of rules and norms that was conducive for knowledge development. Comparing data of this research with the literature, it is striking that social capital researchers have stressed the effect of “legal rules”, i.e. a formalised, written framework, on the emergence and maintenance of social capital and for it to be a conduit for knowledge development (Adler & Kwon, 2002, p. 27). Of written rules, it was only IP related caution observed in the investigated cluster, as those interacting were careful not to disclose sensitive information. Therefore, data does not confirm that legal rules are indispensable for social capital as a driver of knowledge development.

The same was the case for tacit, informal rules and understanding. Where literature suggests that tacit rules, or industry recipe, should guide interaction and relationships for the development of knowledge (Hannan & Freeman, 1977), data of this research showed the opposite for the investigated cluster. For example, Von Hippel (1987) found that informal rules are present in networks and guide the exchange of knowledge. Similarly, Capello (1999, p. 354) defines knowledge development resulting in collective learning as “a social process of cumulative knowledge, based on a set of shared rules and procedures”. Furthermore, in a recent study on social capital and clusters, Gretzinger and Royer (2013, p. 13) found that an “organically grown code of conduct” is present in clusters. Such informal rules are not manifest in writing. Rather, they are “simply understandings that evolve within the [...] network” (Giuliani, 2005, p. 205). Similarly, Tallman et al. (2004, p. 265) propose the existence of cluster level architectural knowledge which represents “understandings developed at the regional cluster level through the routinisation of the network of interaction”, or as they term it “rules of the game”, for knowledge development between cluster actors. According to the literature, the purpose of tacit rules and norms in the absence of a common culture and joint goals is to prevent the “receiver of knowledge may use it against the interest of the sender” (Inkpen & Tsang, 2005, p. 158). To prevent such opportunism, tacit rules govern how people interact with one another, i.e. an implicit code of conduct. Social sanctions are imposed on those not adhering to this rule framework. Inkpen and Tsang (2005) suggest that, for the reasons stated above, a tacit rules and norms framework is indispensable in clusters for knowledge development to happen and for cluster actors to leverage knowledge development for competitive advantage.

Given this body of research emphasising the importance of written down and/or tacit rules and norms guiding knowledge development, it is surprising that interviewees felt that an informal rules and norms framework did not exist in the cluster, emphasising that the absence of such a framework is conducive for knowledge development. A possible

interpretation of this result draws on the type of knowledge developed. In high technology industries, including biotechnology, the exchange and transfer of highly tacit knowledge is the basis for frequent innovation and for sustainable competitive advantage to a significantly higher extent than in 'low technology' industries. In low technology industries innovation is less crucial and tacit knowledge as a resource is less important to firms than tangible resources (Keeble & Wilkinson, 1999). If parties of the exchange feel that they are not bound to any rules and norms, knowledge can flow freely. A barrier-free transfer of knowledge enables easier and quicker access to this tacit knowledge resource by many cluster actors. This is due to the fact that tacit knowledge is highly social in nature and embedded in social relationships and interactions (Chua, 2006). Stringent rules and norms may create a feeling of insecurity in individuals and prevent them from engaging in relationships and interactions without reservation, or in other words, create "excessive expectations of obligatory behaviour" (Inkpen and Tsang, 2005, p.153).

In high technology environments, as tacit knowledge is a strategically valuable resource, it is possible that the benefits of a transfer of tacit knowledge outweigh the possible risks of opportunism inherent in completely unregulated exchange and those engaging in interaction should have reservations regarding the sharing of knowledge with other people (Powell et al., 1996). Therefore, another possible interpretation for the perceived lack of rules and norms is that trust takes the role of a substitute. In commenting on the absence of rules and norms, interviewees explained that rules and norms were not necessary to guide interactions when trust is present. Thus, when trust is present in interpersonal relationships people feel confident that knowledge shared will not be used against them and consequently they are happy to share knowledge. Therefore, knowledge is not shared completely 'freely' in the absence of norms, rather it is trust that dictates the code of conduct in lieu of rules and norms. This is supported by an extensive body literature suggesting that knowledge, and tacit knowledge in particular, is most likely to



be exchanged when trust is present (Adler, 2001; Becerra, Lunnan & Huemer, 2008; Dhanaraj, Lyles, Steensma & Tihanyi, 2004; Holste & Fields, 2005, 2010).

Results showed that trust was present in relationships in the investigated cluster and was a prerequisite for knowledge development. This finding gives rise to the conclusion that in clusters trust acts as a substitute of rules and norms. Rather than adopting an industry recipe, as suggested by Hannan and Freeman (1977), cluster actors create a trust infused environment for interaction. Interestingly, trust is also a facet of the relational dimension of social capital (Nahapiet & Ghoshal, 1998). The way that trust, and hence the relational dimension, drives knowledge development is discussed in 6.3.

Another interpretation of the lack of rules and norms which is in contrast to literature is that there may well be tacit rules and norms present in the cluster. Since those tacit rules and norms are represented by simple understanding which has evolved over time (Giuliani, 2005), interviewees may not be aware of the existence. Tacit rules and norms “govern appropriate behaviour” in the exchange of knowledge (Inkpen & Tsang, 2005, 455). Parties of the exchange, however, may not be aware that they are engaging in, and are bound by, this appropriate behaviour in order to exchange knowledge in the first place. In the absence of awareness, cluster actors may still feel that knowledge flows freely. This perception of freedom may prevent the “excessive expectations of obligatory behaviour” which hinders knowledge development (Inkpen and Tsang, 2005, p.153).

In conclusion, research data partly supported proposition 1b) suggesting that the cognitive dimension of social capital drives knowledge development. While the presence of a shared interaction logic and its impact on knowledge development was observed in the investigated cluster, there was no data for the existence of written down or tacit norms and rules that help develop knowledge. Surprisingly, the opposite appears to be the case

with the absence of rules and norms fostering knowledge development, contradicting existing theory.

### **6.3. The relational dimension of social capital**

Proposition 1c) suggests that

*The development of knowledge in clusters is likely to be driven by the relational dimension of social capital*

Research data supported the above proposition. Specifically, it was trust – a facet of the relational dimension – which had a major role in knowledge development. In the investigated cluster, trust was a major determinant, and in many cases a prerequisite, for knowledge development. This was particularly the case for strategically valuable tacit knowledge. This finding is consistent with social capital literature. In discussing the impact of the relational dimension of social capital on knowledge development in clusters, Inkpen and Tsang (2005) suggest that trust and trusting relationships render cluster actors more willing to engage in knowledge development. The idea of trust as a ‘lubricant’ for knowledge exchange, transfer and sharing between individuals is well established amongst scholars and not limited to the context of clusters, but applies to the transfer, sharing and spill over of knowledge in general (Dyer & Singh, 1998; Putnam, 2012). The underlying rationale here is that trust increases willingness of individuals to share and exchange knowledge and to accept the inherent risks, such as increased vulnerability (Inkpen & Tsang, 2005; Ring & Van de Ven, 1994). In the presence of trust such risks are accepted because trust increases the perceived value of a knowledge transaction (Misztal, 2013; Powell et al., 1996). In the investigated cluster, trust was found to be a very important supporting factor for knowledge development, being inherent in interpersonal relationships, and catalysing knowledge development through informal and spontaneous interaction. Furthermore, in the absence of trust informal and

spontaneous interactions would likely be impoverished in terms of information exchanged with tacit knowledge not being developed. In other words, such an interaction would be of negligible value to those involved if no knowledge is developed at all (Kraut, Fish, Root & Chalfonte, 1990). This is consistent with the suggestion of Inkpen and Tsang (2005; based on Uzzi & Gillespie, 2002) that in clusters, relationships between actors are not purely market based, but have a social and informal component infused by trust.

Results of this research are in line with the literature suggesting that trust and trusting relationships, due to their impact on tacit knowledge development in particular, are crucial for success of high technology clusters in particular, such as biotechnology. Contrary to explicit knowledge, trust needs to be present for tacit knowledge to be exchanged (Collins & Hitt, 2006). Malmberg and Maskell (1999) note that, especially in high technology environments, competitive advantage is based on trusting relations and partnerships (Su & Hung, 2009, p. 610). One prominent example is Silicon Valley. Success of this well known cluster can be attributed to the fact that ‘rich social capital’ is developed because “entrepreneurship has flourished, investors, entrepreneurs and employees have learned to trust each other with eyes wide open” (Phillips, 2006 in Su & Hung (2009), p. 610). This could also be observed in the investigated cluster, with participants emphasising the importance of trust for knowledge development with fellow cluster colleagues.

The fact that results emphasise the importance of trust is consistent with the theoretical underpinnings of the relational dimension of social capital which draws on Granovetter’s (1985) concept of relational embeddedness (Nahapiet & Ghoshal, 1998). In the investigated cluster, trust was inherent in interpersonal relationships and interactions, acting as a lubricant for those relationships and interactions to become pipelines for knowledge development. In such relationships, trust develops over time. Nahapiet and

Ghoshal (1998) use relational embeddedness to emphasise that the relational dimension of social capital is made up of “personal relationships people have developed with each other through a history of interactions” (Nahapiet & Ghoshal, 1998, p. 244). Results revealed that path dependent relationships are present in the investigated cluster. The strongest relationships were based on individuals having a history together, e.g. having worked or studied together, resulting in ongoing interaction between those individuals and trust being built. The stronger a relationship, the higher the trust and more likely individuals were willing to share and exchange strategically valuable knowledge. In summary, results of this research show that the relational dimension of social capital drives knowledge development because trust acts as a lubricant for knowledge to be exchanged in the cluster.

The finding that the relational dimension drives knowledge development in the form of trust emphasises that the relational dimension and the cognitive dimension are closely linked and overlap. Trust is a facet of the relational dimension of social capital (Nahapiet & Ghoshal, 1998). Results revealed that trust in the investigated cluster acted as a substitute for rules and norms and common goals, which are, however, manifestations of the cognitive dimensions of social capital (Inkpen & Tsang, 2005). Therefore, data of this research is consistent with social capital literature suggesting that the dimensions of social capital are not independent, but interwoven (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). Even though it is clear that there is merit to the approach to examine dimensions of social capital discreetly as each has a different impact, one should not lose sight of the overall picture and keep in mind that the dimensions influence each other with some facets overlapping (Nahapiet & Ghoshal, 1998; Yli-Renko et al., 2001). This finding further justifies the approach of this research in investigating all three dimensions of social capital.

#### **6.4. Role of actors**

Propositions 2a) and b) explore the actors involved in development of knowledge through social capital in clusters. In doing so, proposition 2a) suggests that

*Cluster firms are likely to be involved in the development of knowledge through social capital.*

and proposition 2b) suggests that

*Lateral actors are likely to be involved in the development of knowledge through social capital.*

Data suggested that cluster firms and various lateral actors have a role in knowledge development through social capital, hence propositions 2a) and 2b) are supported.

However, their respective roles in knowledge development for competitive advantage differ significantly.

##### **6.4.1. The role of cluster firms**

Proposition 2a) suggests that cluster firms are likely to be involved in the development of knowledge through social capital. Cluster firms, for the purpose of this research, are considered privately held companies involved in production of the main product, or supply those involved, or both. Data showed that cluster firms have a major role in knowledge development of social capital. In the investigated cluster, firms leverage their various interpersonal relationships with other cluster firms or lateral actors to develop knowledge. As a result, cluster firms were involved in virtually all knowledge development activities in the cluster. The contract research laboratories, which represented a very important lateral actor, interacted and developed knowledge with each other minimally. Their interactions in the cluster were predominantly with cluster firms.

Hence, the role of those cluster firms was important because all knowledge developed in the cluster ‘flows’ through their webs of relationships. Furthermore, cluster firms extended their network constantly, subsequently leveraging new connections for knowledge development to draw in knowledge from remote actors. Hence, the role of cluster firms is important as cluster firms can be considered a nexus for knowledge development in the cluster.

This finding is consistent with the value adding web framework which suggests that clusters are characterised by overlapping webs of relationships of which cluster firms are major participants. Since the web of relationships of one actor overlaps with the webs of others, any one cluster actor can leverage other actors’ web of relationships as well (Brown et al., 2010). Essentially, in investigating how those webs are conducive for knowledge development, the overlapping relationships provide cluster firms with access to new sources of knowledge and networking with others during events is a good example this dynamic (Brown et al., 2010).

Furthermore, the finding can be interpreted in terms of Powell’s (2005) hypothesis of multiconnectivity. Powell (2005, p. 1139) describes multiconnectivity as “the multiple linking of partners both directly and through chains of intermediaries” and suggests that multiconnectivity is beneficial for those with multiple and diverse connections. Another distinguishing feature of multiconnectivity is a preference for diversity in those connections. This proposed preference for diversity explains why cluster firms seek to source knowledge from remote actors, rather than within the cluster. Interpreting the role of cluster firms in terms of Powell’s (2005) multiconnectivity, they are in the middle of “a cohesive network, with plural pathway” (Powell, 2005, p. 1139) through this network, access diverse sources of knowledge. Interestingly though, whereas diversity is leveraged through the connections with remote actors, diversity of cluster firms was found to be an obstacle to knowledge development in the investigated cluster. Data suggested that

cluster firms with very different scopes of operations hardly interact, and hence, little knowledge is developed between them. This result is in clear contrast to the preference for diversity, as implied with multiconnectivity, indicating that opportunity for valuable knowledge development is lost due to lacking interaction. A connection between diverse cluster firms, however, is difficult to ensue because “when knowledge is exchanged, participants attend to their network partners more extensively” (Powell, 2005, p. 1140). This can explain why cluster actors tend to interact with remote actors that they have a history of knowledge exchange with, rather than seeking new connections within the cluster.

Even though data clearly showed that knowledge is developed in the cluster through the relationships of cluster firms, this did not occur in a balanced way. ‘Not balanced’ here means that not all relationships between cluster firms were equally conducive for knowledge development, with stronger and closer relationships being more effective pipelines for knowledge development due to frequent informal interaction. In light of this finding, the role of cluster firms for knowledge development can be interpreted by drawing on the value adding web framework and, more specifically, on the concept of interdependencies (Thompson, 2003). Interdependencies describe the quality and strength of a particular relationship (Kostova & Roth, 2003). Hence, the interdependencies framework can explain why some types of relationships are more conducive for knowledge development than others.

Interdependencies are inherent in relationships and range from pooled, to sequential, to reciprocal, to team oriented (Brown et al., 2010; Royer et al., 2009; Van de Ven & Ferry, 1980). Data showed that in the investigated cluster the dominant link between cluster actors, and between different cluster firms in particular, were pooled interdependencies in relationships characterised by competition for resources (Thompson, 2003). This was evident by the fact that cluster firms perceived themselves to be competitors rather than

partners of a cluster, competing for pooled resources, such as skilled staff, funding, clients, and were cautious about their intellectual property. Sequential interdependencies - describing input-output, or buyer-supplier relationships - also existed between cluster firms because some cluster firms provided goods and/or services to others. Data suggested that relationships characterised by pooled or sequential interdependencies were formalised and distanced in nature as interactions were formal, not face to face and infrequent. Knowledge development, however, was mainly driven by close amicable relationships and informal interactions. As a consequence, knowledge development between two actors linked by pooled and sequential interdependencies rarely ensued, and if it happened those involved did not find that this knowledge development contributes to competitive advantage.

Knowledge development in the investigated cluster primarily took place if two actors were linked by reciprocal or team oriented interdependencies. Reciprocal, or balanced, interdependencies describe a mutual exchange of inputs and outputs between parties (Thompson, 2003). Reciprocal interdependencies existed in the investigated cluster, evident by the fact that some cluster firms shared, or had shared, facilities, equipment and other resources with others, especially those that were geographically close. Team oriented interdependencies were, however, not found to exist in the investigated cluster. Team oriented interdependencies are relationships between actors that cooperate to create a joint output which cannot be created in isolation (Van de Ven & Ferry, 1980). The absence of team oriented interdependencies in the investigated cluster is consistent with previous empirical studies which found that team oriented interdependencies may exist in clusters, but to a much lesser extent than the other three types of interdependencies (Brown et al., 2010; Steffen, 2012).

According to the literature, team oriented interdependencies are the type of interdependencies most likely to result in fruitful social capital, manifesting as close,



informal and trust infused relationships (Gretzinger & Royer, 2013). As team oriented interdependencies were not present in the investigated cluster, it was mostly reciprocal interdependencies from which trusting amicable relationships conducive for knowledge development resulted. Many of those close relationships between individuals, or cliques, came about when two cluster firms pooled resources, or decided to do so in the future. Examples included close relationships established because two firms were located in one building or the joint purchase of equipment. Specifically relating to knowledge as a resource, reciprocal knowledge exchange taking place between individuals during networking events because participants find each other's knowledge valuable can also be considered a reciprocal interdependency. These findings are consistent with other studies on interdependencies in clusters and the impact on social capital and knowledge. Social capital is most likely to result in relational rents, i.e., in the context of this research, relational rents manifest as competitive advantage, and is more likely to be leveraged if embedded in reciprocal or team oriented interdependencies, more so than with pooled or sequential interdependencies (Gretzinger & Royer, 2013). It follows that the role of cluster firms in the leverage of social capital for knowledge development is dependent on quality and strength of relationships. Cluster firms that forge relationships characterised by reciprocal interdependencies were involved to a higher extent than those with relationships characterised by pooled or sequential interdependencies.

Findings of this research draw attention to the importance of the quality of relationships for knowledge development. Clusters are characterised by various relationships among actors which form an overlapping web. However, based on findings of this research, not all relationships are equally conducive to knowledge development with reciprocal relationships more likely to result in social capital being leveraged than pooled and sequential interdependencies, in line with recent cluster literature (Gretzinger & Royer, 2013). In other words, in referring to the research problem, not all social capital embedded in those relationships can be leveraged successfully. Therefore,

interdependencies can be used to explain why some cluster actors have a more significant role in knowledge development than others, and hence, why knowledge does not disseminate through the value adding web in a balanced way.

#### **6.4.2. *The role of cluster management***

An interesting finding of this research is the crucial role of cluster management as a catalyst for knowledge development through social capital. It is not surprising that cluster management acts as a facilitator for knowledge development, as this is inherent in cluster managements' purpose as acknowledged by some in the literature, e.g. Andersson et al. (2004) and Bode (2011). Rather, it is striking that the facilitator role in the investigated cluster was so crucial that presumably, without cluster management and its facilitating activities, a large part of knowledge development in the cluster may not have happened. This important role of cluster management for knowledge development is interpreted in the realm of relevant literature, specifically in the context of top down or bottom up approaches to cluster management and the viewpoint of cluster management as a broker to bridge structural holes.

##### **6.4.2.1. Top down or bottom up approach to cluster management**

Referring to a theoretical model of cluster management, according to Bode (2011), two cluster management approaches are recognised in the literature, 'bottom up' and 'top down'. Clusters coordinated in a 'bottom up' way develop governing mechanisms with single firms, or a cooperation of single firms, acting as governing bodies (Fromhold-Eisebith & Eisebith, 2005). The institutionalisation of cluster management in the form of one dedicated person or organisation, on the other hand, is considered a 'top down approach'. Top down cluster management organisations/people are usually installed by cluster initiatives, for example through the government, as a means to implement cluster and regional policy (Bode, 2011). Characteristic for such a top down approach is dedicated cluster management or manager coordinated activities of cluster actors in order

to drive competitive advantage of the cluster and region (Terstriep, 2008). Being managed by a dedicated organisation established by the state government it is clear that, in theoretical terms, the investigated cluster had adopted a top down approach to cluster management.

Regardless of which cluster management approach is in place, it is well established in the literature that clusters driven by some form of cluster management are better positioned competitively compared to clusters that are not centrally managed (Terstriep, 2008). Nevertheless, there has been some debate in the literature whether a bottom up or top down approach is preferable in terms of helping the cluster prosper. This debate arose as there are enormous practical implications for cluster policy in terms of whether a cluster management organisation should be installed, or whether management mechanisms should be left to evolve organically. The question whether expensive initiatives establishing cluster management are worthwhile and add value to the cluster, with benefits outweighing the costs, remains open (Bode, 2011).

To date, no empirical research has addressed the cluster management approach, top down or bottom up, is more advantageous for clusters, especially not with competitive advantage through knowledge in mind. Hence, it is interesting that data of this research indicated that, at least in the context of knowledge development, there appears to be merit to the top down approach. Results showed that firms and institutions in the cluster are unlikely to be able to create a fruitful setting for knowledge development in the absence of top down cluster management. Interviewees explicitly stated that ‘someone from the top’ has to take charge, while simultaneously doubting that firms themselves would themselves take the initiative, at least in the context of knowledge development through social capital. This finding clearly shows that a top down approach of a designated organisation or person is necessary to provide a setting for knowledge development.

In considering relevant literature, however, it cannot be concluded that a top down approach is universally beneficial to clusters. Investigating a mechatronics cluster, Gretzinger and Royer (2013, p. 13) found that the cluster management organisation in place, a top down approach similar to the one in the investigated cluster, was not “close enough to the cluster actors”. These authors reported that cluster management did not fulfil their role as a broker for knowledge effectively and that cluster management’s reputation was not strong amongst cluster actors. This is in contrast to the findings of this research which indicated that cluster management fulfilled the role of brokers, or catalysts, effectively and gained the trust of cluster actors. In considering the findings of this research and Gretzinger and Royer’s (2013) study, one and the same approach to cluster management is not a recipe for success in all clusters and all situations.

Accordingly, Terstriep (2008) notes there is no universally valid cluster management strategy or cluster management approach promising success in all clusters, as cluster management success is strongly dependent on regional factors, such as local culture, size of the industry and history of the cluster, rendering success of one approach path dependent. As cluster management’s crucial role in the investigated cluster was based on providing favourable conditions for knowledge development, it can be concluded that in industries where knowledge is a crucial resource, such as high technology industries, a top down approach is likely to be suitable as knowledge is the most important strategic resource that needs to be managed. Whether this is the case for all high technology clusters should be subject to further research.

#### 6.4.2.2. Cluster management as a broker

The importance of top down cluster management in the investigated cluster was based on the fact that cluster management acted as a ‘broker’ for social capital and knowledge. Thus, the crucial and indispensable role of cluster management as a catalyst can be interpreted within the realm of the theory of structural holes. Drawing on this theoretical framework shows that in clusters a broker, or boundary spanner, may be necessary to

realise the benefits of social capital, which in turn can explain the crucial role of cluster management. According to Burt (2009), structural holes are present between clusters, firms/institutions or individuals that possess non-redundant knowledge. Similar to Granovetter's (1983) weak ties, structural holes can be leveraged for advantages by bridging structural holes so network members can access new knowledge to which they would otherwise not have access (Burt, 2009). In the investigated cluster, structural holes were represented by weaker connections between individuals and firms both inside and outside the cluster as opposed to strong connections, manifest through people in the cluster having minimal opportunity to meet and interact. It follows that the role of cluster management for knowledge development can be explained by the fact that clusters are a collection of strong and weak ties, but in order to leverage weak ties for knowledge development a boundary spanner is necessary (Burt, 2000, 2009), a role assumed by cluster management. In particular, "brokers and boundary spanners facilitate transaction and the flow of information between people or groups who have no physical or cognitive access to each other" (Long et al., 2013, p. 1). This was the case in the investigated cluster, as many actors were unable to engage in interaction because they were located remotely, or did not see a reason to interact with other individuals 'for the sake of it'. Cluster managements' crucial role derives from facilitation of those transactions and information flows by organising activities, such as networking forums, and by establishing connections with remote firms and individuals to interact with the cluster. In doing so, cluster management moderates the negative 'impact' of weaker connections on knowledge development, acting as such a broker, or boundary spanner, for bridging structural holes (Burt, 2009; Long et al., 2013). Furthermore, data showed that cluster management established connections to remote actors (i.e. bridged a weak tie). This was conducive for knowledge development because it created a pipeline to draw new knowledge to the cluster (Maskell, 2014). The role of cluster management as a boundary spanner between the cluster and remote actors is consistent with Bode (2011, p. 156;

translation), who states that a major task of cluster management is to network outside the cluster in order to prevent lock-in and to “broaden the knowledge base”.

#### **6.4.3. *The role of contract research laboratories***

Another interesting result of this research was that academic lateral actors, i.e. the contract research laboratories, did not play as much of a role in knowledge development as expected. This is surprising considering that the literature suggests otherwise. For example, Exposito-Langa and Molina-Morales (2010) emphasise the role of lateral actors, especially academia, as repositories of knowledge. Results of this research confirmed that the contract research laboratories hold tacit knowledge resources, e.g. in-depth experiences with specialised equipment or scientific methods which would be valuable to other cluster actors if shared. However, in the investigated cluster, knowledge developed between contract research laboratories and other actors was limited due to lack of informal interaction. In contrast, literature states that lateral actors contribute to competitive advantage in the cluster by fulfilling the role of a facilitator for knowledge development (Brown et al., 2010, p. 15) with academic actors, such as contract research laboratories, providing valuable knowledge sources to other cluster actors (Andersson et al., 2004).

The limited involvement of contract research laboratories deriving from the lack of opportunity for interaction and the resulting limited knowledge development may be due to the relatively large geographical distance between contract research laboratories and other cluster actors. Close geographic proximity is generally used as the defining feature of clusters, setting clusters apart from other networks, (Andersson et al., 2004), and literature supports the notion that geographic proximity is conducive to the development of a “common language, easy observation and immediate comparison” (Brown et al., 2010, p. 64). Therefore, the fact that contract research laboratories were not considerably involved in knowledge development emphasises another unique finding of this research,

namely that geographic proximity should not exceed walking distance. Where proximity exceeds walking distance the benefits for knowledge development were found to be limited as actors did not have the opportunity to develop relationships or engage in informal, spontaneous face to face interaction. The contract research laboratories were not within walking distance of other cluster actors as they were located across the state. It follows that the physical distance between laboratories and other actors cancelled out the role as a contributor to knowledge development which lateral actors should have according to the literature.

Another possible interpretation to explain the limited involvement of the contract research laboratories is due to interdependencies of the relationships. In the investigated cluster, the research laboratories provided services and facilities to the cluster firms, because they were contracted to do so in an effort by cluster management to make the most of existing equipment and resources in the cluster. As a result, any interaction between contract research laboratories and cluster firms was mostly limited to formal discussion about the provider-client relationship. This implies that the relationship between contract research laboratories and cluster firms is characterised by sequential interdependencies, which describes a situation when one organisation produces output that is the input of another (Brown et al., 2010; Thompson, 2003). These sequential interdependencies in the investigated cluster were artificially created by cluster management by contracting laboratories to provide services to cluster firms. Hence, reciprocal or team oriented interdependencies did not evolve between firms and laboratories. This 'lock in' to sequential interdependencies resulted in little knowledge development. Strong social capital conducive for knowledge development results primarily from reciprocal or team oriented interdependencies which are characterised by cooperation and bundling of resources (Brown et al., 2010). A previous study on interdependencies in clusters found that cluster firms and universities as lateral actors are expected to be connected by reciprocal interdependencies with cluster firms leveraging on the rich pool of knowledge

held by universities and universities benefiting from industry links and cooperation (Gretzinger & Royer, 2013). Reciprocal interdependencies between cluster actors and universities are expected to contribute to competitive advantage in the cluster because “reciprocal interdependencies between the cluster actors and research and education institutions are seen as crucial resources in terms of social capital [in terms of] knowledge sharing” (Gretzinger & Royer, 2013, p. 125).

In the investigated cluster, as the relationship between contract research laboratories and cluster firms was characterised by sequential, rather than reciprocal or team oriented interdependencies, potential for knowledge development was not realised. In fact, the contract research laboratories, meant to be the interface between universities and cluster firms, acted as a barrier to knowledge development between cluster firms and universities. They were perceived by other actors, and perceived themselves, as service providers rather than equitable partners with whom trusting relationships can be built and with whom knowledge can be exchanged for mutual benefit. Sequential interdependency eventually became detrimental to knowledge development being created artificially by cluster management in an effort to pool equipment and other resources in the cluster. Even though this objective was achieved and synergies in the use of physical resources were created, the arrangement does not seem to be beneficial in terms of knowledge development.

## **6.5. Emerging results**

The methodology of this research allowed for results to emerge from data in order to investigate the research problem. Indeed, during the data analysis process many themes and issues emerged which did not explicitly relate to the research propositions, but were nevertheless relevant. Even though emerging results could not be interpreted in the context of social capital dimensions, or in the context of the role of cluster actors, they were found to be important in investigating how social capital is leveraged for knowledge



development. Two such emerging themes were considered and interpreted in terms of social capital, knowledge and cluster literature, namely individual and collective social capital, and types of knowledge.

#### ***6.5.1. Individual and collective social capital***

Results of this research suggest that the individual, rather than firm or institution, had a major role in knowledge development. In the investigated cluster, it was the individuals' networks of relationships and individuals' interactions that were leveraged for knowledge development, rather than relationships between firms and institutions. This finding is interesting given that in referring to 'cluster actors' the literature tends to focus on firms and institutions when the level of analysis is specified (Andersson et al., 2004). This is due to the fact that clusters have traditionally been investigated at cluster level. Hence, a significant gap in the literature which has only recently received some attention is the role of the single firm in competitive advantage creation in clusters, as opposed to clusters as a whole (Brown et al., 2007a). Even though shifting away from cluster level was an important step in investigating how competitive advantage is created through knowledge, results of this research indicate that it may be necessary to focus on one level down and include the individual and the individual's network of relationships.

In explaining why the individual level is relevant for leverage of social capital for knowledge development, rather than the organisational or institutional level, the individual/collective social capital perspective can be consulted (Inkpen & Tsang, 2005; Kostova & Roth, 2003). This framework considers two dimensions of social capital, individual and collective. Individual social capital is possessed and leveraged by an individual, whereas collective social capital is possessed and leveraged by a collective (Kostova & Roth, 2003). When the relevant collective is an organisation, as in the investigated cluster, collective social capital is sometimes referred to as organisational social capital (Kostova & Roth, 2003). Organisational social capital results from the

organisation's network of relationships, whereas individual social capital results from the individual's network of relationships. As a consequence, organisational social capital is a public good which enables members of an organisation to "tap into the resources derived from the organisation's network of relationships without necessarily having participated in the development of those relationships" (Kostova & Roth, 2003, in Inkpen and Tsang (2005, p. 151)). In the investigated cluster, it was individual social capital rather than organisational social capital that was leveraged for knowledge development. Results indicate that knowledge in the investigated cluster was developed through firm spanning, interpersonal relationships and informal interactions of individuals, representing individual social capital.

Research results suggest that some connections between different firms and institutions existed in the cluster, such as supplier-buyer relationships between firms, landlord-tenant relationships and contractual agreements to use facilities. However, those relationships were based on formal arrangements with no informal interaction or amicable, trusting relationships involved and were not conducive for the emergence of collective social capital. It follows that for an effective transfer of tacit knowledge between cluster actors, individual social capital must be developed because the transfer of such valuable knowledge "normally requires intimate personal interactions" (Inkpen & Tsang, 2005, p. 162).

The above finding empirically confirms what has been suggested in the literature on the interplay between individual and collective social capital in clusters. Inkpen and Tsang (2005) propose that in clusters "knowledge flow starts on a personal level" and suggest that relationships between firms are characterised by "commercial transactions" which took the form of supplier-buyer relationships in the investigated cluster. Inkpen and Tsang (2005) conclude that in clusters individual social capital is likely to take priority over organisational social capital, as confirmed by this research. These findings show that

in investigating clusters the distinction between individual and collective social capital and a clear distinction between individual and firm actors is crucial for investigation of knowledge in clusters.

### ***6.5.2. Types of knowledge***

Another emerging result of this research relates to the types of knowledge developed for competitive advantage. In explaining what type of knowledge was developed for competitive advantage in the cluster, many participants referred to experiences, insights, attitudes and know-how emphasising that knowledge they considered valuable could only be transferred during face to face contact. These interviewee accounts match the definition of tacit knowledge (Polanyi, 1966). The fact that social capital was leveraged for development of tacit knowledge is consistent with relevant social capital, knowledge and cluster literature which states that tacit knowledge is highly social in nature, best exchanged through relationships (Vejsagic–Ramhorst et al., 2012) and a valuable strategic resource for competitive advantage (Barney, 1991). Even though the objective of this research was not to explicitly identify the type of knowledge conducive to competitive advantage, it is nevertheless interesting that results clearly confirmed the importance of tacit, rather than explicit, knowledge developed in the cluster.

One important tacit type of knowledge considered valuable by interviewees was of knowledge related to management issues and how to run a biotechnology firm.

Interviewees emphasised that they were very interested in the experiences, understanding and attitudes about running a biotechnology firm, due to the fact that most of them had a science background with formal management or business education. This type of knowledge is termed ‘commercial knowledge’ The importance of commercial knowledge for interviewees is consistent with literature. The biotechnology industry is strongly dependent on successful commercialisation of products in order to break even, as the process of R&D requires major investment and “success rests on the commercialising

innovation and products as soon as possible” (Dosi, Llerena & Labini, 2006, p. 1453). As Shinn and Lamy (2006) put it, “the reality of movement among academic scientists toward commercial knowledge is thus today beyond refutation” (Shinn & Lamy, 2006, p. 1466). Given that commercialisation in the Australian biotechnology industry is still significantly below its potential (Vitale, 2004), it is plausible that that biotechnology managers attach high importance to accessibility of commercial knowledge. The result indicates that lacking commercial knowledge may contribute to inappropriate commercialisation choices on the part of biotechnology firms (Vitale, 2004).

Another type of knowledge important for competitive advantage revealed in research results was explicit awareness of ‘who knows what’, ‘who is who’ or ‘what is what’ in the cluster. In other words, knowledge of skills, physical resources and fellow firms located in the cluster was of importance. In the investigated cluster, many participants explained that this type of knowledge was most frequently exchanged and considered valuable. This finding was surprising given that most cluster literature focuses on tacit knowledge as a major driver for competitive advantage in clusters. The awareness of what knowledge and skills are available within the cluster, whether this knowledge is valuable, who it is held by and how to obtain it is termed ‘knowledge of expertise location’. Knowledge of expertise location is acknowledged in the literature as a type of knowledge that contributes to competitive advantage, which is consistent with results of this research (Brown et al., 2010; McDonald & Ackerman, 1998). Knowledge of expertise location is valuable because the act of sourcing knowledge or skills for competitive advantage is subject to awareness that this source exists and is accessible (Borgatti & Cross, 2003). The inherent value of knowledge of expertise location was confirmed by the finding that for some interviewees, gaining access to knowledge of expertise location was a motivator to engage in networking with individuals from other cluster firms and institutions because they found knowledge of expertise location valuable.

At first glance, knowledge of expertise location as a major contributor to competitive advantage appears to contradict cluster literature which suggests that tacit knowledge is exclusively valuable for competitive advantage (Vejzagic–Ramhorst et al., 2009).

Knowledge of expertise location, however, meets the definition of an explicit knowledge type as knowledge of who does what and who possesses which skills and resources is easy to transfer (Polanyi, 1966). Importantly, knowledge of expertise location goes hand in hand with knowledge about approachability and trustworthiness of the other party (Borgatti & Cross, 2003). In the investigated cluster, individuals were able to ‘assess’ this during informal, face to face interactions. Without informal interaction to establish trust knowledge of expertise location would not be accessible as it is largely comprised of inside information that is not written down and its leverage depends on peer referrals (Borgatti & Cross, 2003). The experience of approachability is highly personal, making face to face contact and trust infused interaction necessary for knowledge transfer, as confirmed by research results. In order to leverage knowledge of expertise location individuals people needed to feel assured that if they needed a particular skill, service or help in the future they could turn to fellow cluster colleagues to ask for help and be certain that the member is willing to help in a trustworthy way. As Borgatti and Cross (2003, p. 433) state, knowledge of expertise location is valuable because “perceptions of another person are formed through direct interaction, observation and/or third party commentary”.

Due to necessity of trust infused, face to face contact for knowledge transfer, geographic proximity is conducive to the exchange of knowledge of expertise location in a similar fashion as it is conducive to exchange of tacit knowledge (Mitchell et al., 2010). This emphasises that knowledge of expertise location is not explicit knowledge in the traditional sense. Hence, knowledge of expertise location as the most important type of knowledge does not contradict the generally accepted idea that explicit knowledge in

clusters should not be a major determinant of competitive advantage (Tallman et al., 2004; Vejzagic–Ramhorst et al., 2012). Rather, it reinforces the idea that in order to be valuable, knowledge needs to have a tacit dimension.

The finding that knowledge of expertise location cannot be leveraged in the absence of trustworthiness reinforces another finding of this research, namely that the relational dimension of social capital is a driver of knowledge development. The most important facet of the relational dimension is trust (Nahapiet & Ghoshal, 1998) and results of this research show that the relational dimension drives knowledge development in the cluster as trust acts as a lubricant for knowledge flow. Indeed, knowledge of expertise location in the investigated cluster was exchanged and sought only where the interaction was trust infused during informal, face to face communication. This shows that trust takes an enabling role for knowledge of expertise location to be developed and contribute to competitive advantage. (Borgatti & Cross, 2003). Furthermore, trust can also decrease transaction costs. A query may be costly and require significant investment of resources. This may particularly be the case if knowledge outside a particular area of expertise is sought. In clusters enabled through geographic proximity knowledge of expertise location can be sourced from the network of relationships at a significantly lower cost (Yuan, Fulk & Monge, 2007).

The fact that knowledge of expertise location was considered valuable by participants in this research, more so than other types of knowledge, gives rise to the conclusion that the current focus on two knowledge typology frameworks, tacit/explicit and architectural/component, to competitive advantage in clusters may not be too broad. Results of this research indicate that other knowledge types, e.g. in the case of the investigated cluster, knowledge of expertise location which has received considerably less attention in the literature, may need to be considered when investigating how competitive advantage is created in clusters.

## 6.6. Summary

This chapter presented an interpretation of research results. Propositions 1a), 1b) and 1c) were largely supported suggesting that all three dimensions of social capital, structural, cognitive and relational, drive the development of knowledge in clusters. The structural dimension of social capital drives knowledge development through interpersonal relationships and informal interactions between cluster actors which act as pipelines for knowledge flow between cluster actors. Furthermore, the network as a facet of the structural dimension fosters knowledge development because individuals leaving the cluster tend to maintain relationships which subsequently act as knowledge pipelines to the remote world. The cognitive dimension of social capital drives knowledge development through a shared interaction logic, i.e. the awareness that the benefits of knowledge sharing outweigh potential costs, motivating individuals to develop knowledge. Another facet of the cognitive dimension of social capital are rules and norms that guide the development of knowledge. However, results revealed it is the absence of rules and norms in the investigated cluster that fosters free exchange and sharing of knowledge. This is due to the fact that trust acts as a substitute for rules and norms. Trust is also a facet of the relational dimension of social capital and was found to be an indirect driver of knowledge development by being a ‘lubricant’.

Propositions 2a) and b) are also supported suggesting that cluster firms and lateral actors have a role in knowledge development through social capital. Cluster firms are involved as the nexus for knowledge development because their relationships and interactions with each other and with lateral actors act as major pipelines for knowledge development. Those relationships are especially conducive for knowledge flow when characterised by reciprocal or team oriented interdependencies. Cluster management as a catalyst for knowledge development takes an unexpectedly important and indispensable role in knowledge development as many of the informal interactions through which knowledge

is developed are facilitated by cluster management's activities. Contract research laboratories are depositories of valuable knowledge resources, but could potentially be more involved in knowledge development. This lack of involvement in knowledge management can be attributed to the fact that relationships between contract research laboratories and other cluster actors are characterised by sequential interdependencies which cannot be leveraged effectively for knowledge development. Furthermore, the lack of involvement of those actors is due to the relatively large geographic distance between them and other actors emphasising the importance of close geographic proximity as a major contributor to knowledge development.

An emerging result of this research was that individual social capital, rather than collective social capital, drives knowledge development. Knowledge is predominantly developed between individuals through their interpersonal relationships, indicating that it is the individual, rather than the firm or cluster as a whole, which is the relevant actor for knowledge development through social capital. A second emergent result relates to the type of knowledge developed between cluster actors. Tacit knowledge and knowledge of expertise location were the significant knowledge types identified. Knowledge of expertise location is one of the major contributors to competitive advantage, a knowledge type that to date has not been identified as one of the relevant knowledge types in clusters.



## (7) CONCLUSION

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This last chapter concludes the dissertation by providing a comprehensive synthesis of research findings and contributions. The first section of the chapter summarises how results of this research informed the research problem, research questions and propositions. Second, the contribution to theory is discussed, followed by implications for practitioners. Last, some limitations of this research are discussed. Suggestions for future research is also presented in this chapter and integrated with the theoretical contributions and limitations from which those suggestions are derived.

### 7.1. Summary of the thesis

The underlying motivation for this research was that clusters contribute to economic prosperity of regions and that clustered firms and institutions realise competitive advantage over remote firms. Location matters, which at first glance appears to be paradoxical in the age of sophisticated information technology and high labour mobility. This research took a resource based perspective to determine how clusters create competitive advantage, focussing on two intangible resources and their interplay, namely knowledge and social capital. Based on existing literature, knowledge and social capital contribute to competitive advantage in clusters. A shortcoming of the literature was the question of how this happens. Hence, the underlying research problem addressed by this project was:

*How is social capital leveraged for knowledge development in clusters?*

To explore this research problem, the research focussed on two aspects of knowledge development through social capital: the drivers for knowledge development through

social capital and the respective roles of different cluster actors in whose relationships social capital is embedded.

The first research question asked:

*What are the drivers of social capital for knowledge development in clusters?*

In addressing this question, this research proposed that the three dimensions of social capital, structural, cognitive and relational dimensions, drive knowledge development in clusters each in their own distinctive way. The propositions of this research were derived from Nahapiet and Goshal's (1998) conceptualisation of social capital, a framework specifically concerned with social capital's impact on knowledge development, and on Inkpen and Tsang's (2005) adaptation of that framework to clusters. These two theoretical frameworks suggest that the three dimensions of social capital have an impact on knowledge development, each in a distinct way.

Results largely supported the propositions that structural, cognitive and relational dimensions drive knowledge development in clusters. Informal interaction and firm spanning, interpersonal relationships between individuals – facets of the structural dimension – were found to be the major drivers for knowledge development in the investigated cluster. Firm spanning, interpersonal relationships between individuals and informal, face to face interactions act as pipelines for knowledge flow between cluster actors. Notably, various forms of relationships and interactions had distinct impacts on knowledge development. Stronger relationships and close bonds were conducive for informal and trust infused interactions, which, in turn, were found to be major drivers for knowledge development. Informality and trust, imperative for the development of knowledge, were particularly fostered through face to face and/or spontaneous interaction. In reverse, such interactions helped establish and strengthen close and strong

relationships. Geographic proximity, which represents the network ties facet of the structural dimension, also drove knowledge development. However, in order to enable spontaneous, face to face encounters and be conducive for knowledge development, geographic proximity should not exceed walking distance. Hierarchical levels, another facet of the structural dimension, could both hinder and foster knowledge development with little knowledge developed between hierarchical levels, but a lot within a level. The dynamic nature of clusters, with cluster actors frequently leaving and joining, is another facet of the structural dimension conducive to knowledge development in that it creates pipelines to access external sources of knowledge.

Results further showed that shared interaction logic, a manifestation of the cognitive dimension, motivated actors to engage in knowledge development in lieu of shared culture or shared goals. However, the absence of rules and norms fostered knowledge development. This finding was in contrast to the literature which proposes that rules and norms as a manifestation of the cognitive dimension are present in the cluster and have a major impact on the flow of knowledge. However, this contradicting finding could be explained by the fact that trust acts as a substitute of rules and norms. Data suggested that trust, a facet of the relational dimension, needed to be present in relationships and infused in interaction for knowledge development to take place initially. Hence, trust was considered a prerequisite for knowledge development.

The second research question addressed the role of cluster actors and asked:

*Which actors are involved in the development of knowledge in clusters and what are their respective roles?*

Based on the value adding web framework, propositions 2a) and 2b) suggested that cluster firms and lateral actors were involved in leverage of social capital for knowledge

development, respectively, however in differing roles. Results showed that cluster firms were the 'hub' of knowledge development in clusters. Specifically, interpersonal relationships and informal, face to face interaction acted as pipelines for knowledge to flow in the cluster. Furthermore, results revealed that numerous lateral actors were involved, however their respective roles in knowledge development differed. One of the most striking findings of this research was the crucial and indispensable role of cluster management for knowledge development. Cluster management was found to be an important facilitator for knowledge development through organising networking events and providing a supportive infrastructure. Those two activities fostered the establishment of firm spanning, interpersonal relationships and provided a setting for informal interaction between cluster members that may otherwise not meet, hence taking the role of a boundary spanner. Strikingly though, results indicated that in the absence of cluster management and its facilitating activities, knowledge development is likely to take place to a lesser extent, or not at all. According to interviewee accounts, other cluster actors, and cluster firms in particular, were unlikely to organise themselves to provide a facilitating structure for knowledge development. This finding emphasised the importance of catalysts for knowledge development lending merit to the top down approach of cluster governance as opposed to the bottom up approach. Furthermore, in theoretical terms, the importance of cluster management for knowledge development derived from its role as a boundary spanner to bridge weak ties enabling access to new sources of knowledge.

A second notable result referring to the role of lateral actors in knowledge development was that contract research laboratories, a term used to describe university and research facilities contracted to provide facilities and services to cluster actors, were not generally involved in knowledge development. Given that the laboratories had access to valuable repositories of tacit knowledge possessed by the respective institutions, a lack of involvement meant the potential loss of opportunities which may arise through access to

that knowledge. The lack of involvement of contract research laboratories was partly due to geographic distance to other cluster actors, a finding which further emphasises the idea that geographic proximity should not exceed walking distance in order to be conducive for knowledge development in clusters. Furthermore, in theoretical terms the lack of involvement of contract research laboratories was attributed to sequential interdependency inherent in relationships between laboratories and cluster firms created by contracting laboratories as service and facility providers. In theoretical terms, sequential interdependency is characterised by a supplier-buyer relationship through which close bonds or informal interactions are unlikely to evolve. As a result, little knowledge was developed between cluster firms and laboratories.

In addressing the research question of how social capital is leveraged for knowledge development, two emerging results were considered and interpreted in the relevant literature. The first of those two emerging results was that knowledge of expertise location, that is, the general awareness of who is who in the cluster and who possesses which skills, was considered to be the most important type of knowledge developed for competitive advantage. Being explicit rather than tacit in nature according to the established definition, knowledge of expertise location required a good, trust infused relationship and face to face interaction to be developed as in order for knowledge to be transferred, trust must be present. This finding further emphasised the importance of trust as a prerequisite for knowledge development in clusters.

Another emerging result was that individuals were the relevant actors in knowledge development in the cluster, rather than groups of individuals or organisations. Knowledge development in the cluster took place between people through individuals' relationships and interactions. In theoretical terms, this finding implied that it was individual, rather than collective/organisational, social capital which was leveraged for knowledge development in clusters.

## **7.2. Theoretical contributions**

Findings of this research contribute to theory by showing how the overlap of three theoretical streams knowledge, social capital and clusters can be drawn on to shed light on how competitive advantage is created in clusters. Before this research, each individual stream and overlap of any two had been the subject of numerous empirical research projects and conceptual papers, but interlinking of the three was under-researched.

Existing literature suggested that the leverage of social capital for knowledge development is a major determinant of competitive advantage. This research contributes to theory by going one step further and unveiling *how* this happens by focusing on the dynamics. Specifically, this research makes four theoretical contributions. Firstly, these include ideas regarding the operationalisation of social capital in a cluster setting. Secondly, results trigger discussion regarding what is ‘geographically close’. Thirdly, results constitute an impetus to rethink what the term ‘cluster actor’ implies. Lastly, this research contributes by shedding light on the crucial role of cluster management for the development of competitive advantage.

### ***7.2.1. The operationalisation of social capital***

One major contribution to theory of this research is that findings indicate how to operationalise social capital in a cluster setting. Due to the complexity and ambiguity of this highly intangible resource, practitioners and scholars alike are to date still debating how to operationalise social capital in practice (Daniel, Huang, Rathnappulige & Neale, 2014). An impetus to develop an operationalisation framework arises because the lack thereof poses a major challenge to empirical researchers. Specifically, researchers may not know what to look for when investigating social capital in a real life setting. As a consequence, more often than not research has focussed on the outcomes of social capital rather than its dynamics because the outcome tends to be easy to measure, e.g. in terms of monetary value and growth rate (Stone, 2001). While this approach has merit, it is

important to note that social capital takes different forms depending on the collective in which it is embedded. Therefore, operationalisation frameworks are applicable and useful only for a particular context, for example, using a family, neighbourhood, organisation or nation as the unit of analysis (Stone, 2001). This is where the contribution to theory of this research lies as it shows a way of operationalising social capital in the specific context of knowledge development in clusters. In doing so, this research draws theoretical rigour from Nahapiet and Ghoshal (1998) by applying their framework to a cluster setting. Results revealed that in clusters the three dimensions of social capital, structural, cognitive and relational dimensions, drive knowledge development. Hence, a focus on these three dimensions is a valid approach to investigate social capital and its leverage for knowledge in clusters. Prior to this research, Inkpen and Tsang (2005) suggested these three dimensions are likely to impact on knowledge development in clusters based on conceptual plausibility. This research empirically confirmed this suggestion. Many facets of Nahapiet and Ghoshal's (1998) three dimensions are relatively easy to observe (e.g. geographic proximity, people moving from or to the cluster, presence or absence of rules and norms) or can be queried by means of common methods of data collection, e.g. questionnaires and interviews. Hence, findings of this research not only contribute to theory, but are highly valuable for future empirical research design by providing an indication of what proxies to look for in investigating social capital in a cluster setting.

### ***7.2.2. Geographic proximity – what is ‘close enough’?***

Another important theoretical contribution relates to geographic proximity, or more specifically, addresses what ‘geographically proximate’ implies in the context of clusters. In other words, the theoretical contribution of this research addresses the question of what is ‘close enough’? Geographic proximity is one of the defining features of clusters, setting it apart from other network types (OECD, 2007). In the context of knowledge development, the underlying assumption of the KBV of clusters is that geographic proximity fosters knowledge flow between cluster actors, making geographic proximity a

condition necessary for the creation of competitive advantage (Arikan, 2009). However, there is an ongoing debate in the literature regarding how close firms and institutions need to be to each other in order to be classified as a cluster. A review of cluster literature reveals that 'geographically close' can range from being located in the same building to spanning entire countries, or even multiple countries, with actors being hundreds of kilometres apart (Andersson et al., 2004).

Results of this research suggested that geographic proximity not exceeding walking is conducive for knowledge development. When proximity exceeds walking distance opportunities for informal and face to face interaction through which knowledge is developed may be reduced. If informal and face to face interaction does not occur, firm spanning, interpersonal relationships are less likely to be established. These relationships were found to be pipelines of knowledge flow in the cluster. As a result, within the realm of the KBV of clusters, results showed that in the investigated cluster, no advantages were derived from clustering if geographic distance between actors exceeded walking distance. Hence, propositions suggested in the literature that geographic proximity can span different states or countries are not supported by results of this research. Rather, findings showed that knowledge is most likely to be developed if firms and institutions are located in a precinct in close proximity.

Another theoretical conclusion can be drawn from the finding of the importance of geographic proximity. In the investigated cluster, knowledge requires geographic distance not to exceed walking distance in order to be leveraged for knowledge development. In practice, however, many clusters with larger geographic distances between cluster actors (i.e. entire regions and nations) realise advantages over remote firms (Porter, 2000). It follows that, assuming a RBV of clusters, resources other than knowledge are likely to be leveraged successfully in geographically spread clusters. Investigating what those other resources are and the dynamics leveraging them for competitive advantage is subject to



further research that draws on clusters spread across a larger geographic distance. A model linking geographic distance and appropriate cluster resources could eventuate from such research efforts addressing which resources are strategically valuable for spread clusters.

### **7.2.3. *Rethinking: What is a cluster actor?***

Results suggest that it is individual, rather than collective, social capital which drives knowledge development in clusters. This was evident in the investigated cluster where knowledge was developed between individuals whose firm spanning relationships and informal interactions with each other acted as pipelines for dissemination of knowledge in the cluster. This finding challenges existing literature by raising the question of how to define a cluster actor. In traditional cluster literature, the term ‘cluster actor’ most commonly refers to a firm or an institution, implying that firms and institutions are the drivers of cluster related activities. In some studies, cluster actors include those involved in cluster activities without specifying the level of analysis (Andersson et al., 2004). The focus on organisations as relevant units of analysis is inherent in the vast majority of cluster definitions with authors using terms such as ‘concentration of firms’, ‘group of firms’ or ‘linked firms’ to define clusters dating back to the most widely cited and accepted definition by Porter (2000) who considers clusters to be a ‘group of [...] companies’ (refer to Table 1 – Chapter 2 for a list of prominent cluster definitions). Cluster definitions imply that the firm is the relevant unit of analysis. Likewise, when referring to lateral actors, e.g. governments, consultancy firms and policy makers, the focus is also on firms and institutions and not on individuals (Andersson et al., 2004). Consistent with the focus on firms and institutions in the literature, in the context of the value adding web framework the relevant level of analysis has traditionally been the single firm (Brown et al., 2007a; Brown et al., 2007b). This is logical given the inherent purpose of this framework is to investigate the role of single firms in the creation of competitive advantage, shifting away from the traditionally dominant approach of

investigating the cluster as a whole. Therefore, the term ‘cluster actor’, as used by the value adding web, describes firms, institutions and other organisations with horizontal, vertical and lateral positions in the supply chain (Brown et al., 2010; Brown et al., 2008; Royer et al., 2009; Steffen, 2012). At the relational level of clusters, studies on relational resources have focused on relationships between firms and institutions as valuable relational resources (Exposito-Langa & Molina-Morales, 2010; Gretzinger & Royer, 2013; Hervás-Oliver & Albors-Garrigos, 2009). The issue of firms or institutions being the dominant unit of analysis has never been broached or challenged. It appears that scholars tend to focus on firms and institutions intuitively because this is how cluster studies have traditionally been conducted. Results of this research indicated that ‘cluster actor’ as a summary term to describe which units are relevant in the cluster and to investigate the dynamics of clusters for competitive advantage creation may no longer be sufficient for the investigation of clusters. Rather, results suggested that clear identification of whether the actor is an individual, a group of individuals, an organisation/institution, or a combination is necessary for cluster study.

Furthermore, in the context of social capital and knowledge development findings indicated that the individual level, rather than the firm level, is relevant. For future research adopting a KBV on clusters this finding implies that it may be beneficial to shift the focus of an investigation to individuals, rather than the firm/institution or cluster as a whole, as it is individuals’ relationships and informal interactions in which social capital is embedded and that is leveraged for knowledge development.

#### ***7.2.4. Cluster management’s role***

Results of this research contribute to a body of literature which investigates cluster managements’ role in cluster success and specifically addresses the question whether a top down or bottom up approach to cluster management is superior in terms of promoting cluster prosperity (Fromhold-Eisebith & Eisebith, 2005; Terstriep, 2008). Results

strongly supported the merit to a top down approach of cluster management in the context of knowledge development. The underlying premise of this finding was that top down cluster management acts as a catalyst for social capital to be leveraged for knowledge development.

The contribution to theory is twofold. Firstly, results empirically support the notion widely represented by scholars that cluster management, be it a dedicated cluster management organisation or firms organising themselves, promotes cluster prosperity and is superior to a situation where no cluster management in place (Bode, 2011; Payer, 2002; Powell, 2003; Terstriep, 2008). This research contributes to the literature because to date there has been no in-depth discussion about how the benefits of cluster management arise (Jungwirth & Müller, 2014). Findings showed how cluster management contributes to cluster success, namely in undertaking the role of social capital broker. To date, little research has been conducted on how cluster management contributes to competitive advantage. This ‘blind spot’ in the literature is due to the fact that “research has rarely taken up the issue how to adequately assess the outcomes of intentional cluster support” (Fromhold-Eisebith & Eisebith, 2005, p. 1253). This contribution highlights the importance of future research on cluster managements’ role as a broker. While this research specifically investigated cluster management’s role for the leverage of social capital for knowledge development, future research, assuming a RBV, could examine whether cluster management’s broker role also extends to other cluster resources. Cluster management’s role as a social capital broker further emphasises that knowledge and social capital, or intangible resources in general, are not valuable unless leveraged effectively. In the context of clusters this implies that cluster resources’ value can only be derived if cluster actors leverage resources effectively and efficiently. Hence, another theoretical contribution of this research is that it supports the applicability of the ‘dynamic capabilities’ perspective (Teece, 2009) to a cluster setting which emphasises the importance of the capability to actively manage resources.

Findings suggested that in the absence of a dedicated cluster management organisation knowledge and social capital would possibly become idle resources. Accounts from interviewees suggested that cluster actors were unable and unwilling to take the initiative upon themselves and actively manage those resources for competitive advantage. Therefore, in theoretical terms, a bottom up approach to cluster management would likely not be successful because of a lack of willingness of self-organisation, a prerequisite for a bottom up approach to be successful (Fromhold-Eisebith & Eisebith, 2005). This is an interesting finding given that in reality there are many successful clusters where governance was installed bottom up, i.e. at the initiative of firms (Terstriep, 2008). Since the bottom up form of cluster management is likely not to have eventuated in the investigated cluster, as evident in the accounts of interviewees, this finding raises the question under what circumstances a bottom up approach can eventuate and become successful to help the cluster prosper. Findings of this research indicated that the importance of a top down cluster management derives from its role as a catalyst for knowledge through social capital. This is an indication that a top down approach may be particularly appropriate for knowledge intensive industries, such as biotechnology, where knowledge is the most valuable strategic resource and its management is imperative. This notion is plausible because whether a bottom up or a top down approach is most appropriate depends on “industry specific [...] conditions” (Fromhold-Eisebith & Eisebith, 2005, p. 1252). Nevertheless, the conclusion that a top down approach is indeed the most appropriate form of cluster management in knowledge intensive industries can only definitively be confirmed by further research. Furthermore, an interesting subject for future research would be an investigation of whether the reverse holds true, i.e. that low technology clusters can successfully be run using a bottom up management approach. Suggestions for future research would be a contribution to theory as to date the role of cluster management, particularly in different industries, is under-researched.

### **7.3. Practitioners' implications**

Numerous implications for practitioners can be drawn from this research where 'practitioners' in the context of clusters refers to policy makers, cluster management and managers of cluster firms and institutions.

#### ***7.3.1. Practical implications for the installation of a cluster management***

The theoretical finding that a dedicated 'top down' cluster management is conducive for knowledge development and competitive advantage has major implications to practitioners. In particular, it bears relevance for cluster policy makers whose objective it is to make the cluster and region prosper and who needs to consider whether to implement a cluster management organisation. Based on findings of this research, there is strong support for a proactive cluster management organisation to be installed in order for social capital to be leveraged for knowledge development. Findings suggest that in the absence of a cluster management organisation cluster actors may be unlikely to take up the initiative and foster knowledge development through the leverage of social capital. Hence, a dedicated broker in the form of cluster management appears to be necessary according to the results of this research. Therefore, an implication for policy makers is that in evaluating costs versus benefits of installing a cluster management organisation it is worth considering the crucial and indispensable role of a dedicated cluster manager for knowledge development. In the absence of top down cluster management social capital in the cluster is likely to remain idle and bottom up cluster governance is not guaranteed to eventuate.

#### ***7.3.2. Foster informal interaction***

Given that informal interaction was found to be the most important driver of knowledge in the cluster, fostering this informal interaction is recommended for practitioners to foster knowledge flow. In particular, providing opportunities for people to meet face to face and creating settings for trust-infused, informal interactions to evolve promote

knowledge flow. Practitioners affected include policy makers and cluster managers. Nevertheless, the finding that informal interaction is a driver for knowledge development poses an impetus for managers of firms and institutions, who would benefit from engaging in maximum informal interactions to leverage social capital for knowledge development, i.e. through the participation in networking events.

Findings further suggested that networking events organised by cluster management are conducive for knowledge development. In particular, the informal part of those events is where knowledge is developed because of informal, trust infused interactions evolving. Hence, the organisation of informal events is likely to be a useful tool for practitioners to foster informal interaction and facilitate knowledge development. In bottom up clusters with no formal cluster management organisation in place findings of this research are an impetus for cluster firms and institutions to take the initiative and organise informal events. Furthermore, networking events are likely to be most beneficial in terms of knowledge development if structured to allow sufficient time for informal networking. A broad attendance base ensures that new relationships can be established which facilitate future knowledge development. Therefore, event organisers should ensure that a broad audience attends, including representatives from cluster firms and lateral actors. Likewise, participants from all levels should be attracted, including R&D staff, administrative staff and management to establish relationships between hierarchical levels. This could be achieved by choosing themes and topics that appeal to a broad audience. For managers and staff of cluster firms and institutions, findings of this research imply that, even if it results in minor inconvenience, e.g. travel and time invested, the potential benefits of attending events appear to outweigh the costs. Therefore, to foster attendance it is imperative that organisers clearly communicate the value of such events for knowledge development and competitive advantage.

### *7.3.3. No stringent rules and policies*

Findings of this research imply that any approach to managing a cluster requires finding a careful balance. On one hand, cluster management and their actions are crucial in leveraging social capital for knowledge development. On the other hand, it was found that stringent rules and norms may hinder knowledge development because cluster actors feel restricted and confined in their interactions. For cluster firms, the status quo in terms of rules and norms in the investigated cluster appeared to be ideal because results revealed that the absence of a rules and norms was conducive for knowledge development, and that trust acted as a substitute for rules and norms. For cluster management, this finding implies that creating a cluster environment where rules and norms that guide the development of knowledge become obsolete is likely to be conducive for knowledge development. This can be achieved by fostering trust between cluster members, for example again through the organisation of networking events.

The finding that rules and norms may hinder free flow of knowledge also bears relevance for the contract research laboratory arrangement. Findings showed that the contract research laboratories, albeit having access to potentially valuable knowledge resources, do not actively participate in knowledge development. This is at least in part due to the contractual nature of the supplier-buyer relationship created, i.e. an artificial sequential interdependency subject to rules, norms, code of conduct and contractual agreements specifying how laboratories interact with firms and what they can disclose. As found in this research, such rules may hinder knowledge development. It follows that, in terms of knowledge development, the contract research laboratory arrangement appears to be counterproductive and does not fulfil its purpose of promoting cluster prosperity. In areas unrelated to knowledge development, the arrangement may provide substantial benefits (e.g. cost benefits through sharing expensive equipment) which were not a subject of this research and hence not explicitly identified. A practical implication derived from research findings for practitioners, and for cluster management in particular, is to consider re-

evaluating the contract research laboratory arrangement by carefully investigating whether costs outweigh the benefits. This suggestion may also be valuable to practitioners in other clusters who consider using contractual agreements between cluster actors as a tool to promote cluster prosperity.

#### ***7.3.4. Knowledge of expertise location***

A surprising finding of this research is that knowledge of expertise location is a type of knowledge considered valuable for competitive advantage. As a consequence, gaining access to such knowledge is a major motivator for actors to initially engage in knowledge development. This finding indicates that cluster actors may not normally have access to such knowledge as they may not know how to source it or knowledge of expertise location currently at their disposal may not meet their needs. At first glance this appears to be surprising given the fact that in the investigated cluster an online database listing all cluster firms and associated institutions existed. However, rather than consulting this database, cluster members appeared to become aware of fellow cluster members' skills and resources through informal interaction.

The current online database does not appear to be sufficient to fulfil the needs of cluster actors to be aware of fellow cluster colleagues' particular skill or resource sets.

Practitioners may therefore find it beneficial to consider other means to disseminate knowledge of expertise location so it can be accessed and leveraged by cluster members.

According to the small body of literature available on knowledge of expertise location, IT systems can be useful to disseminate this type of knowledge amongst people provided they are implemented effectively and targeted to needs of the end user (Vivacqua, 1999).

Hence, one way of helping knowledge of expertise location to be built amongst cluster actors can be to create a database that is easy to navigate and search and to include detailed information provided by cluster actors themselves. Nevertheless, according to the findings of this research and relevant literature, informal social interaction seems to be



the best approach to disseminate knowledge of expertise location (Campbell, Maglio, Cozzi & Dom, 2003). Therefore, providing as much opportunity for informal interaction as possible, in addition to a database, appears to be the most efficient way for practitioners to help this type of knowledge reach cluster actors.

#### **7.4. Limitations and suggestions for future research**

In reading, interpreting and drawing inferences from this thesis, a number of limitations have to be considered. First, it should be kept in mind that the underlying premise of this research is the KBV (of clusters). This is not so much a limitation than it is a word of caution for interpreting results of this research. The underlying assumption of this research was that competitive advantage is created through the impact of social capital on knowledge development. The KBV assumption is consistent with the research problem and research questions. This research addresses the overlap of three theoretical frameworks, knowledge, clusters and social capital. Therefore, results are not necessarily applicable in a context where only one of those frameworks, or the overlap of any two, are consulted. As a consequence, interpretation of results and implications for practitioners are valid only in the narrow context of the knowledge based and relational view of clusters. It follows that results should not be universally applied to other theoretical contexts explaining how competitive advantage is created, e.g. the ‘general’ RBV of clusters. For example, the recommendation to install a top down cluster management organisation for competitive advantage to act as a broker may not be valid if dealing with tangible, rather than intangible resources. Further research is necessary to determine whether results are applicable to other contexts with differing underlying theoretical assumptions.

Secondly, even though measures were taken to ensure soundness of methodology and methods, some limitations inherent in the methodology which can only be dealt with by means of further research. One such limitation relates to the investigation of a single

cluster rather than multiple clusters. A practical reason for investigating one cluster rather than multiple clusters were time and resource constraints, so that travel to another suitable cluster was not possible. Furthermore, multiple access points were already present in the investigated cluster, so that initial contact and subsequent communication with potential participants was facilitated.

While investigating a single cluster rather than multiple clusters enabled the researcher to investigate the cluster and phenomenon of interest in-depth, the selection of a single cluster investigation compromises transferability to other clusters. This trade-off is accepted here for the purpose of this qualitative research as an in-depth analysis of the phenomenon of interest. The main purpose of qualitative research is contribution to broader theory rather than applicability to other cases. Hence, statistical generalisation is not the objective of qualitative research (Riege, 2003). Nevertheless, in order to render results applicable to other cluster settings (e.g. different industries, different countries) and strengthen the relevance for practitioners, further research can aim to increase transferability, and in the case of quantitative inquiry, establish external validity. This could be undertaken by investigating a large number of clusters, rather than one. In order to achieve a large enough number of participants for each cluster, a quantitative methodology may be employed using results of this research as a starting point for research design (e.g. structured interviews and questionnaires).

Another methodological limitation concerns the fact that results were derived from in-depth, semi-structured interviews with various cluster actors. Being exploratory in nature, this research required a methodology where in-depth accounts were given, hence interviews as a method of data collection was suitable. Nevertheless, interviewees harbour emotions and opinions towards the issues discussed in interviews which may influence their accounts, intentionally and unintentionally. Results of the research are based on the assumption that accounts of interviewees are truthful and depict what is

happening in the cluster. Techniques were employed to decrease the likelihood of interviewee bias, e.g. by conducting interviews face to face to establish an atmosphere of trust. To completely eliminate the possibility of interviewee bias, further research should test results using data not based on the subjective opinion of people. However, this research focussed on highly intangible and hard to operationalise concepts including social capital, trust, relationships and perceived effectiveness of interaction for which reliable and quantifiable proxies are difficult to find. One particular issue was the perceived lack of tacit rules and norms that guide knowledge development, which was in clear contrast to existing literature. There is a possibility that participants were not aware of such highly tacit rules and norms, despite their existence. One way to eliminate potential interviewee bias would be to design another case study with a significantly larger number of interviewees. This, however, would involve investigating another cluster as the pool of potential participants in the investigated cluster is exhausted.

Another methodological limitation concerns the focus on one cluster in the Australian biotechnology industry. The industry was purposely selected as an exemplary case (Eisenhardt, 1989) for knowledge as the major determinant of competitive advantage. However, the fact that biotechnology is exemplary for knowledge related activities may render results not fully applicable to 'low technology' industries. Further research could tackle this limitation by investigating low technology industry clusters to reveal how social capital is leveraged for knowledge development in this particular context. If any major differences between high technology and low technology are found regarding how social capital is leveraged for knowledge development, those differences in themselves can be considered a valuable result and be insightful in exploring social capital in high technology/low technology settings.

Another limitation of this research is that the investigated cluster had numerous specific, distinguishing features and characteristics, such as dedicated cluster management in place

and universities to be contracted, setting it apart from other clusters. Even though investigating those characteristics provided valuable insights, there are implications for applicability of research results to other clusters. Other distinguishing features of the investigated cluster may compromise the possibility for transferability to other clusters. One of those features is the existence of a very committed cluster management organisation. Such dedicated organisations are not in place in all clusters with some clusters having single firms or a group of firms developing government mechanisms over time from the 'bottom up' and others having no formal or informal management. Nevertheless, many of those clusters operate successfully with cluster firms having advantages over remote firms. Given that this research revealed cluster management's role in knowledge development is surprisingly crucial, further research could explore differences and similarities in leverage of social capital between clusters with and without cluster management, or between clusters with top down or bottom up management. Such a research project would not only generate results likely to be transferable to clusters without a dedicated cluster management organisation, it may also shed light on the role of cluster management for knowledge development.

Further concerning cluster management, one major implication for practitioners based on the results of this research was that in order to leverage social capital for knowledge development a dedicated cluster management organisation is beneficial. Installing a cluster management organisation involves substantial investment of resources resulting in high costs in the case of failure. With those potential costs in mind, it is imperative for practitioners to ask whether an already existing cluster person/firm/institution could be assigned this role and manage the cluster efficiently, but at a substantially lower cost. This question cannot be conclusively answered by drawing on results of this research. Therefore, further research focussing on cluster management and its role is necessary.

Another feature that set the investigated cluster apart from most others was that research institutions and university facilities were contracted by cluster management to provide services to cluster firms. On one hand, this arrangement is a definite advantage for the purpose of this research because it gave rise to the finding that creation of a sequential interdependency and the imposition of stringent rules and norms guiding this relationship negatively impacts on knowledge development. On the other hand, due to this contractual arrangement results of this research do not depict relationships that usually exist between cluster firms and universities in clusters based on voluntary and mutual cooperation. Hence, further research to investigate those relationships and how knowledge is usually developed between cluster firms and universities would be advantageous and interesting. The value adding web offers a useful underlying framework for such a study focusing on various interdependencies that may exist between cluster firms and universities and their respective impact on knowledge development. A research focus on the relationship between academia and other cluster actors could also be valuable for cluster management and universities alike, as results may provide an indication as to how universities and other cluster actors should be linked to create advantages.

Another limitation of this research is that in the investigated cluster it was neither possible nor feasible to differentiate between horizontal and vertical cluster actors. The vast majority of actors in the cluster supply to each other reciprocally, hence it was not possible to pinpoint their exact position in the supply chain. The fact that suppliers and producers of the main good cannot be clearly differentiated is a distinguishing feature of the biotechnology industry in general. Hence, results of this research may not be applicable to industries where there is a clear distinction between input suppliers, buyers and producers of the main good. In those industries, relationships between horizontal actors and their respective vertical actors are usually characterised by interdependencies which are likely to differ from those existing between the firms in the investigated cluster. Hence, social capital embedded in those relationships may be inherently different

from what was found in this research and may have a differing impact on knowledge development. As a result, further research would be useful to investigate how ‘traditional’ supply chain relationships impact on knowledge development. Fruitful industries to investigate would be those with straight forward and unambiguous supply chains, e.g. manufacturing.

### **7.5. Concluding remarks**

Positioned at the overlap of three theoretical frameworks, knowledge, social capital and clusters, this research unveiled how social capital is leveraged for knowledge development in an Australian biotechnology cluster. In doing so, this research contributed to a body of literature addressing the question of why location matters and how clustering creates competitive advantage. Investigating how the benefits of clustering arise has major practical implications for firms and policy makers alike because clusters have become an important tool for regional development world-wide. This research addresses the problem by assuming a resource based perspective with a focus on social capital and knowledge as resources for competitive advantage.

In informing how social capital is leveraged to develop knowledge, this research joined a body of literature that examines clusters from a resource based perspective by investigating how cluster resources contribute to competitive advantage. The underlying motivation was that social capital and knowledge, and their interplay, are widely acknowledged to be important cluster resources that contribute to competitive advantage. However, the dynamics behind the interplay between knowledge and social capital has remained unexplored. Not only was this a major gap in literature, the shortcoming also posed a major challenge to practitioners, e.g. policy makers and cluster managers, seeking to actively leverage social capital and knowledge to foster cluster success. Hence, this research was motivated by theoretical and practical relevance.

A case study was undertaken to investigate one Australian biotechnology cluster. It was shown that within the cluster knowledge was developed through firm spanning, interpersonal relationships and informal interactions of cluster actors. Other factors, including trust, the absence of rules and norms, and a supportive infrastructure also impacted on knowledge development indirectly through enabling relationships and informal interactions. All of those drivers for knowledge development are manifestations of the dimensions of social capital. Hence, in theoretical terms, this research found that the structural, cognitive and relational dimensions of social capital drive knowledge development in clusters. This finding addressed the research gap of how social capital drives knowledge development because it shows that different dimensions of social capital impact on knowledge development in distinctive ways to create competitive advantage. As a theoretical contribution, this research increased understanding of the social capital concept and its underlying dynamics. For practitioners, such an understanding may help in the active management of this highly intangible resource.

Findings revealed how numerous cluster actors are involved in knowledge development, leveraging their interpersonal relationships either directly or as facilitators, to differing degrees. In particular, results of this research stressed the importance of cluster management as a facilitator, catalyst or broker for social capital. This was an interesting finding with major implications for future research investigating whether and how dedicated cluster management can promote cluster prosperity. Undeniably, the finding was equally interesting for practitioners deciding whether or not to install a cluster management organisation. Furthermore, development of knowledge between academia and other cluster actors appeared not to be leveraged to full potential because universities were formally contracted as service providers for cluster firms, providing facilities, equipment and skills. As a result of this contractual arrangement, relationships and interactions were formalised with minimal informal interaction occurring between academia and other actors. This result further emphasised the importance of informality,

as formal relationships were found to be difficult to leverage for knowledge development. For practitioners, this finding provides an indication that imposing contractual relationships on cluster actors may have its drawbacks, at least in terms of knowledge development.

This research has shed light on the interplay of knowledge and social capital in clusters for the creation of competitive advantage. Results bear relevance to scholars and practitioners alike. In conclusion, this thesis makes an important contribution towards understanding how clusters create value through their knowledge and social capital resources.



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# APPENDIX

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## Appendix I – Interview questions

### Background

1. How long have you worked at (cluster firm/institution)?
2. What is your position at (cluster firm/institution)?
3. Do you think that there are advantages for (cluster firm/institution) to be located in a cluster rather than elsewhere?
  - a. If so, what do you think are these advantages?
  - b. Do you see any disadvantages?
4. Do you see yourself as contributing to the knowledge base of your cluster?
  - a. If so, how do you contribute?
  - b. If you don't feel that your role is significant for knowledge development, why is this the case?
  - c. Whose role do you think it is mainly to cultivate knowledge in the cluster?

### Interview

*I'm interested in the nature of your relationships with other firms and cluster colleagues is, and how knowledge is shared, exchanged and transferred between you all.*

5. When you interact with professionals of other cluster firms, how do you prefer to interact? (e.g. formally or informally, organised meetings/calls/emails as opposed to lunches/dinner etc.)?
  - a. Why is this your preference? Now that you said that you prefer (preferred approach), what are the most likely problems with (non-preferred approach)?
  - b. If informal, how do those informal meetings look like, e.g. do you often go out for lunch, have social events?
  - c. On those informal occasions, do you talk about your work?
6. Do you interact regularly, or rather ad-hoc, for example if something important comes up that initiates the need to interact?

7. Do those professionals that you interact with most frequently have a similar position in their organisation (e.g. management level, R&D)?
8. How would you describe your relationship with those colleagues from other firms you meet with regularly?
9. Do you still interact with colleagues that are no longer working in the cluster?
10. Are there firms or colleagues that you interact with more frequently than with others? Why is this the case?
11. When you meet with professionals from other cluster firms and institutions, do you find that people are feeling comfortable to talk about their work and their work projects, or are they rather cautious?
12. Do you go to any of the events organised in the cluster?
  - a. If yes, how is the atmosphere at those meetings?
  - b. Can you tell me more about those meetings and their results from the past and any benefits for yourself and your firm/institution?
13. What do you consider the role of [cluster management organisation] for the cluster, and for knowledge sharing, exchange and spill over in particular?
  - a. How effective do you consider their activities to be?
  - b. What do you think could be improved?
14. What do you consider the role of other external consultants for the cluster and cluster knowledge development?
15. I'd like to talk about institutions that are relevant to the cluster. What would you consider the role of external institutions for knowledge in the cluster, e.g. universities, R&D laboratories, government agencies?
16. What do you consider the role of trust?
17. Do you think there are benefits, opportunities or perhaps challenges in exchanging your professional knowledge with other cluster firms?
  - a. If yes, how do they come about?
18. If you need urgent expertise or advice which you cannot find in your own firm or institution, do you turn to other cluster firms to get help?
  - a. If such a situation occurs, do you sometimes source knowledge from *outside* the cluster, e.g. if you have a technical problem and need help?
  - b. If yes, from where?
  - c. What is your company's relationship with this person, company or institution (e.g. contractual agreements in place, sharing of research) and how do you interact with them (e.g. formal meetings, events)?

19. How do you think knowledge sharing, exchange and spill over happens in the cluster?
20. Are there any “official” systems in place that allow the flow of knowledge between cluster firms? (by systems we mean. IT systems etc, but also regular meetings with the specific purpose to exchange knowledge)
21. Are there any formal or informal rules or policies in place in your organisation or in the cluster that you feel you have to consider when interacting with other cluster colleagues?
  - a. If yes, in your opinion, do you consider those rules effective or do you think there is room for improvement?

### **Conclusion**

22. Is there anything else you consider important about the “value” of relationships in the cluster?
23. Can you think of any other issues that you consider important for the development of knowledge in clusters?
24. Would you be happy for me to contact you if I need clarification or have any additional questions on what we have discussed today?
25. Would you like me to send you a transcript of the interview?

## **Appendix II – Participant information sheet**



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## PARTICIPANT INFORMATION SHEET

for the project

### 'How is knowledge developed through social capital in clusters'

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This research explores how social capital (interpersonal relationships) is leveraged in business clusters for the generation, exchange and creation of cluster knowledge. Knowledge resources, if cultivated effectively, can contribute to competitive advantage both at cluster and firm level. The aim is to identify the dynamics behind the development of knowledge through social capital and so contribute to advancing our understanding of how clusters create advantages, and hence provide an explanation as to why clusters exist.

The project will first identify the key professionals directly or indirectly involved in the development of cluster knowledge, to ensure appropriately targeted research. A number of these professionals from a selection of firms and institutions associated with the cluster will then be interviewed, individually, for approximately an hour, to learn what activities and interactions they undertake, and what organisational mechanisms they have in place in order to exchange, cultivate and leverage knowledge. Interviews will be anonymous (beyond the identification of their professional field) and digitally recorded for accuracy. Following transcription of the recorded interviews, the material will be analysed and coded to identify useful material which will inform the research.

Four outcomes are expected. The research will 1) provide practical insights for cluster professionals and policy makers into which activities can be undertaken in order to effectively develop and leverage knowledge. Further, it will 2) offer a better understanding for professionals of how tacit resources – social capital and knowledge - can be actively managed to achieve benefits. Further, 3) it will deepen understanding the role of social capital for the development of cluster knowledge. Finally, 4) outcomes will contribute to cluster theory by extending the resource based view of clusters and hence its role for how competitive advantage is achieved in industrial clusters.

In conjunction with this information sheet, a consent form will be provided for participants to assure them of confidentiality and ensure consent of the digital recording procedure. This study has been cleared by one of the human research ethics committees of the University of Adelaide. 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, please refer to the complaints form of the other side of this information sheet. You are free to withdraw from the study at any time.