Innovation Performance and Clusters

A Dynamic Capability Perspective on Regional Technology Clusters

Nicole Röttmer

Innovation Performance and Clusters –

A Dynamic Capability Perspective on Regional Technology Clusters

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SUMMARY

Repeated cluster innovations are the result of a concerted interplay of cluster actors and recombinations of cluster resources over time. These concerted processes build on a variety of elements. Several different research streams that aimed at explaining cluster performance and innovativeness have provided descriptions of these elements, sometimes supporting, sometimes contradicting each other.

This dissertation leverages the dynamic capabilities framework to create a comprehensive, dynamic theory of cluster innovativeness. Dynamic capabilities build on (sets of) learned routines and enable organizations to respond to or even create market change. As a strategic management framework, the dynamic capability view acknowledges the interplay of the organization's activities, including managerial action, and the environment in creating performance. This theory building, dynamic research builds on initial concepts and longitudinal, multi-method, multi-case field research. With its breadth, the dynamic capability view can capture all elements proposed as drivers of innovativeness by relevant research streams as initial concepts and provide an initial framework of their interdependency. These are tested in a retrospective research effort, involving five European satellite navigation application clusters with nearly 100 interviewed participants. Building on the results, hypotheses are developed on the drivers of innovativeness over time and an initial and potentially predictive theory of cluster innovativeness is created.

The results of the study are manifold. First, this research identifies the drivers of cluster innovativeness and their interdependency in and across time. Among them, second, innovation capabilities are identified as a major driver of innovativeness, relatively more relevant in the cases than cluster assets. Third, the different capabilities are described and operationalized, including community building, strategic alignment, reconfiguration, opportunity recognition and networking. Fourth, this research confirms the nature of capabilities and provides further insights into their creation over time. Capabilities build largely on specific and learned sets of routines. Thus, they can be considered best practices that can be observed across clusters. At the same time, they are highly idiosyncratic in their details, contributing to their nature as unique competition factors.

This dissertation contributes to theory in different ways. It provides a novel, comprehensive and dynamic, empirically tested, actionable and generalizable theory of cluster innovativeness. Thus, it firstly extends current research into regional innovativeness by integrating all potential factors contributing to innovativeness into a comprehensive framework, building on empirically tested operationalizations. Secondly, with its longitudinal, multi-method and multi-case research approach it provides a research approach for analyzing the processes underlying cluster innovativeness and obtaining results with a predictive power. Thirdly, it provides a tested, network-level research approach. In this, the study also contributes to dynamic capability research, extending the scarce research contributions on inter-organizational capabilities and providing new insights into the nature of inter-organizational routines and capabilities. Fourthly, it adds to the operationalizations of routines and capabilities and fifthly, provides new insights into the sources of capabilities.

Practitioners such as policy makers or cluster managers also benefit from this research effort. This research implies, that clusters can be strategically managed over time to a certain and relevant extent. By aiming at creating the cluster assets or routines and capabilities that the cluster needs most at a specific point in time, they could achieve the maximum leverage to cluster innovativeness with the least investment. This does not only allow for strategically managing cluster development, but will in most cases also reduce the investment levels we see today. Investment decisions traditionally focus on cluster assets, such as research facilities. These, however, did not turn out to be at a prohibitively low level in any of the clusters within the sample – quite in contrast to their capability profiles. Furthermore, this research points at the need for a long-term strategy to cluster development. As in all organizations, changes in clusters take time. However, the development of a cluster over time should be monitored, extending the scope from the traditional measurement of asset compositions to the measurement of asset, routine, capability and performance profiles over time. This also allows for identifying early warning signs for performance development, for example in the cluster's routine profile.

SAMENVATTING

Continue cluster innovatie is het resultaat van een intensief samenspel van actoren in het cluster en van recombinatie van de middelen van het cluster over het verloop van tijd. Dergelijke intensieve processen bouwen voort op een verscheidenheid aan elementen. Verschillende stromen van onderzoek die zich hebben gericht op het verklaren van het presteren van clusters en hun innovativiteit hebben tot beschrijvingen van dit soort elementen geleid die elkaar soms ondersteunen, maar soms ook tegenspreken.

Deze dissertatie richt zich op het dynamic capabilities framework om zo een veelomvattende, dynamische theorie van de innovativiteit van clusters te creëren. Dynamic capabilities zijn gebaseerd op (groepen van) aangeleerde routines en stellen organisaties in staat om op marktveranderingen te reageren, of om deze zelfs bewust te creëren. Als een strategisch management kader onderkent de dynamic capabilities zienswijze het samenspel van activiteiten van de organisatie, inclusief managementhandelingen, en bovendien de rol van de omgeving als het gaat om het verhogen van prestaties. Om een dergelijke theorie te ontwikkelen wordt gebruik gemaakt van basisconcepten en van longitudinaal, multi-methode veldonderzoek met meerdere casussen. Door haar brede aanpak kan de dynamic capabilities zienswijze alle elementen, die als drijfveren van innovativiteit worden beschouwd door relevante onderzoeksstromen, als basisconcepten opnemen, en op basis hiervan een initieel kader verschaffen dat hun onderlinge samenhang duidelijk maakt. Deze zijn vervolgens getest in een retrospectief onderzoek naar vijf Europese clusters die zich richten op toepassingen van satellietnavigatie, met bijna 100 interviewers met deelnemers. Op basis van de resultaten hiervan zijn hypotheses geformuleerde over de drijfveren van innovativiteit over het verloop van tijd, en is een initiële theorie geformuleerd van cluster innovativiteit die potentieel voorspellend kan werken.

De studie heeft tot vele resultaten geleid. Ten eerste identificeert het onderzoek de drijfveren van cluster innovativiteit en de samenhang daartussen, op een bepaald moment, en over het verloop van tijd. Daarbij zijn, ten tweede, innovatievaardigheden geïdentificeerd als één van de voornaamste drijfveren van innovativiteit, hetgeen uiteindelijk relatief zwaarder blijkt te wegen dan de bezittingen van het cluster. Ten derde

zijn de verschillende vaardigheden beschreven en geoperationaliseerd, waaronder community building, strategic alignment, reconfiguration, opportunity recognition en networking. Ten vierde bevestigt het onderzoek de onderliggende natuur van dit soort vaardigheden en geeft het meer inzicht in de manier waarop ze over verloop van tijd worden gecreëerd. Vaardigheden bouwen voornamelijk voort op specifieke aangeleerde groepen van routines. Als zodanig kunnen ze worden beschouwd als best practices die in het algemeen bij clusters kunnen worden geobserveerd. Tegelijkertijd zijn de details sterk typisch voor de organisatie, wat bijdraagt aan het idee dat ze uiteindelijk toch unieke factoren voor de concurrentiepositie zijn.

Deze dissertatie draagt op verschillende manieren bij aan theorievorming. Het geeft een vernieuwende, veelomvattende en dynamische, empirische geteste, generaliseerbare theorie van cluster innovativiteit die ook in de praktijk kan worden gebracht. Zodoende breidt het ten eerste bestaand onderzoek naar regionale innovatie uit door alle potentiële factoren die aan innovativiteit bijdragen te combineren in een compleet kader, dat gebaseerd is op empirisch geteste operationalisering. Ten tweede stelt de longitudinale, multi-methodische aanpak met meerdere casussen een onderzoeksaanpak voor, voor het analyseren van de onderliggende processen van cluster innovativiteit die resultaten kan leveren met voorspellende waarde. Ten derde geeft het een geteste onderzoeksaanpak op netwerkniveau. In dit opzicht draagt de studie ook bij aan dynamic capabilities onderzoek, door de schaarse onderzoeksbijdragen op het gebied van interorganisationele vaardigheden uit te breiden en nieuwe inzichten te verschaffen op het gebied van interorganisationele routines en vaardigheden. Ook draagt het bij aan de operationalisering van routines en vaardigheden. Tenslotte geeft het nieuwe inzichten in de bronnen van vaardigheden.

Mensen uit praktijk, zoals beleidsmakers en cluster managers kunnen ook voordeel hebben van dit onderzoek. De studie maakt duidelijk dat clusters strategisch kunnen worden gemanaged over het verloop van tijd, tot een zekere, relevante hoogte. Door zich te richten op het creëren van de juiste middelen voor het cluster, of op de routines en vaardigheden die op een bepaald moment het meest nodig zijn, kunnen ze de optimale verhouding tussen cluster innovativiteit en investeringen vinden. Dit stelt ze niet alleen in staat om de clusterontwikkeling strategisch te managen, maar ook om in vele gevallen de

huidige investeringsniveaus te verlagen. Investeringsbeslissingen zijn traditioneel gericht op de middelen van het cluster, zoals onderzoeksfaciliteiten. De kosten hiervoor bleken echter in geen van de clusters in het sample op acceptabel niveau te zijn, in sterk contrast met hun vaardigheidsprofielen. Daarbij wijst het onderzoek op de noodzaak van een langetermijnstrategie voor clusterontwikkeling. Zoals in elke organisatie het geval is: veranderingen binnen clusters vergen tijd. De ontwikkeling van een cluster door de tijd heen moet wel worden gemonitord, waarmee het bereik van traditionele metingen wordt uitgebreid van de samenstelling van middelen naar het meten van zowel middelen als routines, vaardigheden en prestatieprofielen over verloop van tijd. Dit maakt het mogelijk om vroege waarschuwingen voor prestatieontwikkeling te identificeren, bijvoorbeeld in het profiel van het cluster.

ACKNOWLEDGEMENTS

This dissertation is the result of research at the Centre for Technology and Innovation Management at the University of Leiden between 2005 and 2009. This thesis aims at complementing the picture of the drivers of technology cluster innovativeness. Specifically, it is building a theory of cluster innovativeness that comprises the network characteristics or capabilities that research into regional innovativeness has long described in case studies. Building on multiple cases and a network-level, dynamic research approach, this thesis describes the nature, sources and impact of cluster innovation capabilities.

A wide range of people supported this research in a variety of ways. My thanks extend to all of them.

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Nicole Röttmer

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LIST OF ABBREVIATIONS

B-2-B	Business-to-Business
B-2-C	Business-to-Consumer
CAGR	Compound Annual Growth Rate
CASTLE	Clusters in Aerospace and Satellite Navigation Technology Applications Linked to Entrepreneurial Innovation
CeTIM	Centre for Technology and Innovation Management
CS	Commercial Service
DGPS	Differential GPS
EGNOS	European Geostationary Navigation Overlay System
ESA	European Space Agency
GDP	Gross domestic product
GLONASS	Global'naya Navistsionnaya Sputnikova Sistema (GLObal Navigation Satellite System)
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
NACE	Nomenclature Générale des Activités Économiques
NUTS	Nomenclature of Territorial Units for Statistics
OS	Open Service
PRS	Public Regulated Service
R&D	Research and development
SME	Small and medium enterprises

SoL	Safety-of-Life Service
S&P 500 index	Standard & Poor's 500 index
ZUMA	Center for Surveys, Methods and Analyses (Zentrum für Umfragen, Methoden und Analysen)

1 INTRODUCTION

1.1 MOTIVATION AND PROBLEM STATEMENT

For sustaining its economic growth, Europe needs to become more innovative. The Special European Council acknowledged this fact in 2000, leading to the creation of the Lisbon Agenda. Clusters, sector- or technology-specific agglomerations of firms across the value chain which are supported by a specific infrastructure such as Silicon Valley, have a high innovative potential (Krugman, 1991a; Baptista and Swann, 1998). Clusters can develop specific assets, relationships and interactions. These might then enable the protagonists to benefit from an earlier and clearer perception of buyers' needs, faster and more consistent learning about new technological, operational or delivery opportunities, experimentation at lower costs and faster times to market (1998b; Porter, 2008). Accordingly, clusters form a cornerstone in the European Commission's strategy to increase European innovativeness (Commission of the European Communities, 2005; EurActiv.com, 2006).

Over the past eight years, the European Commission developed a variety of initiatives for identifying, developing and supporting clusters. Among them are cluster projects such as "CASTLE" ("Clusters in Aerospace and Satellite Navigation Technology Applications Linked to Entrepreneurial Innovation") and network efforts such as "Innovating Regions in Europe" (see also www.europe-innova.org). The member states devised similar initiatives, such as "BioRegions" and "Networks of Competence" in Germany, the "Pôles de Compétitivité" in France and the "Knowledge Transfer Networks" in England. Additionally, cross-country initiatives such as "BioValley" have come to life. The prominence of the topic with researchers and practitioners reflects this development. A simple Google search in early 2009 returned about 250,000 hits for 'regional cluster conference' and a search in May 2009 on Google scholar returned 462.000 hits for "regional cluster". This number is close to the Google scholar hits for "joint venture", i.e. 528.000, although the variety of other terms for cluster-related phenomena have not been included in the search. As a result, we witness an inflationary use of the term cluster. In

2005, a literature and cross-database search allowed for identifying about 700 clusters in Europe.

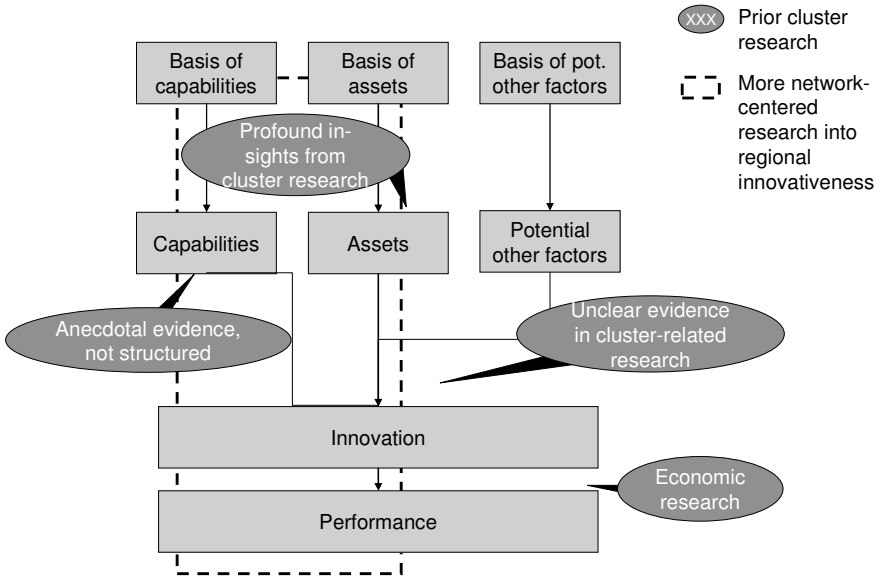
Do these impressive activities provide an answer to Europe's growth challenge? The answer remains outstanding. In contrast to expectations, history has shown that not every region described as a cluster is innovative. This is partially due to the means of identifying clusters prominent nowadays. In the early days of cluster research, the identification of clusters built on the observation of superior performance. These clusters naturally contributed to economic growth. Nowadays, cluster identification tends to rely on specific structural characteristics (Borner et al., 1991; Rosenfeld, 1997; for exceptions, see Feser, 1998). These characteristics comprise a strong endowment with resources, i.e. a critical mass of competing protagonists, the devotion of resources to R&D, policy support as well as profound technological competency (Porter and Stern, 2001; Porter, 2008).

However, these structural characteristics often used for identifying clusters neither can explain nor guarantee innovativeness, as Saxenian (1994) shows in her analyses of the Silicon Valley and Route 128 clusters. "[T]he mere presence of firms, suppliers, and institutions in a location creates the potential for economic value, but it does not necessarily ensure the realization of this potential" (similarly Breschi and Malerba, 2001; Porter, 2008, p.16). So what else is needed? As of today, the mechanisms by which clusters and their supporting institutions benefit the innovativeness of their participants remain unclear, rendering any prediction of future cluster success guesswork (Gerstlberger, 2004b; Snapsed et al., 2007).

Network characteristics or capabilities of clusters appear to allow for the realization of the innovative potential, but receive limited attention in cluster research (recently, Porter and Stern (2001) added more emphasis to them) and also cluster policies (Huggins, 2008c). More network-centered regional innovation research streams cover them to different degrees and with different foci (Figure 1 provides a conceptual overview). Among them are the research into regional networks (Saxenian, 1994; Bresnahan et al., 2001), regional innovation systems (Cooke, 1992; Asheim and Isaksen, 1997; Cooke et al., 1997) and innovative milieux (Aydalot, 1986; Camagni, 1991a; Maillat, 1992; Camagni, 1995). They propose a variety of network characteristics or capabilities as the driving force

behind cluster innovativeness. Among them are joint learning, high quality interaction, collaborative practices and mutual adjustment in the face of intense competition (see also Marshall, 1890). Camagni and Capello (2002) describe these characteristics as regional innovative capability, similar to what Salais' and Storper's (1993; 1997) term regional capabilities or Maskel's and Malmberg's (1999) describe as localized capabilities. They are grounded in "the complex and historically-evolved relations between the internal orgaanization of firms and their connections to one another and the social structures and institutions [in the sense of behavior guidance systems] of a particular locality…" (Saxenian, 1994, p.1).

Figure 1: Scope and focus of cluster research compared to other research into regional innovativeness



Our understanding of the driving forces behind these network characteristics, or regional capabilities, of clusters is limited (Huggins, 2008b; Motoyama, 2008). The institutional context of the interactions between protagonists is often overlooked and any evidence of specific organizational practices and their impact on performance is, at best, anecdotal. In case researchers recognize the need for institutions and public goods, they often do not specify them. For example, Porter and Stern recognize that "[a] variety of formal and informal organizations and networks - which we call "institutions for collaboration" - can

link the two areas [the common innovation infrastructure and a nation's industrial clusters]" (2001, p.30). Porter proposes that "… governments should promote cluster formation and upgrading and the buildup of public or quasi-public goods that have a significant impact on many linked businesses" (1998b, p.89). However, following Doloreux and Parto (2005, p.19; see also Asheim, 2006) it is unclear, "…what the institutions are or how they interact in different system [sic!], at different scales, or at different levels of inter-relation. Regional institutions and institutional arrangements as factors that generate appropriate forms and practices to enhance regional innovation potential can and, we argue, should be identified and categorized…" Similarly, Bergek et al (2008) demand a focus on functions, or strategic actions, in innovative regions and call for a list of the functions required for performance.

For capturing the full picture of cluster innovativeness, a change in the research approach is necessary. On the one hand, the approach needs to acknowledge the organizational nature of clusters. On the other, it should reflect a dynamic understanding of clusters (Motoyama, 2008).

Research into cluster innovativeness needs to acknowledge the organizational character of clusters and focus on the network level of research (Windeler, 2001). In Porter's (1998b, p.79) words, "[C]lusters represent a kind of new spatial organizational form in between arm's-length markets on the one hand and hierarchies, or vertical integration, on the other." Network characteristics of clusters imply that clusters are an own organizational, coordinating entity with participants that have open borders (Becattini, 1989; Saxenian, 1994). For Saxenian (1994), building on Sabel (1988) and Best (1990), the region can be organized to innovate, if not all regional firms are. Regions then act as "important bases of economic coordination at the meso level" (Asheim and Isaksen, 2002). While most approaches that aim to explain regional innovativeness can be deemed network-focused (Gerstlberger, 2004b), this network level is often not reflected in the research questions or the addressees. For example, researchers often either develop recommendations for individual actors and/or happen to measure cluster performance as the performance of selected, individual firms (Saxenian, 1994; see, for example Porter, 1998b).

The dynamic approach is in line with the widely recognized nature of current innovation processes, as well as the co-evolutionary nature of clusters and the relevancy of learning. Innovation processes are interactive and networked. Understanding them also requires a dynamic approach for capturing the structural and social patterns facilitating innovation (Kanter, 1988; van de Ven, 1988; Rothwell, 1994). In contrast, traditionally, cluster research employs static economics, (implicitly) assuming equilibria (Martin, 2006; Sheppard, 2006). Similarly, the number of longitudinal or retrospective case studies or references to history are limited (Saxenian, 1994) as researchers are only starting to empirically and systematically observe cluster evolution (Ketels, 2003; Cooke, 2007; Arikan, 2009). The traditional approaches do not only contradict the often acknowledged co-evolutionary nature of clusters, but also impede any effort to capture innovation and learning activities in clusters (Porter, 1998b; 2008). Cross-regional case studies could provide an avenue for generating new insights (Sternberg, 1995; Gerstlberger, 2004b; Doloreux and Parto, 2005).

We can build on network research for a review of the feasibility of fulfilling these criteria and for ideas on adequate research methods. Network research conceptually acknowledges the organizational character of networks as well as their dynamic nature (see, for example Miles and Snow, 1986; Sydow, 1994; Miles et al., 2005). However, few cases of consistent dynamic and network level research exist (Windeler, 2001; Das and Teng, 2002; Sydow, 2003; Oerlemans et al., 2007 provides an overview of the current state of network research; and Schmidthals, 2007). Among the notable exceptions are, firstly, Koza's and Levin's (1999) co-evolutionary research into the evolution of networks. Secondly, the IMP group conducted research into the drivers of Swedish SME success in global markets, building on industrial networks (Hakansson and Johanson, 1992). Thirdly, Sydow and Windeler perform research into the constitution of enterprise networks, building on Gidden's (1997) structuration theory (Sydow and Windeler, 2001; Windeler, 2001). Katzy and Crowston (2008) recently conducted a longitudinal effort into explaining the sources of network innovativeness.

For fully capturing the drivers of innovativeness in a structured manner, a comprehensive framework is needed. It is missing in regional theories (Doloreux & Parto, 2005; Porter, 2008). Strategic management research could provide this concept, as the research object

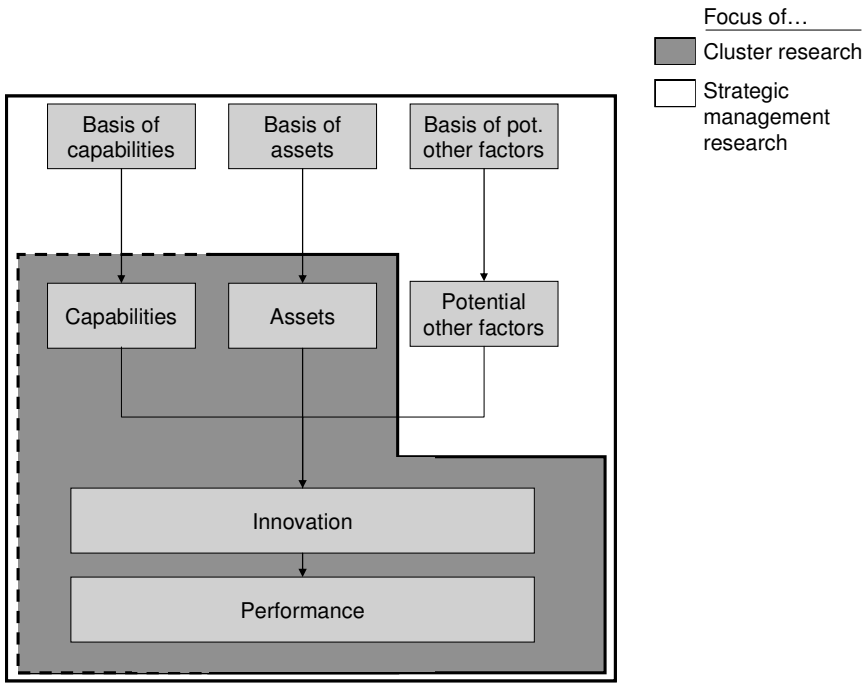
is very much related to the management of clusters and networks. Its dynamic capability view especially has strong linkages to the innovation as well as strategy literature and follows an inherently dynamic research approach (Teece, 2007; Teece, 2008). Katzy's and Crowston's contribution applied a similar perspective and developed evidence on its feasibility. Conceptually, this approach requires the organizational nature of the research object, which is given in the case of clusters. Furthermore, also the development of networks such as clusters depends on managerial action as well as environmental driving forces such as institutional, sociological, technological developments for their success (Lewin et al., 1999).

Dynamic capabilities explain superior performance of firms at times of rapid environmental change. They enable organizations to directly or indirectly profit from their assets, including the (re-)combination of (new) assets or capabilities to affect the transformation of inputs to outputs which would then match or even create market change (Grant, 1996; Teece et al., 1997; Eisenhardt and Martin, 2000; Zollo and Winter, 2002). Also, they lie at the heart of collaboration for innovation with external enterprises and institutions (Teece, 2007). They are specific, identifiable routines (or collections of routines (Winter, 2002; similarly, Helfat, 2003), or regular and predictable patterns of observable collective activity (Teece et al., 1997), allowing to provide concise insights into the drivers of innovativeness.

Strategic management researchers only recently began analyzing small networks among businesses and businesses and research and to my knowledge have not conducted research into clusters (Gerstlberger, 2004b). However, the first efforts into this direction are promising. Dyer and Singh (1998) extended the resource-based view to encompass the relational view, thus providing an explanation for true competitive advantages in alliances (Mesquita et al., 2008). Building on their contribution, Pavlou and El Sawy (2004) recognized that dynamic capabilities, the sources of sustained performance, can also extend across organizational borders. Similarly, Zollo, Reuer and Singh (2002) investigate into the inter-organizational routines that drive performance within alliances and recognized, that capabilities then become "stable patterns of interaction among two firms developed and refined in the course of repeated collaborations…". Building on this,

Figure 2 illustrates how a combination of the cluster and strategic management research objects might provide a full picture of cluster innovativeness and performance.

Figure 2: Perspectives of cluster and strategic management research – compound potential to grasp all potential drivers of cluster innovativeness



Understanding the institutions and organizational practices that underlie sustainable cluster innovativeness is a prerequisite for picturing reality and thus to managing and supporting clusters (van de Ven and Poole, 1995; Motoyama, 2008). "Europe will not be able to reach the ambitious goals it has set itself in the Lisbon-Agenda, if it fails to unlock the potential of its existing and emerging clusters" (Ketels, 2004, p.4). The prominent focus of policy makers to support structural elements of clusters can easily render interventions unsuccessful, as they ignore the fundamental basis of the cluster concept (Martin and Sunley, 2003; Huggins, 2008a).

According to Preissl and Solimene (2003, p.23),

> *"...when firms are not viewed as isolated agents but as parts of a larger system, the most successful type of intervention is that supporting the institutions that build skills and capabilities tailored to the needs of the district and try to overcome specific constraints that prevent the exploitation of inter-firm linkages."*

This dynamic and cluster level research effort is the basis for providing good recommendations to policy makers (Bresnahan et al., 2001).

1.2 RESEARCH OBJECTIVE AND RESEARCH QUESTION

This research aims to develop a dynamic theory of cluster innovativeness. It thus develops and empirically tests concepts, targeting the development of hypotheses and a model of cluster innovativeness. The results, these hypotheses and the model then provide the basis for future, ideally longitudinal theory-testing research.

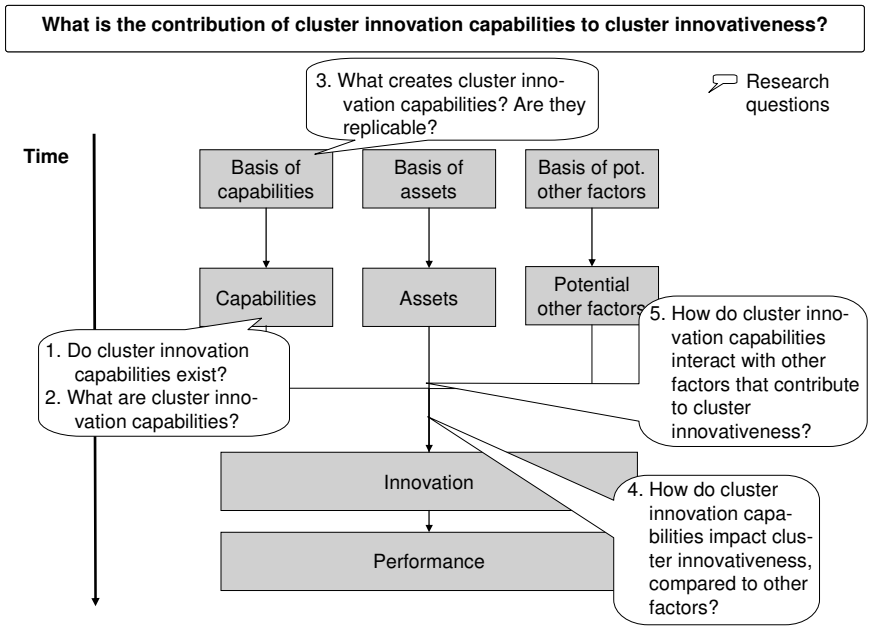
Specifically, this research aims to answer the following research question:

What is the contribution of cluster innovation capabilities to cluster innovativeness?

Several research sub-questions detail this objective (see also Figure 3):

1. Do cluster innovation capabilities exist?
2. What are cluster innovation capabilities?
3. What creates cluster innovation capabilities? Are they replicable?
4. How do cluster innovation capabilities impact cluster innovativeness, compared to other factors?
5. How do cluster innovation capabilities interact with other factors that contribute to cluster innovativeness?

Figure 3: Research questions underlying this thesis



As Chapter 1.1 has shown, only a dynamic and cluster level research approach can fully capture the driving forces behind cluster innovativeness, especially with regard to network characteristics or capabilities. Network research contributes appropriate approaches for dynamic, network level research and the dynamic capability approach within strategic management is an adequate guiding concept for capturing network characteristics, or capabilities, without ignoring the relevancy of other factors. The dynamic capability view offers a practice-oriented, dynamic research concept applicable to clusters as social entities as well as the cluster level (Katzy and Crowston, 2008). At the same time, it inherently links cluster routines, assets and capabilities to performance.

This thesis is another result of a dedicated research program at the Center for Technology and Innovation Management (CeTIM) at Leiden University and University BW Munich, which focuses on the concept of dynamic capabilities. Previous work at this institute prepared the ground for this dissertation. Examples of successful research in this field include the measurement of dynamic capabilities under conditions of high uncertainty in new technology-based ventures (Dissel, 2003), the dynamic capabilities of product

development (Blum, 2004), the dynamic capability research into the growth of technology-based new ventures (Strehle, 2006) or the insights into managing technology networks (Katzy and Crowston, 2008). Due to the promising results, additional work is expected to provide further insights. A research program on cluster and network dynamic or innovation capabilities has been set up.

1.3 RESEARCH EPISTEMOLOGY AND METHODOLOGY

This research project aims at building a theory of cluster innovativeness. Doing so requires a modern constructivist epistemological position. A researcher's epistemological position determines, which sources of knowledge he considers valid and thus determines the choice of the research methodology. The two most prominent epistemological schools of thought are the rationalist and the empiricist. Rationalists believe that absolute truths, such as mathematics, can be known a priori by pure cognition. This view was held by philosophers like Descartes, Leibniz and de Spinoza (Albert, 1992; Röd, 1992). In contrast, empiricists believe that we can only know the truth by experience. For them, observations, experiences, or sense data is most important. This view is based on Aristoteles and was predominantly held by philosophers like Bacon, Hume, Locke, Hobbes, and Newton (Albert, 1992; Röd, 1992; Audi, 2000). In order to align these opponent views, Kant (1787) developed his critical stance (Albert, 1992). Kant suggested that both forms of knowledge co-exist. He differentiated elements, such as space, time, and causality, which we can capture a priori with our opportunities of cognition and elements that can only be known a posteriori, i.e., that the sun is rising every morning.

This project follows Kant's critical stance. It leverages causality and thus explanatory patters as a priori knowledge. Specifically, these allow to a priori derive potential causal relationships among cluster capabilities and innovativeness. However, determining the validity of the potential explanatory patterns requires observation, due to the social nature of routines, capabilities and innovation. Combining both, a priori pattern development and a posteriori observation in an iterative approach allows for generating new insights while striking the balance of being neither too narrow nor too broad. In such an empirically grounded theory building effort, both types of knowledge co-inform one another until saturation.

The epistemological stance influences the choice of the research methodology. Today, the rationalist school largely finds its reflection in positivism (Tacconi 1998). Positivistic research assumes that knowledge is objectively knowable and aims to produce an undeniable truth. A priori hypotheses are tested in experiments with a careful control of

the environment (Audi, 2000). Positivistic research emphasizes the use of quantitative data. Positivistic research s adequate, when the phenomenon being studied is clear and the researcher does not interact with the research object. In contrast, social constructivism assumes that knowledge is only subjectively knowable (Burrell and Morgan, 1979). Ideally, knowledge is acquired through grounded theory building (Berger and Luckmann, 1967; Weick, 2006), in a process of social interaction that also involves the researcher and within which the observer might impact the research object. Constructivism focuses on qualitative data. The modern constructivist position to theory incorporates Kant's epistemological position, allowing for the iterative process of rational and empirical knowledge creation. This research methodology is adequate, when the boundaries of the phenomena being studied are unclear and no undeniable truth is expected (Katzy and Dissel, 2005a). With clusters, routines, innovation capabilities, this research effort addresses social, path- and context-dependent phenomena. Accordingly, capturing this social element requires a (modern) constructivist stance (Wolfe and Gertler, 2004).

This research project follows a modern constructivist position. The research process incorporates an iterative process between rational and empirical knowledge creation, clarifying the issues under consideration, integrating feedback phases and testing results with regard to their logical explanations (see, for a similar approach Dissel, 2003; Strehle, 2006). This process provides a sound foundation for the description of conceptual phenomena (Churchill, 1979; Boly et al., 2000; Cooke, 2007). "[Q]uantitative and qualitative analyses are mutually complementary and render a far more complete story of local innovation dynamics…", (Wolfe & Gertler, 2004, p.1090). As laid out in Chapter 1.1, little is known about the network characteristics or capabilities that might render clusters innovative. Traditional cluster-related research does not incorporate the dynamic and cluster level perspective required for enhancing out understanding of these capabilities. Accordingly, the theory building approach from case studies is especially adequate (Eisenhardt, 1989; Eisenhardt and Graebner, 2007) and the selected approach is especially useful for this (Eisenhardt, 1989), even more so in cases of longitudinal research (van de Ven and Poole, 1990).

The dynamic element of this research requires a process theory approach (Katzy and Crowston, 2008), as applied for example by Dissel (2003), Strehle (2006) and Ma (2008).

Process theory aims at explaining phenomena by means of a series of events in a temporal sequence (Mohr, 1982). It thus complements variance research, which "explains change in terms of relationships among independent variables and dependent variables" (Mohr, 1982; Poole et al., 2000, p.31), ignoring the analysis of development trajectories (Breschi & Malerba, 2001). Process research aims at capturing these trajectories or patterns, focusing on probabilities, not causality (see also Table 1). It is the identification of these process patterns that enables us to derive social scientific explanations, acknowledging the human hand in development and change (Leonard-Barton, 1990; van de Ven et al., 1999; van de Ven and Poole, 2001). Patterns identified in process research are generalizable and have predictive power (Mohr, 1982; Markus and Robey, 1988; Türk, 1989; van de Ven & Poole, 1990). Thus, applying a process research perspective supports this theory building project (Wolfe, 1994) and provides a more well-founded basis for recommendations to policy makers and cluster managers (van de Ven & Poole, 1990; Abbott, 1990; Bresnahan et al., 2001, for firm managers see also Teece, 2009).

Table 1: Comparison of variance and process research (adapted from Mohr, 1982, p.38).

	Variance research	**Process research**
Basis of explanation	Causality	Probabilistic rearrangement
Role of the precursor	Necessary and sufficient condition	Necessary condition
Focus	Variable	Events in a process
Role of time	Irrelevant	Sequence of events is critical
Role of stability	High, equilibria	Low/ none
Potential prescriptive power	Low	High

This research can provide a first indication of the processes underlying capabilities and their development as well as their impact on innovativeness in combination with other factors, building on retrospective data. Based on this ground measurement, further longitudinal research is required to strengthen the insights. Katzy's and Crowston's (2008) research indicated, that the development of competencies in a network for completing

complex projects alone took more than five years. Given these long timeframes, this research cannot provide a comprehensive perspective on the process underlying cluster innovativeness. Additionally, the technology disruption, which could prove the strength of any dynamic capabilities existing, has not yet taken place.

This project follows the case study-based theory building methodology proposed by Eisenhardt (1989), who built on Glaser and Strauss (1967), Yin (1981; 1984) and Miles and Huberman (1984). Eisenhardt's approach is adequate in situations in which "…little is known about a phenomenon [and] current perspectives seem inadequate…" (1989, p.548) and allows to develop novel, testable along empirically tested constructs, generalizable hypotheses and theory that are strongly tied to the evidence. Thus, a theory can be developed that is in accordance with academic requirements, i.e. clear, parsimonious, logically coherent, refutable, and consistent with empirical data (Pfeffer, 1982).

Furthermore, this research integrates specific research requirements to allow for pattern recognition. It leverages multiple longitudinal, i.e. retrospective cases, thus supporting the identification of patterns and cause-and effect relationships (similarly: Leonard-Barton, 1990). Following process research requirements, I will determine potential patterns a priori. Besides using adequate data analysis support, this also facilitates the handling of the vast amount of data as well as the pattern recognition process (Pettigrew, 1990; Ma, 2008), addressing one of the major challenges of this theory building approach. Handling the vast amount of data is of specific relevancy, as according to Eisenhardt and Leonard-Barton, it might lead to the development of a potentially overly complex or a narrow and idiosyncratic theory.

Several quality parameters apply for research. Gibbert et al. (2008) integrated the requirements for rigorous case studies, building on Yin as well as Cook and Campbell (1976). Case study research should show external, internal and construct validity and also be reliable. External validity of research is concerned with the generalizability of results to other settings. Using several case studies building on clear selection criteria and applying a process research approach increases external validity (Leonard-Barton, 1990). Internal validity, the truth of causal inferences from the theory is a traditional weakness of case study research (Orlikowski, 1992; Yin, 2003). Gibbert et al. derive three best practices for increasing internal validity in case study research. The first is building on a

clear research framework, the second engaging in pattern matching among previously observed or predicted patterns and the observations and the third to engage in theory triangulation. Leonard-Barton (1990) adds a process of moving back and forth between the formulation of the theory and the retrospective case studies. Construct validity is concerned with the quality of the conceptualization of the research object at hand. Increasing it requires a clear logical argument that led the researcher from the initial research questions to the findings. Also, using several strategies for data collection as well as different data sources enhances construct validity. Reliability is concerned with error-free research and can be enhanced by using a study protocol and a study database. This project fulfills these requirements.

Eisenhardt has proposed eight research steps that this project follows (see also Table 2). The first step is the definition of the research question and the specification of a priori constructs. The research question guides the research process (Chapter 1.2). A priori construct development requires an ex ante selection of relevant parameters. These should be as broad as possible in theory building research, and ideally not limited by existing theories. At the same time, it provides a search lens, which later allows for a rigorous data analysis. Thus, a review of several theories and empirical research results provides a good path to derive ex ante constructs (Webb and Pettigrew, 1999). Form a process theory perspective, the selection of potentially relevant theories and empirical research results acts as an ex ante sensor. The derived ex ante constructs focus the data collection.

In this specific research project, the literature review leverages related research from different disciplines, i.e. regional innovation systems, innovative milieux and regional networks, which provides additional insights into the driving forces of innovation in cluster-related constructs. Additionally, it incorporates the dynamic capability view, which in itself is strongly linked to the innovation and strategy literature (Teece, 2007) and supports the identification of context factors, assets, capabilities, performance as well as patterns underlying them and their development. This is in line with the findings of dynamic capability research that dynamic capabilities "often have been the subject of extensive empirical research in their in their own right…", (Eisenhardt & Martin, 2000, p.1107). Furthermore, the literature review has informed the epistemological research stance and the research design.

The second step comprises the selection of cases. In this specific effort, this comprises the selection of a specific sector or technological field as well as of the clusters. The guiding principle for selecting the specific sector or technology as well as the cluster population is to generate the maximum insight into cluster innovation capabilities. These innovation capabilities could avoid the danger of cluster lock-ins that can occur in clusters (Storper, 1997b; and Porter, 2008) and should thus show in sustained or increased innovativeness after shocks (Helfat and Peteraf, 2003). According to Porter (1998a, p.244), "[e]xternal threats to cluster success arise in several areas. Technological discontinuities are perhaps the most significant, because they can neutralize many cluster advantages simultaneous [sic!]". These shocks can lead to the decline of clusters, in case they lack the capabilities required for innovativeness. Additionally, they can lead to significant changes in networks (Rosenkopf and Padula, 2008). At the same time, technology clusters are likely to be more innovative, provide a higher potential for co-operation and capture a far bigger market and thus growth potential than sector-oriented clusters (Turner, 2001; Preissl and Solimene, 2003; Wolfe & Gertler, 2004; Porter, 2008). According to the relevance of technology shocks and the motivation of this study, I will focus on a technology that will soon be facing a shock, and select clusters with a technology, not a sector focus. In the sense of this longitudinal theory building project, the clusters should ideally already expect the shock, allowing to observe first capabilities in action. The shock itself, however, would ideally take place at the end of this theory building effort, allowing for profound theory testing and extending the retrospective insights into cluster innovativeness and performance. Satellite navigation technology provides a good case example, as will face a substantial shock with the introduction of GALILEO in 2013 (GPS Daily, 2009). Underlying the creation of GALILEO is Europe's strategic intent to generate 100,000 jobs or more (European Commission - Directorate-General for Enterprise and Industry, 2006) and create a market potential of 9 billion € p.a. (European Communities, 2001). This new system enables both, incremental innovations, i.e. continuous path creation, as well as radical, path breaking innovations, potentially leading to the creation of new markets in a Schumpeterian sense (Schumpeter, 1912). To ensure comparable technology and market conditions, I limit the scope of the study to Europe (Grewal and Tansuhaj, 2001; Song et al., 2005). The selection of the five specific clusters will follow a theoretical sampling approach, aiming at spanning diverse clusters for

enriching the range of insights and enhancing generalizability (Eisenhardt, 1989; Pettigrew, 1990; see also Eisenhardt & Graebner, 2007).

The third phase consists of crafting instruments, operationalizing concepts, formulating the study protocol and empirically (pre-)validating the instruments, operationalized concepts and the research design. As instruments, I will leverage semi-structured interviews with a variety of respondents per cluster as well as reviews of archival data to obtain retrospective longitudinal, qualitative and quantitative data from (for a similar approach, see Gerstlberger, 2004b). As we cannot observe capabilities directly, complementary artifact-based measurement is necessary, which will enhance the quality of the retrospective data. The concepts, operationalizations as well as the interview guideline are validated with cluster experts in thirteen semi-structured interviews for their validity and reliability, comprehensiveness and manageability (similarly, Barringer and Bluedorn, 1999; Zollo et al., 2002; Schmidthals, 2007). Additionally, I have tested them in eight interviews with satellite navigation experts, as the significance of the operationalizations can change across industries. The Zentrum für Umfragen, Methoden und Analysen (ZUMA) reviews the interview guideline, which is then translated into the clusters' native languages. Additionally, a case study protocol is designed. Multiple investigators conduct the interviews, enhancing both, the creative potential of the study and the confidence in the findings. Additionally, using multiple sources of evidence enhances construct validity and the use of case study protocols supports external validity.

In phase four, the field research takes place. An overlapping data collection and case and cross-case analysis characterize it. For increasing the validity of the research, we aim at interviewing two representatives of each cluster entity type that might support cluster innovativeness. These entity types are small and medium enterprises (SMEs), start-ups, large enterprises, research institutes, universities, incubators, venture capitalists and business angels, regional business associations, technology transfer centers, regional development agencies, policy makers, and business service providers (Porter, 1998b). The research process remains open to adding data collection methods in case these turn out to be required. The observer interacts with the research object and might even impact it.

The fifth phase is concerned with within-case and cross-case data analysis. This phase allows for pattern search and recognition. Data coding by multiple researchers improves the likelihood of developing an accurate and reliable theory and of capturing novel findings in the data. Supporting software, i.e. ATLAS.ti and Excel, help handling the amount of data.

In phase six, I will form the hypotheses. The tabulated evidence created in phase five, as well as leveraging the replication logic and searching for explanations behind the observed relationships serve to sharpen the constructs and the theory and support construct and internal validity. Additionally, the key informants will review the research reports, thus supporting construct validity.

Enfolding the results into the literature constitutes the seventh research phase. This also supports the internal and external validity of the research.

The eighth phase serves to reach closure. The researcher perceives theoretical saturation and stops the process of iterating between theory and the data. The researcher can then formulate the synthesis of the results and the implications for future research as well as for practitioners.

Table 2: Overview of research process (adapted from Eisenhardt (1989, p.533))

Steps	Description
1. Getting started	• Defining the research question • Defining a priori constructs
2. Selecting cases	• Selecting cases: Technological field, clusters
3. Crafting instruments and protocols	• Crafting instruments, operationalizing constructs, formulating the study protocol and empirically (pre-)validating the instruments, constructs and the research design
4. Entering the field	• Field research with multiple investigators, including iterative knowledge development and case and cross-case analysis
5. Analyzing data	• Within and cross-case analysis, pattern identification
6. Shaping hypotheses	• Shaping hypotheses, including sharpening constructs, verifying the emergent relationships among the constructs, deriving explanations
7. Enfolding literature	• Enfolding potential literature
8. Reaching closure	• Finalize theory development, summarize findings, implications for research and practitioners and propose future areas for research

1.4 EXPECTED RESULTS AND CONTRIBUTION

This research contributes to research into regional innovativeness and dynamic capability research. Furthermore, it provides insights for practitioners. This theory building research provides a novel, comprehensive and dynamic, generalizable and empirically tested theory of cluster innovativeness. In this, it provides an initial description of the process underlying cluster innovativeness and its contributing elements as well as detailed operationalizations of the concepts used. This description builds on five cross-cluster retrospective case studies. I suggest that the insights are transferable to other settings and serve as the basis for ongoing longitudinal research.

This research contributes to research into regional innovativeness. Thus, it firstly extends current research into regional innovativeness by integrating all potential factors contributing to innovativeness into a comprehensive framework, building on empirically tested operationalizations. Secondly, it provides a research approach for a dynamic analysis of innovativeness, enhancing our understanding of the contributors of cluster innovativeness as well as cluster evolution (Ketels, 2003). Thirdly, it provides a research approach that allows for consistently analyzing clusters on the network level.

As for dynamic capability research, this research also contributes by providing a network level research approach, extending the scarce research contributions on inter-organizational capabilities and providing new insights into the nature of inter-organizational routines and capabilities (Dyer and Singh, 1998; Pennings et al., 1998; Zollo et al., 2002). This is a direct contribution to strategic management research, as it provides additional insights into factors that drive enterprise success (Gerstlberger, 2004b). Secondly, it extends the base of operationalized routines and capabilities, answering a long standing call in this research stream (Teece and Pisano, 1994; Teece et al., 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002). Third, it provides new insights into the sources of capabilities (Galunic and Eisenhardt, 2001).

This research benefits practitioners in three ways. This research sheds light on the dynamics and the comprehensive factors underlying cluster innovativeness. Firstly, the insights allow for determining the extent to which cluster innovativeness is manageable. Secondly, these insights that have been empirically developed, building on a

comprehensive picture of cluster innovativeness and an analysis of several retrospective studies provide a good starting point for developing actionable recommendations to cluster managers and policy makers (Sternberg, 1995; Gerstlberger, 2004b; Cooke, 2007; Bergek et al., 2008). It provides insights into best practices and also allows them to design evidence-based, good policies and provide public transparency on their impact, as increasingly demanded by the public (Mccann, 2007). Thirdly, the results provide initial insights into the kinds and sequencing of relevant investments, allowing policy makes to focus on activities with the highest impact.

1.5 STRUCTURE OF THE STUDY

The first chapter of this thesis explains the motivation for this research project, the contributions and limitations of earlier research and the rationale behind applying a strategic management framework to clusters. It defines the research question and objectives, lays out the research epistemology and methodology, and illustrates the expected results and contributions.

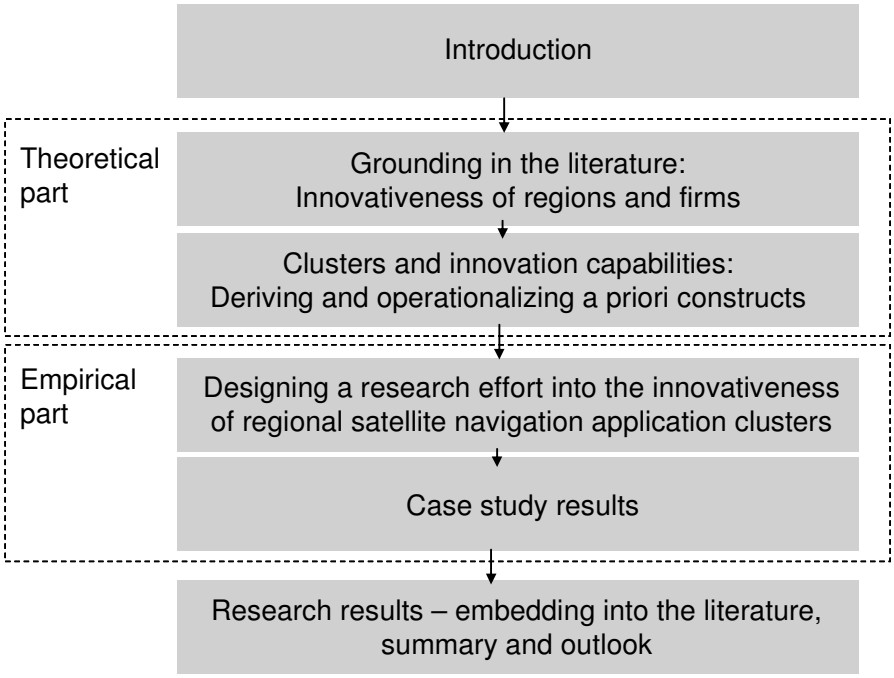
Chapter two and three form the theoretical basis of the study. Chapter two develops the theoretical foundations of the research and the a priori constructs. This chapter, of course, defines the relevant terms and details the concept of dynamic capabilities, which appears to provide an adequate theoretical basis for learning more about the driving forces behind cluster innovativeness. A broad review of the literature on innovative regions serves to identify a priori constructs and to test the capacity of the dynamic capability framework in order to capture the innovation driving forces identified in these frameworks. The review incorporates the literature on clusters, regional networks, regional innovation systems and innovative milieux. Triangulating driving forces of cluster innovation and firm dynamic capabilities serves to define a priori cluster innovation capabilities as well as testing the applicability of the dynamic capability framework to clusters. In chapter three, I will develop an integrated model of cluster innovativeness that serves to define the potential patterns in the empirical research and operationalize the a priori constructs.

Chapters four and five contain the empirical parts of the study. Chapter four lays out the design of the field research and the data analysis. In Chapter five, I will analyze and discuss the results for developing hypotheses. The within-case and cross-case analyses serve to determine, whether the a priori patterns formulated in chapter three hold true as well as develop propositions on how capabilities might be created and how they might impact innovativeness. I also discuss the roles of the additional driving forces of cluster innovativeness. These findings allow us to derive a proposition-based, empirically tested, temporal model of cluster innovativeness.

Chapters six completes the model of cluster innovativeness. Pursuing Eisenhardt's research methodology further, it firstly embeds the results into the literature, discussing

the findings vis-á-vis contradicting and supporting earlier research results. Building in that, it provides an overview of the findings and a research outlook

Figure 4: Dissertation outline



2 GROUNDING IN THE LITERATURE: INNOVATIVENESS OF REGIONS AND FIRMS

2.1 DEFINING INNOVATIVENESS AND TECHNOLOGY CLUSTERS

2.1.1 Defining innovativeness

This research project aims to increase our understanding of the sources of cluster innovativeness. I define innovation as the result of a conversion of knowledge and/or ideas into new products and services (inventions), that are taken to a commercial use (building on Schumpeter, 1912; Freeman, 1982; Nonaka, 1991; van de Ven et al., 1999). Innovativeness indicates the ability of an individual or organization to innovate.

2.1.2 Defining technology clusters

The cluster definition developed in this theory building research project serves as a search lens for identifying clusters. Thus, it should be precise, but not too restrictive to allow for identifying all potential drivers of innovativeness. Therefore, I will derive this definition by leveraging multiple cluster-related concepts, as proposed by Eisenhardt (1989) and in line with the approach taken by Gestlberger (2004b) and Bergek et al.(2008). This reflects the variety of research streams that took interest in regional innovativeness, which provide concepts that often are not clearly distinguished against clusters (Asheim & Isaksen, 2002).

The definition applied in this research project should allow for capturing potential driving factors of innovativeness as proposed by cluster-related research. Regional clustering has been subject to research under a variety of names and from a variety of research disciplines (Stuchtey, 2001; Martin & Sunley, 2003; Dümmler, 2005; see, for example,

the overviews by Porter, 2008). Among them are economic geography research (Marshall, 1890; Krugman, 1991b; Amin and Thrift, 1992; Storper, 1997a), regional science (Giarratani, 1994; Markusen, 1995), the literature on agglomeration (Weber, 1909; Harris, 1954; Lösch, 1954; Ciccone and Hall, 1996), research on urban and regional economics (Scott, 1987; Glaeser et al., 1992; Henderson, 1994), on growth poles and backward and forward linkages (Perroux, 1955; Hirschman, 1958; Lasuén, 1969), and on industrial districts (Marshall, 1890; Piore and Sabel, 1984; Becattini, 1987; Sforzi, 2000). However, the focus on innovation was more prominent in four research streams, namely cluster research, research into regional networks (Saxenian, 1994; Bresnahan et al., 2001), regional innovation systems (Cooke, 1992; Asheim & Isaksen, 1997; Cooke et al., 1997), and innovative milieux (Aydalot, 1986; Camagni, 1991a; Maillat, 1992; Camagni, 1995). Some authors suggest including the concept of learning regions (Lundvall and Johnson, 1994; Florida, 1995). However, the conceptual ambiguities and the proximity to the concept of regional innovation systems limit its potential contribution (Wolfe, 2002). Furthermore, the US-arm of this stream increasingly focuses on individual talent rather than regions (Florida, 2002). Accordingly, this research builds on insights from the four streams mentioned before.

As a consequence of this broad basis, this research project does differentiate between the terms clusters and regional networks. As laid out in Chapter 1.1, several researchers point to the conceptual confusion among clusters and networks, as well as the conceptual unclarity within network research itself (Oliver and Ebers, 1998). Attempts to delineate both concepts appear artificial and, in the case of this theory-building research study, even counterproductive, as it risks excluding innovation-relevant characteristics from the search pattern. For example, in the conceptual differentiation proposed by Rosenfeld (2001) (Table 3), clusters do not have a collective vision. A collective vision, however, might facilitate the cluster participants' co-adaption. Saxenian (1994) emphasizes this collective vision as a key contributor to innovativeness. Similarly, the cluster's management style, which Rosenfeld termed "basis for agreements", could have an impact on innovativeness. Similarly, judging upfront whether majority decisions or social norms and reciprocity foster innovativeness increasingly risks losing sight of important explanatory elements and creating a too narrow-minded theory.

Table 3: Characteristics of networks and clusters (adapted from Rosenfeld, 2001, p.115)

	Hard networks	Soft networks	Clusters
Membership	Closed	Open	None required
Members	Firms	Firms	Variety of actors
Relationships	Collaborative	Cooperative	Cooperative and competitive
Basis for agreements	Contractual	Majority determination	Social norms and reciprocity
Value added	Allows firms to focus on core competencies	Aggregates & organizes demand for services	External economies
Major outcomes	Increased profits and sales	Shared resources, lower costs, benchmarking	Access to suppliers, services, labor markets
Basis of external economies	Shared functions and resources	Membership	Location/proximity
Shared goals	Business outcomes	Collective vision	None

This research will apply the term cluster for three reasons. Firstly, network research does not provide a natural, clear definition that at the same time would be open enough for this research effort. Currently, the "hard network" paradigm is most prominent in strategic inter-organizational network research (Jarillo, 1988; Sydow, 1999; Gulati and Gargiulo, 1999). However, in concepts that apply the idea of social networks to regions, the soft network paradigm prevails (Saxenian, 1994; Bresnahan et al., 2001). Thus, the current use of the term networks in strategic management research appears to least reflect the characteristics of innovative clusters and regional networks. Given the positioning of this research effort in the domain of strategic management, this might create confusion.

Secondly, it is generally acknowledged that co-location can be conducive to interactions and relationship building, and fosters innovation (European Commission - Directorate-General for Science et al., 1997). (Strategic) Network research typically does not reflect the relevancy of the regional dimension (Sydow, 2002; Dümmler, 2005).

The third argument is of a pragmatic nature: I assume that the term cluster can attract the relevant audience, unlike the term network. Network research often focuses exclusively on business-business relationships. Insights into networks will thus most probably attract

the interest of managers only. However, it is widely acknowledged that clusters involve business-business connections, as well as relationships among firms and other protagonists. Literature on clusters will is thus more likely to reach a broader audience including managers, which also includes all protagonists that can be highly relevant for innovative activities.

This research takes Porter's definition of clusters as a first basis. Porter (1998b, p.78) defined clusters as "… geographic concentrations of interconnected companies and institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition. They include, for example, suppliers of specialized inputs such as components, machinery, and services, and providers of specialized infrastructure. Clusters also often extend downstream to channels and customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies, or common inputs. Finally, many clusters include governmental and other institutions - such as universities, standard-setting agencies, think tanks, vocational training providers, and trade associations - that provide specialized training, education, information, research, and technical support." These elements resemble those brought forward by other authors (see Table 4). Additionally, it is important to recognize that clusters require a critical mass of protagonists (Porter, 1998b). While I could not find any operationalization of the term critical mass in the literature, it is apparent that a collocation of a couple of companies does not create a cluster. Accordingly, the key elements of clusters for Porter are a) the geographical concentration of b) firms and institutions in a c) specific area of activity (which might extend across industries), and the existence of d) a specialized infrastructure and of e) horizontal, vertical and lateral links. "The appropriate definition of a cluster can differ in different locations, depending on the segments in which the member companies compete and the strategies they employ" (Porter, 2008, p.7).

Table 4: Overview of cluster definitions (Martin & Sunley, 2003, p.12)

Porter (1998a, p.199) 'A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities.'
Crouch and Farrell (2001, p.163) 'The more general concept of "cluster" suggests something looser: a tendency for firms in similar types of business to locate close together, though without having a particularly important presence in an area.'
Rosenfeld (1997, p.4) 'A cluster is very simply used to represent concentrations of firms that are able to produce synergy because of their geographical proximity and interdependence, even though their scale of employment may not be pronounced or prominent.'
Feser (1998, p.26) 'Economic clusters are not just related and supporting industries and institutions, but rather related and supporting institutions that are more competitive by virtue of their relationships.'
Swann and Prevezer (1996, p.139) 'Clusters are here defined as groups of firms within one industry based in one geographical area.'
Roeland and den Hertog (1999, p.9) 'Clusters can e characterized as networks of procedures of strongly interdependent firms (including specialized suppliers) linked (sic!) each other in a value-adding production chain.'
Van den Berg et al. (2001, p.187) 'The popular term cluster is most closely related to this local or regional dimension of networks… Most definitions share the notion of clusters as localized networks of specialized organizations, whose production processes are closely linked through the exchange of goods, services and/or knowledge.'
Enright (1996, p.191) 'A regional cluster is an industrial cluster in which member firms are in close proximity to each other.'

A review of other research streams does not add elements to the definition, that would not delimit the search lens. Saxenian (1994) describes regional networks as agglomerations of specialized firms and their supporting infrastructure, should focus on related technologies and exhibit interaction, relationships and porous individual boundaries. It is not surprising that no elements are added, as clusters have also been perceived as regional innovation systems (Bergman et al., 2001).

Asheim and Isaksen (2002) chose the more narrow definition for regional innovation system and define them as regional clusters with a strong supporting infrastructure. In them, the collaboration between firms and other institutions is more formal and the supporting infrastructure stronger than in clusters.

Innovative milieux are complex networks of mainly informal social relationships in a given geographical area, which unite the production system and the economic protagonists, enable collective learning and allow for the reduction of uncertainty in the innovation process (Camagni, 1995; Maillat, 2006).

Although these other research streams apply different emphases, the structural characteristics of clusters, regional networks, regional innovation systems, and innovative milieux align throughout the definitions. Additionally, all concepts (increasingly) emphasize the relevance of relationships and interactions. Differences exist with regard to the degrees of formality in the protagonist's interaction and the extent to which researchers emphasize a resulting image or representation. These softer, less readily observable elements might impact the innovativeness of clusters. Thus, they should not form part of the definition. Generally, it is important to recognize that most theories refer to institutions in both meanings, as coordinating mechanisms and structures.

Accordingly, this research applies a structure-focused definition of clusters, specifically of technology clusters.

Clusters are

> *"regional agglomerations of firms focusing on the same technological field that are supported by a specialized infrastructure. The protagonists are connected through vertical, horizontal and lateral links."*

This cluster definition acknowledges the great range of potential cluster configurations (Ketels, 2003). In contrast to other definitions, it does not include any restrictions with regard to the existence of hub firms, the formulation of a vision or strategic goals, or the formality of the cooperation. I will use the term participant for any entity in the cluster region that forms part of the network. In that, I do not differentiate among formal and informal network constitutions.

2.2 REGIONAL INNOVATIVENESS: STRUCTURAL AND SOCIO-CULTURAL ELEMENTS AS DRIVING FORCES

2.2.1 The cluster concept and its driving forces of innovativeness

In this cluster theory, Porter (1990) aims to provide a microeconomic explanation of the competitive advantage of nations, regions, clusters and firms, focusing on structural characteristics. The diamond he developed contains four elements, i.e., the firm's structure, strategy and rivalry, the demand conditions, the related and supporting industries and the factor conditions. With increasing empirical research, Porter extended the diamond to include the government, institutions, i.e. organizations for collaboration, and attitudes toward the economy (Porter et al., 2002b). Recent research provided additional support to the relevancy of these critical non-industry protagonists (Reid et al., 2008).

Porter leverages the diamond to explain cluster performance, but also to explain the performance of regions and nations. In the latter cases, the cluster is part of the diamond, but at the same time, impacts all other elements of the diamond. Additionally, clusters support firms and in consequence grow themselves.

> *"Clusters constitute one facet of the diamond (related and supporting industries), but they are best seen as a manifestation of the interactions among all four facets. Clusters affect competition in three broad ways: first, by increasing the productivity of constituent firms or industries; second, by increasing their capacity for innovation and thus for productivity growth; and third, by stimulating new business formation that supports innovation and expands the cluster" (Porter, 2008, p.12).*

Clusters are embedded in their environment, shape it and are being shaped by it. According to Ketels (2003), the development of clusters can be impacted. Porter acknowledges the human hand as well, but explains that cluster birth is strongly linked to chance, while the cluster's development is driven more by a "chain reaction in which the lines of causality quickly become blurred" (Porter, 2008, p.27). Both external and internal forces are able to cause cluster decline. Technological breaks probably constitute the strongest external force, followed by a shift in buyer's needs. Internal rigidity in the form of "[o]verconsolidation, mutual understandings, cartels, and other restraints to competition undermine local rivalry. Regulatory inflexibility or the introduction of restrictive union rules slows productivity improvement. The quality of institutions such as schools and universities can stagnate" (Porter, 1998b, p.85). Groupthink is another challenge for clusters.

For Porter and Stern (2001), cluster innovativeness builds largely on structural characteristics with the diamond characteristics, a common innovation infrastructure and links to national/regional diamonds. The ideal diamond contains the following elements (Porter & Stern, 2001, p.30; extended with empirical examples in Porter et al., 2002a): Firms operate in a "local context that encourages investment in innovation-related activity" and are characterized by intense local competition. Ideally, firms actively participate in cluster-wide efforts. The region offers factor inputs, such as "high-quality human resources", a "strong basic research infrastructure", a "high-quality information infrastructure" and "ample supply of risk capital". Ideally, the region also offers a good quality of life. Additionally, related and supporting industries are present in "capable local suppliers and related companies" and "clusters instead of isolated industries". These include the existence of local service provides, such as real estate agents. The potential local market is big, local customers are "sophisticated and demanding" and their needs anticipate needs elsewhere. Local, regional and national governments are supportive of the cluster, providing funding and supporting cluster growth. The cluster benefits from local institutions of collaboration. The cluster's diamond constitutes its specific environment for innovation. Additionally, each cluster is embedded in a common national innovation infrastructure, benefiting and feeding into it. This infrastructure comprises cumulative technological sophistication, human capital and financial resources for R&D,

resource commitments and policy choices. The quality of the links between each cluster and this infrastructure, as well as links with other clusters impacts the clusters' performance. As Porter (1998b, p.79) puts it, "[a] cluster's boundaries are defined by the linkages and complementarities across industries and institutions that are most important to competition."

However, not only the structures and resources of the cluster, but also the social processes within them are important for performance.

> *"Social glue binds clusters together, contributing to the value creation process. Many of the competitive advantages of clusters depend on the free flow of information, the discovery of value-adding exchanges or transactions, the willingness to align agendas and to work across organizations, and strong motivation for improvement. Relationships, networks, and sense of common interest undergird [sic!] these circumstances" (Porter, 2008, p.19).*

Along similar lines as Porter, Maskell and Malmberg (1998) constructed a knowledge-based theory of the cluster, emphasizing learning. The proximity of clusters allows for sufficiently speeding up the processes of knowledge creation, acquisition, accumulation and utilization in clusters to work faster than on the outside. As Asheim and Isaksen (2002, p.83) add, clusters are "places where close inter-firm communication, socio-cultural structures and institutional environment may stimulate socially and territorially embedded collective learning and continuous innovation."

2.2.2 The concept of regional innovation systems and its driving forces of innovativeness

The concept of regional innovation systems is based on the literature on innovation systems and regional economics (Doloreux & Parto, 2005). An innovation system consists of elements, their relationships and their characteristics, which in an interactive manner produce, diffuse and use new and valuable knowledge (Lundvall, 1992; Carlsson et al., 2002). Regional innovation systems comprise firms and other organizations. Innovation processes are locally embedded, but the system is social and open, interacting with its environment. The system must not have a specific size. All systems are homogenous in terms of the selected criteria and can be distinguished from their environment by means of a particular kind of association and a kind of internal cohesion (Cooke and Memedovic, 2003). The two constituting elements of regional innovation systems are institutions and knowledge. As in the cluster concept, regional innovation systems are implicitly linked to performance.

With the concept of regional innovation systems, Asheim and Isaksen (1997) and Cooke and Morgan (1998) extend the notion of local production systems to include an institutional structure. These institutions provide the basis for systematic interactive learning among firms and other organizations and thus form an integral part of regional innovation systems (Doloreux & Parto, 2005). The term 'institutions' has been subjected to very broad use, also in the context of regional innovativeness (see, for example Preissl & Solimene, 2003). Doloreux and Prato consider institutions to be social relationships that "define the structure for interactions among humans based on rules, norms, and values". In human interactions, they reduce uncertainty (North, 1990). As collective items, institutions are thus learned and adapted, i.e. produced, modified, and/or reproduced by human action (North, 1990; Giddens, 1997; Scott, 2001). Institutions are context-specific and are integrated with one another. They do not only impact the social, but also the economic system, the local, regional and national level and interactions among individuals, organizations, and entire societies. Resources, symbolic artifacts and activities form institutions (Scott, 2001), which can "appear as organizations, cultural phenomena, or structures…" (Doloreux & Parto, 2005, p.17) As such, institutions are

produced, modified, and/or reproduced by human behaviour (Scott 2001) and change in a co-evolutionary manner. Doloreux and Prato (2005, p.18) identify five roles of institutions in the literature, an "associative", in the sense of belonging to a group, a "behavioural [sic!]", in the sense of behavior guiding, a "cognitive", i.e. an embedding into the culture, a "regulative", i.e. stabilizing, and a "constitutive", in the sense of enduring. Although these roles overlap, they provide a good overview of the potential impact institutions have in guiding innovative behavior. In any case, the system is not directed by a specific actor, but rather informally co-ordinated (Bergek et al., 2008). On a more operative level, Gerstlberger (2004a; 2004b) proposes potential success factors he derived from a variety of research streams. He identified the need for a mission statement, for dense institutionalized discussion, for active promoters (see also Schmidthals, 2007), and intense inter-organizational co-operation networks. He also points at strategies and visions. All of them mutually reinforce each other.

The system's dynamics largely build on interactive and collective learning, which also continuously integrates the system (Preissl & Solimene, 2003). The production of new knowledge and technologies allows the system to not only adapt to the environment, but also to shape it (Cooke & Memedovic, 2003). This reinvention is essential for the survival of the system, as technology changes can outdate regional institutions and cultural patterns. Adaptive learning allows exploiting options, innovative learning leads to fundamental changes required in face of new technological paradigms. For Asheim and Isaksen (2002, p.83), regional capabilities allow regional innovation systems to react faster than other entities. These capabilities are primarily based on "inter-firm networking, inter-personal connections, local learning processes and 'sticky' knowledge embedded in social interaction." Region-specific knowledge potentially constitutes a sustainable competitive advantage. It can hardly be transferred and instead needs to be built (following Lawson and Lorenz, 1999; Asheim & Isaksen, 2002). While Asheim and Isaksen do not elaborate further on the term "regional capabilities", Heidenreich (2004) expands upon the term employed by Salais and Storper (1997) and interprets them as institutions.

More recently, the focus on external relations increases. Rodríguez-Pose and Crescenzi (2008) extended the notion of institutions and provided evidence for the complex

interaction between internal and external research, and the institutional and socio-economic conditions while acknowledging the importance of proximity for transferring knowledge for innovation. Similarly, Cooke's (2007) recent review of the first longitudinal studies of the development of twelve regional innovation systems indicated that these become increasingly integrated and globalized, extending their connections to distant networks.

2.2.3 The concept of innovative milieux and their driving forces of innovativeness

Innovative milieux are complex networks of mainly informal social relationships in a specific geographical area. They comprise a specific culture and representation system and encompass the production system and the social economic protagonists, enabling collective learning and allowing for the reduction of uncertainty in the innovation process (Camagni, 1995; Camagni and Capello, 2002; Maillat, 2006). Norms, values and rules shape the relationships and the protagonists' behavior. They produce trust and reduce the uncertainty in the innovation process. According to authors shaping this concept, it is especially the high degree of informality of the relationships that fosters a dynamic process of collective learning (Camagni, 1995; Maillat, 1998). Innovative milieux can extend across several regions (Crevoisier and Maillat, 1991), but proximity is a fundamental element of milieux (Camagni, 2004). Often, the region is the innovator rather than the firm (Aydalot and Keeble, 1988). Figure 5 provides an overview of the dynamics underlying innovation in milieux.

Five characteristics represent the milieu (Maillat, 2006). The milieu is an organization which develops over time. The milieu is a cognitive concept, which assembles the way of doing of all its protagonists, which focuses on enabling collective learning among them. The milieu has a normative dimension, in that it imposes more or less formal rules and obligations on its participants. Additionally, it is a territorial concept, allowing its participants to benefit from proximity. Empirical research into milieux showed that they often exhibit strong local synergies and a high level of innovativeness (Camagni, 1995).

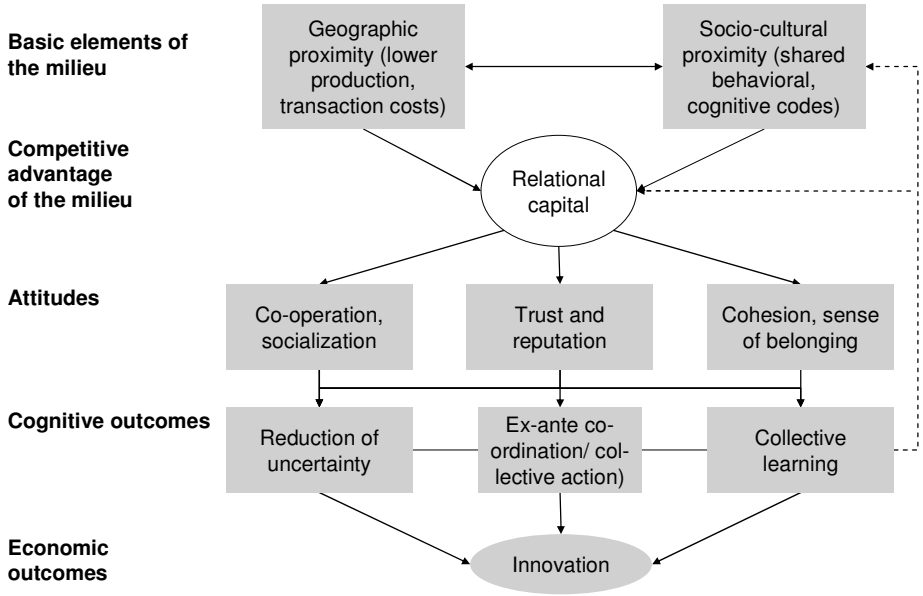
The competence to reinvent itself through innovation is the essential feature of the milieu. Milieux form and reinvent themselves over time. They shape their specific profiles through the process of facilitating and strengthening the regional innovation process. In a changing environment, protagonists in the milieu can initiate a process of reinvention through innovation (Camagni, 1991a; Maillat, 1998; Preissl & Solimene, 2003). For example, new technologies require a modification to the milieu's expertise. In this respect, the region's training and research institutions play an important role in making technologies, generally developed elsewhere, accessible to regional expertise. They do not only take on ready-made solutions, but they also appropriate new technologies and incorporate them into the production of the milieu's protagonists.

The milieux' market and external relations are decisive for innovation. The innovators in a milieu create the organizational processes, which facilitate the encounter between territorial groups and external functional networks (Camagni, 1999). Thus, innovation in milieux is often created by innovative networks, i.e. networks of interconnected innovators (Maillat, 1998). Support measures for innovative milieux include stimulating local synergies, for example through creating public collective agents and launching joint projects. Policies to support co-operation among regions can help to enhance external contacts (Camagni, 1995).

The economic relevance of milieux lies in their cognitive impact. Milieux reduce uncertainty in processes of decision making and innovation, they co-ordinate the participants ex ante, and facilitate collective learning (Camagni, 2004). This allows for the experimental nature of the milieu. At the same time, the milieu builds on its technological and expertise, input and output markets, the supporting infrastructure, its history and organization as well as its external links (Aydalot, 1986; Camagni, 1991b). Through these characteristics, the milieu determines the firm's behavior.

However, not all milieux become innovative, as strongly solidarity-based membership and a convergence of viewpoints, a loss of cohesion or of outward openness might be inhibitive (Maillat, 1998). Similarly, Capello (2004) points at the role of milieux size. In too large mileux, economies of scale could at some point turn into diseconomies. Accordingly, the capability of milieux to change decreases over time.

Figure 5: Driving forces and functions of innovative milieux (Camagni, 2004, p.127)



2.2.4 The concept of regional networks and their driving forces of innovativeness

Regional networks are industrial systems, which contain producers of complexes of related technologies and a supporting infrastructure. They take advantage of the benefits of proximity, i.e. timely communication and face-to-face contacts, and leverage them to build strategic relationships and to specialize(Nohria and Eccles, 1992; Saxenian, 1994). The partners compete intensely while, at the same time, co-operating and learning from each other about market and technological developments. The network promotes mutual adjustment among the participants. The dense social networks and open labor markets encourage entrepreneurship and experimentation. The participants' boundaries are not only porous across functions internally, but also towards other participants, including the supporting infrastructure. Additionally, the networked firms have links to external partners, which foster innovativeness. For Saxenian, the region's organization enables it to innovate. These elements allow networks to react quickly to market and technological opportunities, based on the agglomeration of expertise and information in the region and

processes of a spontaneous regrouping of skills, technology and capital. Accordingly, they expose their strongest benefits in complex, uncertain and fast changing environments.

Interestingly, network researchers do not agree as to whether strong or weak ties support networks more. According to Coleman (1988), networks with many interconnections among the protagonists are advantageous. These largely closed networks foster extensive relations between partners and thus help build trust, shared norms, and routines of inter-organizational behavior and knowledge sharing. Additionally, they support relation-specific investments. However, according to Burt (1992), open networks provide tremendous brokerage opportunities, leveraging structural holes. Thus, all of the protagonists can access more diverse information flows, which could benefit innovation. A recent literature review conducted by Oerlemans et al. (2007) indicates that, for innovation, the emphasis increasingly shifts from weak to strong ties. While cluster-internal interaction is relevant, academic research increasingly points at the relevancy of links to actors external to the cluster, following cluster constitution (Rychen and Zimmermann, 2008).

2.3 THE CONCEPT OF DYNAMIC CAPABILITIES: A COMPREHENSIVE VIEW ON STRUCTURAL AND SOCIO-ECONOMIC DRIVERS OF FIRM INNOVATIVENESS

2.3.1 A dynamic capability model of firm innovativeness: The role of the context, assets, routines, dynamic capabilities and innovativeness as well as performance

The dynamic capability view builds on the resource-based view developed by Wernerfelt (1984), who built on ideas formulated by Penrose (1959; see also Barney, 1991). According to the resource-based view, firms with specific, rare, non-substitutable and non-imitable resources and capabilities will have a competitive advantage over their competitors. However, in dynamic markets these resources and capabilities might create lock-ins (Leonard-Barton, 1992). Accordingly, the dynamic capability view aims to identify those capabilities that allow to avoid lock-ins through path-breaking moves (Eisenhardt & Martin, 2000; Teece, 2007). Dynamic capabilities (see also Nelson and Winter, 1982; Teece & Pisano, 1994; Teece et al., 1997; Eisenhardt & Martin, 2000) form the heart of sustainable competitiveness. They allow firms to avoid and overcome lock-ins in dynamic markets. Several empirical studies indicating their relevancy (for a first overview, see Teece et al., 1997). Dynamic capabilities are defined as

> *"[t]he firm's processes that use resources — specifically the processes to integrate, reconfigure, gain and release resources — to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die" (Eisenhardt & Martin, 2000, p.1107).*

Dynamic capabilities are especially relevant in situations with innovation-based competition and highly dynamic markets as they ensure a rapid action or reaction of the firm (see also Rothwell, 1994; Teece et al., 1997; Eisenhardt & Martin, 2000; Pavlou and El Sawy, 2004 for a discussion). They are context-dependent, conditional and focus on achieving the organizational objective, which often is modeled as survival or profit.

Capabilities can be observed by their underlying elements, their perceived existence as well as their impact (for a review of the academic discussion, see Pavlou & El Sawy, 2004). First of all, the routines (Winter, 2000) or the procedures and processes, skills, disciplines and decision rules, as well as organizational structures that render them observable as regular and predictable patterns of collective activity (Teece et al., 1997) including heuristics (Nelson & Winter, 1982). Secondly, the impact of dynamic capabilities is observable in that they cause resource reconfigurations, which can provide the basis for a perceived existence of the capability. While owning resources does not have a value in itself, the strategic actions that exploit them bring them to bear (Ketchen et al., 2007). Thirdly, dynamic capabilities are observable by means of their impact on performance (Teece et al., 1997). Nicholls-Nixon, Cooper, and Woo (2000) showed in a three year longitudinal study of 454 firms that the ability to perceive and adapt to environmental changes exerts the strongest influence of young company growth.

The dynamic capability view builds on a co-evolutionary concept of change. It assumes that companies shape and are shaped by their environment. The firm and its environment co-evolve, allowing also for managerial action. Though any managerial action is building on bounded rationality, it can change paths (Teece, 2007; Augier and Teece, 2008; Teece, 2008). The environment can impact the firm's current competitive position, and determine its options as well as the firm's success, i.e. wealth creation. The environment acts as a co-evolutionary source of selection. It impacts the firm's level of success in achieving wealth (Lewin et al., 1999) or profit (Teece et al., 1997). At the same time, the firm can shape the environment by employing its dynamic capabilities. During that process, the firm also leverages the resources in its environment, for example by means of networking. This blurs the distinction between the firm and its environment. All entities are path and history dependent. Change takes place at multiple levels, within and among entities, during the processes of co-evolution. Accordingly, causalities are

multidirectional and feedback can produce counterintuitive effects as well as positive feedback (McKelvey, 1997; Lewin and Volberda, 1999).

In the following paragraphs, I will build on contributions from Nelson and Winter (1982), Teece (1997), Lewin and Volberda (1999) as well as Lewin, Long and Carroll (1999) for laying out a model of dynamic capabilities. It consists of five elements. The first is the firm's environment. The second is wealth or profit, the third element is its dynamic capabilities, which constitute the competitive advantage. The fourth is the firm's asset position, and the fifth element is the paths or strategic options available to the firm, which shape these processes (Nelson & Winter, 1982; Teece et al., 1997; Wiegand, 1998).

The firm's dynamic capabilities are managerial and organizational processes. As collective, cross level routines, they do not constitute managerial characteristics, in contrast to some authors' perceptions (Eisenhardt & Martin, 2000; Antonacopoulou et al., 2005). Dynamic capabilities serve to coordinate and integrate, to learn and to reconfigure and transform (Teece et al., 1997). They are knowledge intensive, high level routines (Nelson & Winter, 1982), for example, a rule stating that gas must used instead of oil once their relative price level has reached a threshold value, or rules for the revision of research and development spending over time. These managerial and organizational processes of the firm constitute its dynamic capabilities. They enhance the firm's long-term performance, in the more distant future, by changing and recombining operational capabilities and assets in order to increase performance (Teece et al., 1997; Pavlou & El Sawy, 2004). Of course, the firm also has operational routines, i.e. those routines that handle the production of a good or marketable service (Helfat & Peteraf, 2003). These are close to what Nelson and Winter (1982) termed low level routines, such as production techniques that are strongly tied to constraints, or decision rules that determine the handling of incoming orders. Operational capabilities sustain the firm's performance in stable environments and might also incrementally increase it in the near future through learning while performing them in a process of exploitation (March, 1991; Lewin et al., 1999). "[E]ffective operating routines are always a necessity, and superior operating routines are always a source of advantage" (Zollo & Winter, 2002, p.341).

The firm's assets shape and reside in its dynamic capabilities. The firm's asset position include the firm's operating characteristics, capital stock and other state variables (Nelson

& Winter, 1982), i.e. its technological and complementary, financial, institutional, firm structure, market assets, its organizational boundaries and its reputation (Teece et al., 1997, see also Table 5). Technological assets comprise know-how that is not publicly available. Complementary assets support their translation into commercial products. Financial assets comprise the firm's cash position and degree of leverage. Institutional assets comprise the firm's environment beyond the market, such as the regulatory system, intellectual property regimes, tort and antitrust laws, the national culture and the higher education system. Firm structural assets comprise the firm's governance model, its hierarchical structure level of lateral integration, its formal and informal structure and its external network. The firm's product market position determines its market structure assets. These might be unstable in dynamic markets. The boundaries of the firm, i.e. the firm's level of lateral, vertical and horizontal integration also impact the firm's position. They not only influence the firm's technological and complementary assets, but also signify the firm's choice of co-ordination internally versus through the market. The firm's reputation assets are intangible assets that support the firm's aspiration to achieve goals in the market, as they comprise information about the firm and influence market participants.

Table 5: Firm assets in the dynamic capabilities view (Teece et al., 1997, pp.521)

Assets	Elements
Technological	Not publicly tradable know-how
Complementary	Services that support translating technological know-how into products
Financial	Cash position, degree of leverage
Institutional	Firm's environment beyond the market, comprising the regulatory system, intellectual property regimes, tort and antitrust laws, the national culture and the higher education system
Firm structural	Firm's governance model, its hierarchical structure level of lateral integration, its formal and informal structure and its external network
Market structure	Firm's market position
Boundaries of the firm	Firm's level of lateral, vertical and horizontal integration
Reputational	Firm's reputation

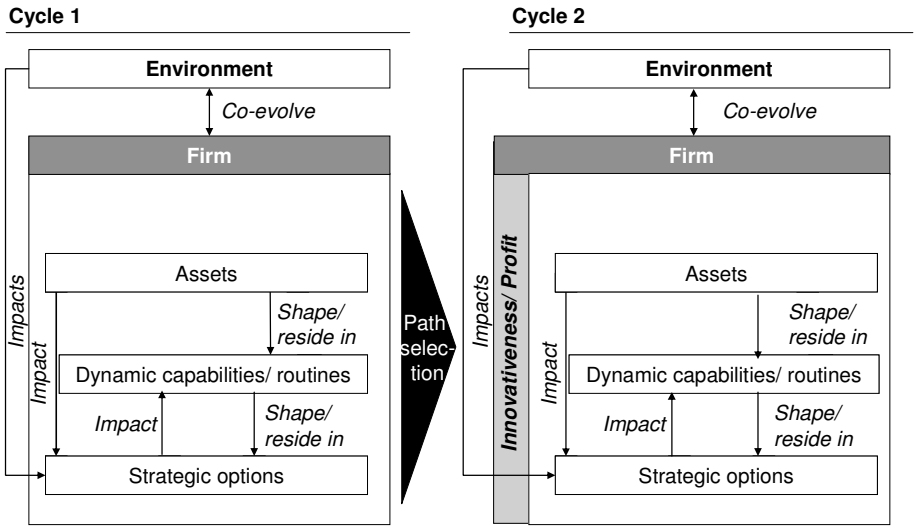
The firms strategic options, also called its paths, shape and at the same time reside in its dynamic capabilities (Teece et al., 1997). The firm's strategic options depend on its assets, its capabilities, and the constraints and opportunities offered by its environment. In this context, it can form two basic strategies, exploration and exploitation (March, 1991). Exploration leverages the dynamic capabilities in order to engage in path creation or path selection (Teece et al., 1997; Pavlou & El Sawy, 2004). This process aims to discover, consider and evaluate changes in the firm's way of operating in order to assimilate external best practices and internal new/recombined knowledge (March, 1991). Exploration is typically required in situations with high market dynamics (Eisenhardt & Martin, 2000) or in situations with intra-organizational misfits (Nelson & Winter, 1982). It is an innovation process, a probabilistic process of learning with adaptive, but unpredictable outcomes and a distant, but potentially high performance impact (Nelson & Winter, 1982; Lewin et al., 1999; Eisenhardt & Martin, 2000). Exploration changes the firm's processes as well as its position. Firms engage in exploitation in stable environments and it is driven by systematic reasoning, risk aversion and performance measurements, leveraging learning and experience curves to improve existing processes (Lewin et al., 1999). The returns generated for exploitation are typically lower and more likely to occur quicker and are less sustainable.

The firm's paths build its legacy. "Organizations increase, deplete, or enhance their legacy through the cumulative effect of their exploration and exploitation activities as mediated by their absorptive capacities to assimilate new knowledge" (Lewin et al., 1999, p.538). The firm's legacy or position (Teece et al., 1997) captures, for example, its reputation, relationships and market position, i.e. its current assets and processes. Due to path dependencies, the firm's legacy moderates the effects of exploration and exploitation (similar to Giddens' structuration theory, 1997; Lewin et al., 1999). Exploration and exploitation update the dynamic and operative capabilities, as well as the asset base, thus leveraging the environment as a learning resource (Lewin et al., 1999; Antonacopoulou et al., 2005).

A firm's innovativeness builds on all of the elements in the model, i.e. all the different required dynamic capabilities, the firm's assets, its environment and of course it's past. Dynamic capabilities enable exploration and thus form the heart of a firm's

innovativeness. They build on the firm's assets and the options offered or created by its environment. The firm's asset base and the strength of its capabilities reflect the firm's legacy. Figure 6 provides a conceptual overview of the underlying processes. Accordingly, the firm's history, in the sense of previous paths taken, and its age must inform research into dynamic capabilities (see also Strehle, 2006).

Figure 6: A model of dynamic capabilities (building on Teece et al., 1997; Lewin et al., 1999).



2.3.2 Characterizing dynamic capabilities

Dynamic capabilities need to be learned. They capture knowledge and require application for continued existence. Dynamic capabilities develop in a path dependent manner through learning (Nelson & Winter, 1982; Teece et al., 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002; Levinthal, 2003), a process that can be guided by human action (Eisenhardt & Martin, 2000). During the process, experience is accumulated and can either be preserved by means of a co-evolving set of experience sharing and codification (Zollo & Winter, 2002) or routinization. Routinization economizes on communication and provides a greater capacity to vary responses, according to a broad range of circumstances, especially when the knowledge generated is increasingly tacit. Eisenhardt and Martin (2000) argue in favour of their more simple, experimental, and iterative nature

in highly dynamic markets and their more complicated, analytic and linear nature in moderately dynamic markets. The knowledge contained in dynamic capabilities is thus likely to increase with the dynamics of the market as well as with their lifetime (Eisenhardt & Martin, 2000; Helfat & Peteraf, 2003). Dynamic capabilities constitute the firm's primary memory for context-dependent, and primarily tacit and dispersed knowledge (based on Leonard-Barton, 1992; Day, 1994; Narayanan et al., 2003). Dynamic capabilities are persistent when they are updated (Zollo & Winter, 2002; Winter, 2003). If they are not updated, some authors argue that they and the knowledge they contain might cease to exist (Eisenhardt & Martin, 2000), other authors suggest that codification can preserve part of the knowledge they contain (Winter, 2002; Zollo & Winter, 2002; Pavlou & El Sawy, 2004). However, given the tacit nature of the knowledge generated in dynamic markets, the memory stored in unused capabilities can probably only be partially sustained at high costs and will quickly cease to exist (Grant, 1996). Independently of the need to conduct the routines, these can be institutionalized in structures, such as roles (Gemünden and Walter, 1995; see, for example Kale et al., 2002; Katzy and Dissel, 2005b).

Dynamic capabilities constitute a competitive advantage. Firstly, they build on sets of learned routines (Dosi et al., 2008), a development process which makes them highly company-specific. Secondly, their impact depends on the firm's assets and paths. Thus, they are hard to transfer and not prone to copying (Leonard-Barton, 1992; Grant, 1996; Teece et al., 1997; Lee et al., 2001; Zollo & Winter, 2002; Eisenhardt and Bhatia, 2002).While dynamic capabilities across firms might be equifinal and expose best practice characteristics, they are also idiosyncratic in their details (Eisenhardt & Martin, 2000).

The literature on firm dynamic capabilities defined them on several levels. For example, without even using the term dynamic capabilities, Nelson and Winter (1982) pointed towards the capabilities of community building, strategic alignment, reconfiguration, opportunity recognition and networking, as well as learning. Teece, Pisano and Shuen (1997) point towards coordination/integration, learning and reconfiguration/ transformation. In a later contribution, Teece (2007) proposes three high level capabilities, i.e. sensing, seizing, managing threats and transforming, that build on the

previously developed capabilities. Eisenhardt and Martin (2000) propose more concrete capabilities and define their subroutines. Among them is, for example, acquisition, which builds on the ex-ante capability of assessing the cultural similarity and the consistency of the vision. For the sake of clarity, I will follow Teece et al and use the term dynamic capabilities to describe the high level functions they perform, which includes the necessary managerial and organizational support mechanisms. I will follow the example set by Eisenhardt et al. in assuming that these dynamic capabilities build on specific subroutines.

2.3.3 Defining and operationalizing dynamic capabilities

The operationalization of dynamic capabilities is a weakness of the dynamic capabilities view (Teece & Pisano, 1994; Teece et al., 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002). Two reasons contribute to this. On the one hand, our limited understanding of where these capabilities come from (Ethiraj et al., 2005) leads to a confusion of cause and effect in describing capabilities. On the other, the term capabilities is generally used in an inflationary manner (Winter, 2003). This leads to a variety of different operationalization attempts at different levels (Teece, 2007).

For the sake of clarity, this research will take Nelson's and Winter's (1982) capabilities as a basis. Nelson and Winter have described five capabilities. These can be described as community building, strategic alignment, reconfiguration, opportunity recognition and networking. They also mentioned learning. Naturally, these routines are not selective (Teece, 2007), they mutually impact one another. However, it can be challenging to foster all of them at the same time.

Following Nelson and Winter, community building relates to the need for alignment of the firm's assets, by means of motivational factors such as formal and informal rules, rule enforcement, the firm's culture, motivation, and the setting of incentives. Strategic alignment enables firms to partly be able to determine their path through exploration and exploitation, given the constraints posed by path and context-dependencies. It includes constructing and revising strategic decisions, bringing this capability closer to the heuristics mentioned by Nelson and Winter (1982). The process of exploration requires

the reconfiguration and integration of assets. The capability to reconfigure and integrate concerns will change in the composition or use of all existing and new assets of the firm. Nelson and Winter (1982) point towards this capability when stating that innovation capabilities could reside in operational research departments and R&D laboratories. Moreover, in order to be able to select those paths that actually enhance the firm's performance, firms require the capability to recognize opportunities. This capability is related to the firm's proximity to the market. Nelson and Winter (1982) recognize, that innovation capabilities could reside in market analysis. These categories capture the capabilities subsequently mentioned by Teece et. al (1997), namely coordinating and integrating, learning, reconfiguration and transformation and those referred to by Eisenhardt and Martin (2000), i.e. integration, reconfiguration, gaining and releasing resources.

The firm level literature allows for a sharpening of these capabilities and their subroutines. According to Eisenhardt and Martin (2000, p.1107), "dynamic capabilities actually consist of identifiable and specific routines that often have been the subject of extensive empirical research in their own right outside of RBV [resource based view] [sic!]." Following them, I intend to integrate research contributions on performance enhancing routines or structures from other research streams.

Dynamic capabilities can be operationalized in three ways, as discussed in Chapter 2.3.1. Firstly, their underlying routines can be observed. Secondly, the firm members' perceptions of the existence of a capability can be measured. The third option is a measurement of the performance impact of innovation capabilities. All of these measures should go together. The following paragraphs focus on the definition of the capabilities, i.e. the elements that firm members should perceive as well as on the routines that can be observed as artifacts. The third element is concerned with the observation of financial performance or innovativeness on the firm level and not detailed here.

The capability of community building includes three strongly interlinked elements. The first is the creation of platforms, i.e. opportunities for communication. Communication allows for knowledge transfer and is especially relevant in innovation processes (Eisenhardt & Martin, 2000; Gulanic and Eisenhardt, 2001; Dissel and Katzy, 2005). The second is the creation of a common culture. This entails creating a collective mind

(Pavlou & El Sawy, 2004), values and norms (based on Leonard-Barton, 1992; Day, 1994), an attractive identity (Van den Bosch et al., 1999), and the general notion of a culture (Van den Bosch et al., 1999). Supporting and interdependent formal rules constitute the third element, including policies and manuals, as well as rules for conflict resolution (Bessant et al., 2003). These elements are strongly interlinked. A shared culture can facilitate communication and the enforcement of rules. Communication facilitates the creation of a common culture. Rules may safeguard the exchange of information and can support building a culture. For Teece, routines that support loyalty and commitment form a part of the capability of strategic decision making. However, given its relevancy and the repeated references in the literature, I will treat the capability of community building as a key capability in itself.

Strategic alignment comprises strategic decision making, strategy revision and the existence of managerial systems. Strategic decision making (Gulanic & Eisenhardt, 2001) is strongly linked to a review and potentially revision of strategies. Strategic managerial systems constitute the third element, such as financial management (Day, 1994) and internal auditing (Carmeli and Tishler, 2004). Strehle (2006) provided evidence of their impact on the performance of firms. For Teece, this capability requires routines which enable the delineation of customer solutions and business solutions, determining and managing boundaries, and establishing decision heuristics in addition to the capability of community building.

The capability of reconfiguration aims to align and realign assets on a permanent basis. It thus resembles Teece's, Pisano's and Shuen's reconfiguration and transformation as well as Teece's asset protection, combination, and reconfiguration. This categorization captures the recognition of a need for change under strategy revision. Under reconfiguration, I capture the different aspects brought up and detailed by other authors. For example, several authors also point to the release of resources, patching and integration (Eisenhardt & Martin, 2000; Gulanic & Eisenhardt, 2001; Song et al., 2005), reengineering and post-acquisition integration (Zollo & Winter, 2002), the integration and recombination of knowledge (Kogut and Zander, 1992; Grant, 1996; Lorenzoni and Lipparini, 1999), or incubation mechanisms (Rice et al., 1998; Katzy et al., 2001). More specific routines are R&D processes (Zollo & Winter, 2002; Helfat & Peteraf, 2003) or

product development processes (Winter, 2002). For Teece, the underlying routines go so far as to comprise the firm's hierarchical and governance structure, co-specialization of assets, and managing knowledge.

The capability of opportunity recognition refers to the recognition, or, as Teece puts it, the sensing of productive opportunities (Penrose, 1959; see also Barringer & Bluedorn, 1999). In line with the push- and pull-paradigms in innovation theory, it is based on two components. The first is market sensing (Kohli and Jaworski, 1990; Day, 1994; Eisenhardt & Martin, 2000), the second is technology monitoring (Day, 1994). It requires routines to direct R&D and select new technologies, to identify customer needs and innovation, as well as target market segments and to tap into new exogenous developments and the innovation of suppliers and competitors (Teece, 2007). Given the relevancy of the latter two elements in dynamic high-tech environments, I consider them part of the next capability.

Networking entails two strongly interlinked elements, alliancing and external representation. Alliancing (Eisenhardt & Martin, 2000; Gulanic & Eisenhardt, 2001; Draulans et al., 2003) or relational capability (Lorenzoni & Lipparini, 1999) refers to external partners, including informal networks (O'Connor and Rice, 2001). Kale, Dyer and Singh (2002) relate this capability to the role of an alliance manager. External representation is formed by reputation (Carmeli & Tishler, 2004) as well as the creation of cognitive legitimacy. It builds on routines that create public knowledge about an activity, by means of structuring ambiguous environments, creating and leveraging social capital and creating a unique and credible identity (building upon Aldrich and Fiol, 1994; Lant, 2003). The capability of networking is reflected in the firm's opportunity to access external resources. Table 6 provides an integrated overview of the capabilities and routines identified in the firm level literature.

Table 6: Literature-based identification of capabilities and routines on the firm level

Capability	Description, initial underlying routines
Community building	Creation of platforms (opportunities for communication), a common culture, formal rules Creation of a common culture (collective mind, values and norms, attractive identity, culture) Creation of formal rules (policies and manuals, rules for conflict resolution)
Strategic alignment	Strategic decision making Strategy review Strategic management systems (financial management, internal auditing)
Reconfiguration	Comprises elements such as the release of resources, patching, integration, reengineering, recombination of knowledge, incubation mechanisms, R&D and product development processes
Opportunity recognition	Market sensing Technology monitoring
Networking	Alliancing, i.e. contacts to external partners External representation, building on reputation

As discussed in Chapter 2.3.2, learning is a cornerstone of dynamic capabilities . Its relevancy also for innovative performance is undisputed (see, for example Alegre and Chiva, 2008). However, its conceptualization as either an element underlying capabilities or a separate dynamic capability is often debated in the literature (see Macpherson and Holt, 2007 for a literature review). As a capability, it has been grounded in two elements, knowledge creation and knowledge management. Learning mechanisms that support knowledge creation are practice, pacing, and making mistakes (Rothaermel and Deeds, 2004), the evaluation of outcomes, self-critical benchmarking, continuous experimentation and improvement, and informed imitation (Day, 1994), and, in the product development process, prototyping, early testing and experimentation (Eisenhardt & Martin, 2000; Ahuja and Lampert, 2001). Knowledge management (Day, 1994) includes codification (Argote, 1999).

As Teece et al. (1997), I conceptualize learning as a systematic and persistent feature of the firm, as learning is often operationalized very similar to dynamic capabilities. The operationalizations of learning found in the literature are diverse and often proximate to

dynamic capabilities (see Wiegand, 1998 for a broad treatise on organizational learning),. Several examples can be reviewed. Firstly, Alegre and Chiva operationalized learning as experimentation, risk taking, interaction with the external environment, dialogue and participative decision making (building on earlier work by Chiva et al., 2007). These elements emphasize the characteristics of the capabilities of opportunity recognition, reconfiguration, networking, community building and strategic decision making.

Secondly, Cohen and Levinthal (1990) emphasize the relevancy of absorptive capacity for learning. Absorptive capacity describes a firm's capability to identify and acquire external knowledge, to recognize its value, to assimilate it (in the sense of processing, analyzing, interpreting and understanding it), reconfigure the existing knowledge base and the existing routines in order to integrate it and to apply it to commercial ends (Cohen and Levinthal, 1990; Zahra and George, 2002). These elements again describe dynamic capabilities, which enable learning and help translate this learning into impact (Van den Bosch et al., 1999; Lenox and King, 2004; Malhotra et al., 2005; Jansen et al., 2005; Lane et al., 2006). The capability of networking allows the company to identify and acquire external knowledge. Knowledge of its own assets combined with the capability of opportunity recognition and strategic alignment enable the recognition of the value of new knowledge. Networking and reconfiguration then enable it to assimilate knowledge. Leveraging its abilities, the firm applies this knowledge to commercial ends.

Thirdly, coordination and socialization capabilities have been mentioned (Jansen et al., 2005) as enhancing the firm's absorptive capacity (Nonaka and Takeuchi, 1995; Leonard-Barton, 1995). Communication enables knowledge to be transferred and enhances the firm's absorptive capacity (Cohen & Levinthal, 1990). It is linked to the capability of community building. The firm's absorptive capacity is path dependent, increasing with the level of previous related knowledge (Cohen & Levinthal, 1990), which depends on the firm's organizational form and its reconfiguration capability (Van den Bosch et al., 1999).

3 CLUSTERS AND INNOVATION CAPABILITIES: DERIVING AND OPERATIONALIZING A PRIORI CONSTRUCTS

3.1 DERIVING CONSTRUCTS REQUIRED FOR UNDERSTANDING CLUSTER INNOVATION CAPABILITIES

The literature review in Chapter 2 showed the proximity of concepts underlying innovativeness in the dynamic capability and the regional innovativeness research streams. All theories propose specific context factors as relevant, mention specific assets that should be at the cluster's disposal, describe strengths of the cluster that appear proximate to the different dynamic capabilities and refer to superior innovativeness or performance. Additionally, all share a similar understanding of change.

As for the purpose of this research, all these constructs as well as the construct of routines are relevant. However, the cluster context and innovativeness and performance have found substantial detailing and operationalization in the literature. As new cluster level constructs, this study focuses on detailing and operationalizing the constructs of cluster assets and cluster innovation capabilities.

3.2 CAPTURING EXISTING CONSTRUCTS: CONTEXT, INNOVATIVENESS AND PERFORMANCE

3.2.1 Specifying and operationalizing cluster context

The cluster's context consists of its age, with its previous specialization as a moderating factor, and its perceived existence. Age of relevant communities is relevant, as it supports the process of learning described in the theories. It is relevant to consider clusters as separate organizing entities (see Chapter 1.1). Thus, the perceived existence of a cluster provides a strong read on the participants' level of embeddedness in the cluster. As discussed earlier, the national and regional culture as well as the technological environment form part of the cluster context. All of them are likely to have an impact on the clusters' performance. Identifying and correcting for the former two would constitute a separate research effort and thus do not form part of the research effort. The latter is inherent to this research set-up, as all clusters are active in the same technological field. Accordingly, it cannot be modeled as a differentiating context factor.

3.2.2 Specifying and operationalizing cluster innovativeness and performance

A combination of previous research and causal thinking allows for identifying the indicators of cluster innovativeness and performance. Innovation capabilities allow the cluster to create and sustain strong innovativeness and performance. In an equilibrium case, capabilities and performance should be observable at the same time. Over time, changes in the cluster's capabilities should change the cluster's innovativeness and performance. I will measure both innovativeness and performance, however, the focus of this study is on innovativeness as it precedes performance and as economic research has established the link between innovativeness and performance. Still, measuring both allows for a broader search lens while at the same time monitoring for performance enhancements that may have a different source. The identification of indicators can build on both prior research and causal argument. Both regional and national innovativeness as well as performance are, and have been, measured in a variety of cases. A review of 18

scientific, statistic and practitioner reports supported the identification of a broad set of indicators (building on Katzy and Röttmer, 2006; Röttmer and Katzy, 2006).

I operationalize innovativeness and performance with quantitative and qualitative indicators. These allow for cross-triangulation and thus enhance the quality of the data. Following Hauschild's (1991) review of measures of innovativeness in the firm level literature, researchers can employ qualitative, quantitative and semi-quantitative indicators to measure innovativeness. Qualitative measurement relies on the respondents' retrospective judgment. Its quality depends on the differentiation of the research subject. Quantitative measures require precise indicators or at least classes. It should not be possible to manipulate them. In the event that data is not collected by an official entity, differing data sources might lead to ambiguity. Semi-quantitative measures aggregate several observations and interview results. While they are increasingly being used, their underlying metrics differ, contributing to a degree of intransparency. To enable triangulation while avoiding intransparency, I will focus on estimated quantitative and qualitative measures.

To serve this research project, any quantitative performance indicator should ideally fulfill six criteria (OECD et al., 2005; Massachusetts Technology Collaborative and John Adams Innovation Institute, 2005). Indicators of innovativeness and performance require careful selection. First of all, performance needs to be determined on the cluster level. National data does not provide insights into regional performance. Exemplary data on the firm level can be misleading for regions (Saxenian, 1994). High regional entrepreneurial activity can, for example, foster competition and contribute to the overall strength of the cluster, but at the same time cause the exit of firms (for a broad overview of firm-level innovation indicators, see for example Hauschildt, 1991; Bresnahan et al., 2001; see also Zeleny, 2001). Collecting company level data, such as returns on sales, returns on assets or sales growth (Pavlou & El Sawy, 2004), across all cluster participants is strenuous and requires the definition of borders, which are unstable by their very nature. Secondly, this focus of this research project is on technology clusters. The data is more telling, the more specific it is. Accordingly, it should ideally be technology-specific. Thirdly and fourthly, the data should be available and reliable. Furthermore, the indicators should be collected in an ongoing manner. This research is dynamic in nature and the repetition of the study

in order to extend it into a longitudinal project is already in planning. Additionally and fifthly, comparable data across time would be greatly beneficial. The European focus of this research, furthermore, requires comparability of data across European countries and thus clusters. Of course, sixthly, the indicators should be comprehensible.

Additionally, data is hard to obtain. Generally, the challenge lies in that fact that the official statistics do not enable us to capture the nature of clusters, and information on cluster innovation activity is hard to obtain (Lublinski, 2002). Unfortunately, also information on the level of regions is less available than national data (Eurostat, 2005)., rendering approximations even harder than they would be in any case. Moreover, the geographical scope of clusters does not necessarily coincide with regional demarcations (Porter, 2008). Even if they do coincide, the cluster might not be the only or strongest contributor to regional innovativeness or growth. Similarly, technology data is scarce. Most statistical sources apply an industry-perspective, substantially limiting technology-centered research and rendering research into multi-industry clusters much more difficult. Furthermore, satellite navigation expert Mr. Rudolph confirmed in the interview in 2006 that satellite navigation is not one of the specific technology fields covered by Eurostat 's technology data portfolio.

Three indicators can be derived from the strategic intent underlying the creation of the GALILEO system. GALILEO, Europe's new satellite system, intends to serve three strategic targets. The first is the creation of new applications, which should then, secondly, allow for the creation of a potential market of 9 billion € p.a. (European Communities, 2001). Thirdly, GALILEO to create more than 100,000 jobs (European Commission - Directorate-General for Enterprise and Industry, 2006). These targets often stand as the indicators of regional innovativeness and performance, with the two former targets being indicators of innovativeness and the latter being a performance indicator. The creation of new applications can, more specifically, be measured with the widely used number of new-to-market products per year (Commission of the European Communities, 2004; OECD et al., 2005). While this data is publicly available for nations and with a sector focus, technology data is not available (Wolfe & Gertler, 2004). Generating it in a bottom-up approach is hardly feasible (Klepper and Simons, 2003). Thus, I will exclude it in this research.

The market created with these applications provides a first indicator. The market size correlates with innovativeness, as innovations are commercialized inventions. Successful commercialization leads to the creation of a market. The size of the market provides an indication of how well the market accepts these products and services (Hauschildt, 1991). However, this indicator may create a fallacy. The market size depends on the volume of products sold, but also on the price of that product. A cluster that serves a broad market with a low-price application might nonetheless be a world market leader. Similarly, a cluster that serves a very narrow, specialized market might produce a limited market size, but nonetheless be the highly innovative world-market leader in that segment. It is challenging to obtain this data from existing sources such as industry reports, as these are very targeted to submarkets (Fagerberg and Malm, 2006). Furthermore, the allocation of clusters to market segments and sizes is ambiguous. Accordingly, data collection is limited to surveys on the clusters' perceived European or global market shares. The market size should reflect cluster innovativeness in an undistorted world, as process innovations allow for decreasing costs relative to competitors and products, thus innovations could render previously competitive products redundant.

I will leverage employment as the second indicator. Employment is a frequently used performance indicator (Hauschildt, 1991; Commission of the European Communities, 2004; Cooke, 2004; OECD et al., 2005; European Commission - Directorate General for Enterprise and Industry, 2006). It has not only been applied to the regional level, but also in connection with capabilities (Heidenreich, 2004). However, innovativeness does not necessarily translate into employment growth (for an initial discussion, see European Communities, 2004; OECD et al., 2005). For example, a process innovation could increase labor productivity and result in job losses. Cluster research often focuses on new high-technology jobs (see, for example Saxenian, 1994), which ignores these indirect effects. Given the broad use of this indicator, I will include it despite the caveats.

As the third indicator, I choose purchasing power adjusted gross domestic product (GDP) per capita. The empirical economic literature provides substantial evidence on the relationship between new to market products and their impact on the GDP (Commission of the European Communities, 2004). However, the GDP constitutes a production-based measure. Using it in the context of cluster innovativeness might produce several

distortions. First, the GDP includes the contributions made by commuters in the production of goods, but takes the size of the regional population as the basis to determine the GDP per capita. Secondly, while the purchasing power adjustment renders national data more comparable, it ignores the potentially (more) substantial regional differences within nations (Europäische Gemeinschaften, 2005). Taking these fallacies into account, I will use this indicator.

Based on insights from entrepreneurship research, I propose a fourth indicator of relevance in clusters, namely new business creation (Rosenfeld, 2002; Massachusetts Technology Collaborative & John Adams Innovation Institute, 2005). As Bresnahan et al. (2001) indicate, a cluster typically grows based on the expansion of start-ups. Additionally, new business creation is an indicator of change in regional innovation systems (Heidenreich, 2004). Due to the technology focus applied in this research effort, data needs to be collected in surveys. Additionally, as number five, I will include the development of the number of co-operations in the cluster as an early potential indicator of cluster innovativeness.

Accordingly, I will quantitatively measure innovativeness by the cluster's perceived market share, new business creation and the development of the number of co-operations in the cluster. The cluster's performance indicators consist of the cluster's employment and the level of the purchasing power adjusted to GDP per capita. These indicators are interdependent (Fagerberg et al., 1997; Commission of the European Communities, 2004; European Commission - Directorate General for Enterprise and Industry, 2006) and positively correlated with innovation performance. This interdependency allows for the triangulation of data and should increase the robustness of the analysis.

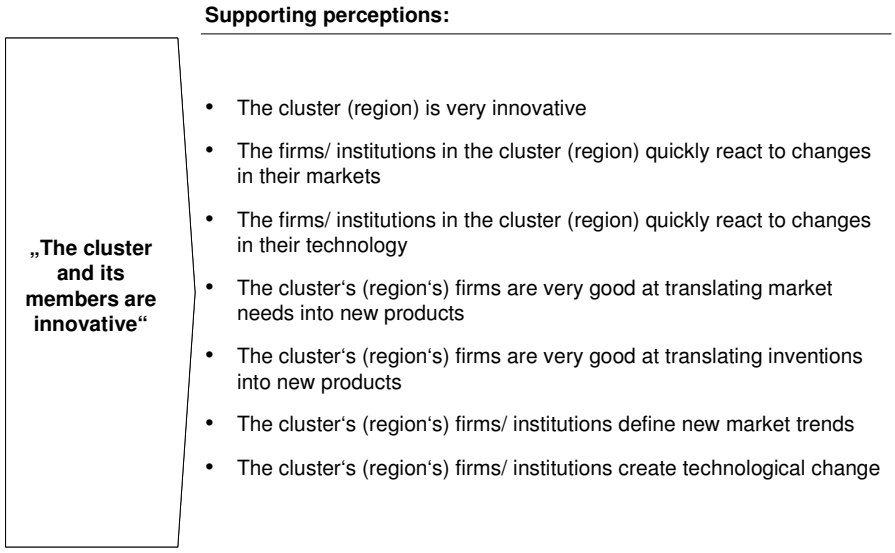
Two additional indicators are typically proposed in the literature. One is patents and patent citation frequency as two additional heavily used indicators of innovativeness, (see, for example Porter et al., 2001; Commission of the European Communities, 2004; Massachusetts Technology Collaborative & John Adams Innovation Institute, 2005). Patents, however, are input indicators. They do not necessarily need to be translated into products and if they are, their commercialization might fail (OECD et al., 2005). Furthermore, the relevancy of patents depends on industry characteristics and company strategy (Breschi and Lissoni, 2001). In some instances, as satellite navigation expert

Rudolph emphasized in the interview in 2006, broad patents might secure a competitive advantage in satellite navigation applications. However, the satellite navigation expert Mr. Lechner confirmed in the interview with him in 2005, that product lifecycles less two years in dynamic satellite navigation mass markets render patenting difficult. Additionally, relevant knowledge is largely captured in software, which the European Patent Office does not patent. Similarly, the relevancy of patent citation frequency in satellite navigation applications is limited. Generally speaking, patent data is not very informative in this domain.

The second are exports, which are frequently used in the literature (Saxenian, 1994; Rosenfeld, 2002; OECD et al., 2005; European Commission - Directorate General for Enterprise and Industry, 2006). However, obtaining relevant data on a regional level is challenging. Firstly, technology-specific data hardly exists, and even less so for new technologies. Secondly, only a limited number of clusters try to determine their export balances. In that, they do not chose comparable approaches. Accordingly, I will not use this indicator.

The dynamic capability view allows for identifying additional qualitative performance indicators. According to the concept of dynamic capabilities, capabilities allow social entities to react better to environmental changes, as well as cause these changes. Thus, the cluster should be perceived as innovative. Cluster innovativeness implies that the aggregate cluster members are more innovative as well. They should be perceived as good at reacting quickly to market and technology changes, at translating market needs and inventions into new products and at defining new market trends and creating technological change (see Figure 7). Following the argumentation in Chapter 3.2.1, the participant's observation of these effects constitutes an additional data point for triangulation.

Figure 7: List of perceptions cluster of innovativeness



This approach allows us to obtain high-quality data. Firstly, it generates cluster level, technology-specific data which can be triangulated. The data is not readily available, but will be collected in the research effort. The pre-test indicated that this approach is feasible as well as that the indicators are understood and comparable on a relative scale across regions. The spread of the responses within the clusters allow us to determine the accuracy of the estimates.

3.3 DERIVING A PRIORI CONSTRUCTS FROM THE LITERATURE: ASSETS AND CLUSTER INNOVATION CAPABILITIES

3.3.1 Feasibility of deriving the constructs assets and cluster innovation capabilities from the literature

The review of the literature on regional innovativeness and dynamic capabilities (Chapter 2) provides strong evidence on the potential of a cluster innovation capability view to act as a comprehensive and structuring framework for capturing all cluster level driving forces of innovativeness as identified in the selected regional innovation theories. Firstly, the conceptual foundations of the regional innovation research streams are largely in line with those of the dynamic capability view. Secondly, the dynamic capability framework appears to be comprehensive enough to capture all potentially relevant drivers of innovativeness. Third, the regional innovativeness research streams only provide anecdotal evidence on the sources of capabilities. The dynamic capability view can support the development of further insights.

The underlying theoretical assumptions of the dynamic capabilities are view close to those of the other research streams. The theories of regional innovation largely reflect the assumptions of the dynamic capability view, i.e. the co-evolutionary and dynamic understanding of organizations. Cluster innovation capabilities would be as learned inter-member capabilities, observable across clusters, impacted by human action, history and context. Porter's understanding of clusters, however, is more reactive than that of the dynamic capabilities view (Teece, 2007). However, its contributions can still serve as a search lens for capabilities.

The underlying assumptions of Porter's research on clusters are similar to those of the dynamic capabilities view, with regard to the conditions of change, including learning, and assume the same role of the environment. The underlying assumptions of Porter's research on clusters are similar to those of the dynamic capabilities view, with regard to the conditions of change, including learning, and assume the same role of the

environment. Porter's and Stern's driving forces of innovativeness can be captured in a dynamic capabilities perspective.

Similarly, the regional innovation system research takes similar assumptions as the dynamic capability view by assuming co-evolutionary change and emphasizing the role of learning. The dynamic capabilities concept captures all driving forces of innovation proposed in the regional innovation systems literature.

Also, the concept of innovative milieux builds on comparable basic assumptions to the dynamic capability view. Its collective, territorial concept inherently links to interaction and alignment, learning and innovation. It explicitly assumes evolution, but leaves room for co-evolution in that the experimental milieu might shape the environment (Camagni & Capello, 2002). The dynamic capability view captures the driving forces of innovation that the theory of innovative milieux proposes, including initial dynamic cause-effect relationships. In innovative milieux, relationship networks provide the ground for learning. Learning then increases the innovative capacity of the region. Additional elements facilitate this process, i.e. the alignment among the protagonists, the image and sense of belonging that results from the relationship networks. This process builds on the technological culture and expertise in the region, local in- and output markets, the supportive infrastructure, the region's history and organization as well as external links. Accordingly, assets and capabilities support innovativeness through learning. In the event of an environmental shock, research and training institutions serve to reconfigure the region. They link to external partners, leveraging the organizational processes that the innovators have established. This interaction follows a similar pattern, allowing for following the path of exploration.

The theoretical assumptions of the regional network concept are in line with those of the dynamic capabilities view and the concept of dynamic capabilities captures the driving forces of innovativeness proposed by it, including initial dynamic cause-effect relationships. Saxenian's understanding of regional networks is at least evolutionary. She emphasizes the role of time and learning and the relevancy of the networks' strength in adapting to environmental changes. She does not elaborate on the role of the human hand in networks, but instead indicates that proximity does not naturally create the benefits that underpin the success of networks. Beyond the notion that the region's organization

enables it to innovate, the source and creation of these benefits remains open. The concept of regional networks proposes equilibrium driving forces of innovativeness, i.e. the complementary competences in the region, its network nature and the existence of external contacts. Social networks and open labor markets lead to entrepreneurship and experimentation, i.e. processes of exploration. Again, this describes a process in which assets and capabilities support innovativeness by means of a process of exploration. In the event of shocks, the accumulation of expertise and information in the region enables regrouping skills, technologies and capital for adjusting to that change.

Secondly, the dynamic capabilities view allows for capturing all elements that these theories proposed as driving factors of innovativeness. The regional innovation theories nearly always point to all the capability categories, with only minor shifts in emphasis on specific assets and capabilities from the firm to the cluster level. Moreover, the dynamic capability view, at the same time, acknowledges the relevancy of cluster assets as driving forces of innovativeness.

We are only starting to understand how cluster level capabilities come about. The previous research indicates that capabilities are learned. However, while network capabilities have been addressed in a couple of research contributions, a structured cluster level research contribution on the creation of capabilities is still missing. On the company level, the creation of dynamic capabilities is still under investigation. The review of the literature on regional innovativeness has confirmed that we are only beginning to understand the cause-effect and temporal relationships underlying soft factors contributing to innovativeness. Neither of the theories of regional innovativeness provides any explanation of, for example, the way networks start to form or how learning is created and or through which mechanisms they translate into innovativeness over time. Accordingly, I will build on the rudimentary a priori search patterns, as well as rational reasoning for establishing a priori search patterns into the creation of cluster innovation capabilities. Capabilities are formed by routines or sets of routines. These routines can be institutionalized in roles (see Chapter 2.1.2). Routines develop by learning, i.e. in a process over time. Thus, I assume the existence of a time lag between the creation of routines and the creation of capabilities.

3.3.2 Deriving literature-based evidence on assets

This chapter serves to compare the asset requirements advanced by the different regional innovation theories with those of the dynamic capability view. The latter appears to provide a good framework for capturing all contributions (Table 7).

On the cluster level, the relevancy of the asset categories differs compared to the firm level. The company level asset category of reputational assets does not find support on the cluster level. Of the firm structure assets, the dimension of external links is emphasized. In contrast, the dimensions governance modes, hierarchy and formality of structure hardly warrant any attention. Similarly, market structure assets are instead considered to be a performance indicator rather than an asset. For institutional assets, the emphasis shifts towards culture and education, rather than IPR. As for technological and complementary, financial and institutional assets, only cluster theory breaks out different dimensions. The technological and business environment and their stability are of high relevance, given the context-dependency of clusters and the potential of technological shocks to destroy clusters. Other research streams content themselves with pointing to the diverse composition of protagonists. I assume that this always includes providers of financial resources. However, all dimensions are implicitly or explicitly reflected on the regional level and require consideration in the sense of this theory building research study.

The dynamic capabilities view provides a comprehensive framework for capturing the assets that the selected theories of regional innovation proposed as relevant. Applying a cluster level perspective, in the sense of Windeler's (2001) network level, broadens the perspective on assets. Cluster assets do not only comprise the participants' assets, but also the agglomeration and one-time effects from static externalities, for example, from the co-specialization of cluster assets, the pooling and common use of existing assets (Saxenian, 1994; Asheim & Isaksen, 1997; Sydow and Windeler, 1998; Porter, 1998b). Furthermore, the cluster can create dynamic externalities. For example, the participants' interactions as rendered feasible through the cluster can create new assets, for example, the potential for innovation through knowledge exchange (see also Saxenian, 1994; Katzy

and Schuh, 1998; Windeler, 2001). In addition, the cluster can create assets on its own behalf, such as a reputation. This could benefit all cluster participants.

Table 7: Evidence on cluster assets from the literature

	Evidence from different research streams			
Assets	**Clusters**	**Regional innovation systems**	**Innovative milieux**	**Regional networks**
Technological and complementary	Cumulative technological sophistication; resource commitments to R&D	Diverse actors	Competencies in the territorial hinterland; technological culture	Producers of technologies form part of the network; participants are specialized; common knowledge base
Financial	Ample supply of risk capital; financial resources for R&D	Diverse actors	In- and output markets	Regroupings of capital allow for rapid reactions to market change
Institutional	Attitudes towards economy; competition; high quality information infrastructure; good quality of life; high quality human resources	Institutions	Industrial culture; technological culture	Porous boundaries; skill availability
Reputational	NA	NA	Milieu is perceived as innovative; image	NA
Market structure	Number of local customers; market size	NA	Output markets; market relations are essential for innovation	NA
Cluster structure	Cluster's linkages to regional and national diamond; linkages across industries	Open system	External linkages	External linkages

3.3.3 Deriving literature-based evidence on cluster innovation capabilities

This chapter supports the comparison of the capability requirements advanced by the different regional innovation theories with those of the dynamic capability view. The capabilities proposed in the dynamic capability view allow for comprehensively capturing the capabilities advanced by the different research streams on regional innovativeness (see Table 8). Reviews of 30, respectively 39 theoretical and practitioner contributions elsewhere have provided additional support to these categories (Röttmer and Katzy, 2005; Katzy & Röttmer, 2006).

All firm level categories of dynamic capabilities can also apply to the cluster level. The review of the regional innovativeness literature provided results on performance-enhancing practices in the same categories as for firm level dynamic capabilities and no additional categories. However, applying a cluster level perspective results in shifts of emphasis. The capability for community building is very relevant in all of the reviewed theories of regional innovativeness. The firm level literature review resulted in three categories, namely the creation of opportunities for communication, informal rules and formal rules. On the cluster level, research emphasizes the two former categories. For the capability of strategic alignment, the cluster level research emphasizes informal alignment. Cluster level theories implicitly capture the need for strategic reorientation in their focus on reinvention. While the firm level literature emphasizes adequate managerial systems, regional innovativeness research does not explicitly mention them. The capability for reconfiguration has the same meaning and relevancy on both the cluster- and the firm level. It includes integrating and recombining internal and external resources. On the cluster level, it emphasizes the adaptation of the cluster participants and the entire cluster. The capability of opportunity recognition also finds its reflection on the cluster level. On both levels, it comprises the recognition of market and technological opportunities. Cluster level literature emphasizes the dimension of alliancing within the capability of networking. All theories support the relevance of establishing and using external contacts. In contrast, none of them refers to external representation.

The regional innovation systems and the innovative milieu literature provide especially detailed contributions. The regional innovation systems literature strongly emphasizes capabilities, allowing it to contribute potential institutions for building capabilities as well as some operationalizations. For example, Gerstlberger (2004a) emphasizes the role of promoter. He encourages the definition of a strategy and the need for formalized private-public transfer networks. Heidenreich (2004) mentions rules and conventions for co-operation and conflict resolution and the role of specific communities, professional or business associations, universities, research institutes or technology transfer institutions. The concept of the innovative milieu indicates a couple of institutions and describes competencies and results that could link to dynamic capabilities. For example, several elements of innovative milieux contribute to community building. Among them are the norms, rules, and values, resulting in informal relationships and a specific industrial culture, a sense of belonging, collective behavior and alignment.

A review of Table 8 indicates, that the capabilities proposed by the different research streams appear to exist across clusters, though they are path- and context-dependent. Their elements might resemble best practices, but the process of learning involved, for example, in building the specific profile of innovative milieux renders them idiosyncratic. It is both the learning and the nature of routines as shared practices that emphasizes the idiosyncrasy. The driving forces of innovativeness advanced by these theories indicate the role of the human hand in innovativeness. Porter points to institutions for collaboration, and the theory of innovative milieux explicitly acknowledges the need for human action to trigger a process of reconfiguration.

Table 8: Evidence on cluster innovation capabilities from the literature on regional innovativeness

Innovation capabilities	Clusters	Regional innovation systems	Innovative milieux	Regional networks
Platform building	Institutions for collaboration; social glue, free flow of information; strong motivation for improvement; shared cultural and social norms; close inter-firm communication, socio-cultural structures, institutional environment; investment in innovation-related activity; participation in cluster-wide efforts	Relationships, interactions, particular kind of association, specific communities; internal cohesion; institutional structure, institutions; inter-firm networking, inter-personal connections; promoter	Complex network of informal relationships; formal and informal networks; sense of belonging, specific internal representation; industrial culture, norms, values and rules; collective behavior of the actors; common lens, created processes support encounter between groups	Timely communication, face to face contact, dense social networks, porous borders; collaborative practices, openness, informal communication
Strategic alignment	Willingness to align agendas; sense of common interest	Strategy, vision	Alignment of actors	Mutual adjustment of the participants
Opportunity recognition	Discovery of value added exchanges or transactions; challenging and trend defining customers	Reach to external changes; shape the environment	Competency to reinvent themselves, appropriate new technologies	Participants constantly learn about market and technological developments; network identifies opportunities; experimentation; triggering reconfiguration
Reconfiguration	Co-adaptation of service suppliers and customers	Reinvention	Competency to reinvent itself; incorporate external know-how into the milieu; regional training and research institutions enable reconfiguration	Network quickly reacts to opportunities through sponteneous regroupings of skill, technology and capital; entrepreneurship, open labor markets
Networking	National government support; linkages to other clusters	Open, social system, interactions with the environment	Specific image, linkages to knowledge centers elsewhere; external relations decisive for innovation	Connections to external partners

3.4 OPERATIONALIZING THE A PRIORI CONSTRUCTS: ASSETS AND INNOVATION CAPABILITIES

3.4.1 Operationalizing cluster assets

The asset categories have generally been acknowledged across theoretical stances. Their operationalization now provides a basis for observing and measuring them in the cluster context. Accordingly, the level of asset endowment requires measurement. All asset categories need to be captured, i.e. technological and complementary, financial, institutional, reputational and market position as well as cluster structure assets. I will develop their operationalization through rational argument, building on expert interviews as well as learnings from the literature review (see Chapter 2). Table 9 provides an overview of the findings.

Technological assets include both the technological assets possessed by the participants as well as joint, previous experience in the field. Satellite navigation expert Mr. Lechner confirmed in the interview in 2005, that technological assets are of particular importance to satellite navigation application clusters. Additionally, the presence of research centers or strong, research focused universities can support the technological asset base of the cluster, potentially acting as complementary assets. The participants' specialization allows them to estimate the extent to which they possess technological assets. Similarly, the cluster definition and the composition of protagonists comprises cluster financial assets, i.e. seed and venture capital providers in the region, providers of higher education and supporting services, i.e. institutional assets.

In addition, the cluster's institutional assets include the regional as well as the cluster's culture and public policies. Due to the co-evolutionary nature of the cluster's culture, it is an input as well as an output parameter. In this theory-building effort, I will consider it as an asset as well as an indicator for a capability. On the one hand, the literature on regional innovativeness strongly emphasized its relevancy for performance. On the other, culture is created over time. It is probable that different enablers underlie it. Accordingly, it is the consequence of the existence of a capability. Building on the latter argument, I will also operationalize reputational assets as well as cluster market structure as an asset as well as

an indicator for the existence of a capability. Similarly, the literature on regional innovativeness emphasized the need for co-adaptation of the protagonists. Accordingly, the cluster structure as well as the support for example by public policies also are an indication of the level of the protagonist's strategic alignment as well as an asset.

Table 9: Operationalization of cluster assets

Asset categories	Potential cluster asset operationalizations
Technological (and complementary)	• Joint previous experience and expertise in the field; presence of research institutes, research-focused universities
Financial	• Presence of specialized business angels, venture capitalists
Institutional	• Higher education institutes, regional and cluster culture, supportive public policies
Reputational	• Image
Market structure	• Market position, number of (potential) local customers, market relations
Cluster structure	• External linkages (across industries, to the regional and national diamond), formal structure of the cluster, size of the cluster (region, number of participants)

3.4.2 Operationalizing cluster innovation capabilities

3.4.2.1 Operationalization through perceived existence

Concept operationalization enables measuring concepts and capturing their change in empirical research. This research aims to measure the existence, creation and impact of cluster innovation capabilities. In order to do so, the concept of innovation capabilities requires operationalization. Following the dynamic capabilities view, capabilities can be observed in three ways (see Chapter 2.3.1). Firstly, their underlying routines can be observed. Secondly, the cluster participants' perceptions of the existence of cluster innovation capabilities can be measured. The third option is a measurement of the performance impact of innovation capabilities. These options enable us to measure the perceptions as well as the artifacts and to complete triangulation among these multiple data points. Previous operationalizations exist on the firm level (see, for example, Pavlou & El Sawy, 2004), but to my knowledge not on the cluster level. As a result, I will develop an operationalization for the cluster level, building on previous firm- and cluster level research and causal thought, confirming them in interviews.

The option to operationalize innovation capabilities through the observation of innovativeness and performance has been detailed in Chapter 3.2.2. The operationalization through perception of the existence of the capability and the operationalization through routines still require detailing. The former is developed in the following paragraphs. Table 10 provides an overview of the findings. The theory building nature of this research study requires a broad search lens, both with regard to clusters and innovation capabilities. The list of capabilities, routines and performance indicators should thus aim at comprehensiveness. The following paragraphs present the process of operationalizing the concepts, as well as the results. The operationalization of capabilities builds on both, company level insights into capabilities and the insights generated from the regional innovativeness literature review (see Chapters 2.2). As mentioned earlier (see Chapter 2.3.2 and 2.3.3), learning underlies all capabilities.

The first innovative capability is the capability of community building. It has three components, i.e. platforming, a common culture and formal rules. The literature proposed

a number of cluster characteristics that foster innovativeness. Accordingly, in innovative clusters the following should be able to be observed. The protagonists should know one another, be able to co-operate with one another more easily than with external partners, share knowledge, have limited conflicts, and quickly be able to resolve them as and when they occur. The network research provides two alternative paths for networked systems (Oerlemans et al., 2007). One proposes that densely embedded networks with many interconnections among the protagonists are advantageous (Coleman, 1988), the other that brokerage opportunities provide network opportunities, as they limit the redundancy of information and knowledge and provide access to different information flows (Burt, 1992). Similarly, Oerlemans et al. (2007), in their review of the literature on networks, perceived a shift in emphasis from weak to strong ties as the primary supporters of innovative activity.

Strategic alignment appears to often come about in clusters by means of informal activities. Generally, the members co-align in order to leverage a beneficial effect. In the event of a formal cluster entity, cluster management should be performance-oriented and the strategic activities performed by the cluster should be beneficial to its members.

The third innovative capability, the capability of reconfiguration, lies at the heart of the concept of dynamic capabilities. Similarly, several regional innovativeness research streams emphasize the role of reconfiguration in developing and sustaining the innovativeness of clusters. This capability allows the cluster to render new opportunities possible and to be a resource pool for its members.

Regional innovativeness research often addresses the fourth capability, opportunity recognition, in an implicit manner. Having built this capability, the cluster participants are able to quickly perceive market and technology changes and opportunities for introducing changes themselves.

The fifth capability, networking, consists of two elements, alliancing and external representation. This capability enables the cluster to connect to the major European and global players in its domain and to build a strong reputation.

Table 10: Operationalization of cluster innovation capabilities

Cluster innovation capability	Supporting perception
Community creation	• Co-operation with cluster (regional) firms/institutions is far easier than co-operation with external firms/institutions • Conflict within the cluster (region) barely occurs • Conflicts among firms/institutions in the cluster (region) are solved quickly • The firms/institutions in the cluster (region) know each other • Firms and institutions in the cluster value innovativeness highly • The cluster (region) has a strong culture • In the cluster (region), knowledge is extensively being shared
Strategic decision making	• The cluster's (region's) strategic activities are supportive to the aims of the cluster's (region's) firms/institutions • The cluster (region) is managed for performance
Asset base enhancement	• Cluster (regional) co-operation projects often render possible endeavors that single firms/institutions could not have undertaken • The cluster (region) is an excellent pool of resources for its firms/institutions
Opportunity recognition	• Firms in the cluster (region) quickly perceive changes in their markets • Firms in the cluster (region) quickly perceive changes in their technology
Networking	• The cluster (region) is connected with the major national, European and global players in their technology field • The cluster (region) has a strong image • Information on activities of the cluster (region) is hard to obtain

3.4.2.2 Operationalization through the observation of cluster routines

Routines are artifacts, repeated, collective and thus shared activities, including institutionalized routines (see Chapter 2.3.1). They can form dynamic capabilities and as such, provide one method of determining the existence of capabilities. For identifying the performance-enhancing routines that support dynamic capabilities, I leveraged a broad literature review. Firstly, the review of the literature on clusters, regional innovation systems, innovative milieux and regional networks produced some indications of routines that might form capabilities. Secondly, I leveraged the fact that dynamic capabilities have

often been subject to research in their own field (Eisenhardt & Martin, 2000). The aforementioned review of theoretical and practitioner contributions on innovation capabilities and routines supported this. Furthermore, I reviewed the company level insights into routines for informative purposes. Causal thinking supported the allocation of routines to capabilities. Experts reviewed all routines during interviews. The following paragraphs, as well as Table 11, provide an overview of the most relevant findings.

As on the level of capabilities, the routines required on the cluster level appear to be more informal than on the level of the firm. For example, formal rules on the firm level build on policies and manuals. Similarly, strategic alignment comprises financial management and auditing, which might not exist in informal clusters (see Chapter 2.1.3). A number of routines are reflected on the cluster level, albeit in other forms. For example, market analysis could support the capability of opportunity recognition. The same holds true on the cluster level, though the way of organizing it and the protagonists will be different.

The capability of community building finds its reflection in networked cluster participants and their flexible, but profound collaboration. Contact platforms, a common culture and rules enable them. Additionally, promoters are able to support them, Gerstlberger (2004a; 2004b). Several routines might create contact platforms, such as regular, internal professional and social events, the distribution of competence profiles and simple IT communication. Professional events include conferences, fairs, work groups, study tours, and visits to cluster participants. Social events include festivities, sports events, luncheons and roundtables. In 2006, both cluster experts, Mr. Haunschild, the cluster manager for bavAIRia e.V. and Mrs. Hoppe, manager for the Projekt Ruhr, pointed to the potential role of a cluster manager, i.e. the broker for co-operation projects among the participants. Business plan or innovation competitions support the creation of an innovation-oriented, entrepreneurial culture. Culture and rules can be mutually reinforcing (North, 1990). Different opinions exist as to exactly how formal cluster regulation should be, both among practitioners and researchers. The expert interviews with Mr. Lechner, president of Telematica e.K. and Chair of the scientific advisory council for DGON in 2005, and with Mrs. Hoppe confirmed a tendency towards more informality. Accordingly, the role of rules in clusters might be weak.

A broad set of rules is mentioned in the context of clusters that should be differentiated functionally. Among them are rules for conflict management, sanctions in the event of misbehaviour, co-operation rules, including property rights, and membership rules. I propose to differentiate between two categories of rules. Firstly, rules that serve to support or reinforce the culture. Among these, are the rules for conflict resolution, the existence of a moderator and of sanctions in the event of misbehavior. The second type of rules enables resource and knowledge sharing. They constitute or allow for contractual arrangements. Functionally, these rules belong to the capability of reconfiguration.

The capability of strategic alignment requires shared targets and information transparency, as confirmed in the expert interview with Mrs. Hoppe. The following routines and structures can support this capability. First of all, the existence of a cluster leadership team and governance rules formalizes and ensures discussions on the direction of the cluster. Additionally, it will probably be linked to the formulation of a vision, a strategy, or targets. Ideally, the cluster also defines its competitive position by developing a strengths, weaknesses, opportunities and threats profile. Given the changing environment of clusters, these directions and competitive positions require regular review and updating. As expert Mrs. Hoppe emphasized, regular phases of reflection on the impact of cluster management should provide their basis. Reviews of the cluster's performance can and should complement them. Alignment also benefits from information transparency in the cluster. The regular dissemination of a newsletter and, more generally, information on cluster activities could support it. Functionally, newsletters most support strategic alignment. This medium serves to best convey information with a low level of propriety and of medium actuality. Information that would serve for opportunity recognition is probably more sensitive and current.

The need for reviewing the cluster's direction indicates the profound relationship of strategic alignment over time and learning. While learning forms part and parcel of all capabilities and routines, strategic alignment provides a great example. Routines such as benchmarking allow us to create knowledge by learning from other regions. However, as cluster expert Mr. Haunschild confirmed in the interview, they need to be adapted to the specific cluster's context. Knowledge management and dissemination provides the participant's with the basis for alignment.

Several routines might support the ability to change cluster resource configurations and to integrate new resources, i.e. the capability of reconfiguration. On the cluster level, participants and their routines, as well as potential resources on the cluster level, might form such resources. Routines supporting cluster reconfiguration are membership rules, established processes for new member acquisition, training opportunities, as well as support offers to cluster member co-operations. Additionally, the cluster as a formal organizational entity or some of its participants might provide support in the identification of new project opportunities, the start of new projects, project management or revision, as well as access to external resources. Additionally, model rules and contracts for cluster-internal and external co-operations might be in place. A formal cluster manager could also assume the role of a broker for financing, as the cluster experts Mrs. Hoppe and Mr. Haunschild confirmed in interviews in 2006. The membership fees that some formal clusters levy might influence the self-selection of members and thus impact the cluster resource configuration.

The capability of opportunity recognition enables clusters and cluster members to grasp new opportunities quickly. The cluster or some of its entities can support it by providing information on market and technology trends as well as on external events.

Few distinct routines support networking. In the interview, Mrs. Hoppe emphasized national and international networking as well as cluster marketing as factors of success. To support this, the cluster is able to consciously establish links to other clusters, associations, research institutes, universities, policy makers or governmental bodies. Cluster marketing relates to external representation. To enhance this, the cluster can release press reports, create and regularly update its website as well as have members participating in external professional and social events in the name of the cluster. Thus, according to the expert interviews with Mrs. Hoppe and Mr. Haunschild, cluster managers could also take on the role of the cluster representative. Mr Haunschild adds, that super-regional professional events in the cluster also contribute to the reputation of the region.

Table 11: Operationalization of cluster innovation capabilities and their supporting routines and structures

Capability	Potentially underlying routine category	Potentially underlying structure	Routine examples
Community creation	Participation of the cluster/ cluster representatives in external professional events		Conferences
			Fairs
			Work groups
			Study tours
			Internal cluster/firm visits
			Other
	Participation of the cluster/ cluster representatives in external social events		Festivities
			Sports events
			Luncheons
			Roundtables
			Other
	Participation in business plan or innovation competitions		
		Competence profiles	
Strategic alignment	Existence and regular review of cluster direction		Vision
			Strategy
			Targets
			Strength and weaknesses
			Opportunities and threats
			Other
		Cluster leader-ship entity	
	Regular cluster leadership meetings		
	Performance reviews		
		Governance rules	
	Newsletter		

Table 11 continued: Operationalization of cluster innovation capabilities and their supporting routines and structures

Capability	Potentially underlying routine category	Potentially underlying structure	Routine examples
Reconfiguration		Cluster membership rules	Accession rules
			Official processes of member recruiting
			Other
	Cluster wide, regular trainings for cluster members		
	Cluster wide, regular support offers to member projects		
			Identification of joint project opportunities
			Set up of joint projects
			Project management
			Project auditing
			Integration of external resources
			Rules for internal cooperation, such as property rights
			Rules for co-operations with external partners
			Conflict management rules
			Neutral conflict management body
			Enforceable sanctions
			Other
Opportunity recognition	Regular distribution of market trend information		
	Regular distribution of technology information		
	Regular distribution of information on events		

Table 11 continued: Operationalization of cluster innovation capabilities and their supporting routines and structures

Capability	Potentially underlying routine category	Potentially underlying structure	Routine examples
Networking	Linkages to external national/international actors		Clusters
			Associations
			Research institutes
			Universities
			Policy makers
			Others
	Participation in external professional events		See community creation, where applicable
	Participation in external social events		See community creation, where applicable
	Regular publications about the cluster or cluster projects in the press		
	Website updates		
	Contributions to showroom		

4 DESIGNING A RESEARCH EFFORT INTO THE INNOVATIVENESS OF REGIONAL SATELLITE NAVIGATION APPLICATION CLUSTERS

4.1 SELECTION OF SAMPLE

4.1.1 Selection of technological field: GALILEO as a satellite navigation technology shock

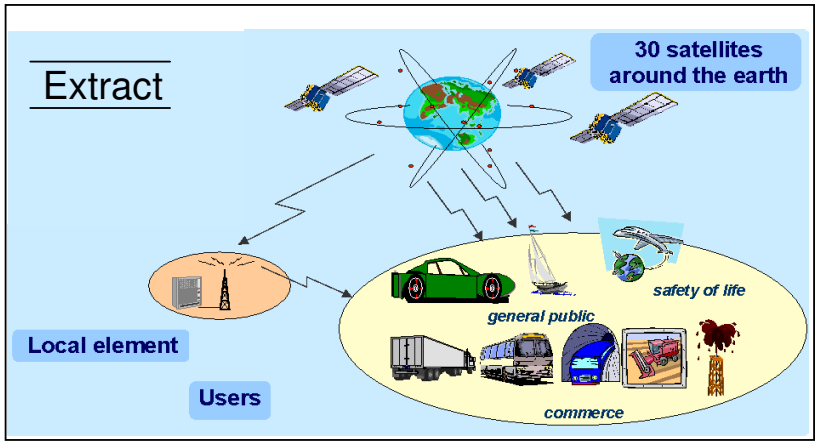
European satellite navigation application clusters are the research object of this study (see also Chapter 1.3). Firstly, they have a high innovative potential, given market and technology characteristics and their cross-industry orientation. Secondly, all of them operate in a comparable environment, reducing the complexity in interpreting the study results. Thirdly, all of them will face a comparable technology shock around 2013 (GPS Daily, 2009) with the introduction of GALILEO, which at the same time allows us to measure the existence and impact of innovation capabilities. Fourthly, the introduction of GALILEO builds on the strategic intent to generate employment and new markets.

Global Navigation Satellite Systems (GNSS) serve to provide location, altitude, and time information. Basically, satellite navigation systems operate as follows (see also Figure 8):

> *"...[T]he satellites in the constellation are fitted with an atomic clock measuring time very accurately. The satellites emit personalised [sic!] signals indicating the precise time the signal leaves the satellite. The ground receiver, incorporated for example into a mobile phone, has in its memory the precise details of the orbits of all the satellites in the constellation. By reading the incoming signal, it can thus recognize [sic!] the particular satellite, determine the time*

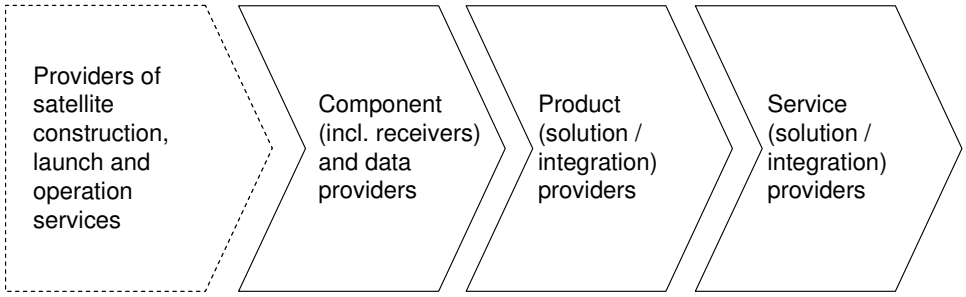
taken by the signal to arrive and calculate the distance from the satellite. Once the ground receiver receives the signals from at least four satellites simultaneously, it can calculate the exact position" (European Commission - Directorate-General Energy and Transport, 2007b).

Figure 8: Schematic of GALILEO operations (European Commission - Directorate-General Energy and Transport, 2002)



Out of GALILEO's three elements of the value chain (see also Figure 9), the largest value generation potential is located in application development. The first step is the construction of the infrastructure. This includes the construction of satellites, their launch and operation (ASD-EUROSPACE, 2007). Signal operators provide the signals. The component segment constitutes the second step, providing the receivers, components, customer devices for using satellite signals. The third step consists of application development and sales. System integrators, the fourth element of the value chain, provide the product equipment, which is used by service providers to offer value-added services (Rath et al., 2005).

Figure 9: Value chain of satellite navigation applications (own image, building on Rath et al., 2005; ASD-EUROSPACE, 2007)



The potential to develop new or even radically new applications depends on GALILEO's system performance. The more precise, accurate, reliable, available, continuous and integer the signals are, the more safety-critical applications can be developed on their basis. Six performance indicators serve to describe the performance of satellite navigation systems (Svítek, 2005). These are accuracy, reliability, availability, continuity, integrity and safety. Accuracy describes the level of conformance between a system's true parameters and the measured values. Reliability indicates the system's ability to perform a required function under given conditions for a given time interval. The system's availability indicates its ability to perform the functions as soon as they are triggered. Its continuity describes its ability to perform its functions without non-scheduled interruptions. Integrity describes the system's ability to provide timely and valid alerts to the user when the system shows fallacies and should not be used for the intended operation. System safety describes the level of its expected performance, based on the knowledge of the system environment and the potential risk. Four factors impact them. These are the number of available satellites, their inclination, the number of codes available to the system and the use of backup-systems providing for corrections where required. Two external factors impact signal accuracy in all satellite navigation systems. These are disturbances caused in the ionosphere and signal blockages from buildings or other entities (ABIresearch, 2003). Several, primarily satellite-based system enhancement mechanisms exist (Rath et al., 2005). One example is Differential GPS (DGPS), which enables a GPS system to be upgraded to provide accuracy to one meter (Schmundt, 2006).

GALILEO will compete with one and complement three existing global satellite navigation systems as well as one supplementary system that is in the process of creation in parallel to GALILEO. The oldest is the military-based American NAVSTAR Global Positioning System (GPS) (for an historic overview, see Rath et al., 2005). Since 1993, its 24 satellites have been fully operational for commercial use. Each receiver should receive signals from, at least, three satellites at any one time, in the sense of trialteration (Rath et al., 2005). The systems accuracy for civilian use is quoted at between 16 (Schmundt, 2007) to 20 or even 100 meters (Rath et al., 2005). The drawbacks of GPS lie in the non-availability of signal corrections for civilian users and the relative weakness of signals, causing a high vulnerability to interference and jamming (Rath et al., 2005). Due to that, the US government continually updates the GPS system. For example, the next generation of satellites is scheduled for launch, new civilian navigation signals added and correction measures introduced to enhance signal accuracy (Rath et al., 2005). For example, the launch of the third satellite generation from approximately 2010 is expected to increase accuracy to about a meter (GlobalSecurity.org, 2008).

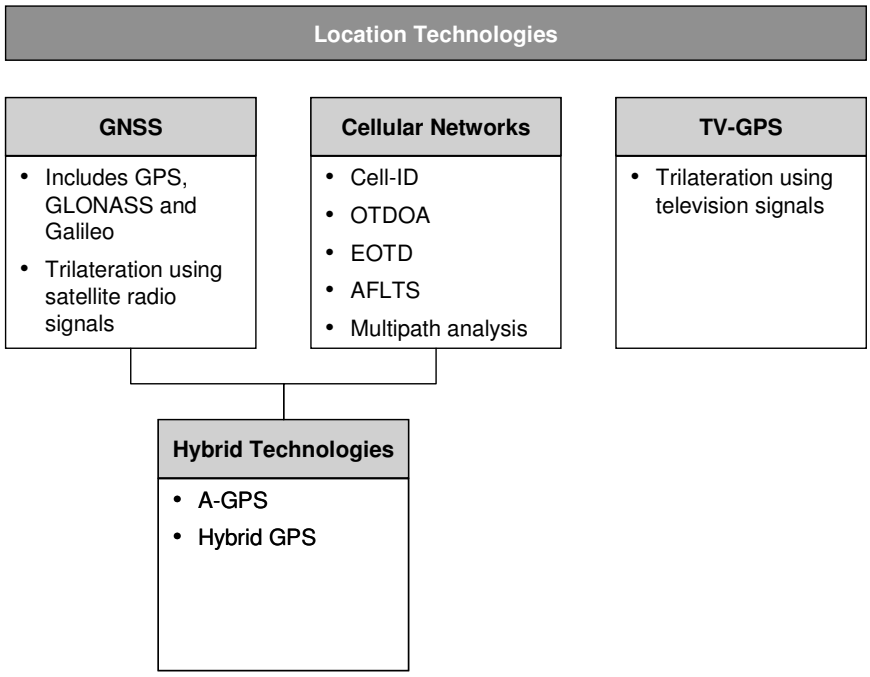
In 1982, Russia launched the first satellite of its military-based GLObal NAvigation Satellite System (GLONASS, also known as Ascos in Germany (Schmundt, 2006)). It went into operation with the launch of the last satellite in 1996 (Rath et al., 2005). GLONASS initially consisted of 24 active and three spare satellites. The system can provide an accuracy of 57 to 70 m. Due to limited development and maintenance, some sources indicate that only ten of these satellites are still in operation (Schmundt, 2006). The system is about to be reconstructed with the help of India.

China started engaging in satellite navigation in 2000. Since then, it has been building the regional Beidou-1 system, which was completed in 2007 (SinoDefence.com, 2008). It will provide 10 meters accuracy to civilian users and greater accuracy for military purposes. China aims to introduce Beidou-2 or COMPASS as a global system with thirty Medium Earth Orbit satellites and five Geo-Stationary Earth Orbit satellites (Chinese Defence Today, 2007a; Chinese Defence Today, 2007b).

There are a variety of other regional and geostationary systems. For example, Europe is engaged in creating a supplementary system that leverages these system's satellite signals as well as geostationary satellites in order to enhance their accuracy. This European

Geostationary Navigation Overlay System (EGNOS) (ESA, 2007b) entered its pre-operational phase in 2006. The system consists of three geostationary satellites and a network of thirty ground stations. It transmits information on the reliability and accuracy of the positioning signals sent by both GPS and GLONASS and thus achieves an accuracy of two meters. This system is only one among a couple of similar systems (for an overview, see Rath et al., 2005). Additionally, the combination of GNSS systems with other technologies can enhance the accuracy of the system. Among them are the cellular network determining methods or TV signals (Rath et al., 2005). The focus of this thesis is on GNSS-technologies. Figure 10 provides a comprehensive overview of available location technologies.

Figure 10: Types of location technologies (Rath et al., 2005, p.159).



Europe is in the process of creating GALILEO, which, in contrast to GPS and GLONASS, is a civilian system. Thus, Europe intends "to protect European economies from dependency on other states' systems which could deny access to civil users at any time, and to enhance safety and reliability…", (PriceWaterhouseCoopers et al., 2001, p.2). The business case calculated for GALILEO was positive. The system should "secure

an increased share for Europe in the equipment market and related technologies, …" (PriceWaterhouseCoopers et al., 2001, p.2). As mentioned earlier, GALILEO is expected to create 100,000 jobs or more (European Commission - Directorate-General for Enterprise and Industry, 2006) and a market potential of 9 billion € p.a. (European Communities, 2001).

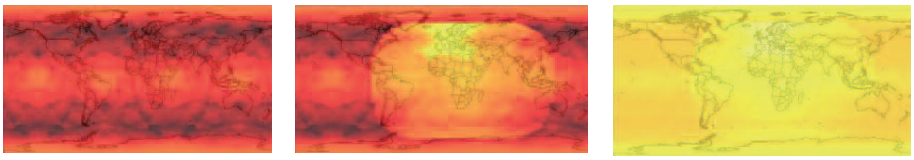
GALILEO's business case builds on its civil character as well as its system superiority. GALILEO is based on thirty satellites, three of which serve as reserve units (PC-Welt, 2007). Besides using more satellites then the other systems, GALILEO is interoperable with GPS and can technically be interoperable with GLONASS (Ashjaee, 2007). Thus, the system can potentially leverage signals emitted from about 10 satellites at any one time. Accordingly, the service coverage can be increased from 55 to 95% (European Commission - Directorate-General for Energy and Transport, 2002). ESA (2005) envisages GALILEO's accuracy to be around one meter, while others even propose a range of centimeters (Schmundt, 2006). Furthermore, GALILEO signals will probably face lower risk of interference in building gorges (Anwendungszentrum GmbH Oberpfaffenhofen, 2006). This is due to the greater inclination of GALILEO's satellites towards the equator and thus the steeper angle at which their signals come in. Additionally, GALILEO's ground stations (Anwendungszentrum GmbH Oberpfaffenhofen, 2006) and the interoperability with EGNOS allow for signal enhancements.

Nonetheless, GALILEO faces risks. GALILEO's competitive advantage depends on the availability of high quality signals and thus non-disturbance from ground and space (Schmundt, 2006). As GALILEO integrates GPS signals, any disturbances there will simultaneously degrade GALILEO's performance. In the event of political conflict or war, signal disturbances will impact also GALILEO. Additionally, GALILEO's competitive advantage will probably be short-lived. Already, its creation is delayed by approximately three years. GALILEO's original start date was 2008, whereas today 2011 is in discussion (EADS Astrium, 2008). Some already see the launch being moved to 2012 (Schmundt, 2007). In the meanwhile, other protagonists are catching up.

Accordingly, GALILEO's introduction can be considered a technology shock. In contrast to its competitors, the system offers higher accuracy, continuity, and integrity as well as

the service guarantees envisaged for the Safety-of-Life Service (SoL) and Commercial Service (CS) (ESA, 2005). It substantially enhances horizontal accuracy, even more so when augmented by EGNOS (see Figure 11).

Figure 11: Horizontal accuracy improvement potential for single frequency users – GPS, EGNOS and GALILEO (GALILEO Joint Undertaking, 2005, p.29)



GPS alone | GPS augmented by EGNOS | GPS augmented by EGNOS and GALILEO

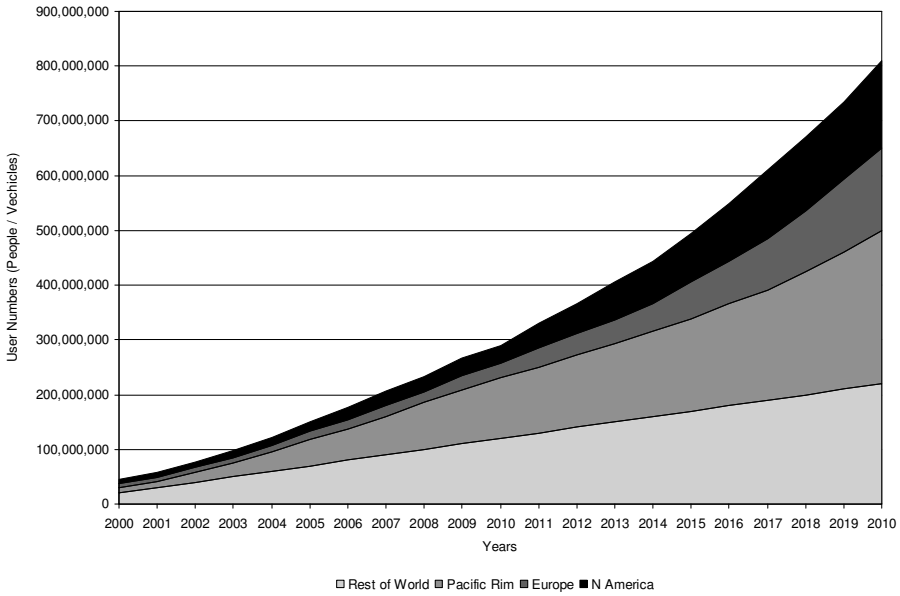
Business opportunities can be created in four main service areas, which are envisaged today (Rath et al., 2005; ESA, 2007a). The Open Service (OS) will be free of charge and available globally. The for-pay CS service provides access to two additional signals, enhancing the data rate and thus the precision. This will probably include service guarantees. The SoL also warns users of the system does not perform up to a specific threshold of global accuracy and guarantees service continuity to the user. It targets services such as rail switching and precision airplane landing (Rudolph, 2003). The government-controlled Public Regulated Service (PRS) provides positioning and time information with high continuity, using a strong signal that is resistant to jamming and spoofing. It will be used by the policy, anti-fraud agencies, for civil protection and other similar organizations (European Commission - Directorate-General for Energy and Transport, 2007). It is not just the enhanced accuracy, but also the service guarantees that allow GALILEO to develop new markets.

4.1.2 Market potential introduced by GALILEO

The market developed by GALILEO is relevant for this study. It first of all determines the potential to see the impact of innovation capabilities on performance. Secondly, it provides a base measurement for the specific impact in different application areas. Depending on their size and their expected growth rates, a percentage increase and market share has different implications. Thirdly, it allows for a cross-read on the potential drivers of the market change. The more diverse and/or smaller the actors are, the more likely a cluster can capture the growth potential.

Market analysts see high growth rates in satellite navigation application markets, which will further be supported by the introduction of GALILEO. Out of the three sections in the satellite navigation value chain, the application segment will probably have the highest innovative and the strongest market potential, according to satellite navigation expert Mr. Hönig with McKinsey & Company. In 2003, the estimated market volume of the infrastructure segment was 0.6 billion euros and that of the hardware segment 5.6 billion euros. Both segments' market growth is assumed to lie around 4% p.a. In contrast, the application development segment's market volume was estimated at 8.4 billion euros with a market growth of 16% p.a (ABIresearch, 2003). The 2004 global navigation application market of 30 billion euros is expected to grow to 276 billion euros in 2020 (GALILEO Joint Undertaking, 2005). This equals a compound annual growth rate (CAGR) of 15%. While the European Commission's estimates are lower, they still see a CAGR of 14% during that time (European Commission - Directorate-General Energy and Transport, 2007a). GALILEO contributes to these projections, as Figure 12 shows. These growth projections outrun those of other technologies. In 2005, for example, the Location Technologies Index beat the Standard & Poor 500 Technology Sector Index (S&P 500 Technology Index) with a return of 42% compared to 6% (Rath and Giang, 2006).

Figure 12: GALILEO's market extension potential (European Commission - Directorate-General Energy and Transport, 2007a, p.16)

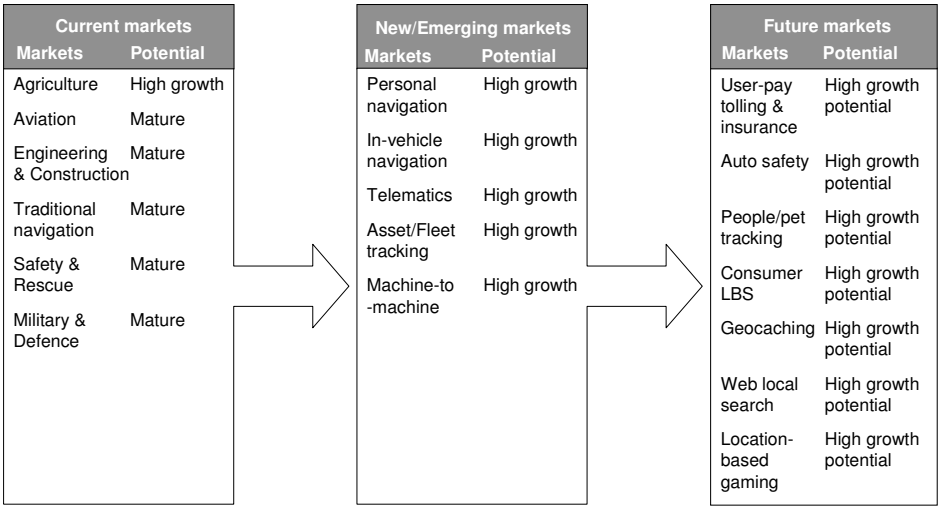


Several trends ensure the continuous growth of satellite navigation applications (ABIresearch, 2003; Rath et al., 2005; GALILEO Joint Undertaking, 2005). These comprise hardware, satellite navigation technology, regulatory and social trends, market trends. Take the example of personal satellite navigation applications, firstly, the prices of devices continually decline at a rate of 25-30% p.a. while their performance improves at the same time. Additionally, devices become smaller, lighter and consume less power, providing additional support to mobile devices and integrated uses. The cost of $200,000 in 1984 compares to less than $5,000 today and the 1984 high-end GPS receiver weight of more than 100 pounds has become less than one pound today (Ashjaee, 2007). Secondly, EGNOS and GALILEO will allow for further performance increases and potentially enable the incorporation of new applications on the devices. Thirdly, governments provide assistance to the development of new applications. The assistance focuses, for example, on more efficient and safer transport networks, environmental monitoring and more efficient fishery, the protection of the public and support measures for people with disabilities. Fourthly, the need for efficient travel and concerns about transport and personal safety grow stronger and the demand for consumer electronics

increases. Fifthly, the enterprises' and customers' market awareness as well as customers' reach and acceptance increase. For example, globalization leads to an increasing need of transportation services.

Market growth stems from existing, but also new markets. GNSS applications will increasingly impact our lives across sectors and services (Figure 13). Thus, applications and services spread not only to new customers, but also to new industries and will redefine existing markets (Galileo Joint Undertaking., 2003).

Figure 13: Current and future location technology markets (Rath et al., 2005, p.7)



This overview has provided evidence on GALILEO's potential to introduce path extension as well as path creation dynamics in the satellite navigation application domain. On the one hand, it allows for improvements in the performance of existing applications through its higher accuracy, continuity and, depending on the Service, integrity. This reflects path extension. On the other, its performance characteristics allow for market creation in the sense of path creation (Katzy & Röttmer, 2006).

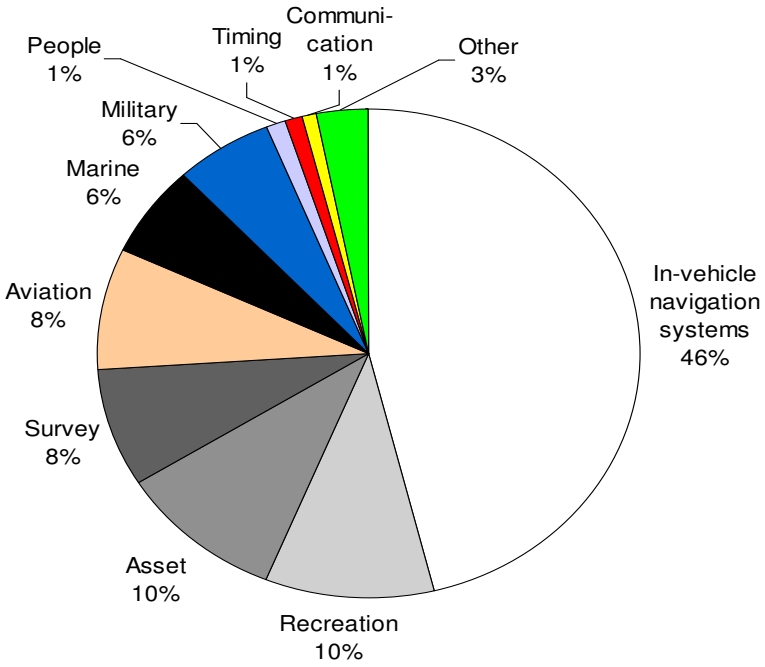
Furthermore, the strong growth projections support this research by facilitating the differentiation of success and failure of clusters in capturing markets. However, the differential dynamic in sector markets requires further consideration, as it might impact the interpretation of this study's results.

Satellite navigation technologies are used in a broad set of different utilization cases. All of them exhibit different competitive dynamics, customers, product development requirements, protagonists and life cycles and require different levels of accuracy and reliability, i.e. GALILEO services. Among the industries that leverage or are expected to leverage satellite navigation technologies are location-based services (i.e., mobile phone based services), road, aviation, maritime, rail, oil and gas, agriculture, fisheries, survey and marine engineering, science, electricity networks, social, customs, justice and home affairs, and leisure (GALILEO Joint Undertaking, 2005). These industries differ in many respects.

Firstly, these industries differ in their potential market size. Figure 14 provides an overview of their estimated 2008 market shares. Secondly, they differ in their competitive dynamics. Automotive navigation, for example, constitutes a mass market, with a scale as a prominent force behind competitive advantage. In contrast, airborne surveillance drones forms a highly specialized, low volume niche market (for an overview of the different markets and their drivers see ABIresearch, 2003). Thirdly, the customer range among and within the industries ranges from B-2-B to B-2-C to business to the public sector. For example, government projects currently account for almost 65% of the total revenue in the geospatial and remote sensing industry (Rath et al., 2005). Fourthly, the product development challenges are different in these segments. For example, satellite navigation expert Mr. Hönig set out in the interview in 2006, that the R&D intensity requirements and the relevancy of international co-operations differ. According to the interview with expert Mr. Lechner, international co-operations are most relevant for innovation in safety-critical applications. Additionally, the relevancy of market or research proximity differs. For example, the developers of personal guiding systems for tourist attractions (Kinderdijk, http://www.stichting-kinderdijk.nl and Cité de l'Espace: www.polestar-corporate.com) were located close to their attractions. In contrast, the development of Mavionics Unmanned Aerial Vehicle Control Suite, was initiated by a university spin-off (www.mavionics.de). Generally, however, proximity to markets, technological knowledge, and potential co-operation partners from other industries or other segments of the value chain can be supportive. Fifthly, the industries experience substantially different product lifecycles. While they lie at less than one or two years in the end customer mass

markets, B-2-B applications such as fleet management reach about three years. According to the satellite navigation expert interviews with Mr. Lechner and Mr. Rudolph, the life cycles for safety-critical applications are much longer with five to ten years, due to certification and longer product launch times. At the same time, according to Mr. Rudolph, the competencies and often co-operations required to provide the applications differ.

Figure 14: GPS revenue share by application, world market 2008 (ABIresearch, 2003, p.1-7)



The expected participants in the satellite navigation application innovation process support a cluster-centered research approach. Likely, SMEs will drive application development and software development, which will lie at the heart of employment creation. According to the interview with the satellite navigation expert Mr. Hönig, SMEs appear to be strong driving forces of application innovations, complemented by large firms in specific application areas. SMEs often operate in co-operations for the (international) commercialization of products, especially when local content requirements

exist. Mr. Lechner assumes that software development for the applications and services will account for most new jobs, followed by secondary effects.

4.1.3 Selection of clusters

The defining elements of clusters (see Chapter 2.1.) provide an initial operationalization of clusters. They are formal or informal regional agglomerations of firms focusing on satellite navigation applications. In that, they are supported by a specialized infrastructure. The protagonists form a critical mass and are connected through vertical, horizontal and lateral links. The protagonists include large and small companies, start-ups, universities and business schools, research institutes, incubators, venture capitalists, as well as policy makers, regional business associations including unions, business service providers, technology transfer centers, and regional development agencies. Policy makers consist of governments at national, regional or lower level.

This definition already demands certain cluster characteristics. Firstly, each cluster needs to possess a regional center, which can and which probably will be independent of administrative borders. Secondly, the existence of horizontal, vertical and lateral links ensure a minimum level of interconnectedness in the cluster. Thirdly, the cluster composition requirements ensure the presence of market and technology players, allowing to capture both types of innovation triggers. Additionally, it ensures a minimum endowment with technological and complementary, financial and institutional assets (see Chapter 3.2.3). The focus on European satellite navigation clusters establishes comparable technological external conditions and the same external shock with the introduction of GALILEO. This shock should allow for observing innovation capabilities in path breaking circumstances.

According to theoretical sampling, the cluster selection process aims at choosing diverse clusters to enhance and enrich the range of insights and to enhance generalizability (see also Chapter 1.3). Following the insights generated in Chapter 2, cluster innovativeness could depend on assets and capabilities, which are formed by routines. Thus, the selected clusters should ideally posses the relevant assets, and provide an initial connectedness in order for capabilities to potentially be created. Assuming that capabilities are observed in

this study, choosing clusters with different routines, age and historical paths can inform the analysis of how capabilities are created. Different levels of formality will probably trigger different routines and thus inform the analysis. The cluster's industry affiliation is a probable indicator of the different historical paths. Still, innovation capabilities should expose their best practice characteristics in clusters across industries and thus should be observable independent of industry affiliation.

The links and complementarities in clusters define the cluster boundaries, which can change over time. This is in line with the socially constructed nature of both formal and informal clusters. The protagonists' identification with the cluster is decisive for the cluster's boundaries and their specific participation in the cluster. However, the positive impact of collocation should allow us to determine the regional area of the cluster. The European Commission's NUTS 3 regions provide a good measurement for capturing it. NUTS regions are defined along consistent criteria throughout Europe and the Eurostat collects data at this level that may be leveraged for triangulation (see also Doloreux & Parto, 2005, who apply the more imprecise NUTS 2 level).

I leveraged three data sources for identifying relevant European satellite navigation application clusters. These were firstly, existing cluster mapping exercises, secondly, archival data and thirdly, eight interviews with technology experts. The cluster mapping exercises provided least value in identifying satellite navigation clusters. Currently, several cluster mapping exercises are under way. Some address the national level (see, for example, www.kompetenznetze.de and www.berr.gov.uk), others the European (see, for example, www.europe-innova.org and Observatory of European SMEs, 2002) or the global level (see, for example, http://www.competitiveness.org/cid/ and Porter and Van der Linde, 2002). Of course, no comprehensive list of clusters does and ever will exist. On the one hand, this is due to the ongoing creation and decline of clusters. On the other, the criteria and thresholds applied to clusters, as well as their industries and technologies differ from exercise to exercise (see, for example, the review of European national practices in Observatory of European SMEs, 2002). Reviewing 22 databases, meta-studies, cluster project overviews and industry- and technology-specific cluster contributions allowed me to identify 729 European clusters. Unfortunately, most of the existing data follows a sector-perspective. However, archival data indicated that none of

the clusters operating in sectors proximate to satellite navigation technologies leveraged them to a substantial extent. The few technology-focused data sources did not break out satellite navigation technology.

Five archival data sources were most helpful in identifying European satellite navigation technology clusters. I started with a review of the regions that either are a siege of a GALILEO-related institution, or of a space-related incubator (http://esinet.ebn.be/), or that participate in the European Satellite Navigation Competition (former GALILEO Masters). I complemented them with eight interviews with satellite navigation technology experts on European product development hot spots and a review of the database on satellite navigation companies in Europe (www.best-in-space.com).

The ex ante identification of regions and the interviews produced a list of 19 potential European satellite navigation application regions. These have diverse industrial specializations, contain a diverse set of protagonists and are renowned for their technological expertise. I refined this list in several interviews with cluster representatives and with reviews of archival data on these clusters. Conferences and cold calls served to establish contact to the representatives. Fourteen clusters did not pass the thresholds established. Nine of the clusters on the list did not showing a significant focus on and expertise in satellite navigation technologies. Often, the clusters took the traditional focus on satellite navigation infrastructure development rather than application development. Similarly, few independent protagonists often drove the regional satellite navigation activities; the supporting infrastructure was missing or very rudimentary. Two clusters dropped out, as they turned out not to systematically work with satellite navigation technologies. As young clusters, three clusters did not promise new insights in the sense of theoretical sampling. Also, they were just starting the process of setting themselves up for satellite navigation and asked for a chance to participate in this study during the next, longitudinal phase.

This process allowed me to confirm five satellite navigation technology clusters that fulfilled the criteria to different extents. In line with the theoretical sampling approach of this research, they exhibited the appropriate technology focus but were at different ages (between one and more than ten years old), diverse participant compositions and industry affiliations as well as different degrees of formality and regional sizes (for a similar

approach, see Gerstlberger, 2004b). Table 12 illustrates this. All clusters were preparing for the technology shock at the time of selection. Thus, they promised insights into the different driving forces of innovativeness. To ensure the anonymity that was granted to the participants of this study, I will not use their names but assign codes.

Table 12: Theoretical sampling: Ex ante identifiable characteristics of selected clusters

	Cluster				
Characteristics	**Alpha**	**Beta**	**Gamma**	**Delta**	**Epsilon**
Context factors					
• Age (yrs)	1-3	>10	1-3	1-3	>10
Assets					
• Number of participant groups not represented in cluster	<2	>2	>2	>2	<2
• Market structure, i.e. breadth of industry affiliation (NACE-industries)	>5	>5	>5	>10	>10
• Cluster structure					
– Formality (single contact identifiable online)	Yes	Several	No	No	Several
– Size of region (no. of NUTS-III regions)	5-10	<5	<5	<5	<5

4.1.4 Selection of respondents

A paramount quality parameter in retrospective research is limiting potential recall biases and particular interpretations of the history, especially in the context of innovation (Leonard-Barton, 1990; Hauschildt, 1991, see also Chapter 1.3), but also with regard to the perceived existence of capabilities and the development of performance over time. As it is not viable to interview all (potential) cluster participants for limiting the bias, the retrospective, cluster level research needs to apply special care in the selection of respondents.

The respondent selection needs to fulfill several aspirations. The respondents need to constitute a fair representation of the cluster and its regional extension. Clusters are best

represented on the cluster level. However, a cluster might find representation through a formal manager or an informal leader (similar to Gerstlberger's key informants, the cluster promoters, see Gerstlberger, 2004b). According to satellite navigation expert Rudolph (interview in 2006), these protagonists are typically very well informed about the cluster. There is no consistent way of identifying them in their regions, as they perform very different formal and/ or informal roles. Experience shows that interviews serve well for identifying them.

Building on these lighthouse persons, I employ the key informant methodology (Sethi et al., 2001; see also Zollo et al., 2002) for selecting the respondents. Identifying the appropriate respondents from outside the cluster is close to impossible (Ahuja & Lampert, 2001; Klepper & Simons, 2003). Additionally, it would require an ex ante understanding of the cluster's boundaries, which is again impossible. Key informants can be leveraged to support their identification. While this method ensures the breadth and depth of knowledge necessary on the side of the interviewees to address the questions and to provide a diversity of perspectives about the cluster innovation activities and performance (Lorenzoni & Lipparini, 1999; Edwards et al., 2005), it can also lead to biases, such as the selection of well-disposed interviewees. To delimit this, not one but three to five main cluster representatives selected the respondents according to the requirements and rounds of subsequent interviews. New candidates that were identified over the course of the study were able to complement the list, once a quality check has been performed.

Naturally, key informants might introduce biases into the research setting. For example, I rely on the formal or informal cluster managers to implicitly acknowledge cluster boundaries when developing the initial list of interviewees. However, safeguards can be implemented. For example, these boundaries were reconfirmed in the interviews, as all interviewees are asked to determine the regional extension of the cluster based on NUTS 3 regions (Nomenclature of Territorial Units for Statistics), i.e. level of the smallest regional entity (for an overview, see Eurostat, 2006).

As described, these lighthouse persons constitute the first group of respondents. The second group of respondents is made up by all cluster participant groups that potentially enhance cluster innovativeness. These are small and medium enterprises, large enterprises, start-ups, as well as the supporting infrastructure, i.e. research institutes,

universities, technology transfer centers, incubators, venture capitalists, policy makers, regional development agencies, regional business associations, and business service providers.

For further delimiting biases, I will interview two entities per category where possible. While all might be substantially biased in the same direction, the probability is decreasing and the effect has a higher probability of leveling out over the clusters, and triangulation can take place (Eisenhardt, 1989; Leonard-Barton, 1990; Golden, 1992; Yin, 2003; for a similar approach, see Pavlou & El Sawy, 2004). Adding to that, I aim to interview two representatives of each company. In all other institutions, only one representative is to be interviewed. In research institutions, interviewing a second person does not often add another functional perspective. In business support entities and other protagonists, often only one person concentrates on satellite navigation. Again, where feasible, one of them should ideally have a managerial perspective and the other a research focus. Thus, I can first of all obtain broad insights into the issue from different and very relevant perspectives. Secondly, as we are looking into cluster capabilities that build upon firm, not single person involvement, asking two persons within an entity allows us to better determine the extent to which an organization is involved in the cluster (similarly, Schmidthals, 2007). Thirdly, interviewing two persons also moderates potential biases, of impressions in general and of temporal sequences more specifically. The collection of qualitative and quantitative data and the use of archival data on artifacts will allow for further triangulation.

On top of this, two reports on the research findings are offered to all respondents. One reported on their cluster, the other on their cluster in comparison to the other European clusters. This constituted an additional incentive for participation (see Davila, 2000; Davila and Foster, 2004 for a similar approach), but also allowed for an additional review of the findings.

4.2 DATA COLLECTION AND ANALYSIS

4.2.1 Data collection method

The method of data collection reflects the theory building nature of this research (see Chapter 1.3). Data collection and analysis will overlap, allowing for incorporating learnings into the ongoing research process. Data collection comprises qualitative and quantitative data, aspiring to produce a reliable picture of each cluster. It should allow for pattern identification while at the same time being open enough to leave room for new patterns. It relies on semi-structured interviews of one to two hours in length and archival data. The unstructured sections serve to validate the framework and operationalizations, providing space to the interviewees for adding additional elements of relevancy.

The interviews built on two different interview guidelines, which serve to maximally leverage the knowledge present in the cluster. I differentiate between cluster managers and the cluster participants. Naturally, the cluster managers have deeper insights into the cluster and are in a better position to comment, among other things, on the age of routines in the cluster, the cluster's history and the most prominent and impactful cluster activities. Also, the likelihood is higher that cluster managers are aware of cluster performance data. Thus, their guideline is more detailed and their interviews range from one and a half to two hours. This compares to one to one and a half hours per interview with the cluster participants.

All respondents were contacted upfront to clarify whether they meet the criteria established and to encourage participation. In most cases, the cluster management initiated this contact. Depending on the clusters' communication habits, this contact was established either in writing or through personal communications. In the event of personal communication, it also served to reconfirm the potential respondents characteristics and their involvement in satellite navigation application development processes.

For this project, multiple interviewers were trained ex ante on interviewing techniques and the interview guidelines and received coaching and feedback to ensure a common standard during the interviews. Three of the six interviewers were CeTIM researchers, the other three members of the European Commission's CASTLE project. These interviewers'

cultural backgrounds largely matched that of the clusters. Interviewer biases are possible, due to the specific role of the latter interviewer group as well as due to the diverse cultural background of the interviewers. To address that, generally, two interviewers conducted the interviews in each cluster, including cross-cultural compositions and co-interviews across regions, as well as the review of the recorded interviews. Using multiple investigators enhanced the creative potential of the study and the convergence of the observations contributed to the confidence in the findings (Eisenhardt, 1989). The in-person interviews first and foremost ensured openness for spontaneous reactions and follow-up questions. This potential for interaction should increase the quality of this theory building research more than distort the insights due to an interviewer impact on the results. Moreover, the interviews ensured adequate partner identification, served to minimize drop-out, and signaled the relevancy and commitment to this research (similarly, Schmidthals, 2007). The semi-standardized nature reflected the openness of this research effort and allowed us to capture cluster characteristics (see also Gerstlberger, 2004b). Wherever feasible, the interviews were conducted in person and recorded. This not only enhanced the potential of capturing specific cluster characteristics, it also encouraged the participants to suggest additional elements and enabled the comparing and triangulation of results across clusters. At the same time, leveraging archival data from publicly available sources (such as intranet and other sources of written material (Rice et al., 1998)) enabled the triangulation of the answers on routines and performance development, limiting the risk of biases (Früh, 1991).

The interview guideline was pre-tested with cluster experts for validity and reliability, comprehensiveness and manageability (similarly, Barringer & Bluedorn, 1999; Zollo et al., 2002; Schmidthals, 2007). The Zentrum für Umfragen, Methoden und Analysen (ZUMA) reviewed the final interview guidelines, i.e. one for cluster managers and one for the participants. In most cases, the interview guidelines were translated into the clusters native languages, following the process used in the European Social Survey (European Social Survey, 2007). For Aerospace Valley (Toulouse) and Leiden, the cluster manager indicated that there was no need for a translation; however, the interviewers translated sections into the respondents' native languages where appropriate during the interview. The interviews in Munich and Brunswig were held in German, the

interviews in the Czech Republic in Czech. Cultural response biases are likely and were identified through interviews by interviewees from different regions as well as the comparison with anecdotal evidence.

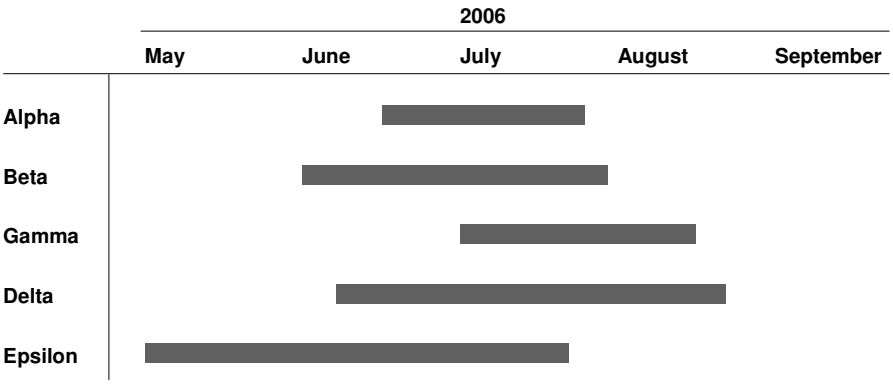
The interview guideline comprised five sections (see also the Annex). Building on the validation of the entities' selection, section two tested the existence of routines (Eisenhardt & Martin, 2000), which were operationalized as artifacts. Section three covered the existence of capabilities and the cluster's qualitative performance, and section four the cluster's quantitative performance. Section five closed the interview with demographic information. The dynamic nature of this research adds the temporal dimension to routines and performance, reflecting their development over time. Capability development over time is not reflected in the interview guideline and is unlikely to be manageable, given the high propensity of biases. Performance measurement relies on the indicators developed in Chapter 3.2.2, which were confirmed in the expert interviews. The cluster's endowment with assets constitutes the fourth element. The dual use of both terms, cluster and region ensured that all participants could answer the questions, regardless of whether they perceive a cluster or not.

Given the challenges in measuring cluster performance (development) in a comparable manner across clusters, I will collect a variety of data points (see Chapters 3.2, 3.3). These allow for intensive triangulation. Statistical data across clusters is not available. The respondents' answers are the primary source of information. Whenever possible these are complemented and triangulated with archival data. Experience as well as the expert interviews has shown that respondents often struggle to provide performance numbers. It is much easier for them to report performance developments over time (OECD et al., 2005). Additionally, it produces more reliable results in view of inconsistent measurements. Targeting maximum triangulation, the interview guidelines generally only cover absolute numbers and developments over the past five years for the cluster as well as the satellite navigation applications and supporting services across indicators. Additionally, I measure the share of satellite navigation applications and their supporting services in, for example, the cluster's GDP as well as its development. It furthermore allows for the differentiating general economic effects from proprietary satellite

navigation applications-related impact. Furthermore, it allows for the mediation of some of the general trends in the applications market development.

Going back and forth between data generation and interpretation forms part of this research approach (see Chapter 1.3). The data collection process across clusters supports this (Figure 15).

Figure 15: Data collection phases across clusters



4.2.2 Data analysis

This research effort leverages qualitative analyses of descriptive statistics as well as qualitative data. Excel will facilitate the descriptive analysis of qualitative and quantitative data. Descriptive analyses support the analyses of a small and non-representative sample (five clusters) and the methods employed acknowledge the skewness of the data. The latter applies to unstructured interview results and archival data and is supported by Atlas.ti, a Qualitative Data Analysis Software.

The descriptive statistics aim at facilitating transparency, comparability and ease of interpretation of the data. With regard to the routines, percentage rates of participation, conscious non-participation, perceived non-existence of the routines as well as non-informed respondents are pictured in a horizontal histogram (for reasons of readability) and analyzed. A (horizontal) histogram and an aggregated measure of the percentage of participants that somewhat or strongly agree with the single and aggregated criteria for capability existence minus the percentage of participants that somewhat or strongly

disagree with the single and aggregated criteria for capability existence are used for picturing the results on capabilities and perceived cluster innovativeness. The cluster's perceived past development of innovation and performance indicators is also presented in a horizontal histogram. These also allow for describing the deviation of answers among participants, an implicit measure of cohesion.

The qualitative analysis supports the interpretation of the data, incorporating information from respondents in the unstructured interview sections or the section on cluster strengths and weaknesses as well as archival data used for triangulation. Furthermore, the data gathered was discussed intensely among the multiple interviewers, also leveraging the recorded interviews. The combination of national interviewer teams and one international interviewer rendered the identification of the influence of cultural factors easier. Additionally, the respondents received the individual cluster and cross-cluster reports for any comments, to enhance the validity of the data.

The single case cluster analyses build on the interviews and archival data reviews to provide a deeper characterization of the cluster and present the findings on the constructs derived from the literature as well as their operationalizations. As discussed earlier, the term cluster is used to indicate a regional base for potential performance, not in the sense of a formal organization. This understanding underlies the presentation of findings. It relates to formal entities only in cases in which these were widely perceived as the cluster's core by the majority of the regional protagonists, including non-members. The following subchapters each start with a brief characterization of the cluster, a brief presentation of each cluster's path, assets, routine and capability profile. This is followed by the cluster's perceived innovativeness and performance. The respondents' perceptions of their cluster's strengths and weaknesses provides an additional read on the comprehensiveness of the model.

The cross-case analysis provides additional information on the core concepts under research as well as their linkages. For each concept, the cross-cluster findings are reviewed and their operationalization analyzed. Additionally, cross-cluster pattern identification does not only allow for identifying patterns within the concepts, but also across them, in a static and dynamic sense.

5 CASE STUDY RESULTS

5.1 DESCRIPTION OF THE SAMPLE

A total of six interviewers conducted 95 interviews with representatives from 86 cluster participant groups in five clusters (see Table 13). Overall, 99 interviews were requested. Four potential interviewees declined for time constraints. The 95 conducted interviews thus represent a rate of return of 94%. In very few instances, the researcher reassigned the participant to another group, as the interviews either reflected a new area of primary activity or as to enhance the comparability of results across clusters. Due to that, in some clusters, participant groups are represented more than twice. In most cases, we conducted two interviews in larger firms and SMEs. Few SMEs requested to only be interviewed once, for reasons of limited personnel capacity.

Table 13: List of interviewees per cluster by entity type

	Number of interviewees				
Cluster participant groups	**Cluster ALPHA**	**Cluster BETA**	**Cluster GAMMA**	**Cluster DELTA**	**Cluster EPSILON**
I.1) First cluster manager/individual very familiar with the cluster	1	1	1	1	1
I.2) Second cluster manager/individual very familiar with the cluster		1		1	1
II.1) First large firm (> 250 employees)	2	1	2	1	1
II.2) Second large firm (> 250 employees)	1	2	1		1
II.3) Third large firm (> 250 employees)			1		1
III.1) First SME (10-249 employees)	1	2	1	1	1
III.2) Second SME (10-249 employees)	1	2	1		1
III.3) Third SME (10-249 employees)	1	1	1		
IV.1) First start-up (not older than two years)	2	2	1	2	1
IV.2) Second start-up (not older than two years)				2	
V) University	1	1	1	1	1
VI.1) First research institute	1	1	1		1
VI.2) Second research institute	1	1	1		
VII.1) First incubator	1		1	1	1
VII.2) Second incubator	1				
IIX) Venture capitalist or other private equity provider	1		1		1
IX.1) First policy maker	1	1	1	1	1
IX.2) Second policy maker	1	1	1		
X.1) First regional business association	1		1	1	2
X.2) Second regional business association	1		1		1
XI.1) Business service provider (for example market research, R&D-services)			1	1	1
XII.1) Technology transfer center	1	1			1
XIII.1) First regional development agency	1	1	1	1	1
XIII.2) Second regional development agency		1	1		
XIII.3) Third regional development agency		1			
TOTAL	**21**	**20**	**21**	**14**	**19**

The clusters were selected in a process of theoretical sampling and, at the time of their selection, i.e. 2006, differed in a couple of core characteristics. Table 14 provides an overview of the cluster characteristics as they presented themselves after the initial interviews, but before the large-scale participant interviews. For the purpose of protecting the clusters' anonymity, the clusters are represented by codes instead of their names and the precise dates of establishment are not given.

Cluster ALPHA is a large cluster that has its roots in the space industry. Single protagonists have been involved in satellite navigation application development for some time, but barely co-operated. Additionally, and unconnected to the space tradition, a couple of small players have been working in the field for a while. Recently, regional policy makers recognized the potential of satellite navigation applications in the region and started clustering efforts together with large enterprises in a formal effort. The region exhibits one strong center. A second center in the vicinity, but in a different state, does not form part of this project.

Cluster BETA is a small cluster that has a long tradition in satellite navigation, especially in the application field of transportation. Among a couple of regional protagonists, especially one regional business association communicates the formal focus of the region for a couple of years. The participants cluster in a small geographical area and connect through strong links.

Cluster GAMMA is a small cluster in a broad geographical area. Most of the participants have a specific affiliation to one of the associations, following their distinct industry and regional focus. While the level of interconnectivity within the associations is high, linkages between the associations are limited. The associations are rather informal, which is even more true for any connections among the them. While the region has a tradition in the space industry, the satellite navigation application focus is recent.

Cluster DELTA is small. Similar to cluster GAMMA, few protagonists formed or were in the process of forming associations within specific regions, but hardly connected outside these regions. As a result, there is no strong regional focus point. Also, while the space tradition is strong, the experience in satellite navigation application development is limited.

Cluster EPSILON is a large cluster with a profound tradition in space and a variety of application industries. While it has a clear regional center, the variety of industrial focus areas has led to a strong affiliation with them instead of a collective perception of a satellite navigation application cluster. Regional policy makers encourage the cluster formation as well as a higher level of formality and communicate the existence of the cluster since about two years. However, its space history dates back decades, allowing for the creation of routines.

The description of the findings include two elements. The first are any temporal data, primarily from the cluster manager interviews. These underlie interpretations and are included in case they do not allow for inferences with regard to the cluster's identity. The second consist of the results of research reviews with the existing archival data. No correction has been made for cultural biases.

Table 14: Ex ante confirmed characteristics of selected clusters

Asset category	Cluster				
	Alpha	**Beta**	**Gamma**	**Delta**	**Epsilon**
• Technological and complementary (presence of renowned institutions)	Yes	Yes	Limited	Yes, in related fields	Yes
• Financial and institutional	Strong government support	Limited	Limited	Limited	Strong financia sector and government support
• Market structure, i.e. breadth of industry affiliation (NACE-industries)	>5	>5	>5	>10	>10
• Cluster structure					
– Formality (single contact identifiable online)	Yes	No, several	No, none	No, none	No, several
– Size of region (no. of NUTS-III regions)	5-10	<5	<5	<5	<5
– Focal area	Yes	Yes	No	No	Yes
– Number of participants (based on interviews)	High	Low	Low	Low	High
– Level of interconnectedness (based on interviews)	Selective	High	Low	Low	Selective

5.2 SINGLE CASE ANALYSIS

5.2.1 Cluster ALPHA

5.2.1.1 Cluster context

The cluster ALPHA is a young cluster. If forms part of a larger, formal organization. Within this structure, satellite navigation applications form one of several areas of focus. All findings presented in the following section relate to this subarea. Policy makers initiated the creation of this formal entity, which mobilized the region. The cluster is well-established, in that approximately 90% of the participants agree that a cluster exists in the region. About 70% feel that they belong to the cluster. This sense of belonging is largely driven by the participant's formal membership in the cluster. For example, one of the participants from a start-up qualified the membership as a door-opener for contracts and for establishing contacts, while it did not really feel connected to the cluster. Membership The cluster does not allow for formal membership of those participant groups that these 20% of the respondents represent. Selected participant groups collaborated in creating satellite navigation applications prior to the creation of this formal cluster. The cluster benefits from the presence of several sectors in the region, i.e. road, rail, air, security, telecom, space, computer and R&D, public administration and defense, to name the biggest. Former collaborations allow the cluster to build on a strong regional culture. Interestingly, two distinct cluster groups point at these former collaborations. On the one hand, these are small and medium enterprises, which in fact have formed a formal collaboration before the cluster's creation. On the other, these are large enterprises as well as the research institutes, which informally were in contact before. Overall, these findings confirm the upfront characterization of the cluster.

5.2.1.2 Cluster assets

The cluster has a strong asset base. It appears to present a critical mass of protagonists, possessing a broad set of technological and complementary assets, as well as institutional assets, such as local higher education institutions. The cluster covers several industries.

All participant groups potentially relevant in the innovation process find their representation, apart from business angels and specialized adult training offers. Additionally, the venture capitalists were barely integrated. As one venture capitalist described it, the cluster barely provides specific services to start-ups and thus is not interesting for him. This not only provides an additional read on the low level of integration of start-ups, but also potentially points at a weak financial asset base, reinforcing the cycle. The several SMEs and large enterprises are located across the entire value chain and benefit from a strong supporting infrastructure. The historic competencies of the region lie mainly in space and research and are largely accumulated in research centers. Several regional associations either enhance research, or drive application development by SMEs or provide regional development support to the cluster. Policy makers are strongly involved in supporting the cluster and there is a high level of competitiveness among the firms, supporting the read on strong institutional assets. While there is substantial divergence among the estimates, the participants believe that, on average, 100 entities in the cluster are concerned with satellite navigation applications. Officially, the cluster comprises 13 NUTS 3 regions, with two of them forming the center of the activity. It is starting to create a strong formal core. The external linkages so far are limited to business relationships of the different enterprises and to support relationships for the SMEs. Table 15 provides an overview of the cluster's asset base profile.

Table 15: Asset base - cluster ALPHA

Technological and complementary assets	●
Financial assets	◔
Institutional assets	◔
Reputational assets	●
Market structure assets	●
Cluster structure assets	◑

5.2.1.3 Perceived cluster innovation capabilities and observation of routines

Overall, the cluster scores low along the capability profile, i.e. on the capability of community building, strategic alignment, reconfiguration, opportunity recognition, and networking. The cluster's routine profile supports this finding. Given its age, the cluster has only had the chance to establish few routines and structures. Early routines were not established before 2005, mostly rather in 2006. Due to the political initiation and thus formal nature of the cluster, the cluster could first build upon initial platforms and routines of strategic alignment. The creation of routines of external networking followed. The dissemination of economic or technological intelligence for opportunity recognition still has a bilateral character rather than a cluster character. Beyond long-standing co-operations within participant groups, the cluster can hardly rely on any historical base. The awareness of and participation in the few, young routines is limited.

Among the routines that could contribute to the capability of community building, the formal work groups are the only regular cluster event that finds widespread attention (Figure 16). Several protagonists started offering platform-building events with an increasing focus on satellite navigation. First fairs were conducted in the cluster area in 2002. These are not regular events, and 81% of the cluster members do not believe in their existence. Beginning in 2005, several conferences and work groups were

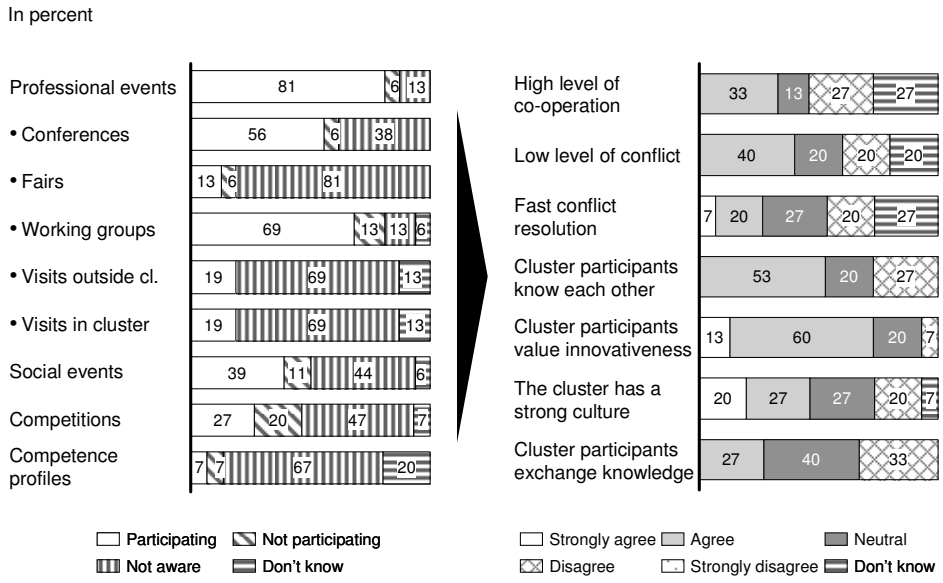
implemented. The conferences are described as largely broad events, i.e. not focused on satellite navigation and consequently are mostly visited by multiplicators. For start-ups, the primary interest in visiting them was less the objective of the conference itself, but rather the opportunity of meeting specific participants. In contrast, all participant groups indicate that they regularly visit the compulsory cluster work groups. The other routines do not appear to be of any relevancy in the cluster. For example, the majority of the participants is not aware of the existence of offers to visit other entities within or outside the cluster. Half of them are aware of business plan competitions, and again half of those participate. A large majority does not believe that cluster participant competence profiles exist and are being disseminated. Social events find the participation of 40% of the respondents. There is no alignment among the respondents as to which of these routines would be most helpful. Younger enterprises encourage events with a stronger content orientation, larger enterprises encourage fairs.

The cluster benefits from a strong regional culture and shared belief in the value of innovativeness. Although the cluster is still young and the cluster's co-operation history limited, nearly 50% of the participants report a cluster culture. 75% believe that the cluster participants value innovativeness highly. In contrast, the cluster scores low on connectedness and high on conflicts. Only about half of the respondents agree that the participants know each other and only 40% report that conflicts are low or relatively low. In the event of conflicts, only 20% feel that these are solved relatively quickly or quickly. Several representatives from SMEs or start-ups pointed at conflicts among small and large enterprises. These find their substantiation in the composition of the cluster board that from a small enterprise perspective too much represents large enterprises, leading to supposedly intransparent decisions by the cluster board on which projects obtain funding by the cluster. Interestingly, also the level of intransparency is perceived as much higher by the smaller enterprises than the larger ones. Similarly, the smaller enterprises also point at a disconnex between the cluster's objectives and its actions. Several respondents encouraged a strong stance of the cluster management to counter these trends, calling for improving the relationships among the actors, increasing the transparency of the decision processes, and improving the communication in the cluster. Similarly, with regard to the

objectives of the cluster, they request to more substantially foster the idea of innovation and employing more project managers to run the cluster.

Along these lines, the regional culture does not translate into strong, cross-functional co-operation. About one third of the interviewees perceives co-operation as easier in the cluster, one third contradicts this and one third does not have a position. According to the respondents, the cluster entities compete as well as co-operate. Co-operation within the cluster is a selective event, not a cluster characteristic. As indicated earlier, co-operation has traditionally been strong within participant groups, such as SMEs and research centers, and there is a strong sense of belonging to the regional entity. However, this appears to negatively impact cooperation across functional and regional borders. The interviewees reported diverse unresolved cross-functional conflicts, especially among large and small companies and research institutes and businesses, as well as regional conflicts that hamper co-operation and learning. Especially the small enterprises provide the segmentation of the future satellite navigation market as a major reason for conflicts. In their eyes, SMEs will drive innovations and thus create new markets. Inadequate representation of small players in the cluster's board in combination with intransparent project decisions by the board and perceived limited support to innovative initiatives might only serve to reinforce the dominance of established players. These conflicts are aggravated by the fact that the satellite navigation division forms just a part of the overall cluster organization, which has a very, and according to some participants, too broad focus. As a consequence, some respondents representing SMEs reported that SMEs are leaving the cluster's core region as it is becoming more and more unattractive to them. This situation explains why only a third of the respondents believe that knowledge is shared extensively within the cluster. However, the picture is profoundly different when looking into the established participant groups. These kernels of co-operation among functionally similar entities concentrate a large share of the relevant knowledge in them and in their regions. They score substantially higher on the frequency of personal interaction, collaboration, and the exchange of knowledge. Overall, the participants show relatively high levels of agreement with regard to the relevant routines, less so with regard to the perceived existence of the capabilities.

Figure 16: Capability of community building - mapping cluster ALPHA's routine and capability profile

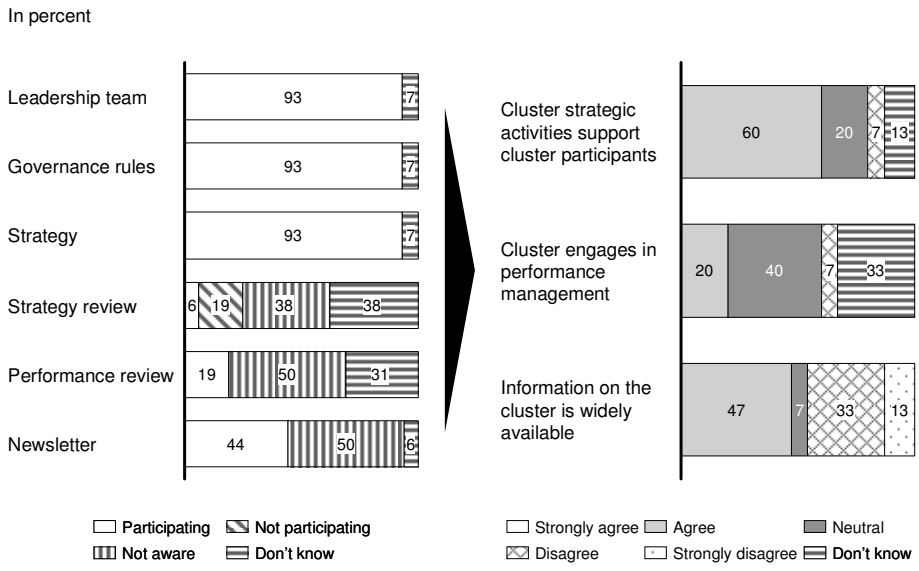


Cluster Alpha possesses several routines that could support the capability of strategic alignment (see Figure 17). Out of these, the formal organization of the cluster ensures that governance rules and a leadership team are in place. Thus, the respondents perceived the management team, governance rules and a strategy for the overall cluster (since 2005) as implemented. However, the division for satellite navigation was still under construction and thus perceived to be less well organized. At the time of this empirical research, cluster companies had granted some employees a (part-time) leave to fulfill the role of the cluster's management team. Accordingly, a couple of respondents expressed concerns about conflicts of interest among the cluster and their employers. Furthermore, some respondents requested a cluster management functional profile that was less focused on marketing and more on project management. Others encourage an extension of the managerial team.

The cluster misses a satellite navigation-specific strategy. According to the majority of the respondents, a satellite navigation-specific strategy has not been defined, let alone reviewed. Again, the cluster participants point at the limited positioning of satellite navigation in the overall cluster and point at the need for a clear strategy. Nonetheless,

60% of them perceive the cluster's overall activities as supporting the members. Performance metrics appear be missing thus far. More than 70% of the respondents are either neutral on or do not know whether the cluster is managed for performance. Only a few participants believe that the cluster's performance is reviewed. This development state of the cluster is reflected in a couple of broad comments. Several respondents reported that they are unaware of the criteria applied for assigning cluster-internal support measures, of the cluster's strategy and targets, its funding and the extent of involvement of policy makers. The dissemination of information appears to pose another challenge. Only half of the participants are aware of cluster newsletters. Similarly, while the majority of the respondents feels that information is available in the cluster, a third disagrees with this. Again, the cluster participants show strong alignment in their thinking about most routines and good alignment on the existence of the capability.

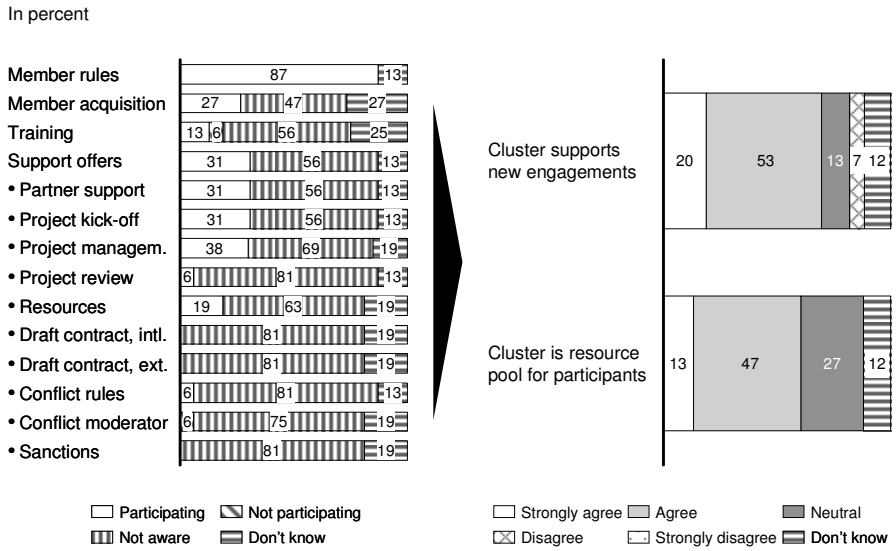
Figure 17: Capability of strategic alignment - mapping cluster ALPHA's routine and capability profile



The cluster appears to possess some capability of reconfiguration, although its routine profile is not strong (see Figure 18). More than 70% of the cluster members agree and strongly agree that the cluster renders feasible new engagements. For 60% of them, the cluster also forms an asset pool. So far, the cluster has set up few routines and structures

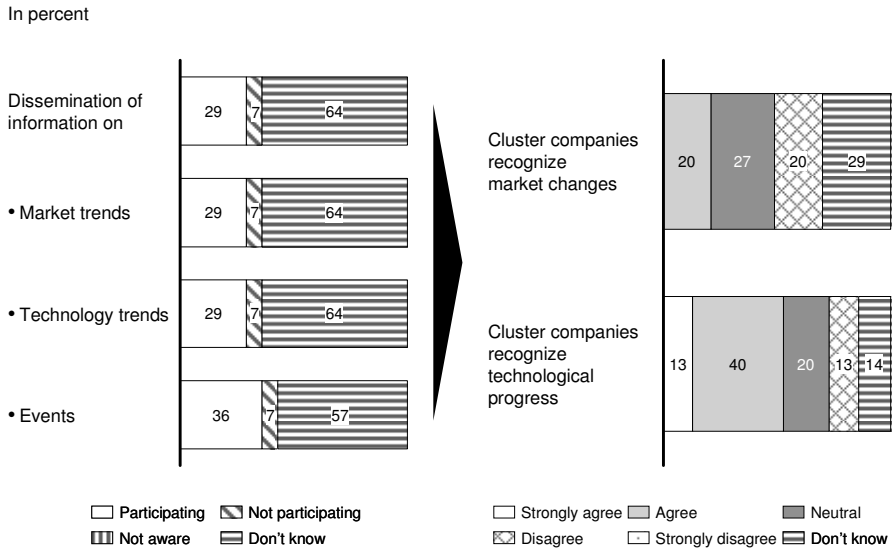
to support cluster reconfiguration. The cluster does not actively work to change its resource base by encouraging new, high quality partners to join. All regional entities with a focus on satellite navigation applications that belong to the participant groups the cluster accepts can join the cluster. Accordingly, these membership rules do not represent a quality gate. The majority of the respondents is neither aware of any member acquisition activities nor of cluster member trainings. Following the general cluster guidelines, satellite navigation projects can obtain application-based funding for selected projects since 2006. However, several participants expressed that they are unclear about the exact guidelines for obtaining funding. Similarly, most are not aware of any additional cluster support offers to co-operations, which appear to be provided in an informal manner. The participants are least aware about offers for conflict moderation, support for establishing contacts within and outside the cluster and start-up support. It appears that the dynamics created by establishing the cluster and establishing a mechanism for project funding created motivation and the perception of capability existence. This expectation needs to be met by future requirements. The participants very much agree on the (non-) existence of the routines as well as the capability.

Figure 18: Capability of reconfiguration - mapping cluster ALPHA's routine and capability profile



Cluster ALPHA does not exhibit a strong capability of opportunity recognition (Figure 19). Only 20% of the respondents believe that the cluster entities quickly recognize market changes. The cluster is stronger on the technology side. Here, 13% strongly agree and 40% agree that the cluster entities perceive progress. The cluster did not establish strong routines to support opportunity recognition. The vast majority of the respondents is not aware of any dissemination of information on market and technology trends. However, they would appreciate obtaining that kind of information, especially economic intelligence. Some respondents obtain information on upcoming events that is disseminated to an established distribution list by regional associations. Interestingly, entities outside the cluster appear to disseminate the information that is most valuable to SMEs. With regard to this capability, the alignment on routines again is high and less prominent with regard to the capability elements.

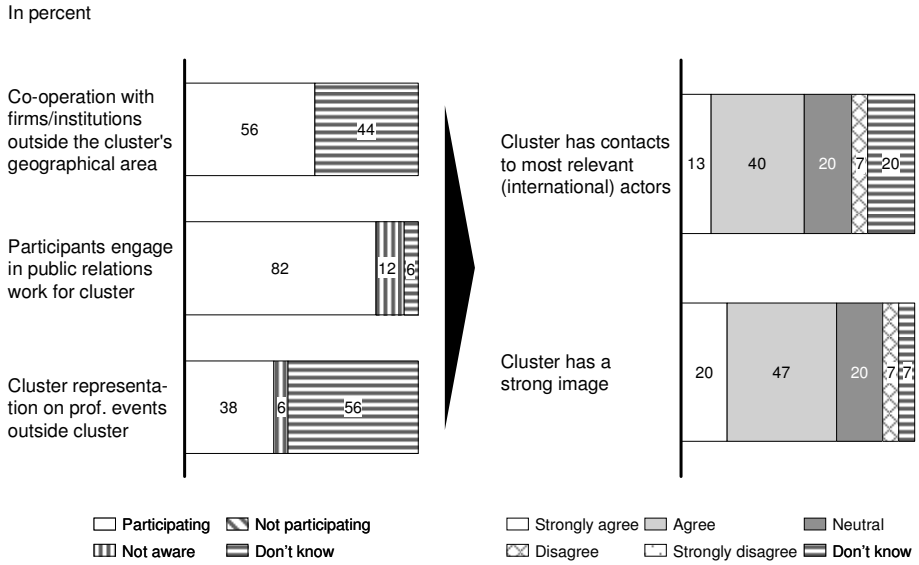
Figure 19: Capability of opportunity recognition - mapping cluster ALPHA's routine and capability profile



While the cluster's capability to network appears to be not strong (see Figure 20), it might be built over time. As of the time of the investigation, slightly more than half of the participants believed that the cluster is connected to the most relevant national European, and global, satellite navigation technology and application protagonists. These contacts

however were largely held by the cluster members themselves, and some respondents see a role for further network building in the cluster. However, they largely agree that the cluster will build further contacts with increasing age. Only slightly more than half of the respondents perceive links to other clusters, associations, research institutes, universities, and governmental bodies. Since 2006 the cluster has started to establish alliances with other clusters of external knowledge carriers. Generally, there is a perception of an insufficient focus on contacts at the European level, including policy makers. Cluster ALPHA appears to barely participate in external events. In addition, enterprises support the public relations work of the cluster rather in a passive manner. Surprisingly, however, the cluster shows the strongest performance in its image. There are two potential reasons for this. The first is that the respondents use the overall cluster (beyond satellite navigation) as their mental anchor. The overall cluster is not only very large, but also has been substantially lobbied for. The second potential reason is the relatively strong local culture, which produces a halo effect on the assumed external perception of the cluster. The level of alignment is lower with regard to these routines compared to other routines, but about comparable to the other capability profiles.

Figure 20: Capability of networking - mapping cluster ALPHA's routine and capability profile



The cluster enjoys a reasonable level of external representation. Nearly 70% of the respondents believe that it has an image, but at the same time, the cluster's profile is perceived as weak. The cluster is just starting to engage in very active external communication, also driven by its members. More than 80% of the interviewed entities state that their firm/institution refers to the cluster in their public relations work. However, active cluster promotion is largely driven by public authorities. Even less respondents believe that the cluster is being represented at external events with an additional half of them insecure. This implies that the cluster does not leverage that path to establish contacts to external entities.

5.2.1.4 Perceived cluster innovativeness and performance

Overall, cluster ALPHA's perceived development in economic performance over the past five years is strong. The cluster participants report that the economic performance increased strongly or even substantially over the past five years, both in terms of employment and GDP per capita. While the region's development has generally picked up, the cluster still appears to shows higher performance. About 40% of the interviewees see a heavy (>10%) or as well as 40% a strong (5-10%) increase in absolute GDP generated over the past five years (i.e., 2000-2005). About 45% do not feel able to estimate the development relative to the total cluster development, but 25% believe that it only increased modestly, i.e. 1-5%. The development of employment exposes a similar pattern, although the increase in absolute employment appears to be slightly lower. Also, relative employment development was harder to estimate for the participants and perceived as more moderate. Only 56% of the participants felt confident in estimating the development of start-ups, which showed a similar pattern. In absolute terms, the participants see it as strongly increasing, in relative terms rather as moderately increasing.

However, the participants were not reporting high levels of perceived cluster innovativeness. Almost half of the respondents believe that the cluster is innovative. Only a third of them believe that the cluster's entities can define market trends and translate technological progress into new products. 40% feel that they translate market trends into new products and react quickly to market trends. The cluster is stronger on the technology side. Nearly 50% believe that they react quickly to technological progress, and 60% that

they define technological progress. Half of the respondents felt that the number of cluster co-operations had increased strongly. Overall, the cluster participants report the wide range of 10-100 co-operation projects in the cluster region for the development of satellite navigation applications. Most participants struggled to determine the global market share. A couple of respondents estimated the European market share (41%) and largely perceived it as moderately increasing. Overall, the level of alignment among the participants on the past development of economic indicators is lower than for the routines and also slightly lower for the perceived innovativeness. Figure 21 illustrates the difference among the perceived past development of cluster ALPHA's performance indicators and its perceived innovativeness.

Cluster ALPHA's perceived innovativeness is in line both with the past development of its performance indicators (Figure 21) and its capability profile (Figure 22).

Figure 21: Innovativeness and past performance – Mapping cluster ALPHA's participants' perceptions

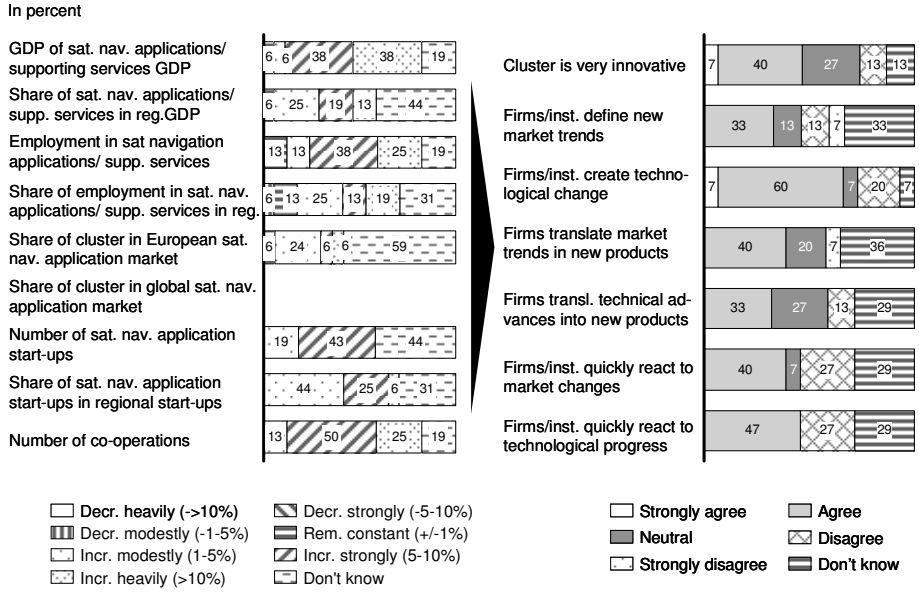
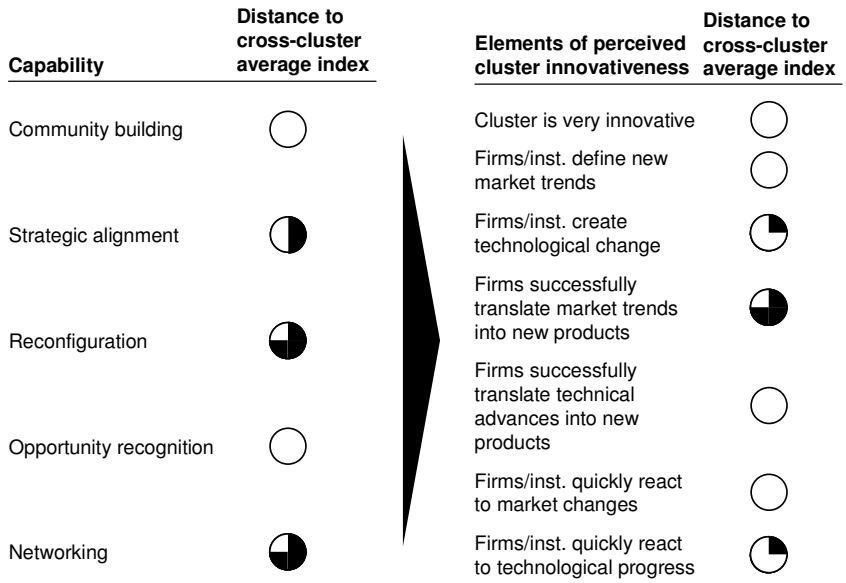


Figure 22: Mapping cluster capability profiles with perceived innovativeness - cluster ALPHA



5.2.1.5 Perceived cluster strengths and weaknesses

The respondents painted a clear picture of the cluster's strength and weaknesses. They perceive a strong regional asset base, in the sense of the diverse entities present in the region, its historical technological knowledge base and the strong political support as major strengths of the region. The cluster's major value proposition is the establishment of a reputation gate for projects and the facilitation of funding for selected clusters.

Limited linkages and conflicts among the cluster participants constitute a profound weakness. The cluster's age could be a strong contributor to this situation, as several respondents acknowledged. Still, the participants neither perceive a momentum nor a common spirit. Their creation appears to be hampered by conflicts among satellite navigation application cluster participant groups, the cluster organization's divisions with satellite navigation as a relatively weak division, and the cluster's regions. The respondents encouraged a couple of roles for the formal cluster, which would enhance the value added of the cluster. All of these roles were encouraged more than once. Among them are conflict management, complementary supportive action, a collective mission, increased communication of cluster activities, a broader and more profound dissemination

of economic intelligence and stronger networking efforts, especially within Europe. Some respondents that represented SMEs or belonged to their supporting infrastructure demanded more support to them. They requested financial support as well as support to co-operations large protagonists and more interest and financial support from public authorities. Additionally, some interviewees encouraged enhancing the regional (common) satellite navigation application development infrastructure, for example, by setting up common testing and education facilities. These could also serve to sharpen the cluster's profile.

The cluster manager perceives SMEs as the innovative entities in the cluster, but the large enterprises as the entities driving economic performance. For him, the size of the cluster is a blessing as well as a curse. The clusters primary future tasks lie in supporting good projects, and especially in supporting the transfer of ideas to applications and in increasing the size of projects.

The high insecurity connected with GALILEO finds its representation in a couple of the cluster participants' responses and their perceptions. On the one hand, it leads to conflicts as to which participant groups will dominate future markets. On the other, some respondents doubt whether the clustering initiative comes at a point in time, which is too late relative to other European players.

5.2.1.6 Implications for a dynamic capability view on clusters and discussion of findings

Cluster ALPHA generally confirms the model. It is well endowed with assets, but at the same time shows few cluster routines, limited capabilities and a low level of innovativeness. This combination is in line with the dynamic capability`s model prediction that routines form capabilities and capabilities support innovativeness in a process over time. Given the youth of the cluster, it is not surprising that the routines have not yet formed. The respondent's encouragement to establish and improve routines in the area of community creation, strategic alignment, and opportunity recognition provides evidence to the relevancy of routines.

At the same time, there are a few additional and interesting observations to be made in this case. Cluster ALPHA shows a strong perceived economic growth. Two reasons have been mentioned by the respondents that can account for this effect. One is the historical basis of the cluster. Though the formal cluster is young, it incorporates a couple of established business and research co-operations. These have formed routines and capabilities and can provide a strong contribution to regional performance. Secondly, the general economic environment is prone to support an increase in performance.

The case provides evidence for other factors impacting the development of capabilities and innovativeness. We found a high level of conflict in the cluster, which can be explained by three elements. The first is the variety of topics addressed in the cluster, which accordingly compete for funds. Satellite navigation only constitutes a minor area. Secondly, the cluster formally comprises a variety of groups, but it is felt that some are overrepresented. Thirdly, the cluster incorporates a variety of subgroup entities and regions with their different interests. These conflicts might be a strong contributor to the fact that the cluster assets are not leveraged to their full extent.

Along similar lines, we find that the cluster participants report a high level of belonging. However, this belonging is first and foremost of a formal nature and thus might have less impact on the capability building process than an emotions-based sense of belonging.

Interestingly, we find a strong capability of reconfiguration, i.e. that the cluster constitutes a resource pool for its members and that its activities are supportive to its members, as well as of networking, in the sense that the cluster is perceived as having an image. Both could be explained by a motivational and expectation building factor arising from the sudden increase in the cluster's resources through the channeling of financial funds and government-supported marketing. These dynamics are inherently different than those described in the co-evolutionary model. They are instead comparable to a one time shock to a system in an equilibrium. A second explanation for the image of the region might lie in a strong regional and national culture and pride, which the interviewees pointed at during the interviews.

5.2.2 Cluster BETA

5.2.2.1 Cluster context

Cluster BETA is a well recognized small cluster with a long tradition. Collaboration in the region is well established in the field of satellite navigation application development. At the time of this research, several regional associations were active in providing support to clustering and specifically to firms with regard to different aspects of satellite navigation application development. One of them has developed into the most prominent, heavily supporting the innovation capability development in the region by building on earlier associations, strong personal networks and the initiative of few individuals, allowing it to leverage a strong historical foundation of co-operation and strategic alignment. At the time of the empirical research, it established an increasingly strong formal cluster management role. However, in this chapter the term cluster denominates the overall community of aligned protagonists in the two regions. Any referrals to formal organizing mechanisms are made to the one focal association. All respondents perceive the existence of a cluster. About three quarters consider themselves cluster members, with the remaining quarter being public protagonists, who are not allowed to join the cluster. According to the respondents, co-operation within the cluster is stronger than competition. The cluster serves diverse industries with satellite navigation but the focus is on transportation and logistics by rail, road, and air. Largely, it focuses on niche markets. The majority of the relevant markets lie outside the cluster's regions. Overall, these findings confirm the upfront characterization of the cluster.

5.2.2.2 Cluster assets

Cluster BETA's asset profile is unbalanced (see Table 16). While it has strong technological assets and quite strong institutional assets, its reputational assets are more limited. Market and cluster structure assets are low, financial assets very limited.

The cluster comprises research institutes and universities as the biggest group, followed by SMEs. It also comprises start-ups, regional business associations, policy makers and regional development agencies, incubators and business service providers. Recently, large

enterprises have joined the cluster. Supporting policy makers and regional development agencies are located outside the cluster area. However, the cluster participants still perceive them as proximate and part of the cluster. While the cluster has a strong base of technological and complementary assets, its base of financial assets is weaker. The cluster does not comprise incubators, venture capitalists, business angels. One technology transfer centers exists and the number of SMEs is limited. The cluster participants perceive the connection to large enterprises in the cluster as advantageous, as they benefit from them as customers, supporters of pre-development, mass-market creators, and investors.

The cluster has a strong collaborative base in a small regional area, but with broad external contacts, contributing to a certain reputation. Overall, the cluster appears to offer a critical mass of diverse protagonists in a small geographical area. On average, the participants believe that 5-50 entities in the cluster are concerned with satellite navigation applications. The interviewees perceive the cluster to be extending across two NUTS 3 regions and strongly emphasize the positive effects of this proximity. Nonetheless, the cluster comprises additional regular contacts to specific players in other regions, among them large enterprises. These are perceived as strongly involved in the cluster's activities. The formal organization of the cluster is low, it largely builds on informal dynamics.

Table 16: Asset base - cluster BETA

Technological and complementary assets	
Financial assets	
Institutional assets	
Reputational assets	
Market structure assets	
Cluster structure assets	

5.2.2.3 Perceived cluster innovation capabilities and observation of routines

Cluster BETA builds on a very strong routine and capability profile (Figure 23). It is strongest in community creation and networking. In that, the cluster benefits from a common history and (informal) routines that have been in place for up to twenty years, though the cluster saw an increase of relevant routines over the past two years.

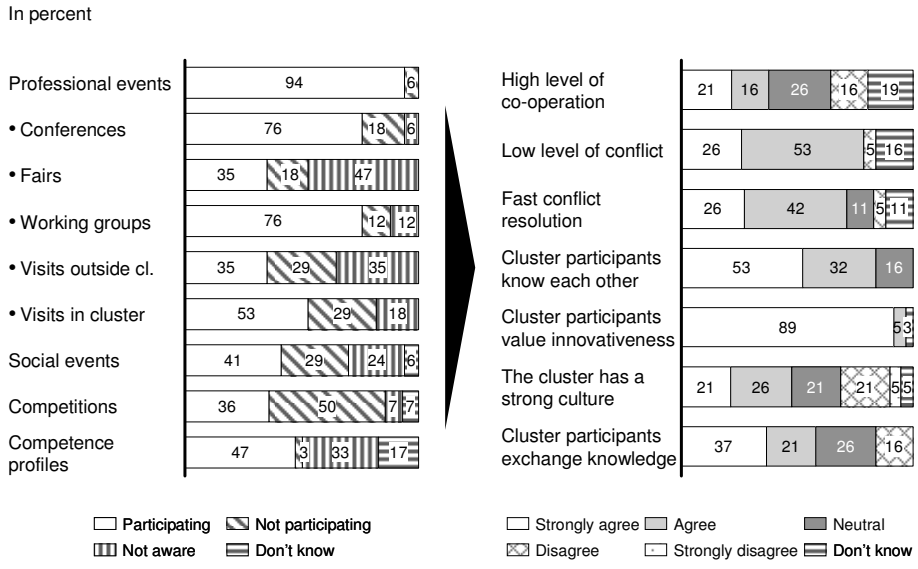
The cluster exposes a strong capability of community creation. 90% of the respondents strongly believe that the cluster members value innovativeness highly. More than 80% of them strongly agree or agree that the cluster participants know each other. Similarly, the cluster scores high in conflict management. Nearly 85% of the respondents strongly believe or believe that conflicts in the cluster are low. 70% agree or agree strongly that they are solved quickly. Similarly, 40% strongly agree and 20% of the respondents agree that knowledge is shared extensively. Interestingly, co-operation within the cluster is perceived as substantially easier than with outside partners by 20%, and as easier by another 15%. 20% of the interviewees strongly perceive a cluster culture, 25% perceive it.

The cluster's strong capability of community creation is reflected in a strong routine profile. Besides fairs, the cluster participants report the existence of all routines covered in the questionnaire. Furthermore, most of them are very well received. Conferences and work groups exist and are well received. Nearly 80% of the respondents visit them frequently. More than half of the respondents report that they regularly participate in visits to other cluster members. 40% of them mention that they participate in social events in the cluster, which are organized by different protagonists. 35% participate in organized visits to entities outside the cluster. Nearly 40% participate in business plan competitions, which are, however, not satellite navigation-specific and take place on the state or national level. Nearly half of the participants confirm that competence profiles of the cluster members exist. While the region itself does not have any fairs these take place in the vicinity. Some interviewees reported that the cluster associations have already adapted the profile of events where required.

The strong, personal and informal cluster networks might constitute a double-edged sword. On the one hand, several respondents emphasized that they do contribute

considerably to cluster learning and collaboration, especially pointing at the focused co-operation within the core cluster entity. On the other hand, they might manifest existing relationships at the expense of excluding new participants. The participant's perceptions confirm this. One group of participants feels very well informed, while the other perceives itself as not having access to non-confidential information about current cluster projects and the competence profiles of other members. Accordingly, the latter group of participants suggests establishing more, regular and open networking events. Others propose that the focal cluster organization takes a greater role in driving the communication within the cluster. Overall, some respondents suggested that the focal cluster organization could leverage the members more in order to increase the effectiveness of the cluster. Overall, the participants show quite high agreement on several routines as well as capability elements.

Figure 23: Capability of community building - mapping cluster BETA's routine and capability profile



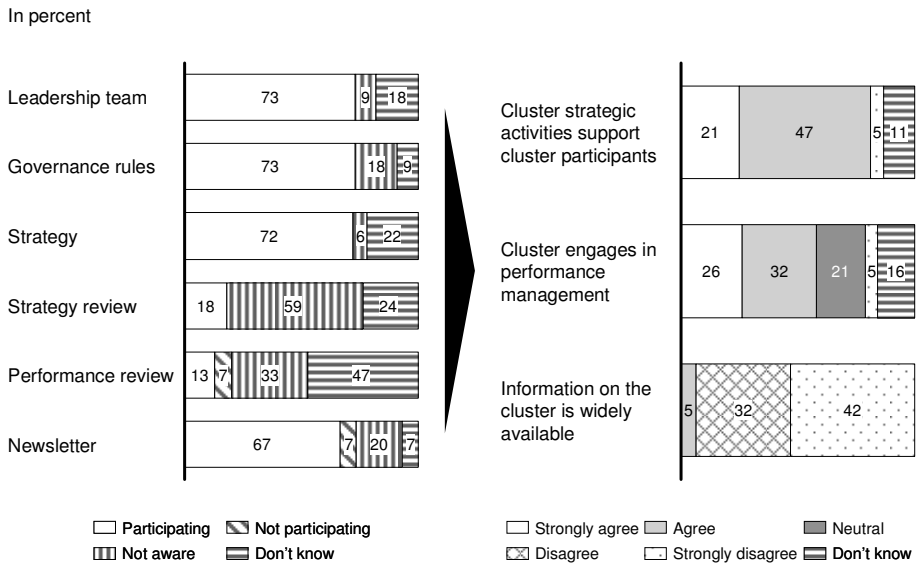
Cluster BETA presents itself quite strongly on the capability of strategic alignment (Figure 24). While the cluster comprises different associations, most interviewees refer to the focal association with regard to relevant routines. However, the respondents perceive the different associations in the cluster, especially the older ones, as being advantageous

for the cluster members. 20% of the respondents strongly believe and 47% of them believe that the cluster's strategic activities are supportive to the cluster's members. More than a quarter of them strongly and an additional third perceives the cluster as being managed for performance.

The cluster exhibits several of the probable relevant routines in its focal organization. More than 70% of the respondents agree that a leadership entity exists in the new, formal association. The rate of concordance with it is very high for this association and still high for the other associations. Governance rules are in place, which the respondents perceive to be professional. The respondents know the focal association's strategy very well and report that the association has developed into a regional competence mark. According to most participants, cluster strategy reviews do not (yet) take place. 60% of the interviewees do not believe in reviews, 25% do not know. With 13%, even fewer of them believe in cluster performance reviews. However, public funding for some of the associations requires reviews of some parameters. The respondents encourage introducing a regular review of widely communicated performance indicators as a component of performance-oriented management. Furthermore, they emphasize the need for sustainable business models for and across the different associations, especially in view of the limited availability of public funding.

The cluster is struggling with ensuring the information flow between established and new protagonists. Overall, more than 40% of the respondents strongly disagree that information on the cluster is hard to obtain and about one third disagree. Some interviewees expressed their level of disinformation about on the other associations and their inner workings. A representative of the policy makers indicated that a direct contact to the cluster substantially contributes to staying involved. Similarly, some interviewees who do not belong to the 'inner circle' expressed that they cannot follow the decision making process, which for them appeared to be impacted by network factors. Different groups disseminate newsletters defined by recipients. These appear to reach a large subgroup of the cluster participants, but not all of them. Nearly 70% read them regularly and 20% are unaware of their existence. Additionally, the cluster groups provide mailings, information briefs and websites of different protagonists. The participant's agreement on the routines is stronger than on the capability elements.

Figure 24: Capability of strategic alignment - mapping cluster BETA's routine and capability profile

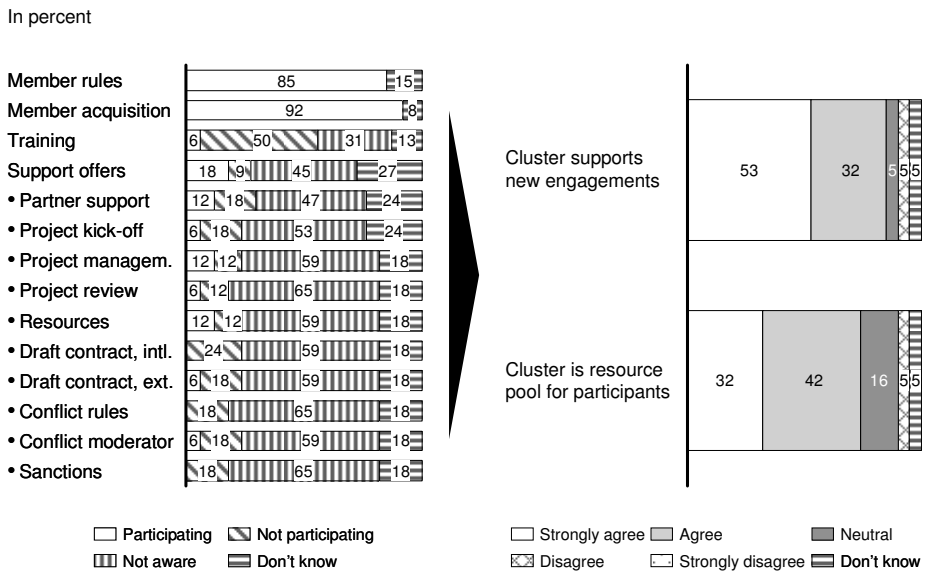


Overall, the respondents perceive the cluster as strong in reconfiguration (Figure 25). They respondents strongly emphasize the benefits provided by the cluster. Nearly 55% strongly agree and about a third agrees that the cluster renders engagements feasible that would not have been undertaken without it. A third strongly believes and more than 40% believe that the cluster is an asset pool for its members.

The cluster sustains several routines that might support the capability of reconfiguration. The focal association is more restrictive than the other associations. It has established membership rules which relate to the new participant's location, competence profile and the relative fit to the other participants. Additionally, more than 40% of the respondents believe that the focal association engages in member acquisition activities. Some encourage the cluster to even pursue new member acquisitions in a more strategic manner. The cluster provides several support offers to member co-operations. However these are largely informal. Accordingly, they provide very effective support for the members of the inner circle. In contrast, the participants outside it are very insecure about availability and are often not in a position to use it. Generally, the respondents would appreciate further support, especially with regard to new projects. Overall, only 20% of

the interviewees use the support offers in contrast to 10% who do not use them. 45% of the respondents do not believe in their availability, and more than a quarter of them do not feel in a position to answer this question. Training offers in the cluster do not find strong attention. More than 55% of the respondents are aware of them, but only about 5% visit them. Most participants do not believe that conflict rules and sanctions exist, underlining the informal basis of the cluster. However, several interviewees point towards the fact that these functions are often taken on by individuals in the cluster. The focal association is generally perceived to be a good conflict moderator. One of the associations supports the exchange and reconfiguration by an exchange of employees. The participants' responses conform strongly with regard to the routines and slightly less with regard to the capability elements.

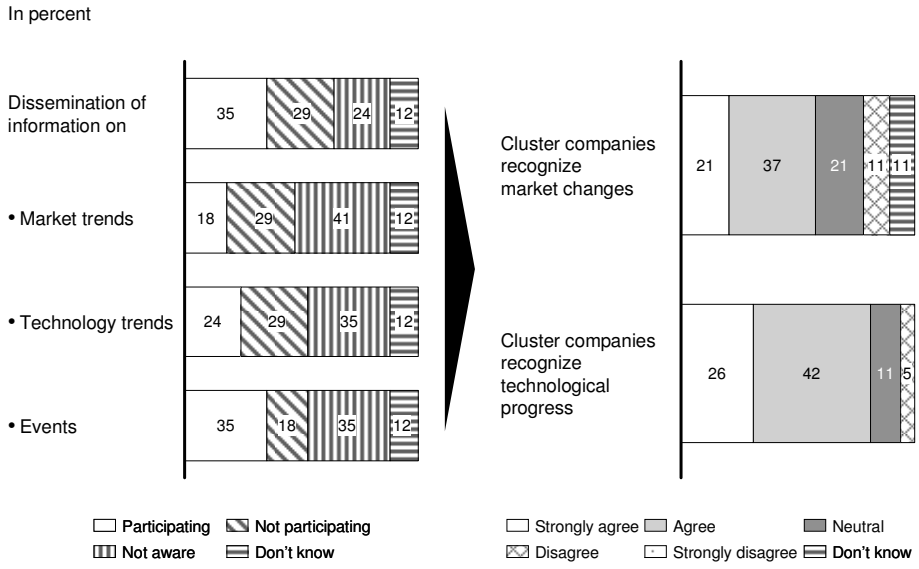
Figure 25: Capability of reconfiguration - mapping cluster BETA's routine and capability profile



Also, the interviewees perceive the cluster as strong in opportunity recognition (Figure 26). According to them, the cluster participants quickly perceive changes in their markets and, even more, their technologies. Different protagonists disseminate market, technology and event information. More than 20% of the respondents strongly support and 35% support this perception for market changes and 25%, respectively more than 40% support

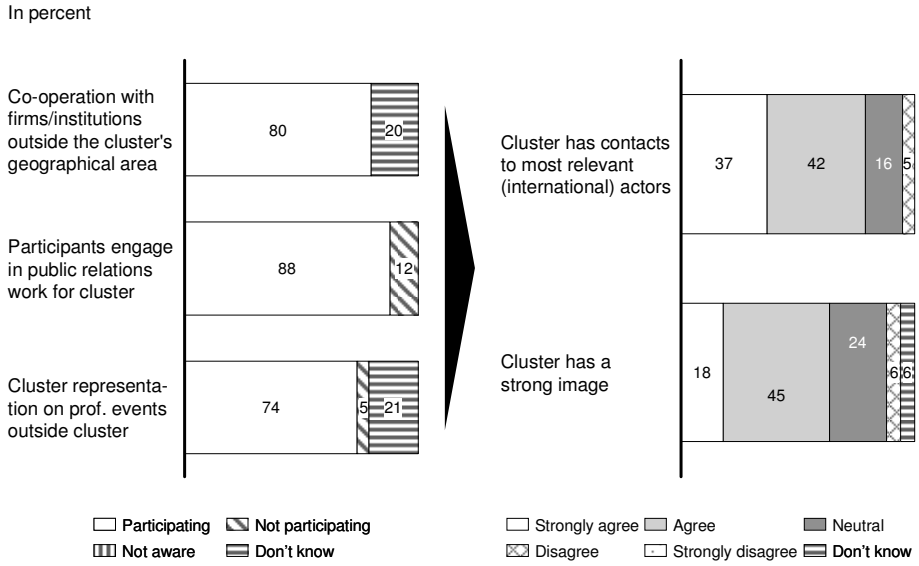
this for technology changes. Probably, routines support this capability. About 45% of the participants believe that information on market trends is disseminated in the cluster. In contrast, more than 40% disagree. Out of the 45% who perceive market trends as being disseminated, less than 20% use them. The respondents heavily encourage further dissemination of market intelligence. Some request the introduction of discussions of market trends in subgroups of interested cluster members. For technology trends, nearly a quarter believe in their dissemination, with a similar usage pattern. 55% of the respondents receive information on external events, 35% do not. At the same time, the respondents acknowledge the size of the task and the specific nature of the knowledge to be disseminated. For example, very specific technical know-how neither is of interest to all partners and not potentially shared, due to its sensitive nature. However, the cluster's role could well lie in pointing the different stakeholders to important contact persons and well as in reporting on general trends. The participants' neither show a strong agreement in their answers on the routines nor on the capability elements.

Figure 26: Capability of opportunity recognition - mapping cluster BETA's routine and capability profile



The respondents see the focal association as being especially effective in establishing new networks (Figure 27). More than 35% of the interviewees strongly and more than 40% support it. The cluster is perceived as having several contacts to the major national European, and global satellite navigation technology and application protagonists. Still, the interviewees encourage a further expansion of the efforts, especially at the international level. Nearly 20% of the respondents strongly agree and 45% of them agree that the cluster has an image. One of the associations primarily concentrates on regional brand building and is perceived to be successful in this endeavour. Also, the cluster is very active in disseminating information about itself. 88% of the participants state, that their firm/institution engages in public relations work for the general cluster. For some of them, these efforts could still be extended and improved. 80% agree that the cluster has external linkages. Some of the respondents make clear, that they see the cluster in a spokesman's role vis-à-vis policy makers. Furthermore, the external representation of the cluster is well organized. About 75% of the participants perceive the cluster as being represented in external events. Interestingly, it is a widely shared behavior to represent the associations on fairs and conferences in the same manner that the own entity is being represented. In several instances, the participants reach upfront agreement on who will represent the association on which event. Relevant information is then shared after the event. The level of the participants' agreement on routines is very high. They are less in agreement with regard to the capability elements.

Figure 27: Capability of networking - mapping cluster BETA's routine and capability profile



5.2.2.4 Perceived cluster innovativeness and performance

The respondents perceive the cluster as very innovative, which is not reflected in past economic performance (Figure 28). Generally, the respondents did not feel comfortable in estimating the development of performance indicators. In the following section, only absolute development will be reflected. For relative developments of indicators, 64% of the respondents or more answered with "don't know". The development of the GDP almost exposes a normal distribution between a deterioration of 1-5% with 5%, a relative constancy with 11%, an improvement of 1-5% with 21%, one of 5-10% with 16% and one above 10% with 5%. A third of the respondents perceived a slight increase in employment and half of them do not consider themselves in a position to answer this question. As for the European market share and the development of start-ups, about a quarter perceives a slight increase, with about 60% not knowing. About 20% perceived a strong increase in the number of (interdisciplinary) co-operations, with about 65% of the respondents not knowing. These co-operations focused largely on research. Market-oriented projects are limited in number.

Nearly 55% of the respondents strongly agree and more than a quarter agree that the cluster is innovative. For nearly 50% of the interviewees, the cluster members define new market trends and for about 75% they define technological progress. They translate market trends into new products for nearly 70% of the respondents and technological progress into new products for 65% of them. More than 45% perceive the cluster entities as reacting quickly to market change, nearly 60% as reacting quickly to technological progress. The participants show very low agreement with regard to their perception of the past development of economic indicators, but provide more conform answers on the perceived level of innovativeness.

The cluster's perceived innovativeness is roughly in line with the perceived past development of cluster BETA's performance indicators (Figure 28), as well as with its capability profile (Figure 29).

Figure 28: Innovativeness and past performance – Mapping cluster BETA's participants' perceptions

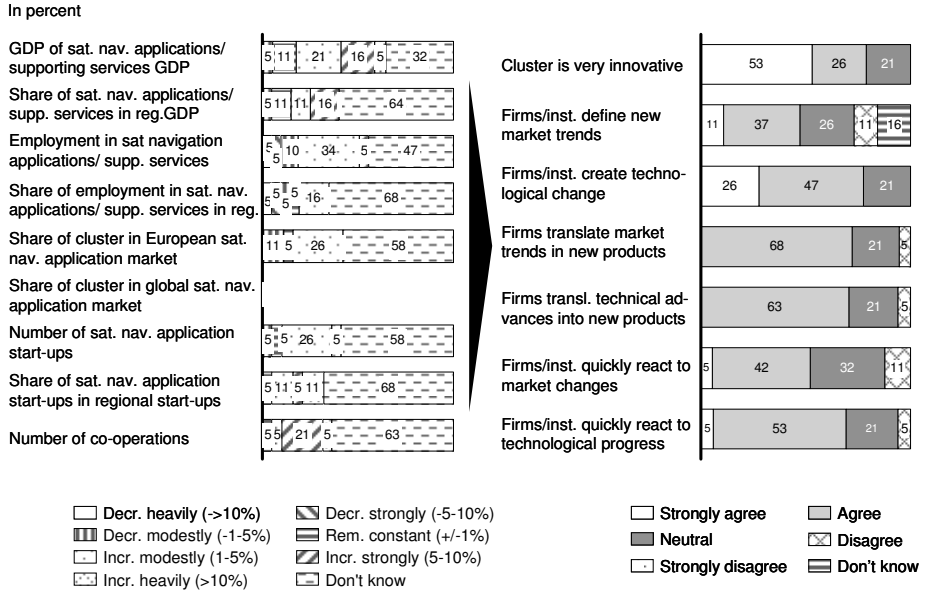
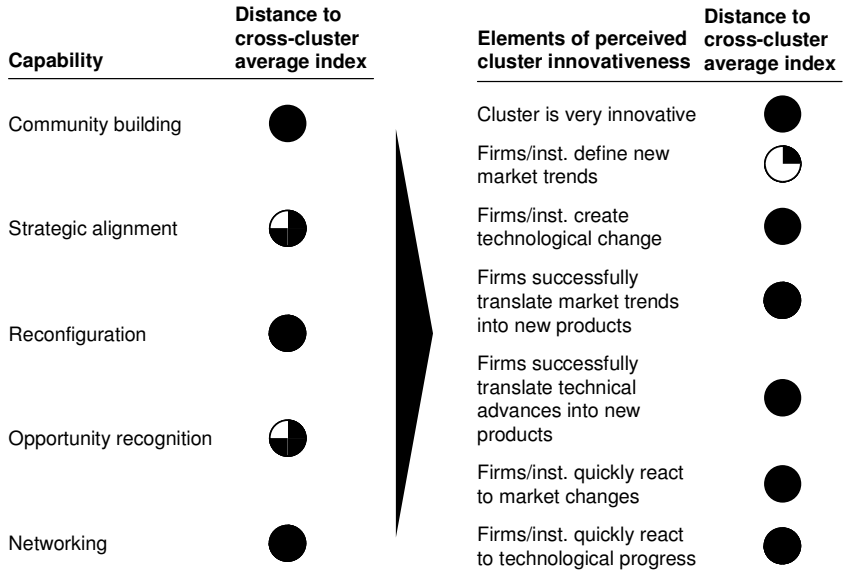


Figure 29: Mapping cluster capability profiles with perceived innovativeness - cluster BETA



5.2.2.5 Perceived cluster strengths and weaknesses

The respondents strongly appreciate the clear strategic focus as well as the strong alignment with the regional asset base and established competence base. The strong personal networks and the resulting high level of informality in the cluster are perceived as a large plus by the members of the inner circle, as is the cluster leadership team. Furthermore, the strong support of the state policy makers and the success in regional brand building is acknowledged. According to the cluster managers, innovativeness is mostly supported by the focus topic, the political impact of the association, the innovation ability of the participating firms, the cluster's strategic direction and the high level of awareness. The performance of the cluster depends on the facts that all members participate, on the generation of new ideas and the participant's networking. The pre-eminent position in the state, country and Europe, the clear profile, the expertise, regional, national, and international networks, public relations work and political networking constitute the cluster's strength.

The cluster faces challenges in its research focus, reliance on public funding, and the variety of protagonists active in the cluster. Furthermore, European legislation heavily influenced the cluster's strategic focus is heavily influenced by European legislation. While the strong research competence of the cluster constitutes an advantage for several cluster members, it also implies a relative lack on the market side. Along these lines, some respondents indicate that the entrepreneurial spirit is limited. Additionally, the interviewees point to the reliance of several of the associations on public funding and the inadequacy of the regional infrastructure for conferences or receiving guests. Although the region is subject to a diverse set of supporting institutions, their alignment is limited. Some respondents encourage a common entry point for interested partners or investors, providing them with the relevant contacts. The participants consider public project funding relevant, with some participants encouraging it. In some instances, co-operations across different entity groups are complicated by the diverse working modes and tempos of these entities. Especially regional policy makers are perceived as not being aware of the high level of potential offered by the cluster and as providing limited support to it – especially with regard to bureaucratic processes. In face of the variety of protagonists, several respondents encourage their stronger alignment and integration in the sense of an overall cluster, developing a division of tasks and clear profiles. Also in the eyes of the cluster managers, the dependency on environmental conditions and the early status of projects pose a danger to the cluster. Overall, the cluster participants and the cluster managers agree that the cluster is encouraged to enhance its public relations work, acquire new members in a strategic manner, to levy the level of competencies, collect and communicate performance indicators. The associations could emphasize the involvement of all participants, focusing on personal contact.

5.2.2.6 Implications for a dynamic capability view on clusters and discussion of findings

The findings in cluster BETA generally support the application of the dynamic capability model to clusters. The cluster builds on a profound historic base as an established, informal and largely co-operative cluster. At the same time, it builds on strong technological competencies and thus shows both a strong routine and capability profile. Interestingly, the case confirms the relationship between a strong capability profile and a strong perception of innovativeness. However, it does not support the translation of (perceived) innovativeness into economic performance. There are three possible explanations for this.

The first relates to the cluster's focus. As a heavily research- and niche market-oriented cluster, the cluster's projects probably do not have an economic impact that would be comparable to that of large enterprises serving mass markets. The second is timing. The strategic focus of the cluster is heavily impacted by European legislation and relies on GALILEO's launch. Both are not yet in place. Accordingly, an economic impact cannot yet be expected. At the same time, the lack of technology-transfer entities and financing in the cluster delays market launches and thus further hampers growth.

Cluster growth and professionalization recently led to a formalization of the cluster in an association. So far, the cluster strongly benefitted from a long-standing regional tradition of co-operation. Most respondents express a high level of emotional belonging, engagement and alignment, as well as their support to the cluster. While the tradition of regional communication and cooperation enhances informal work sharing and support mechanisms, some new members struggle with their integration. The long-standing routines might have created substantial sub-networks that are closed to newcomers. The newly introduced routines might support their integration, which also is one of the major requests by the participants , in combination with an extension of the cluster's routines on strategic alignment and networking.

5.2.3 Cluster GAMMA

5.2.3.1 Cluster context

Cluster GAMMA is characterized by a variety of different, business-driven associations and low levels of co-operation. Due to a different national use of the term cluster, the participants struggled with the cluster definition underlying this study. Frequently, they referred to their business associations as the cluster. Independently of the clarification by the interviewers, this might introduce biases with regard to the cluster's value proposition, its organization and the perception of a cluster overall. Additionally, the interviewers shared an impression of a positive response bias. As for all clusters, the following paragraphs do refer to the entire cluster GAMMA in contrast to just subareas of co-operation. The primarily application area-centered associations are mostly very young or still in the process of forming. They (potentially) act as project pools. None of these entities is strong, diverse or recognized enough to qualify as a focal entity. However, nearly 90% of the respondents believe that a cluster exists. Also, nearly 90% of the respondents feel as cluster members. The cluster is characterized by an intense competition and low trust, especially among firms of all sizes. According to the respondents, not even individual partners in bilateral relationships can build on more than ten years of co-operation experience. Co-operations with external, international partners were more likely than internal co-operations. Often, external partners were involved instead. The respondents generally report a low level of co-operation among science and industry as well as public authorities and industry. However, several of the associations intend to extend their membership criteria or strengthen the ties to other groups in other ways. The cluster targets diverse industries with satellite navigation. The most prominent are transportation by rail and road as well as fire fighting. Europe is the cluster's core market. Overall, these findings confirm the upfront characterization of the cluster.

5.2.3.2 Cluster assets

Cluster GAMMA is a cluster in a large geographical area with profound technological and some complementary assets (Table 17). Inferring from the cluster's participant base, it probably faces limited financial and institutional assets. The cluster's associations comprise SMEs, start-ups, research institutes and universities, incubators, regional business associations, policy makers and regional development agencies, and business service providers. Technological assets ground in research centers and highly specialized universities. The respondents perceive public authorities to be supporting the different associations. Large enterprises, venture capitalists and technology transfer centers are located in the area, but not members of the associations. While the potential cluster participants are co-located in one area and focus on the same technology, their level of alignment appears very low overall but strong within small subunits. The participants largely refer to these subunits as clusters, though following the terminology applied in this thesis they would rather be qualified as business associations. Accordingly, the respondents often indicate that they belong to several "clusters" and perceive any number between three and thirty participants in the cluster. Also in face of the archival data, this number seems to be biased by the mental anchor in associations. Generally, the links among them and the associations are weak. The cluster does not comprise business angels and regional business associations. The low level of trust and co-operation in the cluster as well as limited linkages among the cluster members and some of the business support providers indicate a low level of institutional assets. For example, one respondent points at "limited trust within the region; the region is rather characterized by strong competition". The cluster has a background in space, but the associations rather ground themselves in the different application domains. According to the respondents, the cluster extends across 14 NUTS 3 regions, i.e. the entire country. However, one NUTS 3 region forms the focal area. The cluster itself is not organized at all, the level of organization within the associations limited in most cases. The different participants and to some extent the organizations have external linkages.

Table 17: Asset base - cluster GAMMA

Technological and complementary assets	●
Financial assets	○
Institutional assets	◔
Reputational assets	◑
Market structure assets	◑
Cluster structure assets	○

5.2.3.3 Perceived cluster innovation capabilities and observation of routines

Cluster GAMMA has a strong capability and routine profile. This perception, however, is biased by the interviewees' mental reference to their associations instead of the overall cluster. Additionally, the cluster interviewees exhibited a substantial bias towards high scores to structured answers, which did not find reflection in their unstructured and more informal answers and comments. This is partially due to the mental anchoring in the associations rather than the clusters. While 95% of the participants believe that conflicts barely occur in the cluster, they also comment that co-operation is easier in the association, not the region and that they prefer to extend co-operation agreements to outside the country, given the strong competition, unreliability, and non-disclosure of information and unfair play of and by national partners. The following paragraphs reflect both, their structured and unstructured responses.

The cluster exhibits a strong capability of community creation (Figure 30). About 20% of the respondents strongly and an additional 70% agree that the cluster participants value innovativeness highly. 85% believe or strongly believe that the cluster members know each other. For 95% of the interviewees, the cluster has a low propensity for conflicts, which 85% perceive as being solved quickly. However, only about 10% of the respondents strongly believe and 35% believe that knowledge is extensively being shared.

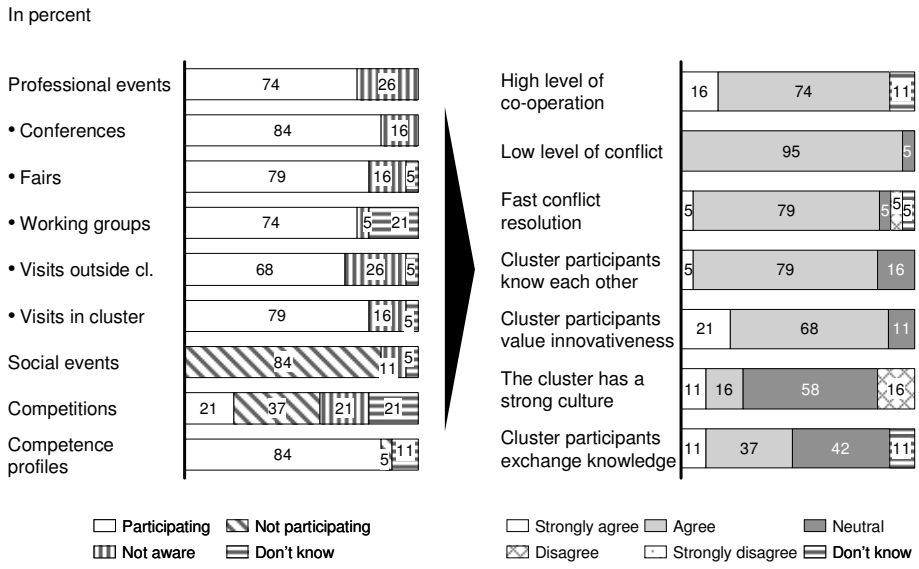
Even less interviewees report a common culture. Only 10% strongly believe and 15% believe that the cluster has a common culture. Reflecting the respondents' bias towards their associations instead of the cluster in its entirety, their responses on the knowledge exchange in the cluster and a missing common culture are shocking and cannot help to expalin the strong innovativeness assigned to the associations. If the prior responses related more to the cluster in its entirety, they are not at all consistent with the indications of low trust and a weak co-operation track record.

The broad set of routines that potentially contribute to the capability of community creation has largely been created recently. These routines find significant attention from the cluster members. About 85% of the respondents agree that conferences related to satellite navigation application development exist and indicate that they generally visit them. For fairs, the share is at about 79%. Many respondents include project meetings and general association meetings under work groups. 75% of them participate in these. For organized visits outside the cluster the share is at nearly 70%, and 80% for visits within the cluster. Social events have no relevance in the cluster. 85% of the respondents indicate that they do not visit them. The primary reason for visiting them would lie in the opportunity for informal networking, rather than the content of the event itself. Information on business plan competitions on satellite navigation reaches 60% of them, with about 20% participating. 85% believe in the existence of participant competence profiles, though these appear to be limited to the associations. Generally, the respondents feel that information is primarily shared in an informal manner and within the different associations or projects. Although the rates of participation in events are already high, the interviewees encourage greater information dissemination at events, as well as on the different associations in the cluster, their membership requirements as well as the players active in the field of satellite navigation. Additionally, some emphasized the closed character of most of the events, which thus do not naturally encourage networking in the cluster. Additionally, there appear to be a variety of small events, which do reduce the opportunity of cluster participants to meet in them.

Overall, the associations find strong formal support by their participants. 10% of the respondents strongly and an additional 75% believe that the cluster's strategic activities are supportive of its members. About 25% of the participants strongly and 55% of them

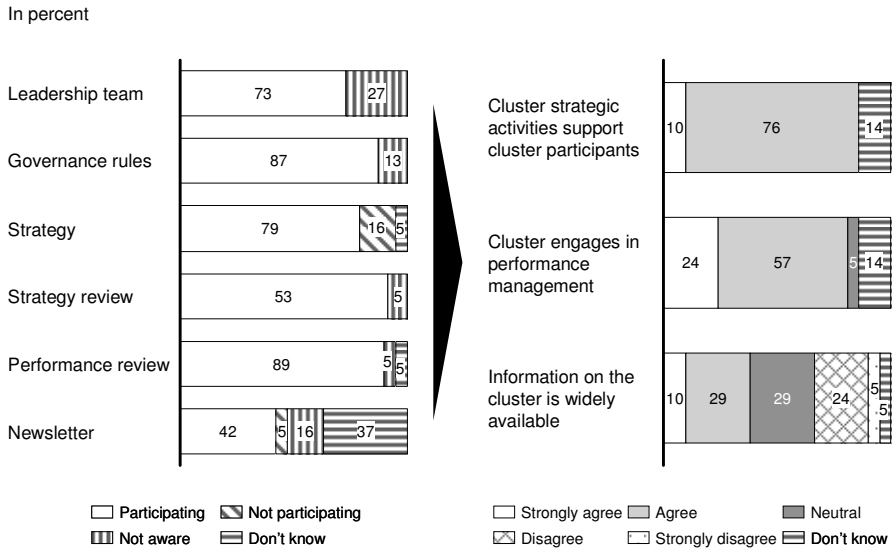
report that the cluster is being managed for performance. At the same time, the respondents mentioned that the direction of some of the associations has not been fully defined, which results in ongoing discussions among their members. Some interviewees point to a low level of professionalism and unsystematic management processes. Elements that were repeatedly pointed out include intellectual property regulations, limited support to open the companies to co-operations within the region, inadequate administrative processes, including the lack of a central point of contact, and limited availability of information in the cluster. Only about a third of the cluster members feel that information on the cluster is easy to obtain. As no overarching cluster organization exists, these responses further build the evidence that the respondents were concerned with the business associations, not the cluster in its entirety. Furthermore, several interviewees also point to the limited size of the association and their focus on specific participant groups instead of cross-functional integration. The participants' agreement on both, the routines and the capability elements is very strong.

Figure 30: Capability of community building - mapping cluster GAMMA's routine and capability profile



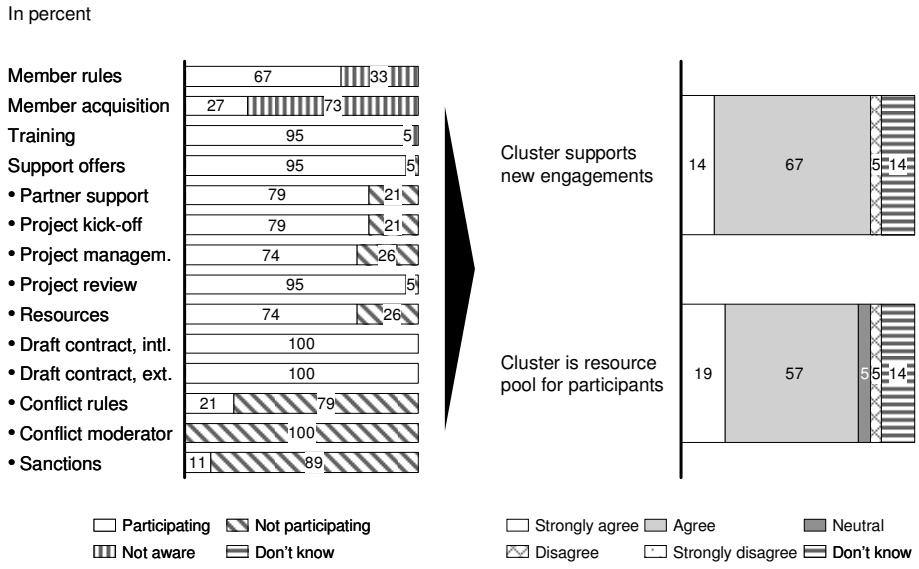
The interviewees report the existence of a variety of the potentially relevant routines for strategic alignment (Figure 31). Interestingly, side-comments during the interviews suggested that the level of alignment within the associations was not as high as the formal responses indicate. Formally, about 75% of the respondents agree on the existence of leadership teams in their associations. About 85% report that governance rules exist. According to 95% of them, strategies have been defined. 80% of them strongly agree with these strategies. The associations also exhibit review routines. 95% of the interviewees perceive regular strategy and 90% regular performance reviews. Apparently, newsletters do not fulfil the need for information. While 42% of the respondents are aware of newsletters and partially read them and while they report knowledge exchange in the associations, they still do not perceive information in the cluster as being easily accessible. The respondents' bias towards answering with regard to their associations might explain the strong results. Of course, aligning a limited number of similar entities is substantially easier than aligning a large set of actors with very different profiles and aspirations. The weakness of cluster GAMMA shows in the dissemination of information, where a large set of respondents explicitly referred to the overall cluster and indicated substantial gaps. The participants' responses on routines and capability elements are very conform.

Figure 31: Capability of strategic alignment - mapping cluster GAMMA's routine and capability profile



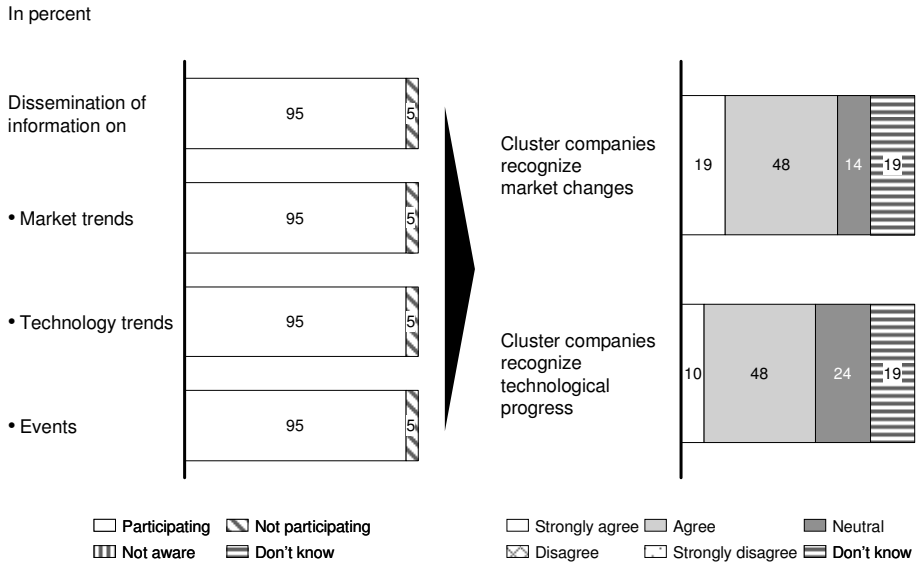
The respondents perceive the cluster as able to reconfigure (Figure 32). 15% of them strongly and about 65% agree that the cluster encourages new engagements that else would not have been possible. However, about 20% strongly and more than 55% perceive the cluster to be an asset pool. The potentially supporting routines provide a mixed picture. According to 70% of the participants, the associations have established membership rules. Only a quarter of them are aware of member acquisition activities. In contrast, the support offers are largely informal and limited to the associations. A minimum of 74% of the interviewees agree that the cluster grants support to the identification, start, management and revision of projects, as well as facilitates the access to external resources and provides trainings and contract guidelines for internal and external co-operations. Only a minimal share of them agrees that the cluster has established a moderator and sanctions in case of misbehavior. Again, the participants' answers show a high level of conformity.

Figure 32: Capability of reconfiguration - mapping cluster GAMMA's routine and capability profile



For the interviewees, cluster GAMMA is strong in opportunity recognition (Figure 33). The cluster entities appear to have a comparative advantage in recognizing market versus technology trends. While for both, about half of them believe that they quickly recognize trends, in the first case about 20% also strongly believe so, compared to only 10% in the latter. 95% of the respondents agree that information on market and technology trends as well as external events is disseminated within the associations. The process appears to be rather informal. The level of conformity of the participants' answers is very high for routines, but less prominent for the capability profiles.

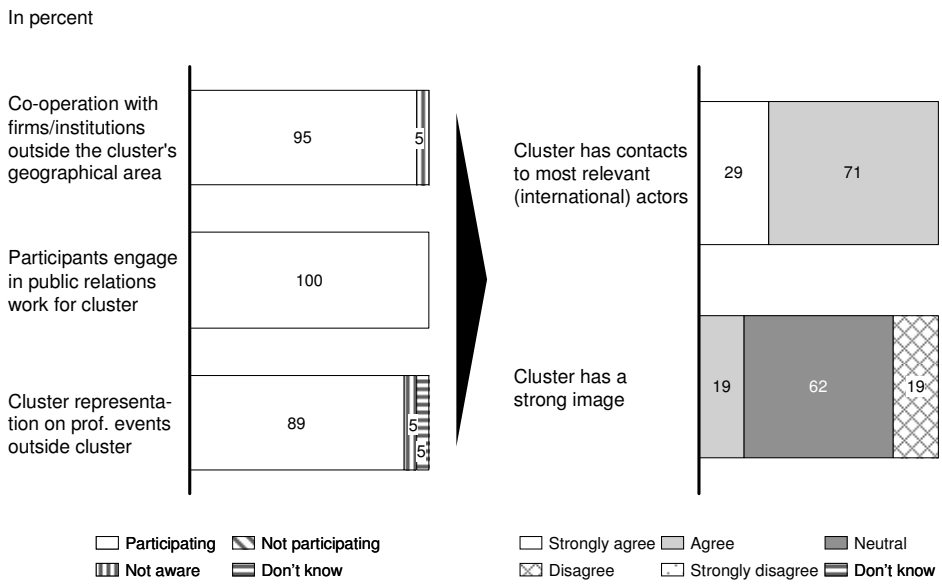
Figure 33: Capability of opportunity recognition - mapping cluster GAMMA's routine and capability profile



For the respondents, cluster GAMMA is very strong in the capability of networking, building on strong routines (Figure 34). Cluster GAMMA has several contacts to the major national European, and global satellite navigation technology and application protagonists. 30% of them strongly and more than 70% support this. This is reflected in a wide-spread perception of regular external contacts, as confirmed by 95% of the interviewees. This might be supported by the national climate of distrust and the orientation towards European markets. According to nearly 90% of the respondents, the cluster is represented at external events. In contrast, only 20% agree that the cluster has

an image. For this, the finding that all participants engage in public relations work for their associations, but none in work for the cluster might provide an explanation. The participants' answers on the routines and capability elements are very conform.

Figure 34: Capability of networking - mapping cluster GAMMA's routine and capability profile



5.2.3.4 Perceived cluster innovativeness and performance

Cluster GAMMA shows a stronger performance in perceived innovativeness than in the development of economic performance indicators. While about 45% of the respondents perceive a modest increase of relative and absolute GDP, employment, and European market share, the bias for all of these indicators tends towards stagnancy. In contrast, the global market share is perceived to be stagnant with a bias towards a modest improvement. Similarly, a quarter of the respondents perceive the absolute development of start-ups as being stagnant with about a quarter each perceiving a modest or strong increase. The relative development is slightly better. However, the number of co-operations has strongly increased, with a bias towards a heavy increase. Overall, the respondents were very comfortable with estimating the development of performance indicators. Generally, no more than 20% indicated that they did not know.

Overall, the cluster is perceived as being innovative with nearly 20% of the respondents strongly agreeing and more than 70% agreeing. About three quarters of the interviewees agree or agree strongly that the cluster's entities define new market trends. About the share of them believes that they translate market trends into new products. For 85% of them, the cluster's entities define technological progress and for 80%, they translate that into new products. More than 60% perceive the cluster entities as reacting quickly to market change, and more than 65% believe that they react quickly to technological progress.

In contrast to the high levels of agreement with regard to routine profiles, the participants agree less on the past development of economic indicators. The level of perceived cluster innovativeness is much higher then the perceived past development of indicators (Figure 35). However, the participants very much agree on the cluster's level of innovativeness, which again very much aligns with cluster BETA's capability profile (Figure 36).

Figure 35: Innovativeness and past performance – Mapping cluster GAMMA's participants' perceptions

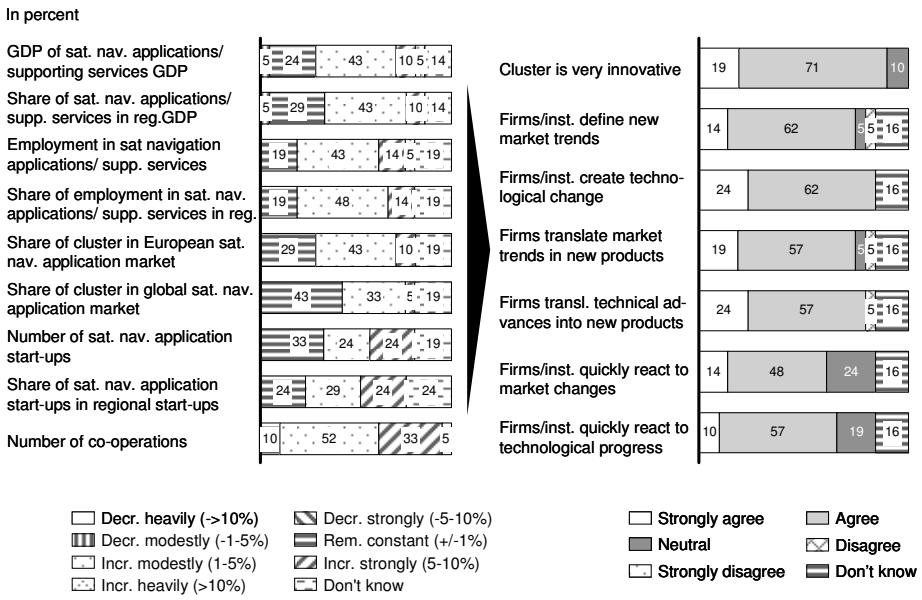
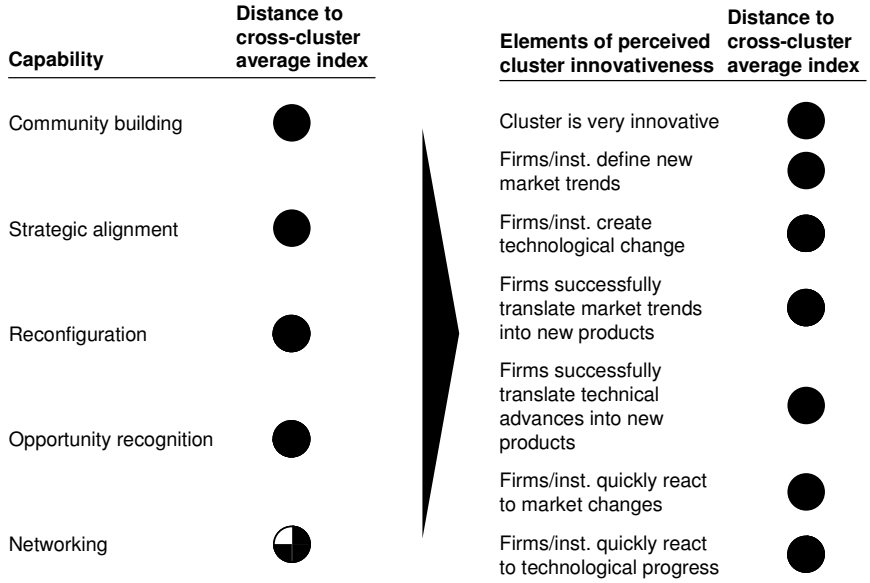


Figure 36: Mapping cluster capability profiles with perceived innovativeness - cluster GAMMA



5.2.3.5 Perceived cluster strengths and weaknesses

According to all respondents, the cluster benefits from the region's position in Europe, a broad composition of protagonists, a strong technological competency and small associations as the kernels of co-operation. Most associations have a specific application focus. The cluster is perceived as more innovative as is reflected in the estimated development of the performance indicators.

For the managers, the danger to the cluster lies in its limited financial base and the lack of a clear specialization of some entities. Additionally, they strongly encourage international embedding, both for getting known more and for enhancing the quality of the products

The participants raised a variety of issues. Among them are the association's low level of professionalism, their slow progress in developing new applications and the limited base of projects. Additionally, property rights issues and limited financing and formal public funding in the region pose additional risks. The respondents encouraged strengthening the weak co-operation base between science and industry and the limited trust base among

enterprises. They furthermore encourage all of the existing associations to professionalize and grow, also cross-functionally, to define their direction, engage more in internal as well as external communication and to extend their contact base. Additionally, the interviewees demand public support with regard to finance, eased administrative processes, including at the European level, to the commercialization of products, public relations work for the region as a satellite navigation location and, more generally, to information dissemination. Co-operation with external protagonists is very attractive to the respondents and thus also encouraged. Some interviewees also demand support measures specific to SME competitiveness.

5.2.3.6 Implications for a dynamic capability view on clusters and discussion of findings

The case of cluster GAMMA supports the application of the dynamic capability model to clusters. However, a correction for strong biases is required, especially given that the cluster is in a very early stage of its development. One of these biases is a strong mental anchor in small subgroups instead of the cluster, the other a cultural bias to give positive answers, which was reported by all interviewers. In general, the cluster is at a very early stage in its development and lacks financial assets and public support. We assume that a consistent and strong focus by the respondents on the cluster instead of the associations would have resulted in a much weaker routine and capability profile. The respondents provide implicit reads on this by referring to the low level of trust and co-operation as well as the limited information flow in the region.

In cluster GAMMA´s subgroups, the participants perceive strong routines and strong capabilities. This strong capability profile coincides with strong perceived innovativeness. What we did not find is a the translation of the perceived innovativeness into strong performance. This might be due to two reasons. One is the associations' as well as the cluster's limited age. While the associations were able to set up routines for small networks and build first capabilities in these networks that create the perception of high innovativeness, they have not yet launched products and miss the critical mass for substantial market impact. The second is their limited size. Even if the associations had prior projects in the field of satellite navigation applications, these would probably not

have achieved a scale of regional or even national economic impact. Along these lines, the cluster participants' support the relevancy of routines by encouraging the introduction of new and the enhancement of existing routines from the list.

The respondents indicate a level of trust and co-operation as well as the limited information flow in the region. Three reasons can explain this. First, traditionally only few selected protagonists cooperated in small projects. Beyond that, the level of co-operation experience is limited. The second reason is the low level of trust between enterprises and firms and research institutions. While the cluster associations obtain strong support from their members, these members also provide a variety of ideas on how to improve the cluster. These largely relate to improved professionalism of the associations, enhanced community building, alliance and reputation building for the cluster, and enhanced information dissemination. Thirdly, property rights agreements are reported as missing.

5.2.4 Cluster DELTA

5.2.4.1 Cluster context

Cluster DELTA is in the process of forming. It builds on a variety of small protagonists and serves as a broad spectrum of application domains. Only about 45% of the respondents believe that a cluster exists and perceive themselves to be members. As a result, they often referred to one of a variety of diverse initiatives, even within which the protagonists barely co-operate. As one respondent puts it, companies in practice are reluctant to co-operate. Either, these aim to support the regional development in the field of satellite navigation or constitute business associations working in specific application domains. Additionally, largely SMEs founded a couple of associations. These mostly are very young, small and in the process of forming and show a low level of involvement of public protagonists. The earliest association came into existence in 2003 with a very limited participant base. However, none of these initiatives or associations have found broad enough recognition to be labeled a focal entity. In some instances, the participants referred to an incubator or to regular large business co-operations as clusters. Where required, beyond the clarifications during the interviews, the results were corrected for those. The term cluster denominates the entirety of satellite navigation protagonists in the region in most cases. The interviewees' mental anchor in their associations might create some biases. The cluster faces challenges in that the relationships among the different entities are extremely limited. Additionally, some respondents perceive public funding schemes as creating unfair competition. Furthermore, the cluster's institutional capital appears weak. Several respondents encourage a more proactive behavior on the side of public protagonists, as well as further support of the cluster in the form of additional funding, an effort to ease the bureaucratic burden associated with municipal processes, further flexibility and speed in decision making and more transparent decision making processes. The industries targeted with satellite navigation are very diverse, including transportation in the air, on water and the road, education, health & social, agriculture, investigation & security, pipeline, media, public administration and defense, chemicals. Nonetheless, many respondents are insecure about the existence and potential size of

satellite navigation application markets. Overall, these findings confirm the upfront characterization of the cluster.

5.2.4.2 Cluster assets

According to the respondents, cluster DELTA has a weak asset base, if not taking strong technological assets into account (Table 18). The different associations within the cluster region comprise SMEs, start-ups, large enterprises, research institutes and universities, incubators, regional business associations, technology transfer agencies, and business service providers. Policy makers and regional development agencies are supporting a selection of them. The region does not have any venture capitalists or business angels and thus likely exposes a weakness in financial assets. The respondents encourage further support to start-ups and SMEs, for the former groups especially from large enterprises. National and European research centers might bring some technological competency with regard to satellite navigation to the region. However, some respondents question this. The cluster builds on both, a space tradition as well as an orientation towards a variety of application domains. Cluster DELTA extends across six NUTS 3 regions, with one NUTS 3 region clearly crystallizing as the focal area. However, the number of participants is limited. The respondents report four to thirty-five cluster participants. The cluster itself is not organized, but the different associations are to some extent. They, but even more the different large players, also hold the external contacts.

Table 18: Asset base - cluster DELTA

Technological and complementary assets	●
Financial assets	○
Institutional assets	◔
Reputational assets	◑
Market structure assets	◔
Cluster structure assets	○

5.2.4.3 Perceived cluster innovation capabilities and observation of routines

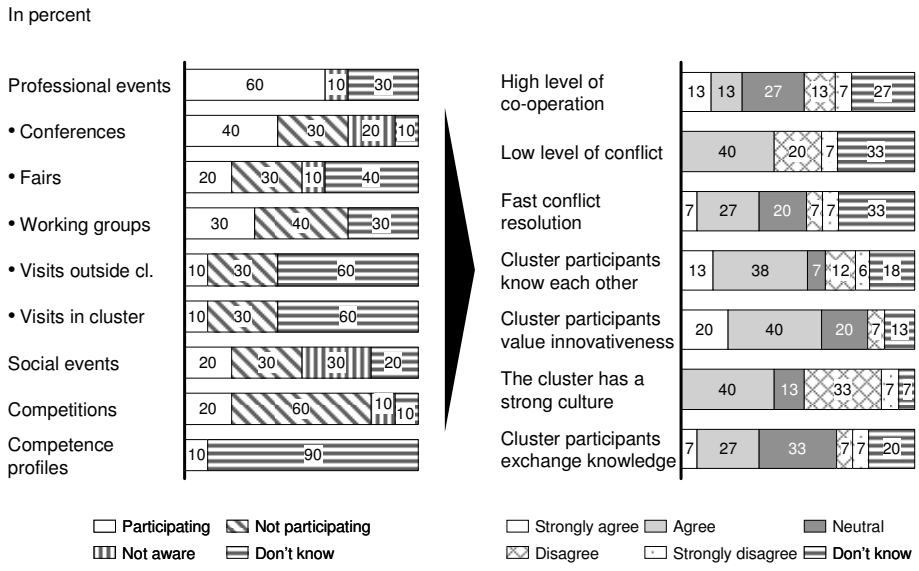
The cluster exposes weak capabilities of community building, strategic alignment and networking and strong capabilities of reinvention and opportunity recognition.

The cluster's capability for community creation is weak, building on a weak routine profile, especially when taking routine quality into account (Figure 37). Only about 20% of the respondents strongly and 40% agree that the cluster participants value innovativeness highly. Furthermore, only 13% strongly and about 40% believe that the cluster members know each other. For about 40% of them, the conflict propensity of the cluster is low, with an additional third not knowing how to respond. However, only about a third perceives conflicts as being solved quickly. At the same time some interviewees point not only to the cluster members' reluctance to co-operate, but also to conflicts among space and application players as well as among (semi-)public entities and companies in obtaining funding. They encourage public protagonists to support high-tech industries proximate to applications rather than the space industry. It appears that the protagonists try to avoid new co-operations in order to avoid conflicts. Once conflicts occur, the cluster appears not to possess routines for solving it. Fitting into this picture, the knowledge exchange in the cluster is limited. Only 30% of the respondents believe in extensive knowledge sharing in the cluster. Similarly, only 40% believe that the cluster has a common culture.

Similarly, the cluster barely exposes any satellite navigation specific routines that might support capability building. Often, the respondents rather refer to other types of events in the context of which they were asked to present, such as technology events, market-centric events, for example focusing on tourism or space, or innovation events in the context of EU-spnsored programs. The protagonists' limited participation in these events aggravates this. Out of 70% of the respondents that are aware of conferences with some relation to satellite navigation, only 40% visit them. Half of the interviewees are aware of fairs with only 20% participating in them. Out of the respondents, only 60% know of work groups, which 30% of them visit. Similarly, only 40% of the respondents are aware of organized visits within and outside the cluster, with only 10% taking part in them. A fifth of the respondents visit social events. The interviewees indicated that the initiatives

and associations form the major platform for information exchange. Nonetheless, several of them express strong interest in regular cluster events, social networking opportunities and in creating application-oriented co-operation projects in the cluster. They encourage increasing the information transparency on regional events and organizing more satellite navigation-specific professional and social events. Interestingly, they also perceive the level of regional awareness of satellite navigation applications and their potential to be low. For countering this, they encourage the introduction of further awareness-creating mechanisms as well as the establishment of a small central entity that would support the cluster and its different initiatives. The participants provide a very diverse picture of the routines, but largely agree within the different elements. This agreement is less with regard to the capability elements. Especially with regard to the routines the participants' show high levels of insecurity with regard to several routines.

Figure 37: Capability of community building - mapping cluster DELTA's routine and capability profile

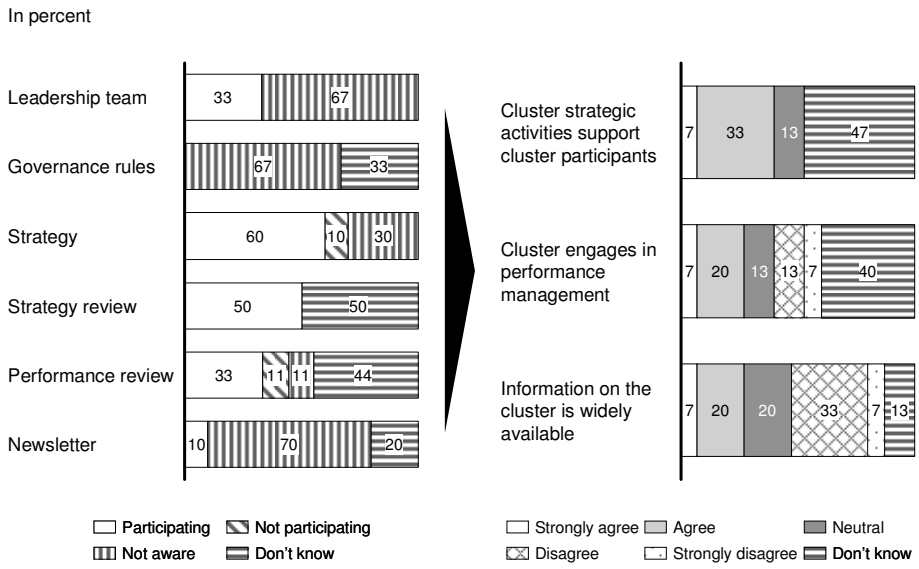


The cluster does not expose a strong capability of strategic alignment. Again, this partially links to a weak routine profile (Figure 38), as this is largely due to the multiplicity of disconnected initiatives and their limited age. Overall, the respondents perceive the cluster as somewhat benefiting them. More than 5% of the respondents

strongly and a third believe that the cluster's strategic activities are supportive to the cluster's members. Only 5% of them strongly and 20% support the perception that the cluster is being managed for performance. About 35% of the interviewees believe that information is available on the cluster. However, alignment requires, first of all, the perception of a cluster and secondly a process of collective decision making or at least communication from an entity generally accepted as representing the cluster. Cluster DELTA is missing both of these features. However, the respondents' mental anchoring in their associations produces the positive perception of their impact for their members. The respondents do not provide significant support to the perception, that the cluster is managed in a performance-oriented manner. This might be an indication of their age.

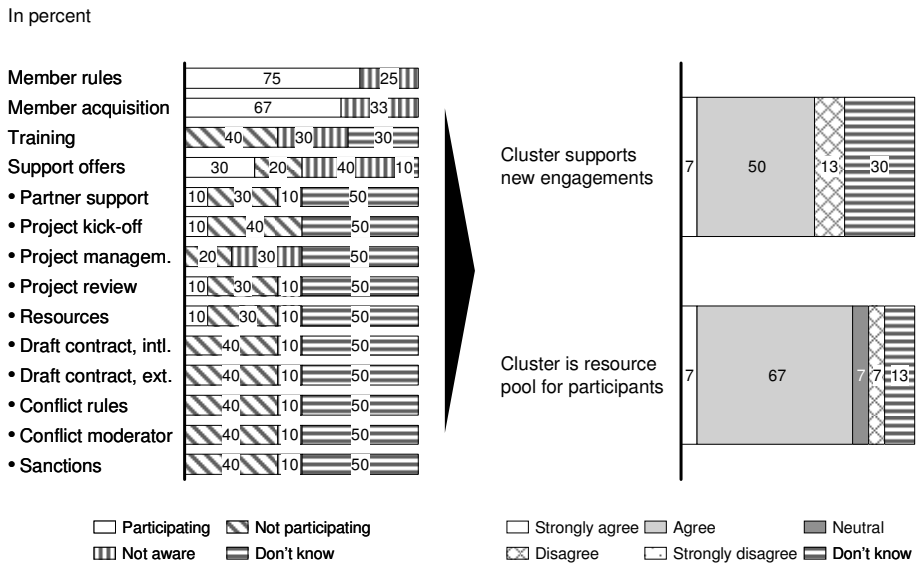
Similarly, few of the routines that might support the capability of strategic alignment exist in the cluster. Due to the age of the cluster's associations, only one third of the respondents agree that leadership teams exist and none believe that governance rules are established. So far, the management of the associations is largely informal. According to 70% of the interviewees, a strategy is defined. In that, however, they refer to the unaligned strategies of a variety of different protagonists. The interviewees point out that there is no strategy for satellite navigation. Another points at the intransparency of actors in the region. He believes that is organization is well aligned with one of the regional strategies, but has a hard time being acknowledged by the leading entity. Half of the respondents believe, that these strategies are regularly reviewed and a third, that the same holds true for performance. Some satellite navigation protagonists disseminate newsletters, which are largely targeted towards a national audience. Only 10% of the respondents are aware of them and partially read them. The participants agree strongly with regard to the routine profiles and slightly less with regard to the capability elements. The majority of the respondents does not feel in a position to answer on two of the three capability elements.

Figure 38: Capability of strategic alignment - mapping cluster DELTA's routine and capability profile



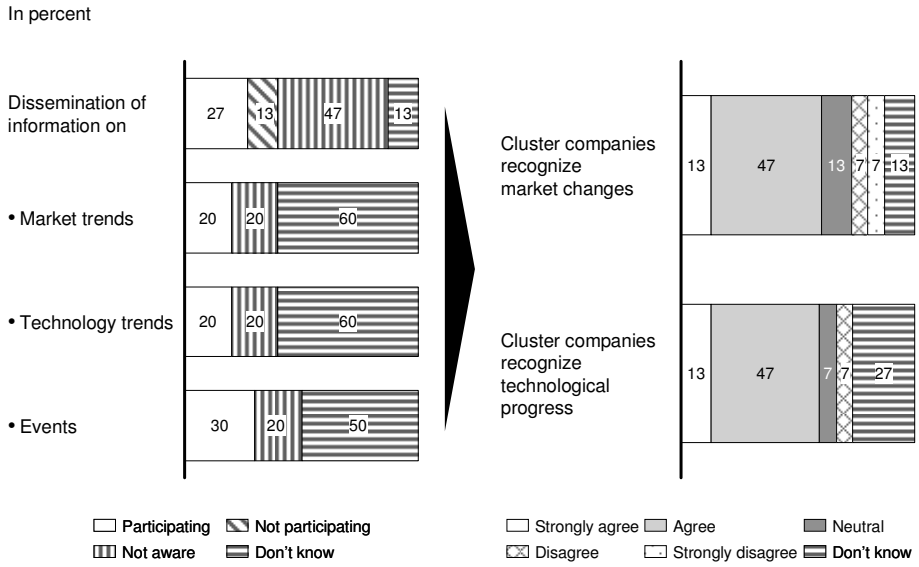
The cluster's capability of reconfiguration belongs to its strongest capabilities, though routines only partially support it (Figure 39). More than half of the interviewees agree or agree strongly that the cluster allows for new engagements that else would not have been possible. Additionally, more than 70% of the respondents perceive the cluster to be an asset pool. With 70%, most of the respondents agree that the associations have established membership rules and are engaging in member acquisition activities. The cluster is less well endowed with support offers. No more than 10% of the interviewees each agree on the existence of four of these offers. Largely, the associations appear to offer them. For the interviewees, public innovation support offers appear to exclude the majority of players by their specifications. While 40% are aware of training offers in the cluster, none of the respondents visits them. The participants often agree with their responses on the routine questions, but also often feel that they can not answer the questions. They very much agreed on their perception of the capability elements.

Figure 39: Capability of reconfiguration - mapping cluster DELTA's routine and capability profile



The second strong cluster capability is opportunity recognition. Again, the strength of potentially supporting routines is limited (Figure 40). The cluster is as strong on the technology as on the market side. In both cases, about 15% of the respondents strongly believe and about 45% of them believe that they quickly recognize market and technology trends. The mechanisms for information dissemination appear to be largely informal and centered in the associations. Only 20% of the respondents agree that information is disseminated on market and technology trends and 30% agree for external events. Interestingly, an SME representative also indicated his willingness to contribute to any information service and another participant pointed at the need for a list of active companies in the regions, another expressed the hope to become better connected to other technology players through cluster activities over time. All of the respondents who are aware of market and technology trend information read them fully. Again, the respondents showed a strong discomfort in answering the routine-related questions. They were in a better position to answer on the capability elements.

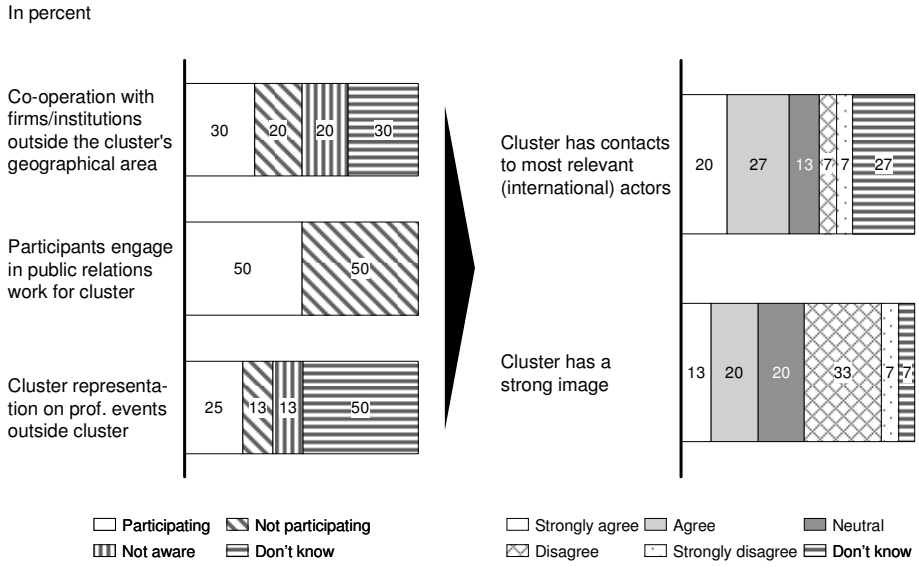
Figure 40: Capability of opportunity recognition - mapping cluster DELTA's routine and capability profile



Networking is another weak capability of the cluster. This is reflected in a low routine profile (Figure 41). Only 20% of the respondents strongly and 27% believe that the cluster has contacts to the major national European, and global satellite navigation technology and application protagonists. 20% agree and nearly an additional 15% strongly agree that the cluster has an image. Accordingly, the cluster is not perceived as and used as a quality or competence signal by its members. One participant even stated that in his eyes, the image of the region would not have an impact on his business. Several respondents suggest a public relations strategy for the cluster as well as the communication of success stories outside the cluster for enhancing the cluster's image. The respondents engage in supporting routines which largely focus on the associations and institutions. Half of the participants engage in public relations work for them. Only 30% of them believe that their associations have external linkages. In the event that they exist, these are largely held by different individuals or individual entities and barely constitute contacts to other clusters, rather to universities and research institutes. Only a quarter of the respondents feel that their associations are represented at external events. Generally, the respondents are not aware of any lobbying for the cluster at the national or

European level. Several interviewees thus encourage the creation or enforcement of routines. Among them are lobbying at the national and European level, which could lead to higher business volumes, the generation of more support and the acquisition of European and international partners. Additionally, the cluster should strengthen its public relations work.

Figure 41: Capability of networking - mapping cluster DELTA's routine and capability profile



5.2.4.4 Perceived cluster innovativeness and performance

The cluster exhibits a low perceived level of innovativeness as well as performance (Figure 42). The respondents were very uncomfortable in estimating the development of performance indicators. On average and across all indicators, 60% answered indicated that they would not know how to answer the question. All of the respondents perceived heavy increases of the respective indicators, i.e. absolute and relative GDP per capita, absolute employment, the foundation of start-ups, the global and European market share as well as the number of co-operations in the cluster. Only the relative development of employment and the relative development of the number of start-ups, on average, tended to a moderate increase. The cluster's perceived innovativeness is moderate, with nearly

15% of the respondents strongly and about 45% agreeing. The interviewees do not see it as defining new market trends. Only about a quarter of them support this, while a third contradicts this statement. The cluster's strength in trendsetting is on the technology side. A total of 60% believe that the cluster defines technological progress. The same holds true for the translation of technological progress into products. On the technology side, about 55% approve, about 15% oppose and more than 5% strongly oppose. On the market side, a third agree and a quarter disagree. Interestingly, the cluster is stronger on the market side in quickly reacting to new trends. 40% of the interviewees approve and 20% disapprove with regard to market change and more than a quarter approve and nearly 15% disapprove on technological progress. The participants' agreement on the past development of economic indicators is low, combined with a high level of discomfort in estimating past developments. The level of comfort improved with regard to perceived cluster innovativeness.

In cluster DELTA, the participants struggled with defining the perceived past development of performance indicators. These nonetheless are roughly in the same range as the cluster's perceived innovativeness (Figure 42). The overall level of perceived innovativeness aligns roughly with the cluster's capability profile (Figure 43).

Figure 42: Innovativeness and past performance – Mapping cluster DELTA's participants' perceptions

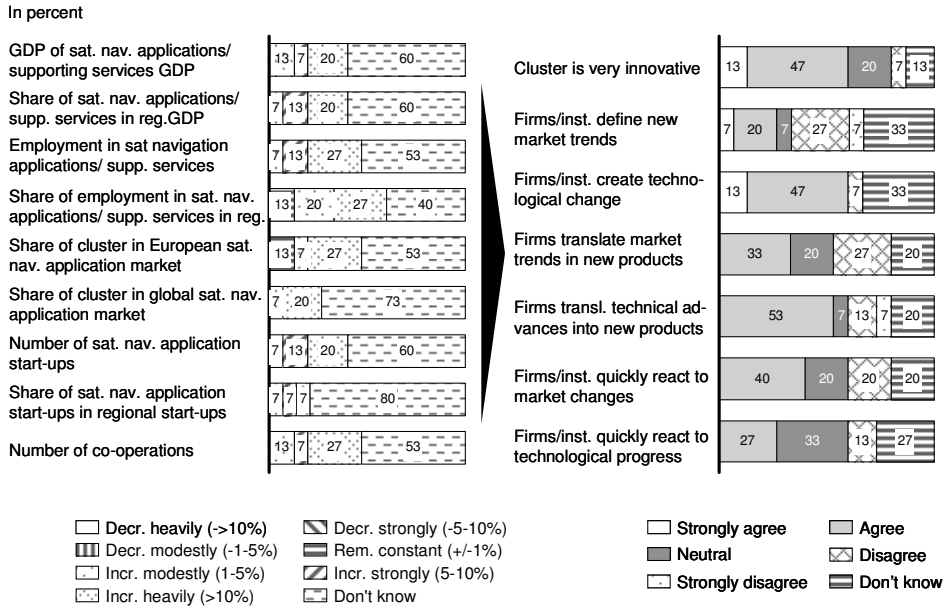
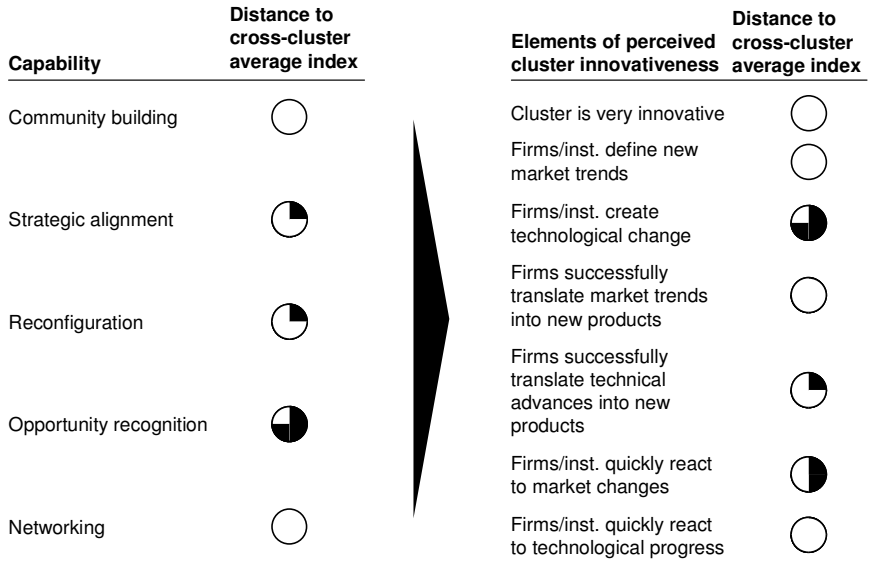


Figure 43: Mapping cluster capability profiles with perceived innovativeness - cluster DELTA



5.2.4.5 Perceived cluster strengths and weaknesses

The cluster benefits from a good asset base in the eyes of some respondents. Strong contributors are the national and international institutions located in the area and the associations that have been established so far. Additionally, the region offers interesting markets for navigation applications. These are strengthened even more by the national initiative to enhance the service sector. However, this asset base constitutes an opportunity, which has not yet been exploited. As one participant put it, becoming the core region for satellite navigation would substantially support business as well as increase indirect support, for example by policy makers. The cluster managers perceive the specific, specialized associations as most supporting cluster innovativeness and performance.

The cluster suffers from limited financing, unclear competence profile with regard to satellite navigation applications and low levels of support from policy makers with regard to this, from high levels of bureaucracy and politics. Several respondents indicate that the positioning of the cluster should clearly be defined as satellite navigation based services

and products, in contrast to space or signals. Furthermore, the respondents often commented that they neither feel well connected in the region nor believe in a sufficient regional potential. This potential might in fact be sufficient, given the low awareness of other regional players and the specific demands to learn more. Also, they reported low regional awareness of satellite navigation applications as well as a limited image of the region outside the region. The pending conflicts among space-based application development protagonists and application domain-based product development protagonists further aggravated this. In line with this, the cluster managers perceive the need to integrate the diverse regional satellite navigation landscape and the protagonists, exchange information, create business opportunities, and promote regional competencies as most pressing to support cluster innovativeness and performance. Additionally, they also perceive the lack of financing as well as low loyalty to the associations.

The respondents encourage a couple of initiatives for supporting the cluster. Among them are, firstly, the development of a small, central agency for supporting the cluster and its sub-clusters. Secondly, the cluster could develop an educational offer for enhancing the regional knowledge base for the development of satellite navigation applications. Thirdly, some respondents encourage the creation of regional competence profiles and information events. Fourthly, they encouraged better regional, national as well as international communication on application development in the region. The cluster managers added the need for a formalization of structures and processes in the associations for supporting their growth. They should employ managers to support their coordination and pay them at a professional level. Their members should assume a more active role in the cluster.

5.2.4.6 Implications for a dynamic capability view on clusters and discussion of findings

The cluster DELTA is still in the process of forming. We found a reasonable asset base, but barely any alignment by the respondents on whether the cluster existed and if so, that the focal points would be. The protagonists are in the process of establishing initial routines. So far, there is no focal entity and the level of communication and cooperation in the region as well as representation to the outside are all very low. The routines that were created over the past two years did not attract the relevant and diverse satellite

navigation target group. According with the dynamic capability model, the cluster has limited capabilities and shows limited innovativeness and growth.

Interestingly, there are routines in cluster GAMMA, which have not yet been effective. One reason to explain this might be the fact that they barely qualify as collective routines. They neither address the different participant groups nor are being used to a substantial extent by the targeted participants.

The overall cluster shows two capabilities, reconfiguration and opportunity recognition. These might be grounded in perceptions. The perceived strength in reconfiguration might be due to the motivational effect from observing a strong asset base. The strength in opportunity recognition might reflect an individual firm strength, in contrast to a collective cluster strength.

5.2.5 Cluster EPSILON

5.2.5.1 Cluster context

Cluster EPSILON is a long-established, informal, space-centered region. However, a formal satellite navigation application cluster entity has only recently been established. The cluster is able to look back on a rich tradition of co-operation in the field of space. Additionally, it benefits from a variety of players in diverse satellite navigation application areas, who are less well connected. The relevant industries include agriculture, rail, road, water, telecom, air, space, investigation & security, public administration and defense, education, forestry, and other. Europe is the target market of most players. The newly established association representing the satellite navigation application cluster builds on earlier work groups and political support structures. It is generally acknowledged to constitute the focal entity. Unfortunately, the feeling of belonging to the cluster entity is low and the space- and application domains are hardly integrated. The size of the cluster and the diversity of participants appear to make communication and learning difficult within the cluster. Potential conflicts among space and application domain protagonists enforce this situation. Overall, these findings confirm the upfront characterization of the cluster.

5.2.5.2 Cluster assets

Cluster EPSILON is endowed with all assets (Table 19), contains a broad geographical region and comprises a variety of protagonists representing all potential participant groups and along the value chain. Overall, the cluster comprises SMEs, start-ups, large enterprises, research institutes and universities, regional business associations, technology transfer agencies, regional development agencies, policy makers, and business service providers. Venture capitalists or business angels are located in the region. Start-up support mechanisms are strong. Policy makers are perceived as strongly supporting the cluster, although some respondents encourage an even higher level of political commitment also in the sense of more cluster support. Additionally, a diverse set of protagonists is concerned with promoting the region. The research base of the region

allows the cluster to build on a strong and historically grown competence base. Overall, a spirit of competition prevails over that of co-operation. At the same time, the participants encourage stronger co-operation and (formal) communication in the cluster. While the participants on the one hand perceive that the cluster benefit from a strong regional "we-feeling" and a culture of innovation, they on the other describe a latent conflict among the participant groups, which impedes the realization of the regional potential. Officially, the cluster, as represented by the focal association, extends across 11 NUTS 3 regions. However, according to most respondents, three of them form the focal area. The number of participants given by the respondents ranges from 15 to 150. The cluster has a formal organizing entity, which however is only starting its operation. So far, the level of informal co-ordination in the different subgroups still is stronger. The cluster has several external contacts, on the level of the participants as well as organizations.

Table 19: Asset base - cluster EPSILON

Technological and complementary assets	●
Financial assets	◕
Institutional assets	◕
Reputational assets	●
Market structure assets	●
Cluster structure assets	◕

5.2.5.3 Perceived cluster innovation capabilities and observation of routines

Cluster EPSILON's capability profile is not very strong. Apart from the capability of community creation, its level of routines supports this finding. The cluster profile shows a strong space-based community with a diverse set of routines. However, neither does this community integrates new and other protagonists, nor are new routines established for these other protagonists strong enough at this point. Additionally, the activities of the established network and the new players partially overlap. One participant described the resulting mentality as a "lone-warrior"-mindset.

The cluster participants perceive some capability of community creation in the cluster which is supported by a strong routine profile (Figure 44). All participants agree and 88% even agree strongly agree that the cluster entities value innovativeness highly. However, the participants are not well connected. Only 12% of the respondents strongly believe and 35% believe that the cluster members know each other. One respondent described the situation further in that companies continuously try to learn more about other players, but largely do this on their own account and without relevant formal support.

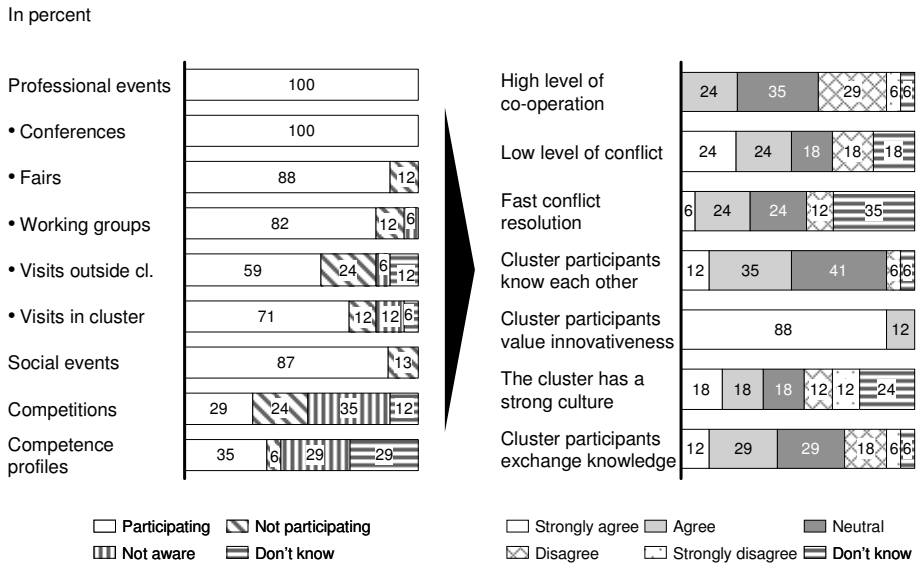
About a quarter of them each perceive the cluster's conflict propensity as low or very low. However, when conflicts occur they appear not to be solved quickly. Less than a third of the respondents agree with a fast resolution. One participant pointed out that large enterprises in the cluster rely on their own conflict solving mechanisms. Similarly, the exchange of knowledge in the cluster appears to be limited to subgroups. Only 12% strongly and about 30% believe that it is extensively being shared within the cluster. Similarly, less than 20% each perceive a common culture in the cluster. While the region generally exposes a strong 'we-feeling', including strong regional networks, this is not the case for the specific field of satellite navigation applications. Some respondents actively articulate the beneficial effects that a feeling of community in the cluster and a higher level of familiarity would have. For supporting this, some propose the distribution of regularly updated competence profiles of the different protagonists. Communication in the cluster appears to be centerd in the different established initiatives and networks. Accordingly, the respondents' perceptions of the intensity of co-operation and exchange in the cluster differ substantially, depending on whether and which initiatives they belong to. Networking and co-operation is perceived to be limited especially among large players.

The long-established co-operation among space protagonists and the plentiful supporting institutions provide a wide variety of events in the cluster. All respondents indicate that they visit conferences, about 90% of them visit fairs, about 80% the work groups. About 60% take part in organized visits outside the cluster, about 70% in visits inside the cluster. 90% visit social events, which, however, do not necessarily offer the opportunity to get to know the relevant satellite navigation players. Interestingly, professional events form the major platform for informal contacts. Business plan competitions are not as

prominent as other events. 30% are not aware of their existence and 35% take part in them. Beyond events, about half of the respondents believe that competence profiles of the cluster's entities exist and are disseminated.

The variety of events and the heavy participation in them does not translate into a level of capabilities that one would expect. It is unlikely that this is due to the recent establishment of routines. It is more likely that the variety of events, on the one hand, makes it harder to attract a sufficient share of the relevant participants and, on the other, for single events to attract all the different participant groups. On average, the respondents visit 58% of the events, which they need to carefully select. Additionally, in the interviews, the respondents refer to different events when confirming their attendance and reported that several of the events attract specific participant groups more than others. Interestingly, professional events find their most interested visitors in public authorities, business service providers and research institutes. However, some respondents indicate their interest in taking on a more active role in shaping the cluster. The participants agree largely on the cluster's routine profile, but overall are barely aligned on the capability elements.

Figure 44: Capability of community building - mapping cluster EPSILON's routine and capability profile



The respondents report different impressions of the extent of strategic alignment in the cluster, allowing us to infer a weak capability of strategic alignment. However, several routines (or structures) exist (Figure 45). The interviewees' impressions of whether the cluster's strategic activities are supportive to the cluster's members are very diverse. More than 10% of the respondents strongly believe and more than a third believe that they are, with more than five percent contradicting. Similarly, more than 10% perceive or strongly perceive the cluster as being managed for performance, with more than 10% strongly and 5% disagreeing. About a quarter of the interviewees strongly believe that information on the cluster is hard to obtain, nearly 20% believe so. About a quarter contradicts and an additional 10% contradict strongly.

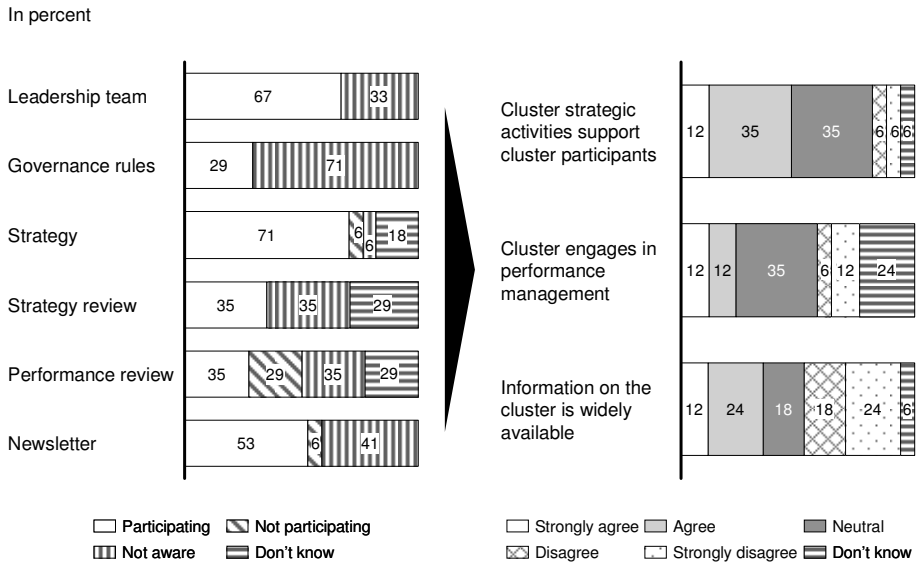
The respondents largely report that routines exist that might support strategic alignment. More than 65% perceive a leadership team. Only 30% report governance rules. About 75% of them perceive a strategy, in contrast to 5% who do not. About one third each believe, do not know, or do not believe in reviews of the cluster's strategy and performance. About 60% are aware of newsletters within the cluster.

The respondents provided a variety of suggestions for improving the cluster's capability of strategic alignment. Some of the respondents explicitly point at the need for a cluster vision instead of cluster management. Additionally, they suggested a stronger business-orientation, profit-oriented and performance review-based cluster management and a further formalization of the cluster, including the definition of a clear structure and the engagement of more managerial personnel. Additionally, the communication between the cluster management and the members could become more active, coordinated and formalized, especially with regard to the cluster's and the initiatives' visions, strategies and structures. Similarly, several interviewees encourage increasing the visibility of co-operations within the cluster.

The low level of alignment appears to find its reasons in conflicts and unclear responsibilities. Several interviewees perceive the large number of supportive protagonists to be unaligned. Additionally, they point to potential conflicts in the cluster. Some express the concern that the strong influence of large and established players hinders innovation by SMEs. Others suggest that satellite navigation activities should be anchored in IT rather than in space, as the space industry has an entirely different market

structure. The participants agree to some extent on the routine profile, but less on the capability profile.

Figure 45: Capability of strategic alignment - mapping cluster EPSILON's routine and capability profile

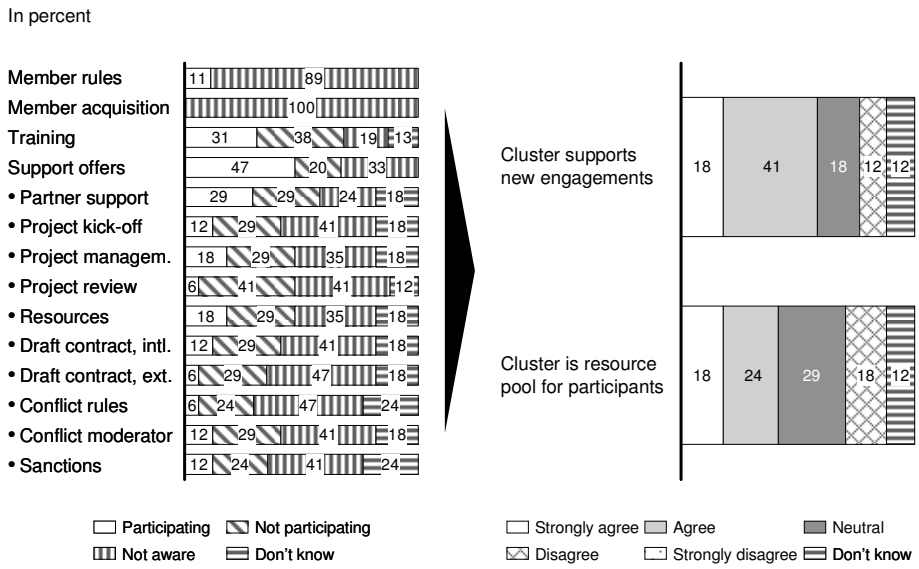


The respondents report a weak capability of reconfiguration, in line with a weak routine profile (Figure 46). 18% of the interviewees strongly agree and an additional 40% agree that the cluster enables new engagements that else would not have been possible. However, only 18% strongly and close to a quarter perceive the cluster as an asset pool. Thus, cluster EPSILON scores low on both dimensions. This is interesting, as cluster EPSILON has one of the best asset pools in the sample. One possible explanation might be the extent to which several actors have already established contacts to external partners. Additionally, its core entity's role of a facilitator might contribute to the perception that it does not contribute to new engagements.

While the cluster exhibits several routines that could support reconfiguration, these routines are not substantially used. According to about 11% of the participants, the cluster has established membership rules. None of the interviewees believes that the cluster engages in member acquisition activities. Out of the 70% of the respondents who are

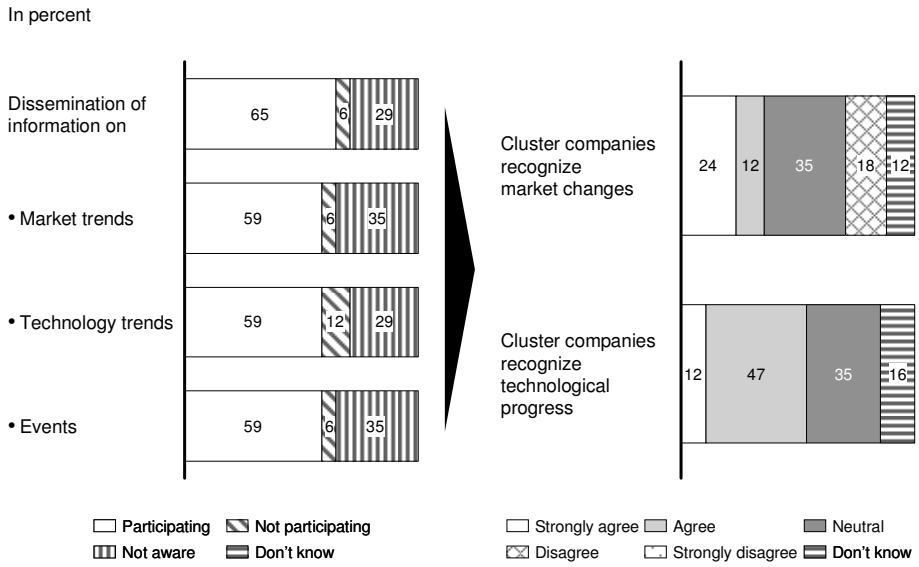
aware of training offers, about 30% use them. Similarly, only half of the 60% of the respondents who are aware of support offers for the identification of new projects use them. No more than about 45% are aware of other project-related support offers, with among 6 and 18% using them. 30% of the interviewees are aware of conflict rules, 35% of sanctions and about 40% of a moderator. Overall, some participants explicitly encourage more support to joint projects. As core items hampering co-operation, they raise data and intellectual property protection. The participants' level of agreement is high for the member rules and their acquisition, in contrast to the support offers and the capability profiles.

Figure 46: Capability of reconfiguration - mapping cluster EPSILON's routine and capability profile



The cluster EPSILON is not strong in opportunity recognition, although the cluster's routine profile is quite strong (Figure 47). Only about 35% of the respondents believe strongly or believe that the cluster entities quickly recognize market trends. The share reaches 45% for technological progress. Interestingly, the dissemination of market, technology and event information appears to be an established routine in the cluster. Among 65 and 70% of the respondents agree to their existence. Overall, the level of agreement on the cluster's routine profile is high, in contrast to on its capability profile.

Figure 47: Capability of opportunity recognition - mapping cluster EPSILON's routine and capability profile

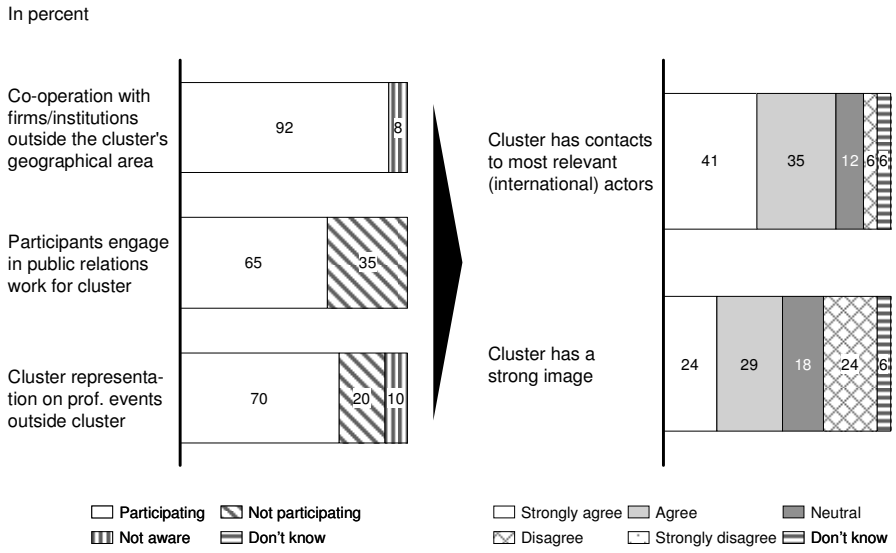


Most respondents attest cluster EPSILON a networking capability of medium strength., though supported by a strong routine profile (Figure 48). More than 40% strongly believe and 35% believe that the cluster is strongly connected to the major national European, and global satellite navigation technology and application protagonists. A quarter strongly agrees and about 30% agree that the cluster has an image. However, another quarter contradicts this perception. In any case, some of the participants encourage enhancing the visibility of the cluster and improving its image. This includes lobbying at the highest political level and taking up ideas from other clusters.

The majority of the participants report that they support the cluster's networking capability with routines. 65% of the respondents engage in public relations work for the cluster, in contrast to 35% of them, who do not. Public authorities are most engaged in public relations work. More than 90% of the interviewees believe that the cluster has external linkages. 70% of the respondents feel that the cluster is represented on external events. However, this perception is largely based on entity specific activities, not a formal representation of the entire cluster. Additionally, the lead cluster entity engages in an awareness creation campaign on satellite navigation and, more specifically, GALILEO.

On top of that, it distributed the first cluster participant competence profile within as well as outside the cluster and thus further supports cluster awareness creation. Some of the respondents encourage enhancing these efforts as well as improving the information flow from the outside. Again, the participants agree on the cluster's routine profile, but agree less on the capability elements.

Figure 48: Capability of networking - mapping cluster EPSILON's routine and capability profile



5.2.5.4 Perceived cluster innovativeness and performance

Overall, the respondents perceive a positive economic development over the past five years. While most perceptions are positive or neutral, they differ substantially among the respondents. For example, about 10% of the interviewees report a constant relative GDP, 20% perceive a modest or strong increase and about 15% a heavy increase. For most respondents, the absolute GDP increased strongly and the absolute and relative development of the employment, the European market share and the relative development of start-up creation increased modestly. The absolute development of the creation of start-ups lies between a modest and a strong increase, and the number of co-operations shows a heavy perceived increase. The respondents were relatively comfortable with estimating

the development of performance indicators. For the GDP and employment, less than 30% answered "don't know", for the other indicators the rates were above 30%.

Similarly, the cluster is perceived to be somewhat innovative. Nearly a quarter of the respondents strongly agree and about 40% agree that the cluster is innovative. About 20% of them strongly feel and 35% feel that the cluster entities define new market trends. These numbers are higher for technological progress. Here, about a quarter strongly supports and about 40% support this. Similarly, the cluster exposes a strength on the technology side with regard to the translation of technological progress or market trends into new products. A total of 65% of the interviewees believe that the cluster defines technological progress, compared to 30% for market trends. More than 45% believe that the cluster members react quickly to technological progress and about 35% for market change. The participants show some alignment on the past development of economic indicators and more agreement on the cluster's perceived innovativeness.

Cluster EPSILON's perceived innovativeness is weaker than the past development of its performance indicators (Figure 49), but maps better with the cluster's capability profile than the cluster's perceived level of innovativeness (Figure 50).

Figure 49: Innovativeness and past performance – Mapping cluster EPSILON's participants' perceptions

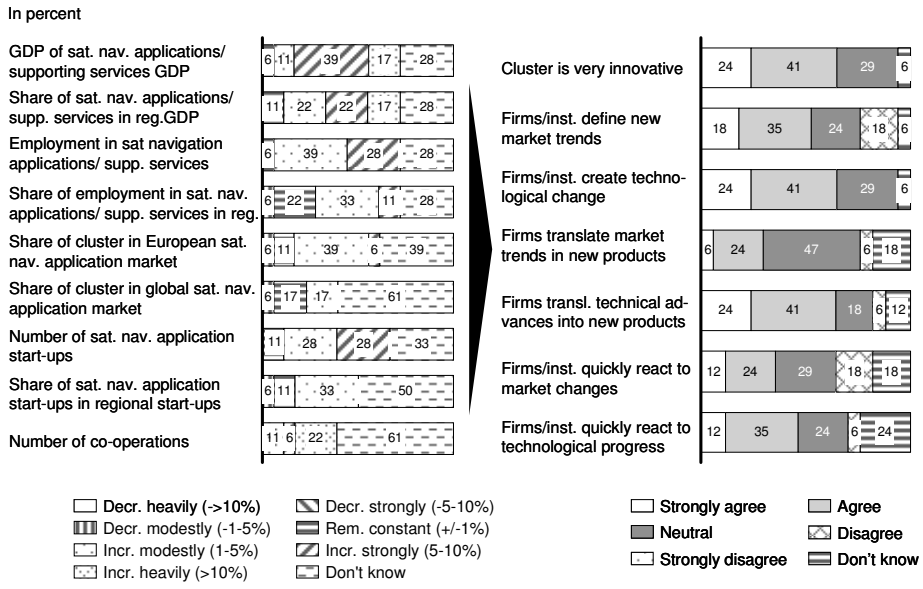
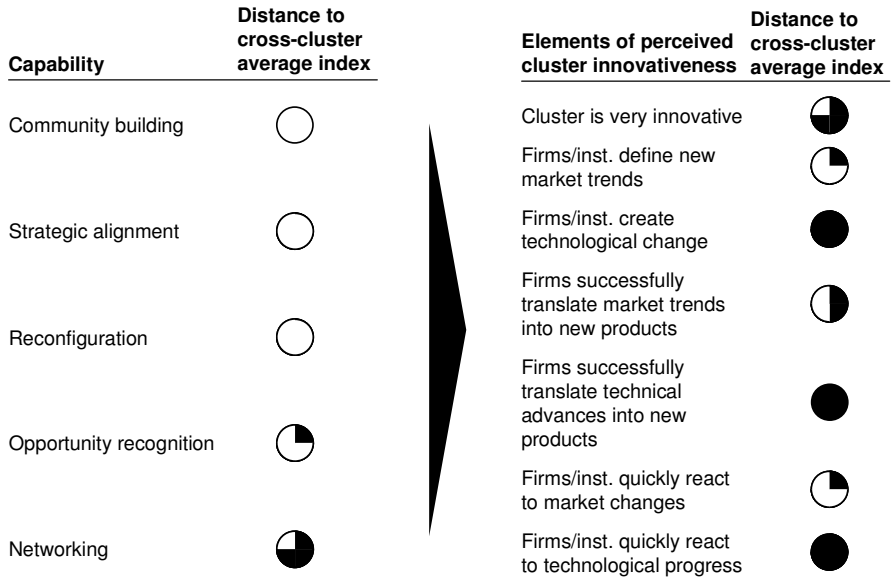


Figure 50: Mapping cluster capability profiles with perceived innovativeness - cluster EPSILON



5.2.5.5 Perceived cluster strengths and weaknesses

According to the respondents, the cluster benefits from its strong asset and market base, the variety of networks, the region's image and climate as well as from the focal cluster entity. The participants comprise entities across the entire value chain and from all supporting domains in different sizes and with a variety of different competencies. Some interviewees underline that they are open for information exchange as well as for actively involving themselves in activities. Additionally, several protagonists have long been involved in networks. Furthermore, the region exhibits a strong image and benefits from a supportive innovation climate. Additionally, the respondents acknowledge the role of the focal cluster entity in networking and lobbying. Some perceive it as a strength that the focal entity is barely formalized. The cluster manager largely shares these perceptions, but does not indicate any areas for improvement. For him, the activities for making GALILEO known in the region as well as the work groups are most supportive to regional innovativeness and performance.

Several respondents wish for improvements in the regional information flow, the level of integration of the protagonists and the awareness of GALILEO, the role of the focal entity as well as the support by public entities. Furthermore, they raise potential and existing conflicts. For them, the participants do not know each other enough. This is aggravated by lone warriors in the cluster as well as by conflicts among participant groups. For example, some respondents point towards the strong space base of the region, indicating that the development of satellite navigation applications should rather be grounded in the IT sector. Additionally, the members express that regional awareness of satellite navigation in general and GALILEO specifically is too low. Some suggest a stronger leadership role for the focal cluster entity, as well as a stronger business orientation. Policy makers could enhance their support to the cluster by becoming more committed and taking clear decisions. Furthermore, the cluster should be better endowed with managerial personnel. The cluster manager did not raise any weaknesses or specific areas for improvement.

The interviewees propose a number of measures to enhance the cluster's workings. Firstly, they encouraged a stronger exchange among the cluster's firms and the new focal entity. Secondly, they propose to leverage the focal entity as a common information platform. As part of this, it could also enhance the regional awareness of satellite navigation in general and GALILEO specifically. Thirdly, several respondents encourage a common vision, which could provide the basis for cluster participants to join forces. Fourthly, they propose to promote the region more, allowing for generating membership pressure, enhancing the attractiveness of the region for participants moving to the region, and facilitating application marketing.

5.2.5.6 Implications for a dynamic capability view on clusters and discussion of findings

Cluster EPSILON provides some support to the application of the dynamic capability model to clusters. It has a strong resource endowment and builds on a profound historical basis. Several routines exist, but do not lead to a strong capability profile. Nonetheless, the cluster exhibits a good performance.

Several reasons can explain the limited translation of routines into capabilities. In cluster EPSILON, time is not a reason, as most of the routines are more than four years old. However, firstly, the cluster integrates a major, long-standing subgroup which appears closed to the other participants and benefits from strong internal routines. However, the participation in the routines across participant groups is limited. Secondly, the cluster comprises a variety of diverse participants with different expectations and needs, which often have never co-operated before. Thirdly, the routines in the cluster are very diverse to accommodate these needs, but thus fail to provide common ground for all relevant participants and rather serve to reinforcing existing group structures. Along these lines, most participants perceive themselves as cluster members, but refer to different subgroups. Additionally, the cluster participants reported several incidences of conflict between the major cluster groups, hampering the propensity of collaboration.

These diverse requirements find their expression in the different requests to the new focal entity voiced by the participants. Generally, the participants who are part of existing networks advance an understanding in which the focal cluster entity contributes mostly to connecting the firms to policy makers and to potentially creating an external and internal image and reputation. It is less involved in contributing to business and probably acting in a more informal manner. Participants who do not yet form a part of the existing networks perceive the focal cluster entities role to be supporting networking and integrating the cluster members through a process of further formalization. The fact that the respondents encourage the introduction of new and the enhancement of existing routines allows to infer that the routines selected in this research effort in fact might contribute to cluster innovativeness and performance.

5.3 CROSS-CASE ANALYSIS

5.3.1 Case-based evidence on a priori constructs: Cluster assets

The empirical cases provided evidence for the existence and measurability of all asset categories. All assets were observable across the clusters, however, the clusters were endowed with different asset combinations, qualities and quantities (see Table 20 for an aggregated overview). In line with the scope of this study and the cluster characteristics determined upfront, all clusters had substantial technological assets. However, their endowment with financial, institutional, reputational and market, as well as cluster structure assets differed substantially.

Table 20: Asset base - cross-cluster profiles

	Alpha	Beta	Gamma	Delta	Epsilon
Technological and complementary assets	●	●	●	●	●
Financial assets	◔	○	○	○	◕
Institutional assets	◔	◕	◔	◔	◕
Reputational assets	●	◑	◑	◑	●
Market structure assets	●	◔	◑	◔	●
Cluster structure assets	◑	◔	○	○	◕

Of all clusters, ALPHA and EPSILON are best endowed with assets. The least prominent assets across clusters were financial and cluster structure assets was weakest, with only cluster EPSILON demonstrating strong financial assets within the cluster. As for cluster structure assets, the clusters GAMMA and DELTA did not benefit from any structural

assets. Cluster EPSILON is best endowed with structural assets, followed by the clusters ALPHA and BETA.

Looking at the specific asset categories, cluster BETA and EPSILON were the strongest on institutional assets. This is especially prominent with regard to a regional culture and supporting public policies. All clusters were endowed with higher education institutes. Only in cluster GAMMA, the participants pointed at insufficient protection of intellectual property rights. Cluster ALPHA and EPSILON showed the strong endowment with reputational assets, followed by BETA, GAMMA and DELTA.

The clusters ALPHA and EPSILON also were best endowed with market structure assets. The markets at their disposal were largest and most diverse, and the contacts best established. Cluster GAMMA also showed some market structure assets, followed by the clusters BETA and DELTA with weak assets endowments.

The cases provided rich evidence for the asset constructs. Additionally, the evidence suggests that the technological, financial and institutional assets are the most relevant. They were most mentioned by the participants in each cluster as well as across clusters and form part of the typical strengths and weakness profile observations.

5.3.2 Case-based evidence on a priori constructs: Cluster innovation capabilities

5.3.2.1 Community building

The cases provide ample evidence on the perceived existence and relevancy of the capability of community building, as well as the operationalization chosen in this research project. According to the respondents, the capability of community building is of high relevancy to clusters. It was both heavily mentioned in unstructured comments during the interviews as well as in the section on strength and weaknesses. The relative prominence of the elements defined as underlying the capability of community building correlated strongly.

Overall, the cluster participants across clusters were aware of the existence of the routines selected in this study and provided strong reads into the quality of routines with their

level of participation. Building on this first evidence, the routines of conferences and work groups were consistently strong across clusters, with those clusters leading that also showed strong participation in visits within the cluster, i.e. BETA, GAMMA, EPSILON. The other professional events as well as innovation and start-up competitions as well as competence profile updates were of less prominence, both in terms of existence and in terms of (relative) participation.

Table 21: Capability of community building - cross-cluster routine profiles

In percent

Existence of and participation in / frequency of…	Share of participants aware of routine (Share of participants participating)				
	ALPHA	**BETA**	**GAMMA**	**DELTA**	**EPSILON**
• Professional events	87 (81)	100 (94)	74 (74)	60 (60)	100 (100)
– Conferences	63 (56)	94 (76)	84 (84)	70 (40)	100 (100)
– Fairs	19 (13)	53 (35)	84 (79)	50 (20)	100 (88)
– Work groups	81 (69)	88 (76)	74 (74)	70 (30)	94 (82)
– Study tours outside cluster	19 (19)	65 (35)	68 (68)	40 (10)	82 (59)
– Visits in cluster	19 (19)	82 (53)	79 (79)	40 (10)	82 (71)
• Social events	50 (39)	76 (41)	84 (0)	50 (20)	100 (87)
• Innovation/start-up competitions	47 (27)	93 (36)	58 (21)	80 (20)	53 (29)
• Frequency of competence profile updates	13 (7)	67 (47)	89 (84)	10 (10)	41 (35)

At the same time, the study supports the link between the routines selected in this study and the capability. Qualifying for the quality of routines, a strong routine profile coexists with a strong capability profile. The semi-structured questionnaire offered open parts to allow for an extension of the list of potentially relevant routines by the interviewees. These however have only been used in rare instances. Among the new routines proposed with regard to the capability of community building across clusters are professional events that serve lobbying, demonstrations of new products in the regions or of events creating technology awareness. At the same time, the results imply that the routines need not necessarily be very plentiful.

The findings confirm the nature of routines as well as establish a quality requirement for routines. Routines turned out to be most effective as inter-member learned and observable routines, followed by the participants regularly and with dedication. This study extends

these characteristics to four learnings with regard to the quality of routines. Firstly, the routines need to be targeted towards satellite navigation. Cluster ALPHA and DELTA provide events, but these have a low specificity towards satellite navigation. Similarly, cluster ALPHA's respondents indicate the existence of a shared culture. However, the unstructured elements of the interview confirmed that cluster ALPHA does not have a satellite navigation cluster-specific culture, but rather a regional or association cultures. Thus, the cultural bond is less effective than in other clusters with specific cultures. The same holds true for cluster EPSILON, which showed a strong routine profile and a weak capability profile. The cluster respondents pointed at a very strong, established group of participants that comes together in very specific events and thus excludes new participants.

Secondly, the extent to which these events continually target the interest of the community is of high relevancy. As laid out earlier, routines are repeating activities. Thus, the participants need to regularly participate in events for them to develop their nature as routines which can support capability building. In cluster DELTA, for example, the cluster participants do not regularly participate in the events, contributing to a weak capability profile. The opposite is the case in cluster BETA.

Thirdly, the variety of events might have positive effects in the sense of reaching diverse participants. At the same time, it potentially diminishes the potential of these events to act as common platforms. Cluster EPSILON might suffer from this circumstance, in which the variety of events appears to manifest the fragmentation of the community instead of building common ground.

This partially comprises the fourth learning. It is relevant, that diverse groups attend the events. In cluster EPSILON, the large number of events and the subsequent limited participation of different groups in cluster EPSILON's events might further manifest the fragmentation of the community. Thus, a number of different events can be positive, as long as they do not have the potential to split the community. This learning is strongly linked to the coherence of perceptions within the cluster. For example, cluster EPSILON's participants indicate that knowledge is being shared. However, in the unstructured elements of the interview the respondents indicated that knowledge sharing only takes

place within small subgroups of the cluster. Thus, the cluster can not fully benefit from its potential.

In line with the required participation of diverse groups in cluster routines, intra-cluster conflicts expressed in the unstructured sections of the interview hamper the creation of capabilities, especially of the capability of community building. Typical and sometimes overlapping lines of conflict are between old and new cluster members (limited conflict in cluster BETA, strong conflict in cluster EPSILON), between large enterprises and potentially other large players and SMEs, start-ups and their supporting institutions (apparent and strong conflict in cluster ALPHA, latent and weak conflict in cluster BETA, latent and strong conflict in cluster DELTA), between policy makers and businesses (latent and weak conflict in clusters BETA, DELTA, EPSILON) as well as between established space actors and application domain-oriented actors (strong conflict in clusters ALPHA, EPSILON).

Generally, it appears that clusters need to define the best trade-off between including as many competencies and resources as necessary on the one hand and delimiting the complexity to ensure adequate involvement of all players on the other. The integration of new competencies and resources mostly takes place through the integration of new players, impeding the common basis for all participants.

The research results also underline the relevancy of time, on top of routine quality, both for routines to become effective and for capabilities to form. For example, cluster BETA benefits from several old routines as well as some new and very strong routines, allowing for a quick development of capabilities. Cluster DELTA does not build on any established routines. The routines that show in Table 21 are still young and did not yet translate into capabilities. Similarly, cluster ALPHAs recently established routines did not have an effect on capability building. Additionally, they are relatively weak compared to other clusters. The insufficient translation of cluster EPSILON's established routines into a strong capability profile can be explained by the quality of the routines.

A review of the operationalization of the capability of community building across clusters (Table 22) provides three insights. Firstly, some of the elements appear to be more common across clusters than others. Among these are, for example, the level of

innovativeness of the cluster or, though less prominent, the fact that the cluster participants know one another. Secondly, the clusters' participants were able to react to all of them in a very differentiated manner, supporting the operationalization as understandable and measurable. Thirdly, the clusters overall obtain very different aggregate scores, pointing at substantial capability differences, which can be explained by the routine profiles. However, these findings can only be preliminary. Further research could potentially reduce the number of operationalizing elements.

Table 22: Capability of community building - cross-cluster capability profiles

Distance to average, percentage points
● Far above, >10
◕ Above >3-10
◑ Average ><3
◔ Below <3-10
○ Far below, <10

Operationalization of community building capability	Cluster					Average across clusters[1]
	Alpha	Beta	Gamma	Delta	Epsilon	
• Co-operation in cluster is easier	○	●	●	○	○	22
• Conflict barely occurs	○	●	●	○	◔	46
• Conflicts are solved quickly	○	●	◕	○	●	37
• Participants know each other	●	●	◑	○	◑	54
• Participants value innovativeness	○	●	●	◔	◕	81
• Cluster has a strong culture	●	●	◑	○	◑	14
• Strong knowledge exchange	○	●	●	◔	◕	24
Average score[1]	**21**	**57**	**71**	**21**	**29**	**40**

1 Percentage of positive answers minus percentage of negative answers

5.3.2.2 Strategic alignment

The cases provide ample evidence on the perceived existence and relevancy of the capability of strategic alignment, as well as the operationalization chosen in this research project. The clusters exhibited very different capability profiles and the respondents confirmed the relevancy of the capability of strategic alignment in their informal comments. The relative prominence of the elements chosen to operationalize the capability of strategic alignment correlated strongly. While the routines and structures of a leadership entity, the governance rules and the level of conforming with the respective cluster's strategic direction received strong support across clusters, both in terms of their existence in the clusters and the rates of participation, where applicable (Table 23).

The role the formal or informal core institutions of the cluster take on appears to impact the participants' perception of the support the cluster's strategic activities provide to the individual participant's entities. Cluster EPSILON's core institution acts more as a facilitator, and thus might be perceived as more distant from daily business life than cluster BETA's core institution, which strongly supports the identification and realization of business opportunities.

Table 23: Capability of strategic alignment - cross-cluster routine profiles

In percent

Existence of and participation in / frequency of…	**Share of participants aware of routine (Share of participants participating)**				
	ALPHA	**BETA**	**GAMMA**	**DELTA**	**EPSILON**
• Leadership entity exists	93	73	73	33	67
• Governance rules exist	93	73	87	0	29
• Agreement with cluster strategy	93 (93)	72 (72)	100 (79)	70 (60)	76 (71)
• Cluster strategy review	25 (6)	18 (18)	95 (79)	50 (50)	35 (35)
• Cluster economic performance review	19 (19)	20 (13)	53 (53)	44 (33)	65 (35)
• Reading of newsletters	44 (44)	74 (67)	47 (42)	10 (10)	59 (53)

The capability of strategic alignment is supported by specific routines (see Table 23). As for the capability of community building, both the quality and the age of routines appear

to impact their impact on the capability of strategic alignment. Additionally, among the routines the leadership team, governance rules and the existence of a shared strategy appear to be the strongest drivers of the capability of strategic alignment. In contrast, the role played by strategy and performance reviews so far appears limited. Considering the age of the clusters, this is not surprising. Both, the cluster and the strategies need to be in place for some time to render the reviews worthwhile. At the same time, several respondents encourage the creation of these routines for their clusters.

As laid out in Chapter 5.3.2.1 for the capability of community building, the quality of routines is of relevancy here as well. Looking into cluster BETA, a strategy and governance rules are in place, but do not extend across the entire cluster. Accordingly, these routine can be considered as weak. Cluster GAMMA benefits from the participants' respondent bias towards their business associations, leading to transparent and shared routines and a strong capability of strategic alignment. Similarly, cluster ALPHA's strategy is not specific to satellite navigation, significantly limiting the impact of this routine. At the same time, cluster ALPHA's participants formally confirmed the existence of governance rules, but informally several of them indicated, that they do not understand the guiding principles or disagree with them. Cluster EPSILON appears to be handicapped by the same challenges that already impeded the translation of its routines into the capability of community building.

The potential relevancy of age becomes apparent when looking into cluster ALPHA's capability profile (for an aggregated overview of the clusters' element profile of the capability of strategic alignment, see Table 24). One could expect cluster ALPHA's core association to strongly support the participants with its activities of providing financing. However, cluster BETA's core association profile is stronger, despite its focus on facilitation. The limited age and track record of cluster ALPHA's core institution might explain this.

Table 24: Capability of strategic alignment - cross-cluster capability profiles

Distance to average, percentage points
● Far above, >10
◕ Above >3-10
◑ Average ><3
◔ Below <3-10
○ Far below, <10

Operationalization of strategic alignment capability	Cluster					Average across clusters[1]
	Alpha	Beta	Gamma	Delta	Epsilon	
• Cluster's strategic activities support entities	◑	◕	●	○	○	55
• Cluster is managed for performance	○	●	●	○	○	32
• Information on cluster is easily available	◑	◑	●	○	○	-2
Average score[1]	**22**	**38**	**59**	**11**	**12**	**28**

1 Percentage of positive answers minus percentage of negative answers; negatively phrased questions reversed here

A review of the operationalization of the capability of strategic alignment across clusters (Table 24) provides three insights. Firstly, some of the elements appear to be more common across clusters than others. For example, the strategically relevant support granted by the cluster overall is much more prominent with an average of 55% gap between the positive and the negative answers than the easy availability of information on the cluster. Secondly, the clusters' participants were able to react to all of them, supporting the operationalization as understandable and measurable. Thirdly, the clusters overall obtain very different aggregate scores, pointing at substantial capability differences, which can be explained by the routine profiles. However, these findings can only be preliminary. Further research could potentially reduce the number of operationalizing elements.

5.3.2.3 Reconfiguration

The cases provide evidence on the perceived existence and relevancy of the capability of reconfiguration, as well as the operationalization chosen in this research project. The clusters exhibited different capability profiles. The relative prominence of the elements chosen to operationalize the capability of reconfiguration correlated, except for cluster DELTA. This generally supports the operationalization of this capability developed in this study. Overall, however, the results need to be considered with a grain of salt. Given GALILEO's state of development, none of the clusters up to now had the opportunity to show their performance in reconfiguring in case of a technology shock. In several instances, respondents might not even be aware at this point in time which additional resources they will need from inside or outside the cluster to serve future markets.

However, considering the research results, the relevancy of time again is underlined. In cluster DELTA, the strength of the two elements constructing the capability of reconfiguration differs substantially from a relative perspective. While the cluster's support to new engagement is relatively low, it is considered a resource pool for the cluster participants. It appears reasonable, that at this early stage of cluster development the cluster still is in the process of constructing itself, rather than focusing outwards to scan opportunities.

Table 25: Capability of reconfiguration - cross-cluster routine profiles

In percent

Existence of and participation in…	Share of participants aware of routine (Share of participants participating)				
	ALPHA	**BETA**	**GAMMA**	**DELTA**	**EPSILON**
• Formal rules for becoming members	87	85	67	75	11
• Active new member recruiting	27	92	27	67	0
• Participation in cluster-wide trainings	19 (13)	56 (6)	95 (95)	40 (0)	69 (31)
• Participation in cluster support offers	31 (31)	27 (18)	100 (95)	50 (30)	67 (47)
– Identification of joint project opportunities	31 (31)	29 (12)	100 (79)	40 (10)	59 (29)
– Project set-up	31 (31)	24 (6)	100 (79)	50 (10)	41 (12)
– Project management	38 (38)	24 (12)	100 (74)	20 (0)	47 (18)
– Project auditing	6 (6)	18 (6)	100 (95)	40 (10)	47 (6)
– Access to cluster-external resources	19 (19)	24 (12)	100 (74)	40 (10)	47 (18)
– Draft contracts for internal collaboration	0 (0)	24 (0)	100 (100)	40 (0)	41 (12)
– Draft contracts for external collaboration	0 (0)	24 (6)	100 (100)	40 (0)	35 (6)
– Conflict management rules	6 (6)	45 (0)	100 (21)	40 (0)	29 (6)
– Conflict moderator	6 (0)	24 (6)	100 (0)	40 (0)	41 (12)
– Sanctions	0 (0)	18 (0)	100 (11)	40 (0)	35 (12)

The empirical research provides a diverse picture with regard to the relevance of the routines that might support the creation of the capability of reconfiguration (Table 25). These concern the definition of membership criteria, the strategic extension of the group of cluster participants as well as training and support offers to cluster co-operations. In some instances, the routine profiles differ substantially from the capability profile. One reason for this could be the fact that it is linked more to the clusters' future potential then to past achievings. In cluster GAMMA, for example, where co-operation was substantially limited and now increases in small business associations, these activities contribute substantially to a perceived capability of reconfiguration. Some respondents pointed out that this capability would be much easier to read once GALILEO is in place.

With regard to the specific routines, this project does not provide strong evidence on the role of training or other support offers by a core cluster entity to the to the cluster participants. This might either indicate that training and support offers are not important

and should not be included in a subsequent study. At the same time, this might be due to the early age of these support mechanisms. In the clusters, the supporting infrastructure largely is still informal. In several instances, the extension of informal offers to a broader group is encouraged by the cluster participants. In addition to the routines covered in this research projects, some respondents suggested adding financial support to projects to the list of routines to increase its comprehensiveness.

Excluding training and other support offers from the picture, the profound differences among the routine profile and the capability profile only show in the cases of cluster ALPHA, GAMMA, and DELTA. In the case of cluster DELTA, the age of the cluster might explain an insufficient translation of the routine profile into both elements of the construct of the capability of reconfiguration. In the case of cluster GAMMA, a strong capability profile despite weak member rules and limited member acquisition activities might result from the bias towards the business associations. Cluster ALPHA exhibits strong membership rules, including the location of potential participants. This at the same time also limits the potential to acquire new members. As the cluster already comprises virtually all relevant actors in the core region, this might not result in a negative impact on the capability of reconfiguration.

As pointed out before, the quality of the routines might also provide an explanation for the finding that the routine profiles do not necessarily correlate with the capability profiles. For example, in contrast to the quantitative interview findings, the qualitative interview findings suggest that cluster BETA provides the strongest and broadest, though highly informal support to its participants. While cluster BETA's support is informal and offered by well-known individuals, the variety of different support offers in cluster EPSILON appears to not reach its audience. Similar to cluster BETA's gap in formal and informal responses, cluster GAMMA's indication of a strong supporting infrastructure did not find any evidence in archival data.

The empirical results allow for three insights into the quality of the operationalization chosen for the capability of reconfiguration (Table 26). Firstly, the two elements are strongly aligned, apart from in cluster DELTA. Secondly, the clusters' participants were able to react to all of them, supporting the operationalization as understandable and measurable. Thirdly, the clusters overall obtain very different aggregate scores, pointing

at substantial capability differences, which can only partially be explained by the routine profiles. Further research is required to test the operationalizations.

Table 26: Capability of reconfiguration - cross-cluster capability profiles

Distance to average, percentage points
● Far above, >10
◕ Above >3-10
◑ Average ><3
◔ Below <3-10
○ Far below, <10

Operationalization of reconfiguration capability	Cluster					Average across clusters[1]
	Alpha	Beta	Gamma	Delta	Epsilon	
• Joint cluster activities enable new endeavors	◕	●	●	○	○	63
• Cluster is excellent resource pool to participants	◕	●	●	●	○	58
Average score[1]	**63**	**74**	**74**	**55**	**35**	**60**

1 Percentage of positive answers minus percentage of negative answers

5.3.2.4 Opportunity recognition

The cases provide evidence on the perceived existence and relevancy of the capability of opportunity recognition, as well as the operationalization chosen in this research project. The clusters exhibited different capability profiles. The relative prominence of the elements chosen to operationalize the capability of opportunity recognition correlated, except for a strong difference in cluster EPSILON. This generally supports the operationalization of this capability developed in this study. Additionally, the balanced profile of market and technology trend recognition might support the innovativeness of the respective clusters.

Table 27: Capability of opportunity recognition - cross-cluster routine profiles

In percent

Existence and reading of…	Share of participants aware of routine (Share of participants participating)				
	ALPHA	BETA	GAMMA	DELTA	EPSILON
• Information	36 (29)	65 (35)	100 (95)	40 (27)	71 (65)
– … on market trends	36 (29)	47 (18)	100 (95)	20 (20)	65 (59)
– … on technology trends	36 (29)	53 (24)	100 (95)	20 (20)	71 (59)
– … on upcoming events	43 (36)	53 (35)	100 (95)	30 (30)	65 (59)

In contrast, the routine profiles (Table 27) of most clusters do not appear to be liked to the capability of opportunity recognition. Several reasons might explain this. On the one hand, the routines might have been introduced recently and not yet have had enough time to create the capability. Also, several respondents pointed out that they would consciously not engage in opportunity recognition as GALILEO has not yet been launched. At the same time, according to the participants' comments in the unstructured sections of the questionnaire, the sensitivity of relevant information itself also inherently limits the access to and dissemination of relevant knowledge to a few protagonists, also limiting the knowledge flow to bilateral interactions within the cluster. Accordingly, while opportunity recognition might still become (more) relevant, any formal facilitation within the clusters would likely lie in network creation and enhancing as well as high level information dissemination.

This specific routine set within the cluster would also be in line with the variety of information needs expressed by the different cluster participants. On the one hand, several participants expressed a general need for economic and technological intelligence, as several players are not aware of the potential of satellite navigation applications. On the other, some participants are already involved in application development or in relevant research activities and thus require very specific technological or market knowledge. Supporting cluster routines in the former case might be through road-shows or generalist events. For the latter, they might be informal information brokering, specific events and in some instances through specific newsletters disseminated by specialized actors. However, the relevant information often is sensitive and thus not subject of broad

sharing, underlining the cluster's role of a facilitator. The case of cluster GAMMA supports this. In contrast to the respondents' indication that routines exist, these do not find any archival evidence. Still, they might be shared highly informally within the business associations. Additionally, a core cluster institution would typically not be best informed in the cluster. In contrast, companies and research institutes often are better informed. Thus, information dissemination naturally is of limited value to technology and market opportunity-focussed actors. However, the core institution might play a role in enabling participants in reaching out to entities outside the cluster for information.

These findings propose changing the relevant cluster routines into informal contacts, knowledge brokering and professional events. According to the respondents, informal contacts and potentially knowledge brokering services are most appropriate for dealing with often sensitive information. Professional events appear to offer the best platform for discussing implications. At the same time, the quality of the routines again requires consideration. For example, cluster BETA exhibits weak routines. However, the participants that are informally connected by them appear to drive opportunity recognition in the cluster.

A review of the operationalization of the capability of opportunity recognition across clusters (Table 28) provides three insights. Firstly, the elements are quite strongly linked within clusters. Secondly, the clusters' participants were able to react to both, supporting the operationalization as understandable and measurable. Thirdly, the clusters overall obtain different aggregate scores, pointing at substantial capability differences, which however cannot be explained by the routine profiles. These findings can only be preliminary, further research could support further testing of the operationalization of routines and the capability.

Table 28: Capability of opportunity recognition - cross-cluster capability profiles

Distance to average, percentage points
● Far above, >10
◕ Above >3-10
◑ Average >=<3
◔ Below <3-10
○ Far below, <10

Operationalization of opportunity recognition capability	Cluster Alpha	Beta	Gamma	Delta	Epsilon	Average across clusters[1]
• Firms quickly perceive market changes	○	●	●	●	○	36
• Firms quickly perceive technology changes	○	◕	◕	◑	◕	54
Average score[1]	**20**	**55**	**62**	**50**	**38**	**45**

1 Percentage of positive answers minus percentage of negative answers

5.3.2.5 Networking

The cases provide evidence on the perceived existence and relevancy of the capability of networking, as well as the operationalization chosen in this research project. The clusters exhibited different capability profiles. In three of five cases, the relative prominence of the elements chosen to operationalize the capability of networking correlated. In both other cases, ALPHA and GAMMA, the context of the clusters provides strong explanations. The participants of cluster ALPHA acknowledged relatively few cluster contacts to the most relevant satellite navigation actors. At the same time, they perceived a strong cluster image. Cluster ALPHA is a young cluster that is building on a strong regional image. Thus, it did not yet have the chance to create own contacts. Cluster GAMMA is in the opposite situation. It is building on a variety of international market and other contacts held largely by the individual businesses. However, as no core cluster entity exists, the cluster does not have any image. Accordingly, the findings generally support the operationalization of this capability developed in this study.

Table 29: Capability of networking - cross-cluster routine profiles

In percent

Existence and frequency of…	Share of participants aware of routine (Share of participants participating)				
	ALPHA	BETA	GAMMA	DELTA	EPSILON
• Contacts to external players	56	80	95	50	92
• Public relations work for cluster by participants	82	88	100	100	65
• Cluster representation in external professional events	38	74	89	38	70

The routine profiles of the clusters exhibit a link to their capability profiles. In that, all three routines appear to be of relevance (Table 29), the routine of public relations work, the participation in external events in the name of the cluster as well as the linkages to external entities. Again, the quality of routines appears to foster their impact on this capability. Broad member support to public relations work of the cluster, its clear representation on external events and not only the individual representation of single enterprises or research institutes, and the establishment of linkages to entities potentially supporting the cluster support the networking capability. Cluster ALPHA's routine profile confirms that it relies on the region's image and did not have the chance to create its

Also, the evidence for the temporal path is strong. The clusters GAMMA and DELTA virtually have no history in cluster cooperation. These have the lowest perceived cluster image. Along the same lines, clusters with a limited history in external orientation, such as DELTA and ALPHA score low on external contacts.

The semi-structured questionnaire offered the respondents room for extending the list of potentially relevant routines. These however have only been used in rare instances. With regard to the capability of networking, these extensions concerned the use of firm websites or presentations as instruments of supporting regional public relations work. Some respondents from business-oriented cluster (sub-)association suggested to include contacts to large enterprises as relevant cluster linkages.

Furthermore, a review of the operationalization of the capability of networking across clusters (Table 30) provides three insights. Firstly, the strength of the elements differec across clusters while both appear important. Secondly, the clusters' participants were able to react to all of them, supporting the operationalization as understandable and measurable. Thirdly, the clusters overall obtain very different aggregate scores, pointing at substantial capability differences, which can in most cases be explained by the routine profiles. Cluster GAMMA is the exception, which might be due to the cluster participants' focus on smaller co-operating entities then the cluster when considering routines. However, these findings can only be preliminary. Further research could potentially reduce the number of operationalizing elements.

Table 30: Capability of networking - cross-cluster capability profiles

Distance to average, percentage points
● Far above, >10
◕ Above >3-10
◑ Average >=<3
◔ Below <3-10
○ Far below, <10

Operationalization of networking capability	Cluster					Average across clusters[1]
	Alpha	Beta	Gamma	Delta	Epsilon	
• Cluster is well connected to major players	○	◕	●	○	◕	65
• Cluster has a strong image	●	●	○	○	◑	28
Average score[1]	**53**	**65**	**50**	**13**	**50**	**46**

1 Percentage of positive answers minus percentage of negative answers

5.3.3 Cross-cluster innovativeness and performance

This research indicates a disconnect between a cluster's past performance development and the perceived innovativeness. Across clusters, this research indicated a growth of the satellite navigation segment, in share of GDP, employment, market shares and start-ups and the number of co-operations. This growth was most profound in cluster DELTA. In this cluster, 20-30% of the respondents almost consistently pointed at growth rates of above 10% in absolute and relative GDP, employment, market share and the creation of start-ups. This is surprising, given the cluster's low capability profile. At the same time, the cluster's context again provides an explanation. The cluster encompasses a variety of start-ups that experienced strong growth over the past years. Cluster ALPHA showed the second-strongest results, which interestingly are consistently lower for satellite navigation than for the overall cluster. Cluster EPSILON and BETA followed, both largely indicating growth rates between 1 and 5%. For both of them, the growth rate for new co-operations was substantially higher with above 10%. Cluster GAMMA showed the weakest growth. These results might support this research project's expectation that it is too early to observe the impact of capabilities on (past) performance.

The perceived past development of key indicators is often not strongly in line with the qualitative perceptions of cluster innovativeness in the clusters. At the same time, the perceived level of innovativeness is in line with the strength of the clusters' capability profiles in all clusters but cluster EPSILON (see Chapters 5.2.1.4, 5.2.2.4, 5.2.3.4, 5.3.4.4 and 5.2.5.4). For example, cluster ALPHA shows low perceived innovativeness in line with its overall routine and capability profile and at the same time in contrast to its asset profile. The cluster itself is not innovative and the cluster firms and/or institutions do not define market and technology trends, do barely translate perceived trends into new products and are generally not fast in reacting to these trends. Along the same lines, cluster BETA's and GAMMA's relatively strong routine and capability profiles are reflected in strong perceived innovativeness. Cluster DELTA's profile of innovativeness is slightly worse than its capability and routine profile, especially when compared to cluster EPSILON. Cluster EPSILON, however, builds on a substantially stronger and more established resource base, which can contribute to this better result.

The analysis of cross-cluster innovativeness and performance can only be indicative at this point in time. Still, several reasons could explain the disconnect between the perceived past development of core economic indicators and the clusters' perceived innovativeness and capability profile. One lies in the youth of the clusters. Once routines and at a later stage capabilities have been developed, their translation into innovations, including, for example, product development and the creation of start-ups would still take some time. This applies even more to the translation of innovations into significant economic growth. Another reason lies in the fact that the expected technology disruption that is expected to occur with GALILEO has not arrived yet. Thus, any products building on GALILEO do not yet find a market, no matter how large their potential is. Furthermore, no comparable statistical data exist that would allow for validating the participants' perceived growth rates. However, the clusters' perceived performances provide insights into their past and current state.

This research served the three purposes laid out in Chapter 1.3. First, it determined the availability and non-availability of indicators. Second, it provided insights into the potential of respondents to provide consistent estimates. Third, it served as a zero measurement for further studies. As mentioned before, this research confirmed that comparable statistical data on cluster innovativeness and performance generally is not available. However, the respondents provided largely consistent estimates of the development of performance indicators over time, especially GDP, employment and start-ups. Besides strong differences across clusters in the participants' willingness to estimate past developments, across clusters, market share estimates were generally perceived as hardest and often limited to Europe. Similarly, few participants had transparency of the number of co-operations in the cluster (compare Figures 34, 38, 42, 46 and 50).

5.3.4 Pattern identification: Case-based evidence on the static and dynamic relationship among the constructs

5.3.4.1 Impact of cluster context on cluster assets, routines, capabilities and performance

In Chapter 3.2.1, the cluster's context was defined as its age, its previous specialization and the perceived existence of the cluster by the respondents. This research provides evidence on the relevancy of the clusters age, previous experience as well as the clusters' perceived existence, although it could only leverage a retrospective focus and the retrospective data availability was limited both in the interviews and the archival data. While all elements show an impact on the clusters' routine and capability profiles, the quality of the clusters' assets appears to not be affected by them.

The cluster's age absolutely and relatively impacts the cluster's routine, capability and performance profile. Across clusters, the clusters that were longest in existence show the strongest overall routine and capability profile (Table 31). This supports the hypothesis, that routines as well as capabilities are learned and built over time. This research also provides evidence on the relevance of relevant experiences and co-operation. In Chapter 5.3.2, the author discussed the repeated finding that the quality of routines has an impact on their potential to build capabilities in more detail. Similarly, the clusters' specific prior experiences appear to be of utmost importance. The clusters' prior specialization in combination with their respective ages appear to strongly predict cluster routine and capability development over time. While cluster EPSILON, for example, has a strong tradition in satellite navigation technology, its application focus evolved rather recently, rendering the cluster relatively young. Accordingly, its strong asset position is not mapped by a strong routine or capability profile.

Table 31: Mapping the clusters' ages and prior specializations with their assets, routines, capabilities and performance

	Cluster				
	Alpha	**Beta**	**Gamma**	**Delta**	**Epsilon**
Age					
Prior specialisation					
Endowment with assets					
Strength of routines					
Strength of capabilities					
Cluster performance					

Similarly, the extent of the perceived existence of the cluster provides a read on the embeddedness of a critical number of participants in the cluster. As discussed in Chapter 5.3.2, this level of dedication also contributes to the quality of routines and thus stronger routines and capabilities. The findings illustrated in Table 32 consistently support this, when cluster GAMMA's participants' bias towards the small co-operating entities is accounted for.

Table 32: Mapping the clusters' perceived existence with their assets, routines, capabilities and performance

	Cluster				
	Alpha	**Beta**	**Gamma**	**Delta**	**Epsilon**
Perceived existence					
Endowment with assets					
Strength of routines					
Strength of capabilities					
Cluster performance					

5.3.4.2 Impact of cluster assets on cluster routines, capabilities and performance

In contrast to typical expectations, the clusters' current endowment with assets neither appears to exert a strong influence on the clusters' routines and capabilities nor on cluster innovativeness or performance. According to these findings, a strong asset base alone cannot explain a strong routine or capability base and does not ensure a strong performance. However, over time it might foster cluster performance together with a strong capability profile. Across clusters, the asset base is specifically perceived as an enabler to translate new ideas or technologies into market products and revenues. Table 33 provides an overview of the clusters' context factors, assets, routine base and capability profile as well as perceived performance.

Table 33: Comparison of the clusters' performance along the major elements of the model

	Cluster				
Characteristics	**Alpha**	**Beta**	**Gamma**	**Delta**	**Epsilon**
Context factors					
• Age	◔	●	◔	○	◕
• Prior specialization	◔	●	◔	◔	◔
• Perceived existence	◑	●	◔	○	◑
Endowment with assets	◕	◑	◔	◔	●
Strength of routines	○	◕	●	○	◑
Strength of capabilities					
• Community building	○	●	●	○	○
• Strategic alignment	◑	●	●	◔	○
• Reconfiguration	◕	●	●	◔	○
• Opportunity recognition	○	◕	●	◕	◔
• Networking	◕	●	◕	○	◕
Perceived cluster performance	○	◑	◔	○	◑

Several reasons might underlie the finding that a strong asset base does not coincide with strong routines. One explanation might be that it is linked to either few, very strong players, which might then also drive innovativeness on their own. Another explanation could lie in the size of the cluster, as larger clusters are more likely to posses more assets but at the same time are more challenged in developing high-quality routines. Both,

cluster ALPHA and EPSILON appear to struggle more with providing a platform for their participants. The endowment with a strong supporting infrastructure does not appear to support the creation of capabilities or cluster innovativeness. Furthermore, a strong cluster asset base can reflect past achievements, but also very strong players in the region. Their strength would not necessarily impact cluster performance.

However, the cluster's asset base still appears important for creating innovativeness from strong capabilities. In the unstructured sections of the interviews the participants of clusters with a weak supportive infrastructure pointed at the need for integrating more players. Overall, as the cases of the well-endowed clusters ALPHA and EPSILON demonstrate, the influence of routines is substantially stronger than that of the breadth of the cluster's resource base or its abilities. However, the relevancy of assets might increase while the cluster grows older.

Additionally, this research indicated that the clusters' specific regional environment can exert an impact on the creation and quality of routines. For example, cluster GAMMA's environment is characterized by competition and, according to several respondents, unfair play. Co-operation thus is difficult and the cluster entities are strongly oriented towards partners outside their region. Thus, the routines are all informal in nature, centered in the business association and no cluster image exists.

5.3.4.3 Impact of cluster innovation capabilities on performance

As laid out in Chapter 3.4.2, cluster innovation capabilities should be observable through the superior innovativeness and performance they inspire. For reasons laid out in Chapter 5.3.3, this is not the case for the perceived retrospective growth rates. At the same time, a comparison of the clusters' routine and capability profiles with their perceived level of innovativeness and performance support the perception that a stronger capability profile drives stronger performance. As the single case reviews have shown, the clusters' levels of perceived innovativeness align with their capability profiles in all clusters but cluster EPSILON.

The research results indicated a strong role of routine quality when analysing routine profiles. Similarly, the clusters' performance appears strongest when combined with a

consistently strong capability profile. Rejeb et al. (2008) had similar findings for innovation management. Single strong capabilities appear to exert a far lower impact on performance than a consistently medium capability profile. Examples for these types of outliers can be found in cluster DELTA's strong capabilities of reconfiguration and opportunity recognition and cluster ALPHA's strong capability of reconfiguration and networking. However, the perceived strength of the cluster's companies can add to the perceived cluster performance, as in the case of cluster EPSILON. In cluster GAMMA, the proximity of the entities involved in the clusters to the economic process might have caused a boost to performance.

5.4 DEVELOPING THE CLUSTER INNOVATION CAPABILITIES VIEW

5.4.1 Deriving hypotheses on cluster innovation capabilities

The research results presented in Chapter 5.2 and 5.3 allow for developing hypotheses, answering the research questions that underlie this research and formulating a model of cluster innovativeness. The following paragraphs will develop the hypotheses that underlie the model of cluster innovativeness.

1. Innovation capabilities of technology clusters are observable across clusters

The results presented in Chapter 5.3 have provided substantial evidence that capabilities are observable across clusters, independent of their characteristics, such as size, strategic direction, composition or age. Accordingly, the capabilities investigated into here appear not to be cluster specific.

2. Innovation capabilities of technology clusters are formed by sets of routines

Following the cross-cluster results presented in Chapter 5.3.2, clusters that are endowed with high-quality routines also show strong capabilities. The number of routines is not necessarily relevant. Additionally, when taking the clusters' age and the age of the routines existence into account, though the data basis for the latter was limited, these factors appear to support the link between the existence of routines and the development of capabilities. This finding provides support to a learning of routines and, building on them, of capabilities over time. Thus, capabilities expose best practice characteristics, but are still specific in the routines they are building on (Eisenhardt & Martin, 2000).

In that, this research again benefitted from the very different characteristics of the clusters. On the one hand, regional associations in the field of satellite navigation are still young, while on the other some clusters are already building on long traditions of communication and co-operation in that field. The last chapter has provided strong evidence for this hypothesis, especially for the capabilities of community building, strategic alignment and networking. However, as the case of cluster EPSILON

demonstrated for the capability of community building, not only the existence of the routine is of relevance, but also its focus, the (extent of) relevance for the community and the community's interest and participation.

3. Innovation capabilities of technology clusters can to some extent be formed by human action

Building on hypothesis 2, this research provides evidence to the human hand in developing routines and thus also capabilities. However, routines set up and supported by specific actors do not necessarily need to be successful. Due to their co-evolutionary nature, they require substantial preparation in the sense of the creation of interest and a sense of belonging and have to be focused on the community's needs. In addition, regional traditions, culture and existing routines impact the specific routines required.

4. Innovation capabilities of regional technology clusters contribute to cluster innovativeness

While the evidence on the link between capabilities and cluster innovativeness is still largely qualitative, this early research supports it from a static perspective. Thus, it is even more likely that a link might exist over time, in that capabilities first need to reach a specific strength and impact the cluster's activities for a while before they fully show their impact in innovativeness. As Porter (2008) indicates, the development of clusters can take a decade. It would be presumptuous to assume any substantial impact of capabilities on the regional economy of clusters that are less than two years old. Additionally, due to the current technological insecurity several companies are putting their investments in the field on hold.

5. Innovation capabilities of technology clusters are inter-member capabilities

This empirical investigation into the five clusters supported the inter-member nature of capabilities. Across clusters, the respondents provided very consistent answers with regard to the existence of cluster routines. Additionally, as Chapter 5.3.4 shows, routines and thus inter-member alignment is much more relevant than, for example, the clusters' asset base. The relevancy of the quality of routines underlines this. For example, cluster EPSILON shows less innovation capabilities as well as perceived performance than

smaller clusters with more limited resource bases. Among others, the limited alignment among cluster EPSILON's members appears to support this.

Additionally, there is a size dimension to the notion of inter-member capabilities. Some clusters show strong subgroups, which might also have built innovation capabilities. Cluster GAMMA is a strong example of this. However, these subgroups are subject to strong growth constraints, given their limited size, diversity and/or relevant knowledge base. At the same time, growth of small subgroups can pose a challenge to the established, informal communities had they not engaged in substantial networking earlier.

6. A strong technology cluster's asset base can support the translation of capabilities into innovativeness and performance

This research has indicated that for none of the clusters under investigation, the cluster's asset base is correlated to the strength of its routines or capabilities. However, the participants have pointed at the relevancy of assets in the unstructured sections. Building on rational reasoning, I propose the hypothesis that assets are not only required to create a cluster and develop routines, but also impact the translation of strong capabilities into measureable economic impact over time. Several reasons might explain the missing link in this study (see Chapter 5.3.4.2).

5.4.2 Answering the research questions on cluster innovation capabilities

Building on these hypotheses, the research questions underlying this effort can be answered. Specifically, these concerned first, the nature of cluster innovation capabilities, second, their existence, third, their creation and replicability, fourth, their impact on cluster innovativeness and fifth, their interaction with other factors that contribute to cluster innovativeness.

Overall, this research provided evidence that cluster innovation capabilities exist and are created by learned sets of intra- and inter-cluster routines that impact cluster innovativeness and performance over time. Ideally, they are supplemented by strong cluster assets to develop the maximum impact on innovativeness and performance.

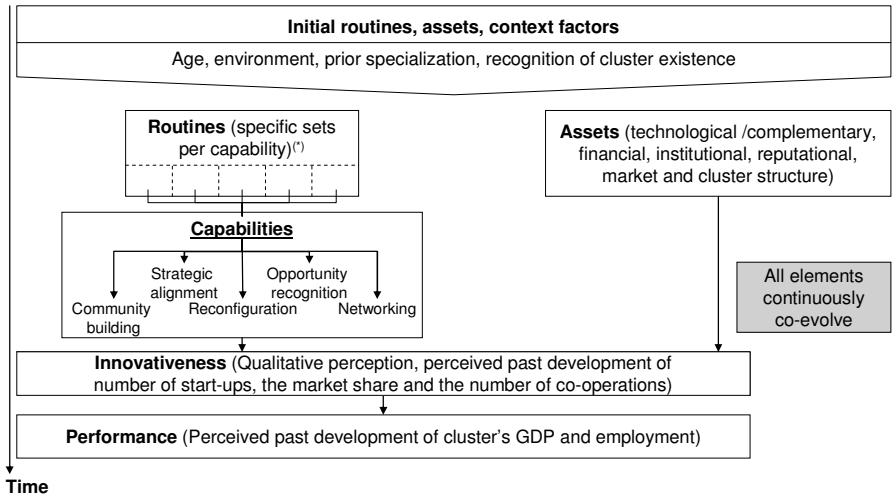
Conceptually, cluster innovation capabilities are thus comparable to dynamic capabilities on the firm level.

This overview already provides answers on the existence and nature of cluster innovation capabilities. Furthermore, they are observable across clusters. While an initial asset base together with cluster-specific routines contribute to their creation, the required specificity only allows for recognizing capabilities on a high level across clusters. However, copying routines existing in another cluster does not necessarily support the creation of a capability. Thus, conscious human efforts to create these routines increase the probability of building high-quality routines as well as of creating capabilities, but are no safe path to it. This research also provided early evidence on the positive impact of capabilities on innovativeness. It appears that for achieving maximum impact on innovativeness, the capabilities need to be supplemented by a strong asset base.

5.4.3 Developing a model of cluster innovation capabilities

The empirical findings of this research strongly support a model of cluster innovativeness that is conceptually close to the dynamic capability model of the firm. On the firm level, assets and capabilities are modelled as drivers of innovativeness, while capabilities are created based on routines. Figure 51 provides an overview of the model.

Figure 51: A model of cluster innovativeness



* Community building: Professional, social events, competitions and competence profiles
** Strategic alignment: Leadership team, governance rules, direction and its revision, performance review, newsletter
*** Re-configuration: Member rules and acquisition, training
**** Opportunity recognition: Dissemination of information on market, technology trends and events
***** Networking: Co-operations outside cluster, public relations work for the cluster, external representation of cluster

This research provides early evidence on the impact of assets on cluster innovativeness and the impact of routines on capabilities and of capabilities on innovativeness. Additionally, context factors showed to have an impact on the creation of routines and capabilities, i.e. the cluster's age and previous specialization as well as the cluster's perceived existence. Its environment also has an impact on which routines are more or less likely to support cluster innovativeness and performance. Furthermore, this research has indicated that routines also need to be in place for some time to potentially form capabilities. Thus, the findings of this research also underline the co-evolutionary nature of capabilities and the dynamic as well as probabilistic approach required to understand cluster innovativeness.

None of the interviews returned additional drivers or facilitators of cluster innovativeness or performance with relevancy across clusters, neither the unstructured sections of the interviews nor in the section on cluster strength and weaknesses.

This research reconfirmed the strong need for a dynamic account of cluster innovativeness. The strong impact of cluster age and prior specialization supported the relevancy of learning in building routines and capabilities. Given the early development stage of the clusters, time will have to tell how strongly the impact of capabilities continues to impact cluster innovativeness and performance. A static perspective on cluster innovation capabilities allows only for determining their past impact on performance (through looking at performance indicators) and their potential future development (through looking at routines). However, not understanding where the cluster comes from significantly impedes the potential to predict its future development. Two clusters might expose a very similar routines profile, with one of them deteriorating and the other one improving substantially.

Additionally, this research points at the interdependent nature of capabilities in impacting innovativeness and performance. Single, strong capabilities in a cluster's capability profile appear not to be able to significantly influence its perceived performance. Their impact rather appears to be below average.

6 RESEARCH RESULTS - EMBEDDING INTO THE LITERATURE, SUMMARY AND OUTLOOK

6.1 CONTRASTING THE RESULTS WITH THE LITERATURE ON DYNAMIC CAPABILITIES

This research largely supports the concept of dynamic capabilities, extends and specifies it for the cluster level and adds some insights into discussions ongoing in the dynamic capability community.

This empirical research supports the existence of cluster level innovation capabilities and their close conceptual relatedness to dynamic capabilities on the firm level. As proposed for dynamic capabilities (see Chapter 2.3.3), cluster innovation capabilities were observable through three elements. The first are routines and structures, which build capabilities. The second is the operationalization through their perceived existence. This research has provided support to this operationalization, though further research will allow for increased conciseness of this operationalization.

The third element for operationalizing innovation capabilities is the perceived cluster innovativeness or the change of economic indicators. While this link was clear for perceived innovativeness, this research did not return any clear results with regard to the perceived past development of economic indicators. However, there could be several reasons for this. On the one hand, GALILEO has not been launched yet. Thus, the impact of the new market opportunities can not yet be apparent. On the other, the model of cluster innovativeness developed in this research suggests, that clusters and their capabilities and performance builds over time. In that case, the young age of the clusters implies that the often recently developed routines and developing capabilities could not yet have exerted an impact on cluster performance. As dynamic capabilities, cluster innovation capabilities thus allow for exploration as well as exploitation. On the one hand, clusters currently engage in exploiting the position they acquired in GPS while, on

the other, preparing for GALILEO, EGNOS, or the system updates for GPS and GLONASS.

Furthermore, this research supported the conceptual embedding of capabilities into a theory of innovation and performance. The dynamic capability view builds on the firm's environment, its wealth or profit, on dynamic capabilities, the firm's assets and the paths or strategic options available to the firm. The concept of dynamic capabilities assumes firm embeddedness and posits, that the firm's assets shape and reside in the firm's capabilities, which then create the options, potentially generating profit. This research confirms the role of context, this time the cluster's, details the capabilities into routines and capabilities, indicates how capabilities develop over time through learning and provides early support to the impact of capabilities on innovativeness and performance.

This research only supports a weak impact of assets on routines and capabilities and allows to form early hypothesis on their impact on the cluster's potential to create innovativeness and performance. At least with regard to perceived innovativeness, the extent of perceived capabilities appears to have much stronger impact than the strength of the asset base. However, the limited age of the clusters renders additional analyses of the impact of innovation capabilities on innovativeness and performance necessary, especially once GALILEO is established and has been in operation for some time.

Additionally, this research largely confirmed the same capability types as were proposed on the firm level. While the insights into the capabilities of community building, strategic alignment, and networking provide a clear picture, future research is required on how the cluster capabilities of opportunity recognition and reconfiguration are created, once GALILEO is in place. This research also provides strong evidence on the need of a balanced capability profile. Evidence for this on the firm level so far is scarce. In contrast to Zollo's and Winter's emphasize on coding in capability learning, this research rather supports the role of routinization for learning.

This research also provided additional insights into the nature of routines once they become inter-organizational. It extends the scope beyond bilateral interactions and supports the creation of capabilities by clusters, independent of single cluster participants. Thus, it substantially extends Zollo's, Reuer's and Singh's idea of inter-organizational

capabilities. As predicted by early research into inter-organizational capabilities, this research confirmed the nature of cluster innovation capabilities are cross-participant capabilities.

While this is not at the center of dynamic capability research, this research points at the relevancy of the quality of routines, i.e. of three characteristics. First, they are to be targeted towards the target group and continue to change for fulfilling this objective. This ensures the participation of a critical number of participants. Second, the participants need to regularly participate in them. This research suggested that the influence of cluster routines decreases with less 'participation'. Third, their offer should be broad enough to attract a variety of actors, to avoid the formation of too strong subgroups. The research results also underline two drivers of routine effectiveness. These are on the one hand the relevancy of time, on the other that of routine quality. Both are essential for the effectiveness of routines in supporting the creation of capabilities. In clusters, the relevance of quality might be emphasized by the fact that cluster routines ideally do not only cross functions but also entity types. The need for the regular use of routines across a critical number of participants contradicts the potential to store routines.

One current discussion ranges about the nature of dynamic capabilities as sustainable competition factors. As posited by Eisenhardt and Martin, in this research effort several routines appeared to be equifinal in supporting the creation of specific innovation capabilities. Similarly, innovation capabilities are observable across clusters and expose best practice characteristics. As initially supported by this research, this implies that the capabilities required remain the same. Independent of their environment or the cluster context, they determine an overarching potential for change in the 'right' direction. The content on which they are applied and the individuals and entities involved in exerting them however might and will change. For example, a cluster is truly capable to network in case it is able to, among others, constantly establish new bonds and to shift them to acquire the then relevant resources or abilities. Furthermore, the ease of copying dynamic capabilities is subject to debate in the dynamic capability view. While this research effort cannot provide a final answer to this question, it suggests for innovation capabilities that all clusters should build a consistently strong set of capabilities and are theoretically in the position to do so. However, they need to create their specific routines, depending on

their assets, context factors and past paths adopted. While routines existing in other clusters might open search lenses, directly copying them is unlikely to be successful. The notion of creating a routine also hampers copying in the sense of a direct and immediate translation, but points at the need for time to learn.

Another current discussion touches on the characteristics of dynamic capabilities. According to Eisenhardt and Martin, routines change their nature in different environments, being more simple, iterative and experimental in dynamic markets and more complicated, analytic and linear in moderately dynamic markets. The cluster level routines identified in this research rather appear stable and simple, what might be linked to the dynamic nature of satellite navigation application markets and the highly insecure technological context. Additionally, the specific role of clusters as enablers and supporters might render them as well as their routines more stable as this could be the case on the firm level.

Within the concept of dynamic capabilities, there also are discussions ongoing on the location of dynamic capabilities within the firm. While some authors posit their nature as managerial characteristics, others suggest that they cross multiple levels. This research supports the latter assumption, strongly supporting cross-organizational interactions on different levels, i.e., on the management level for strategic alignment and the level of technology know-how for opportunity recognition.

6.2 CONTRASTING THE RESULTS WITH THE LITERATURE ON REGIONAL INNOVATIVENESS

6.2.1 Clusters

This empirical research incorporated several core elements of the concept of clusters (see Chapter 2.2.1), extending it to put more weight on routines and capabilities for explaining cluster performance. The research results confirm both, the core elements of cluster research and the shift in focus from assets to routines and capabilities and integrated relevant context factors into the scope of analysis. Furthermore, it underlines the relevancy of showing all capabilities to a comparable extent, instead of focussing only on one. Through linking these factors with performance, it allows for a performance-based definition and identification of clusters. Also, this research provides specific information on the nature of "institutions of collaboration" as well as the specific capabilities that Porter implicitly incorporates in his model. These insights impact the content of normative recommendations that are derived based on the cluster concept. Moreover, this research extended the research scope to a systematic analysis of the cluster level and underlined the probabilistic nature of cluster innovativeness.

Cluster theory very much centers around national, regional and firm assets, including the demand situation, the presence of supporting industries and factor conditions. While these factors cannot be neglected, this research indicates that it is more important to develop cluster capabilities that allow it to recognize and react to or cause changing circumstances and demand conditions rather than taking these as the priority focus for developing clusters. Still, the proximity to factor markets and customers might support cluster creation, but it might as well develop in a co-evolutionary manner with the cluster.

For Porter, collaboration-building institutions, in the sense of organizations, support the cluster. This research focused on routines and structures that are largely independent of driving organizations, but still provides insights into the role of organizations. Apparently, organizations with a focus on the technology or market are in a very good position to provide valuable support and platform-creation services. In contrast, the most

valued service of organizations that focus largely on general cluster development support was finding space, raising funds, or supporting public relations work.

With his collaboration-building organizations, Porter proposes to form rather formal cluster relationships while at the same time emphasizing the relevance of a common culture, of the actors knowing each other, of joint learning as well as of a sense of common interest. This early research suggests that formal, as well as and especially informal relationships are required for building the capabilities that Porter implicitly incorporates in his concept. The cluster BETA, for example, is working on a high level of informality although formal structures exist, are supported and strengthened. Apparently, both elements are important. Cluster ALPHA in contrast does not benefit from a high informality while implementing strong formal structures. It remains to be seen whether this constellation will support the creation of capabilities and performance. Generally, the respondents' calls for cluster formalizations were stronger when cluster respondents did not feel well integrated into the cluster. This underlines the relevancy of open borders between established networks to allow for a continuous growth of the cluster. At the same time, the capability of strategic alignment appears to be supported by some level of formality. At this point of time, the conclusion can only be that the cluster needs to allow for substantial informal activity while providing some structure to areas that find broad support by their members. As for the capability of opportunity recognition and reconfiguration, Porter locates them only on the firm level. While further research into these capabilities is required, this early research indicates that the respondents clearly perceive them as cluster level capabilities. In contrast to Porter's concept which only mentions contacts to external clusters as relevant, this research also underlines the role of the capability of networking with external partners. A cluster with strong external networks can access external assets and thus expand its asset base, rendering the initial endowment with assets less relevant.

The insights developed in this research can support normative recommendations with regard to cluster development. These would extend those developed based on the cluster concept. Establishing relevant routines and supporting networking becomes more prevalent than focusing on subsidizing or otherwise supporting the creation of a very strong asset base.

This research also allows for an extension of the cluster research approach. It provides initial evidence that research on cluster performance can fully incorporate the cluster level, instead of looking into specific firms and regional (not cluster) statistics. This acknowledges the fact that the cluster ideally is independent of the fate of single firms. Similarly, rather the overall level of assets is relevant than the assets held by specific firms. This research also underlines the relevancy of process research, i.e. dynamic and probabilistic research for understanding a cluster's inner working. The analysis of the impact of routines on capabilities and capabilities on innovativeness over time indicated the time-lag between the stages and thus point at the potential misinterpretations that might result from a static perspective on clusters.

6.2.2 Regional innovation systems

The concept of regional innovation systems (see Chapter 2.2.2) is very close to the model of cluster innovativeness developed in this research. It also acknowledges the cluster as a co-evolutionary entity embedded in the region, an open and learning system of which any analysis needs to include the environment. Also, it aims at analyzing the cluster on the cluster level. This research supports these characteristics as well as underlying assumptions such as the relevancy of learning and routines in the cluster. The institutions, in the sense of routines, proposed in the concept of regional innovation systems are very much in line with the routines analyzed in this research. This research extends the concept of regional innovation systems by providing more insights into the specific nature of routines, allowing to describe, identify, measure and potentially build relevant routines. The routines developed in this research specify the reaction to external changes and shaping of the environment to the routines that lead to the capability of opportunity recognition. Furthermore, it integrated relevant context factors as well as assets into the scope of analysis, providing a holistic picture of innovativeness.

Also, the concept of regional innovation systems underlines the relevancy of showing all capabilities to a comparable extent, instead of focussing only on one. This is supported by these research results. Through the capabilities, this research also establishes a direct linkage between routines and innovativeness and performance, allowing for a

performance-based cluster definition and identification and provides further means of measuring all elements of the model.

This research also supports the recent discussion within regional innovation system research on the relevancy of external links. Clusters can obtain several assets from outside their boundaries. The underlying capability of networking has proven to be highly relevant. Nonetheless, the exact potential of substituting internal with external assets remains subject of research.

Similar to cluster research, the research approach chosen in this study could also extend regional innovation system research.

6.2.3 Innovative milieux

The concept of the innovative milieu (see Chapter 2.2.3) explains cluster performance through an ability of recreating itself. For doing so, it builds on a set of relationships, a sense of belonging and the specific internal representation of a region as well as often the cluster's image. Furthermore, the milieu requires external contacts, a technological culture and know-how, a supporting infrastructure and in- and output markets for performance. The concept also inherently incorporates the milieu's age and prior specialization and the extent of belonging, thus covering the context factors. While the concept of innovative milieux, very much in line with the model developed here, strongly builds on assets and capabilities, it does not consistently operationalize the relevant capabilities and routines. This research allows it to become more specific by providing specific, observable and measurable routines, for example for the alignment of actors. Among them are routines such as establishing and reviewing a strategy and conducting performance measurements. Building on these and the recognition of performance, the capability of strategic alignment can then be observed. At the same time, this model allows for measuring normative alignment, building on the routines of community building. Furthermore, this research underlines the relevancy of showing all capabilities to a comparable extent. While the concept of innovative milieux largely builds on informal routines, this research provides some evidence that formal structures can be supportive to a certain extent.

Similar to cluster research, the research approach chosen in this study could also extend research into innovative milieux.

6.2.4 Regional networks

The concept of regional networks (see Chapter 2.2.4) largely focuses on proximity and strategic relationships among co-operating, specialized actors that are connected through informal linkages to explain performance. The model developed in this research effort supports these elements and supports the concept by laying out the different elements, i.e. context factors, assets, routines and capabilities in a structured and detailed manner. For example, the notion of mutual adjustment of participants is translated into specific, observable and measurable routines, as described in the last chapter. Another example is the notion of connections to external partners, which can be recognized through the frequency of external interactions as well as the participation in external events. leading to the creation of the capability of networking. Furthermore, the model developed in this research extends the informal notion of regional networks to incorporating the support of formal structures. At the same time, this research underlines the relevancy of showing all capabilities to a comparable extent and extends the largely descriptive concept of regional networks to provide insights into the drivers of performance and their creation. Through linking these factors with performance, it allows for a performance-based definition and identification of clusters.

This research could also provide additional pieces of evidence on the relevancy of weak ties, as discussed in the regional network research community. While this research did not explicitly look into the relevancy of tie strength, the relevancy of external contacts underlines the role of weak ties.

Similar to cluster research, the research approach chosen in this study could also extend regional network research.

6.3 OVERVIEW OF THE RESEARCH RESULTS

This research aimed at determining the contribution of cluster innovation capabilities to cluster innovativeness. For doing so, I conducted a theory building, retrospective cross-cluster research effort, building on the concept of dynamic capabilities, as well as insights into the contributors to regional innovativeness from the major research streams on regional innovativeness. These include research into clusters, regional innovation systems, innovative milieux and regional networks.

In this research, I was able to derive first hypothesis and a potentially comprehensive model of cluster innovativeness, building on recognition of patterns in retrospective data across very different clusters (for details, see Chapter 5.4).

Cluster innovation capabilities take a central role in this model, linking strongly to perceived cluster innovativeness across clusters. In that, their impact on perceived innovativeness is much stronger than that of cluster context factors or cluster assets. Several research questions detailed the research question, addressing their existence and nature, their source and their interaction with other factors contributing to innovativeness, on top of their impact in innovativeness. This research provides evidence on the existence, nature and sources of capabilities. Capabilities are in fact best practices underlying innovativeness, which are observable across clusters. Capabilities come into existence over time, building on sets of relevant routines. The specific routines and sets of routines required for capabilities to form relies on the cluster's context and asset base. Thus, routines could be copied but would then be unlikely to show high quality within the copying cluster, i.e. not regularly attracting diverse participant groups in a limited number of technology-specific routines. This renders capabilities, which need to build over time, impossible to copy as time and the specific, high-quality routines need to be available.

Naturally, clusters and their routines require assets to for their creation. Accordingly, capabilities building on routines implicitly embed assets. Beyond that, this research provides early evidence on the role of assets in translating capabilities and thus innovation potential into innovations and growth. Clusters with a strong asset base and a weak capability profile show low perceived innovativeness, but an increase of past performance. For clusters with a weaker asset base and a strong capability profile, the

picture was inverted. Potentially, combining both would allow for creating and leveraging the largest performance potential.

Taking a dynamic perspective on clusters and their innovativeness was at the heart of this research effort. This retrospective research aimed at providing a ground measurement of cluster context, assets, routines, capabilities, innovativeness and performance, especially given that the technology shock with GALILEO has not yet arrived. Though data on the age of routines was rare, both from interviews and the archival data, the available data consistently supports that routines as well as capabilities are learned, especially when also taking routine quality into account. Also, the current data base leaves room for cluster capabilities and perceived innovativeness to over time translate into cluster innovation and performance.

Theory building research aims at developing novel, testable and generalizable hypotheses and theory that are strongly tied to empirical evidence and can be tested in future research along the same, measureable and empirically tested constructs. The hypotheses and the theory of cluster innovativeness serve these objectives while at the same time providing new insights that can inform current strategic management as well as regional innovativeness research. Embedding the results into the literature has underlined this (Chapters 6.1 and 6.2)

6.4 CONTRIBUTIONS AND IMPLICATIONS OF RESEARCH

This research makes a contribution to theoretical research, especially regional innovativeness and dynamic capability research, as well as to the practitioner community.

This research contributes novel, comprehensive and dynamic, empirically tested, actionable and generalizable theory of cluster innovativeness. Thus, it firstly extends current research into regional innovativeness by integrating all potential factors contributing to innovativeness into a comprehensive framework, building on empirically tested operationalizations. Secondly, it provides a dynamic basis for analyzing innovativeness, including a tested research set-up. With this research set-up, it at the same time provides both higher predictive power and generalizability. This dynamic approach also informs the evolution of clusters. Thirdly, it provides a research approach that allows for consistently taking a network level research approach. Furthermore, this research provides the basis for an innovation- or performance-based definition of clusters. Defining clusters based on their endowment with assets does not provide substantial insights into their current or future innovativeness and growth. In contrast, analyzing their asset base as well as endowment with routines and innovation capabilities appears to have more predictive power.

As for dynamic capability research, this research also contributes by providing a network level research approach, extending the scarce research contributions on inter-organizational capabilities and providing new insights into the nature of inter-organizational routines and capabilities. Secondly, it extends the base of operationalized routines and capabilities. Third, it provides new insights into the sources of capabilities.

This research has several implications. It points at the need for a comprehensive, asset- and capability-based perspective on clusters. Furthermore, it requires dynamic understanding of clusters. A static perspective on clusters can not inform any decision on which element in the model requires strengthening. For example, a cluster might show a decent asset base, routine, capability and performance profile, indicating no need for immediate action. However, the cluster might follow a variety of paths that are unrecognizable from a static perspective. For example, the cluster might in fact just show

a consistently decent pipeline of performance drivers and performance, being in an equilibrium state. However, it might also have an eroding routine base which already impacted the capability profile and will subsequently impact the performance.

These findings have substantial implications for cluster development projects and cluster managers. This empirically confirmed and actionable model provides a comprehensive overview of the drivers of innovativeness in a stochastic sense as well as their relative relevancy over time and provides a basis for developing policies with measurable impact. Furthermore, they allow them to prioritize their investments into the cluster, to derive concrete actions needed with regard to the cluster's position and to determine the impact direction of their action. This is in line with current demands to provide transparency on funding decisions and their impact (Mccann, 2007). The following train of thought underlies this.

First, the research results imply that clusters can be strategically managed for innovativeness and performance. Through building adequate cluster routines and structures, human action can increase the probability of positive cluster development and performance. This research effort provides first and actionable insights into the routines and structures required. Additionally, the human hand can support the development of several assets.

However, this research secondly implies that basing cluster development efforts only on assets does not necessarily increase cluster innovativeness, but a balanced perspective on capabilities and assets is required. This poses a substantial change to current cluster policies and is in line with Autio's and his team's (2008) findings that enhancing the identification with communities of practice has a larger impact on learning than subsidizing for example R&D efforts. Interestingly, will in most cases render them a lot less investment-intensive than they are at this point in time.

Third, the findings support all voices calling for long-term strategies with regard to cluster development. As in all social-economic settings, changes require time. Investments into cluster routines will for sure not be visible in performance changes after a period of one to two years, which are typical impact review timeframes. Impact review standards should be changed from an asset-focus to a comprehensive account of the

drivers of innovativeness, and the evaluations should consider changes in routine and capability profiles as well. Alternatively, initial performance review cycles need to be extended substantially, decoupling them from legislative periods. The focus on developing innovation capabilities should be advantageous for the cluster independent of specific technological advances or market changes.

Furthermore, this research allows for providing investment and investment sequencing recommendations to cluster managers. First of all, the cluster should have a reasonable asset profile, but more importantly a good routine profile across the different capability categories (remember, that the routines and capabilities build some of the assets as well). Assuming that the cluster exposes strong differences in its routine profile, the marginal benefits of capability investment decisions appear to differ. Balanced routine and capability profiles appear to have a stronger impact on perceived innovativeness, thus investing into the weaker areas is the correct investment decision with higher marginal impact.

6.5 LIMITATIONS OF THE STUDY AND DIRECTIONS FOR FUTURE RESEARCH

Two interdependent limitations apply to this study. This study built a model of cluster innovativeness, building on a ground measurement of the elements as well as the available retrospective data. The technology shock required to demonstrate the impact of the clusters' innovation capabilities is only expected in 2013 (GPS Daily, 2009). Fully confirming the model thus requires first of all, ongoing longitudinal research into the model. Secondly, it requires the introduction of GALILEO as well as some time to pass to determine the clusters' performance within this new field. This longitudinal effort can build on the measurable and empirically tested concepts developed in this study. Findings this research might develop could relate firstly to the relative relevancy of and required extent of assets, routines and capabilities in creating innovativeness and performance. Secondly, they could clarify the routines required for building the capabilities, especially with regard to the capabilities of opportunity recognition and reconfiguration. Thirdly, they can help determine whether all or which specific capabilities and in which combination have a strong innovative impact and whether a temporal sequence applies to them, as suggested by Katzy and Crowston (2008). It could also provide additional insights into the duration of the process of building routines and translating them into capabilities, innovativeness and performance. These questions could also be applied to the asset base, i.e. the potential balance of accessing external assets through strong networking and owning assets internally or the relative composition of assets required over time, as addressed by Häussler and Zademach (2007). This research effort should largely build on a comparable research setting and could substantially benefit continuing to co-operate with the clusters selected in this study through leveraging the existing ground measurement.

Two further avenues of research can address biases encountered in this research. Generally, biases are inherent to the chosen research approach. The research design intended to delimit them to a minimum. However, there are two biases that should be explicitly addressed. First of all, this research provides strong evidence that culture might

impact the propensity of cluster participants to design other routines, build capabilities and translate them into innovativeness and performance. This cultural embeddedness or these cluster macrocultures form an interesting research area (see also Bell et al., 2009)

Secondly, this research defined four ex ante characteristics of clusters for their selection. First of all, they possess a regional center. Secondly, horizontal, vertical and lateral links exist and ensure a minimum level of interconnectedness. Thirdly, they comprise market and technology players, allowing to capture both types of innovation triggers. Fourthly, they benefit from a minimum endowment with technological and complementary, financial and institutional assets (see Chapter 3.2.3).

These ex ante defined cluster characteristics have an impact on the results of this study and allow for further learning from the case studies. The ex ante selection criteria potentially allowed all clusters to behave according to the model, as long as routines and capabilities had been developed. They were not restrictive to the findings on regional clusters, as the theoretical sampling approach ensured substantial diversity in the clusters.

This research has shown that interconnectedness is of high relevancy for creating and living routines and building capabilities. The proximity of the protagonists further supported this. Also, this research supports that the asset base, including market and technology know-how is an enabler for cluster performance, supporting the initial hypothesis.

There is application case that inherently is out of scope of this research, which are networks without defined regional centres. While this research emphasizes the role of networking, it inherently provides no support to the hypothesis that a non-proximate network could achieve similar levels of innovativeness. Nonetheless, with increasing relevancy of networking the regional centre might loose some of its relevancy.

This process-based research should be generalizable to other clusters as well. Testing not only the impact of GALILEO's operability on these clusters' innovativeness and performance, but also testing their extension to other technology and non-technology clusters within and outside of Europe would provide additional insights into the validity of this research. The research approach lends itself to investigating further into a variety of questions currently discussed in the academic literature, especially by providing a

research approach that inherently acknowledges the impact of time. As one example, Teece (2007) recently addressed the question of the linkage between the capabilities of individuals and firms again. The linkage among capabilities on the cluster and on the firm level would provide an interesting research area. Naturally, these directions for future research are not comprehensive.

ANNEX: INTERVIEW GUIDELINE

- MEMBER VERSION, ENGLISH -

The impact of cluster (regional) routines and structures on cluster (regional) performance

- Interview with cluster members -

All comments in italics are addressed to the interviewers

Filling out this questionnaire should not take longer than one hour

Part 1: General questions

1.1 Does your firm/institution engage in the development of satellite navigation applications or does it provide support to firms and institutions developing satellite navigation applications?

Yes	No	Don't know
□	□	□

1.2 Does your firm/institution belong to a cluster?

A cluster as defined in this questionnaire refers to regional agglomerations of firms focusing on the development of satellite navigation technology based applications. They are supported by a specialized infrastructure (business service providers, venture capitalists, universities, and others).

Yes	No	Don't know
□	□	□

=> "No" requires using the term "region" in the following.

1.3 Please indicate the relevant NUTS 3 or 2 region of your cluster (region) and provide correction when it does not confirm with a NUTS 2 or 3 – region

The Appendix 1 (not included here) offers information on the NUTS regions. Please apply the NUTS 3 region where feasible.

Yes	No	Don't know
□	□	□

Part 2. Cluster (regional) routines and structures

All of these questions relate to the field of satellite navigation technologies or their applications

Answers relate to the total number of cases as long as not indicated differently

2.1 How often do representatives of your firm/institution participate in professional events in your cluster/region?

These events can be organized formally or informally; the organizer might change

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

Please specify:

a. Conferences

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

b. Fairs

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

c. Work groups

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

d. Study tours

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

e. Cluster (regional) firm/institution visits

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

f. Other:_____

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

2.2 How often do representatives of your firm/institution participate in social events in your cluster/region?

These events can be organized formally as well as informally and the organizer might change

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Festivities

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

b. Sports events

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

c. Luncheons

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

d. Roundtables

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

e. Other:_____

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

2.3 Do representatives of your firm/institution read the cluster (regional) newsletter?

A newsletter needs to be published at least quarterly to be considered relevant

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

2.4 Do representatives of your firm/institution participate in competitions that are aimed at the creation of new innovations or new enterprises?

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

Which is the relevant geographic scope of these competitions (please circle)?

Cluster-wide/regional	National	European	Global

2.5 Do representatives of your firm/institution support the creation of a positive public image of the cluster/region?

The contribution needs to mention the cluster (region)

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Professional contributions in journals/books

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

b. Press reports about the cluster or cluster projects

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

c. Regular reports on the cluster's/regional activities

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

d. Cluster (regional) webpage

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

e. Cluster (regional) technology showroom

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

f. Other:_____

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

2.6 Do representatives of your firm/institution participate in cluster-wide (regional) trainings?

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

2.7 Do representatives of your firm/institution make use of cluster-wide (regional) support offers to cluster (regional) co-operation projects?

These support measures could be organized in a centralized as well as decentralized manner and organizers might change

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Support in the identification of joint project opportunities (including dissemination of calls)

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

b. Support in the setting up of joint projects

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

c. Support in project management

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

d. Support in project auditing

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

e. Support in gaining access to resources from outside the cluster (region)

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

f. Support through offering predefined sets of rules/contracts for internal co-operations (such as property rights distributions)

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

g. Support through offering predefined sets of rules/contracts for external co-operations

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

h. Support through offering rules for conflict management

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

i. Support through offering a neutral body for conflict management

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

k. Support through offering enforceable sanctioning mechanisms in case of misbehavior

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

l.
Other:_____

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

2.8 Do representatives of your firm/institution read information on market and technology trends distributed within the cluster/region?

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Information on customer trends

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

b. Information on competitors' market movements

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

c. Information on technological advances

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

d. Information on competitors' technological movements

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

e. Information on professional events outside the region

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

f.
Other:_____

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

2.9 In the cluster/region, all cluster (regional) co-operation projects are recorded

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Registration of new joint efforts

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

b. Registration of project progress

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

c. Registration of project results

None	1/4	1/2	3/4	Always	Unavailable	Don't know
□	□	□	□	□	□	□

2.10 Does your firm/institution confirm with the strategic direction of the cluster/region

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

Please specify:

a. Vision

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

b. Strategy

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

c. Targets

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

d. Strength and weaknesses

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

e. Opportunities and threats

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

f. Other:_____

None	1/4	1/2	3/4	Always	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

2.11 Is the cluster's/region's economic performance reviewed?

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

2.12 Are the competence profiles of the cluster's/region's firms/institutions updated?

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
☐	☐	☐	☐	☐	☐	☐

2.13 Is the strategic direction of the cluster (region) reviewed?

Please only ask for the elements defined as existing in 2.11)

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Vision

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

b. Strategy

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

c. Targets

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

d. Strength and weaknesses

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

e. Opportunities and threats

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

f. Other:_____

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

2.14 Does the cluster (region) co-operate with firms/institutions outside its geographical scope?

Please indicate the relevant geographic scope in the line indicated for it.

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Clusters

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

b. Associations

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

c. Institutes

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

d. Universities

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

e. Policy makers/governmental bodies

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

f.
Other:_____

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

2.15 The cluster (region) is regularly represented on professional events organized by firms/institutions outside its geographical scope

Please indicate the relevant geographic scope in the line indicated for it.

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Conferences

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

b. Fairs

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

c. Work groups

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

d. Study tours

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

e. Cluster (regional) firm/institution visits

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

f.
Other:_____

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

2.16 The cluster (region) is regularly represented on social events organized by firms/institutions outside its geographical scope

Please indicate the relevant geographic scope in the line indicated for it.

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

Please specify:

a. Festivities

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

b. Sports events

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

c. Luncheons

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

d. Roundtables

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

e.
Other:_____

□ National □ European □ Global

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

Please pose the following questions only if the firm/institution considers itself part of a cluster

2.17 To become part of the cluster, formal accession to the cluster along specific criteria is required

Yes	No	Don't know
□	□	□

2.18 Cluster membership entails a membership fee

Yes	No	Don't know
□	□	□

2.19 In the cluster, processes for new member recruitment are in place

Yes	No	Don't know
□	□	□

2.20 The cluster (region) engages in benchmarking with other regions

Yes	No	Don't know
□	□	□

2.21 Does the cluster have a leadership entity?

Yes	No	Don't know
□	□	□

2.22 Does the cluster have governance rules?

Yes	No	Don't know
□	□	□

2.23 How often does the cluster leadership meet?

Never	<1x p.a.	1x p.a.	4x p.a.	12x p.a.	Unavailable	Don't know
□	□	□	□	□	□	□

Respondent's comments

A) Strength of the cluster (region):

_____
_____
_____

B) Weaknesses of the cluster (region):

_____
_____
_____

C) Areas for improvement from the perspective of the respondent's firm/institution:

_____
_____
_____

D) Areas for improvement from the perspective of the cluster (region):

_____
_____
_____

Part 3. Respondent's perceptions of the cluster (region)

An innovation, as defined in this survey, is a new to market satellite navigation application

3.1 Overall, firms and institutions in the cluster (region) value innovativeness highly

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.2 Overall, the firms/institutions in the cluster (region) are very competitive

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.3 The cluster (region) has a strong culture

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.4 The cluster (region) has a strong image

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.5 Overall, conflict within the cluster barely occurs

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.6 Overall, the cluster (region) is very innovative

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.7 Overall, conflicts among the firms/institutions in the cluster are solved quickly

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.8 Overall, firms in the cluster quickly perceive changes customer driven changes in their markets

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.9 Overall, firms in the cluster quickly perceive changes competitor driven changes in their markets

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.10 Overall, the firms in the cluster (region) quickly perceive changes in their technology

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.11 Overall, the firms/institutions in the cluster (region) quickly react to customer driven changes in their markets

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.12 Overall, the firms/institutions in the cluster (region) quickly react to competitor driven changes in their markets

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.13 Overall, the firms/institutions in the cluster (region) quickly react to changes in their technology

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.14 In the cluster (region) knowledge is extensively being shared

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.15 Information on activities of the cluster (region) is hard to obtain

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.16 Overall, the firms/institutions in the cluster (region) know each other

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.17 The cluster (region) is connected with the major national, European and global players in the field of satellite navigation technologies and satellite navigation technology applications

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.18 Overall, co-operation with cluster (regional) firms/institutions is far easier than co-operation with external firms/institutions

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.19 Cluster (regional) co-operation projects often render possible endeavors that single firms/institutions could not have undertaken

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.20 Overall, the cluster's/region's strategic direction is supportive to the firms'/institutions' aims

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.21 Overall, the firms/institutions in the cluster create technological change

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.22 Overall, the cluster (region) is managed for performance

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.23 Overall, cluster (regional) firms/institutions define new market trends

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.24 Overall, the cluster's/region's firms are very good at translating market needs into new products

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.25 Overall, the cluster's/region's firms are successful in translating /technical) inventions into new products

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

3.26 The cluster (region) is an excellent pool of resources for its firms/institutions

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
□	□	□	□	□	□

Part 4. Cluster (regional) performance

The respondents probably will not know the figures requested in the following. Please proceed quickly through this section but strongly encourage estimates. In case the firm/institution considers itself part of a cluster, please ask for cluster data first. Use regional data indications only as the last resort.

Please be aware that the questions on the regional shares are unnecessary when no cluster exists and the region confirms with a NUTS classification.

GDP means gross domestic product

In case estimates are applied, please circle the word estimate in each response section; in case of estimates, data for 2005 needs to be provided. Else, please indicate the relevant year.

4.1 Absolute GDP generated by the cluster (region) in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the GDP generated by the cluster (region) has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

Some clusters are in existence for less than five years. Please indicate the number of years you were able to ask for

4.2 Share of satellite navigation applications and their support in absolute GDP generated by the cluster (region) in 2005

_____ € Estimate 2005 OR year:_____

Support areas include those fields such as universities and business service providers that do not themselves produce satellite navigation applications but support their creation

Over the past five years, the share of satellite navigation applications and their support in the GDP generated by the cluster (region) has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.3 GDP generated by the cluster (region) in the field of satellite navigation applications and their support as share of your NUTS region
The NUTS region has been defined in question 1.3)

_____ € Estimate 2005 OR year:_____

Over the past five years, share of satellite navigation applications and their support in the GDP of your NUTS region has:

4.4 Number of persons (FTEs) employed in the cluster (region) in 2005
FTEs are full time equivalents; if that data is not available, please use the absolute number of contracts and circle the word "contracts"

_____ € Estimate 2005 OR year:_____

Over the past five years, the number of persons employed in the cluster (region) as a share of the region has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.5 Number of persons (FTEs) employed in the cluster (region) in the field of satellite navigation applications or their support in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the number of persons employed in the cluster (region) in the field of satellite navigation applications or their support has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.6 Number of persons (FTEs) employed in the cluster (region) in the field of satellite navigation applications and their support as share of your NUTS region in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the number of persons employed in the cluster (region) in the field of satellite navigation applications and their support as share of your NUTS region has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.7 Share of the cluster (region) in the European satellite navigation application market in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the share of the cluster (region) in the European satellite navigation application market has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.8 Share of the cluster (region) in the global satellite navigation application market in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the share of the cluster (region) in the global satellite navigation application market has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.9 Net rate of firm creation in the cluster (region) during 2005

The net rate of firm creation is the difference among the number of firms founded and the number of firms that died during the reference time frame

_____ € Estimate 2005 OR year:_____

Over the past five years, the net rate of firm creations in the cluster (region) has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.10 Share of satellite navigation applications and their support in the net rate of firm creations in the cluster (region) in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the share of satellite navigation applications and their support in the net rate of firm creations in the cluster (region) has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.11 The net rate of firm creation in the field of satellite navigation applications and their support as share of your NUTS region in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the share of satellite navigation applications and their support in the net rate of firm creations in the NUTS region has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.12 Number of products/services new to market in the cluster (region) in 2005
Relevant products and services need to be new to the market. They include incremental and radical innovations (i.e., technologially new products and major product innovations).

_____ € Estimate 2005 OR year:_____

Over the past five years, the number of products/services new to market in the cluster/region has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.13 Share of satellite navigation applications in the number of products new to market in the cluster (region) in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the share of satellite navigation applications in the number of products new to market in the cluster (region) has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.14 Share of satellite navigation applications in the number of products new to market in the cluster (region) as share of your NUTS region in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the share of satellite navigation applications in the number of products new to market as share of the NUTS region in the cluster (region) has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.15 Number of co-operations in the cluster (region) in 2005

_____ € Estimate 2005 OR year:_____

Over the past five years, the number of co-operations in the cluster (region) in the field of satellite navigation applications has:

Increased heavily (> 10%)	Increased strongly (5-10%)	Increased modestly (1-5%)	Remained constant (+/-1%)	Decreased modestly (1-5%)	Decreased strongly (5-10%)	Decreased heavily (>10%)
□	□	□	□	□	□	□

4.16 Please indicate the major focus of co-operations:

_____
_____
_____

Part 5. Demographic information

For information on regional demarcations, please refer to Appendix 1.
For information on industry classifications, please refer to Appendix 2.

General information on the respondent

Name _____

Job title _____

Phone _____

Fax _____

Email _____

General information on the firm/institution

Name _____

Address _____

Location and postal code _____

Website _____

Date of establishment _____

Main activity in industry segment _____

Total turnover 2005 _____ €

Number of employees as of 31.12.2005 _____

Length of product lifecycle of major product _____ years

General information on the cluster/region

The respondent might not know the required information. Please proceed quickly through this part of the questionnaire.

Cluster (region) name _____

Cluster age _____

Main cluster (regional) activity lies in industry segment

_____

Cluster (regional) focus (including technologies, materials, processes, specific applications)

_____

Number of firms/institutions in the cluster (region) (estimates, when data not available)

_____

Number of employees in the cluster (region) (estimates, when data not available)

_____

Do you wish to obtain a copy of the results? Yes □ No □

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CURRICULUM VITAE

Nicole Röttmer was born on January 5, 1977 in Hamburg, Germany. In 1996, she attended the Otto-Friedrich-Universität Bamberg to study economics with a focus on international management, international economics and finance. During her studies, she completed several internships with international organizations, economic development institutions, research and consulting. Among them were the GTZ, the Inter-American Development Bank, the OECD, UNCTAD, the German Chamber of Commerce in Estonia. In 1998, she also completed a semester program on US Foreign Policy at the American University in Washington, DC. Nicole graduated in 2002 with a diploma, which is equivalent to a M.Sc. degree, and joined McKinsey & Company, an international strategic management consultancy. Her projects focused on enterprise transformation, innovation and operational excellence in automotive, the public sector and financial services.

In 2004, Nicole took a sabbatical to join Prof. Bernhard R. Katzy at the Centre for Technology and Innovation Management (CeTIM) at the University BW in Munich, Germany and at Leiden University, the Netherlands as an external researcher. With a special interest in the drivers and management of innovation and regional development, Nicole started a CeTIM research program on the drivers of innovation in European satellite navigation application clusters. During her research, she supported the scientific management of the European Commission's "CASTLE" project (Clusters in Aerospace and Satellite Navigation Technology Applications Linked to Entrepreneurial Innovation), acted as expert speaker for the Europe INNOVA Conference "Re-innovating Europe: Challenges for Clusters and Innovative Business" in 2006. Furthermore, she participated in several research conferences, workshops and colloquia, such as the ISFAM conference and doctoral colloquium and the CEMS doctoral consortium.

In 2007, Nicole rejoined McKinsey & Company in the USA. Since 2008, she supports McKinsey Germany as a project manager. Nicole primarily serves clients on transformation projects (strategy and operational excellence) as well as energy efficiency. Her clients are largely automotive and high tech players, but also financial services providers or public actors.