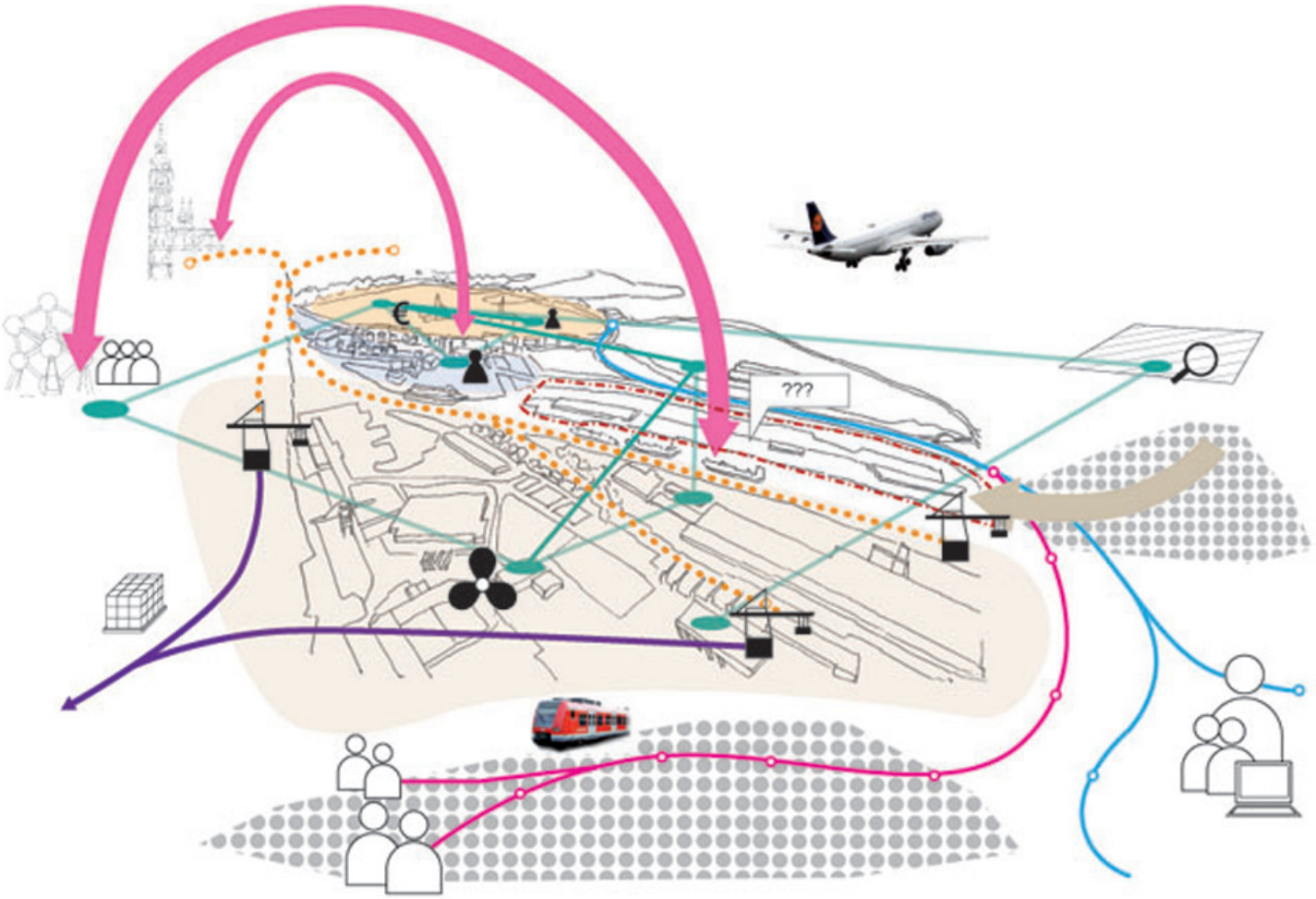
Processes of Exchange and Places of Encounter

The topology of the port-city interface
between spatial ambitions and functional realities

Anne Wiese



Fakultät für Architektur
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Anne Wiese

Summary

This thesis develops a theoretical concept of corporate sites as means of production in a network of exchange processes and applies this empirically to the case of the maritime economy in northern Germany. Structural change and globalization in this industry have spurred spatial development processes at the port-city interface, which are increasingly multi-scalar and withdraw themselves from human perception. Research to date suffers from a disciplinary divide between planning, transport geography and social sciences, creating fragmented spatial concepts and ambitions, which inadequately address the vision of prosperity of these places. Processes of material and immaterial exchange and places of encounter are intrinsically linked as corporate sites and facilities are increasingly defined by accessibility, meaning and location in relation to other places locally, regionally and globally.

The analysis shows three findings with regard to the development of spatial relations of the maritime economy. Firstly, the functional network of the maritime economy is held together by a limited number of actors, namely maritime service providers, shipbuilders and research institutions. Secondly, whereas spatial proximity is crucial for experience based learning at transformation based interfaces, cognitive proximity is equally important and a shared language drives specialization in engineering and high-tech activities globally. Thirdly, distinct processes of spatial development can be identified on the basis of the triangulation of methods employed: the first is a centralization of maritime services in main cities, particularly in Hamburg. These services are attracted to enhanced urban-based opportunities for face-to-face contact and greater accessibility to national and global partners. Other activities in manufacturing, such as shipbuilding and shipping suppliers, are concentrated in remote areas along the river Ems axis. The lack of permanent geographical proximity to other parts of the maritime economy seems to be less important for enabling knowledge spillover, however these actors are found to selectively seek temporary proximity by attending events or sustaining smaller subsidiaries in Hamburg or Bremen. Finally, shipping companies and research institutions are identified as gatekeepers connecting the production and the service oriented activities of the maritime economy on all scale levels. Other actors actively seek proximity to these actors, to sustain their own competitive advantage.

The knowledge intensive, high-tech and manufacturing operations of the maritime economy are connected by spatially distinct transaction, transformation and information processes, which critically affect the utilization and capability of the sites and their context. Furthermore, the relational siting of maritime economy firms in northern Germany conditions the development of interlocking flows of knowledge and goods. Departing from the singular decision to occupy or develop a location, the functional and spatial consequences affect multiple scale levels along the identified development trajectories.

Content

A. Introduction

When architects start work on a project, key spatial decisions have in many cases already been made. A site has been chosen, a program specified and a structure for delivery agreed. Equally however, when architects complete a project, key spatial decisions remain to be taken. The new structure's appearance within the environment, the use patterns of the built form, and the capability of the construction to adapt to change are only defined over time. Hence, the decision as to whether a place is successful exceeds the project frame in respect of scope and time. The spatial transformation is conceived before a project commences and reaches beyond it. In some cases, it evolves without any project at all. Human interaction with the built environment in use gives rise to an ongoing process of appropriation, which is of physical, functional, and symbolic relevance for the success of places. In the case of corporate sites, this encounter is twofold: on the one hand, the organization engages with the site in pursuit of their business, and on the other hand, agents from outside the organization establish contact with the premises as clients, collaborators, or the general public. Over time, streams of people, ideas, goods and services shape the physical, functional, and symbolic transformation of the site and its context, and vice versa. It is the extent and scope of these exchange processes today which render traditional models of projects, organizations and cities as contained systems obsolete.

The understanding of the contemporary impact of economic exchange processes on spatial transformation is limited to individual industries, aggregated scales, and broad concepts. The potential synergies, however, which can be achieved from aligning location strategies with spatial transformation processes and functional exchanges, are significant. Provided architects and urban designers are ready to extend their scope beyond the traditional project frame, their skillset could help to inform more integrated spatial ambitions by applying the professions' competencies of multi-level spatial conceptions, communication and visualization skills, and future thinking (Wiese et al., 2014). The motivation of this work is to contribute to the current debate on these issues in academia and reflect on experience in practice.

A.1. Starting position and motivation for the study

This investigation proceeds from the change in spatial development dynamics beginning in the 1980s, which continues to affect development on the global, regional and local scales. Quantitatively, the result is an urban hierarchy generated by and directive for corporate and private location choices, which anchors the flow of people, ideas, goods and services in space. Qualitatively, the interaction of individuals and organizations with their environment has changed, with new working practices, technologies, products and strategies drawing them towards locations which provide the "right" setting for interaction with internal and external partners.

A key driver for these changes is a re-structuring of economic exchange processes (Castells, 1999; Graham and Marvin, 2001), which affect organizations and cities alike. These exchange processes are characterized by three generic interfaces, which stipulate distinct spatial logics under the influence of globalization and technological advance. The first type are human to human exchange processes, with economic actors interacting in the pursuit of knowledge exchange and service provision. Secondly, human to material exchange processes, which occur at critical points in the value chain, most prominently in the product development and production process. Finally, material to material exchange, propelled by transportation and transaction processes, namely financial or material transactions, without direct human interaction. Their spatial logic evolves along the following lines of argument:

Technological change and the complexity of global production, finance and service solutions have given rise to a form of the knowledge economy, where "the action of knowledge upon knowledge itself" (Castells, 2000:17) is the main source of productivity. The speed and significance of these transactions has vastly increased over the past thirty years. Thereby

> *Cities and the face-to-face interactions that they engender, are tools for reducing the complex communication curse. (Glaeser, 2011:24)*

The spatial concentration of command functions (Sassen, 1991), and human capital (Florida, 2008) in a selected number of global cities catalyzes the exchange of knowledge between individuals and organizations through functional diversity and spatial proximity.

Furthermore, the spatial organisation of industrial activities has undergone fundamental changes (Dicken, 2011). Globalization and the rise of information and communication technologies have propelled the restructuring of value chains (Derudder and Witlox, 2010). The increased demand for customization and differentiation in goods and services has resulted in sophisticated, geographically dispersed production networks and product strategies of flexible specialization (Piore and Sabel, 1984). Knowledge as an input in value chain processes has therefore gained importance, rendering it as a key resource and making space a principal mode of social ordering and control (Harvey, 1989; Soja, 1989). As a result

> *…large cities around the world are the terrain where a multiplicity of globalization processes assume concrete, localized forms. These localized forms are, in good part, what globalization is about. (Sassen, 2000 :91)*

This need of a contemporary city and corporate site to perform as a hub (Conventz et al., 2014) is increasingly acknowledged by stakeholders from the public and private sector.

Lastly, consistently low transportation costs have propelled the emergence of production, service and transportation systems which span the globe (Bryson and Daniels, 2010; Hesse, 2010). Sophisticated facilities, such as airports, seaports, high-speed data, and logistics hubs are the infrastructure of material exchange processes. Thus

> *The town is the correlate of the road. The town exists only as a function of circulation and of circuits; it is a singular point on the circuits which*

> *create it and which it creates. It is defined by entries and exits: something must enter it and exit from it (Deleuze and Guattari, 1987).*

Rather than simply being present, these infrastructures create spatial asymmetries by anchoring activities as nodes in space and providing or negating accessibility to a site (Graham and Marvin, 2001). Furthermore, their distinct topology and morphology create strong physical spatial interventions in their own right.

All three of these interfaces give rise to distinct topologies, which shape corporate sites locally, but more importantly belong to a network of spatial sites beyond the local scale, which are tied together by functional and physical exchange processes. At an aggregated level, the urban space, rather than being an object in itself, is constituted by these relations as well as their position and meaning in the global network of interrelations (Lefebvre, 1991). The product – the urban – is created and constantly recreated by economic exchange processes, which imprint on the physical and non-physical environment of the city (Löw, 2001). The physical setting, corporate activities and conceptions thereof jointly define a place. As these are man-made systems, urban transformation is the result of a multitude of parallel processes, which result from "rules and resources recursively implicated in social reproduction" (Giddens, 1984) and generate a "patchwork of heterogeneous fragments" (Shane, 2005). The individual city is therefore an amalgam, whose individual components are in demand as a "bundle" of physical and non-physical resources (Frey, 2009; Storper and Manville, 2006). Its sites are interwoven with one another not least through the supply and demand of shared morphological and functional territorial assets (Henderson et al., 2002; Sassen, 2000) but also situated practices in space and time (Giddens, 1984). As a result

> *[e]ven the most advanced information industries have a production process that is at least partly place-bound because of the combination of resources it requires even when the output is hypermobile (Sassen, 2000 :81)*

Successful spatial development under this relational, multi-scalar concept, becomes the art of mediating the interplay of internal and external resources and providing the flexibilities to adapt to change in order to create enduringly prosperous places (Thierstein et al., 2012).

In summary, technology and globalization have fundamentally changed the way we interact with our environment physically and functionally. In order to remain competitive, organizations and cities are challenged to realign their location strategies. A site's physical, functional and symbolic impact is affected by processes on an array of spatial scales from local to global, constantly evolving over time.

The motivation for this work arises from my experience and observations in practice and academia. Based on twelve years of work as a consultant, one of the measures of success is managing to activate previously unacknowledged interconnections between the material conditions and processes of interaction. This holds for the planning, realization and use phase of buildings as well as the origination process of products and solutions.

Scholars from a broad range of disciplines have extensively examined port cities, both historic and contemporary and have spurred the development of spatial ambitions, which frequently lack coherence. Transport and economic geographers have focused on the position of ports in spatially extensive supply chains and global production networks, the regionalisation of logistics activity and port governance reform. Architectural and planning practitioners, as well as historians of the built environment have explored waterfront transformation as the frontline of urban regeneration and as part of the shift to a post-industrial economy. Social and urban geographers have examined the redevelopment of waterfronts for high-end uses, as well as the displacement of the urban working class. As a result, port cities are now studied through different disciplinary perspectives that tend to amplify the mistaken impression that ports and cities are islands of unconnected actors and stakeholders. An integrated analysis of the complex intersection of these disciplinary perspectives and a comprehensive analysis of diverse aspects of port cities has yet to be undertaken (Hein et al., 2013). This work seeks to make a contribution in this regard. The first challenge lies in the lack of an interdisciplinary framework and shared language, which is developed over the first part of the dissertation. A glossary in Appendix F.12 provides guidance on the use of terminology. The second part provides a comprehensive empirical analysis of the port city-interface in northern Germany.

A.2. Focus of the study

In this context of organizations and cities striving for attractiveness and competitiveness, port cities have the opportunity to reset themselves as nodes in physical and non-physical networks, and capitalize on their resources in terms of cultural, historical, and political assets, which set them apart from other places (Daamen, 2007; Eisinger, 2012; Wilson, 2002). The Mercer quality of living index features a large number of cities on the waterfront as the most desirable locations to live in worldwide. A number of these also hold a high position in the ranking of the top 100 maritime destinations. Mercer produces worldwide quality-of-living rankings annually from its most recent Worldwide Quality of Living Surveys, as presented in Figure 1.

The list provides a basis for like for like comparison aimed at employers and decision makers in organizations and cities. From an aggregated demand point of view, the index represents the most sought after urban locations for business and talent.

Research on urban attractiveness to date has focused largely on creative industries (Florida, 2002) and the knowledge economy (Lüthi et al., 2013). In some instances, this has led to an over-emphasis on advanced producer services, finance functions, and institutional functions by researchers and policy-makers, treating the traditional economy as outdated. It is important to note, however, that knowledge flow has always been important for trade and development and constitutes an integral part of all economic exchange systems from ancient times to today (Hall, 1998). The difference is the way in which value is created at the interfaces between economic agents, as well as the speed, scope, and spatial reach of these interactions.

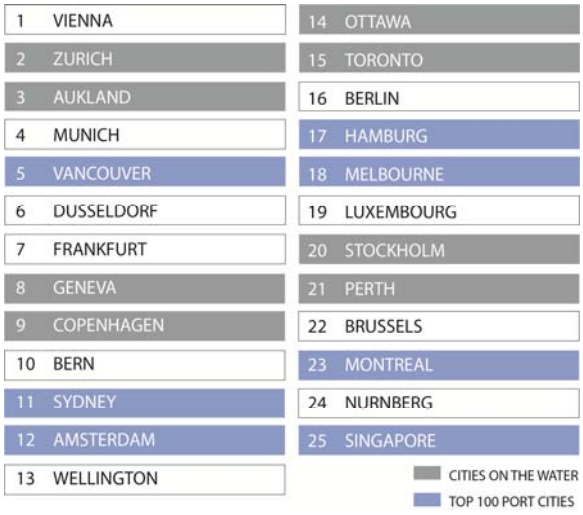

Figure 1
Ranking of cities in accordance to their quality of living (Mercer, 2012)

The maritime economy has been instrumental in economic change and the formation of the urban system in Germany by producing knowledge and innovation for centuries. Recently, structural change has propelled the integration of specialized services that facilitate the flow of information and goods at key interfaces. New drivers for location decisions and the importance of these for the maritime economy have been explored, suggesting that advanced producer services are key for the development of port cities as maritime service hubs (Jacobs, Ducruet, et al., 2010; Jacobs, Koster, et al., 2010). The increasing importance of human-human interfaces concurs with the restructuring of port activities and the rise of port city-regions as relevant units (Notteboom and Rodrigue, 2005), marking a process of upscaling and phenomenological alignment with emerging Mega-City Regions (Hall, 2007c: 5ff). The spatial transformations, which drive and are being driven by changes in the industrial organization of the maritime economy reveal relevant interdependencies for the future spatial decisions in port cities and their hinterland. Functional and morphological polycentricity (Green, 2007) are jointly creating a space in which economic actors actively pursue their business.

Traditional port cities have an advantage in two respects. Firstly, they often already have global visibility and historic building stock which makes them distinct from other industrial cities. Secondly, the functional and spatial organisation of the maritime economy has formed these cities for centuries, rendering them as spearheads of the globalized network of cities. As a result, spatial ambitions from the 1980s until today have addressed the opportunities and threads which have arisen from the ongoing structural change which affects the port-city interface. However, modern port spaces extend beyond the immediate waterfront far into the cities and regions, where maritime actors are bound into a wider international network of the economy. This network superimposes the traditional value chain relationships with new linkages covering the increased need for services and technology, and creates globally interrelated structures spanning sector boundaries. The result is the emergence of

new spatial configurations and proliferations on multiple, superimposed geographical scales (Brenner, 1999). In some instances, formerly remote places are transformed into urbanized hybrid landscapes, where service and technology firms and housing functions locate, and traditional central places decline (Glaeser, 2011).

Against this background, this work explores how urban and regional topologies are sustaining exchange processes in the maritime economy. The interdependencies of the activities of the maritime industry and the spatial environment are researched from a relational perspective on intersecting scale levels from super-regional to local. The study is centred on northern Germany, where the ports remain an important economic factor and the port-city interface has been subjected to a series of transformations. Germany's main ports of Hamburg, Bremen and Bremerhaven are contained within the geographical extent of the study area as depicted in Figure 2.

Figure 2
Study area in the context of Europe

This thesis focuses on organizations as economic actors. Location choice is considered as a conscious and strategic process, which has repercussions on multiple spatial dimensions. This is not to say that corporate location choice is the only relevant factor driving spatial development or urban prosperity. However, the exclusive access to data in that area offers an opportunity to approach port city development from a relational, multi-scalar perspective, focusing on the interdependence of exchange process and urban transformation.

A.3. Research question and hypotheses

This thesis takes an interdisciplinary approach and draws on economic, geographic and planning aspects to provide the basis for assessment of spatial interdependencies between non-physical networks of the knowledge economy, physical networks of transportation and infrastructure and the qualities of the urban environment on interrelated scale levels. In the case of the maritime economy, it conceptualizes the urban environment as a catalyst for situated processes of value creation, by providing capabilities, potentialities and opportunities. The basic assumption is that qualitatively different spatial conditions are created by and reproduced through fields of economic interaction at different scale levels. The research question is therefore:

> *What is the use value of the built environment for the maritime economy and how does it relate to the material and immaterial processes of exchange?*

The research is led by a number of hypotheses based on the findings of existing research. Port cities are multi-functional nodes, which feature in the network of goods flow as well as the network of knowledge flow. The degree and the scale at which they exhibit this feature is key to understanding the demand for spatial qualities and potentialities for urban development. The first hypothesis is therefore:

> *If the material flows of goods and the immaterial flows of knowledge are intertwined, then there are places of encounter, which feature in both systems (Hypothesis 1).*

Location choice and processes of exchange between firms in the maritime economy lie in the focus of this research. One key assumption is that firms seek to optimize their access to resources externally and that physical space and functional space are recursively linked. The applied methods seek to reveal evolving patterns of spatial specialization and appropriation, which can be attributed to organisational changes in corporate networks and industries. Hence, the second hypothesis is:

> *If the built environment is the coagulated product of processes of production and consumption, then changes should be observable in form and structure which reflect organizational change (Hypothesis 2).*

As the study seeks to gain insight into the catalytic effect of space on innovation, the places, which nurture economic success are a further key interest. These are expected to be assemblages of physical and non-physical qualities and the third hypothesis is:

> *If the built and un-built environment catalyses processes of production and consumption, then successful urban areas will feature distinct patterns of spatial organisation (Hypothesis 3).*

By examining different sources of evidence, namely network data, expert interviews and urban topology at different scale levels in the context of the maritime economy of northern

Germany the study constitutes a single case design, which contains three embedded units of analysis, derived from the results of the network and interview analysis.

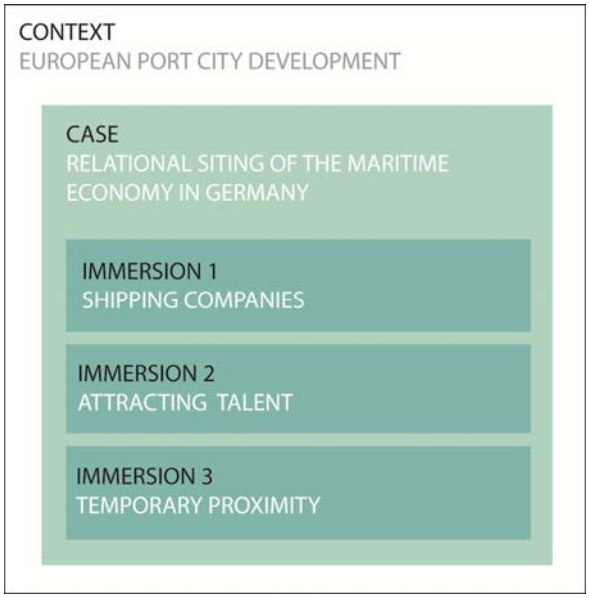

Figure 3
Case study design

The resultant in-depth case study, which is informed by theory and structured around the research question, allows the results to be linked back to the propositions and avoid the bias of a purely inductive research design. However, the research framework and methodology has limitations in terms of the interpretation of the results, as only one geographic area is considered with three specific methods. The data collection strategy nevertheless provides rich and multi-faceted sources of evidence by combining network analysis, expert interviews and topological analysis, and is derived in the subsequent section.

A.4. Outline of the chapters

This thesis is developed over five main sections, as depicted in Figure 4. This introduction constitutes Section A. Section B elaborates the context of the study. The port city framework is drawn together on the basis of key paradigms in the relevant research areas, and defines the line of inquiry taken in the study. It sets the primary frames of reference, namely the current schools of thoughts in urban studies, urban economic development, and innovation research. The case study requires a carefully crafted research framework and methodology for data collection, which is explained in Section C. Findings using the multi-method approach are presented in Section D, ordered by scale. At the end of this section, the limitations of the study are discussed. The last section gives an overview of the findings and answers the research question and the three hypotheses.

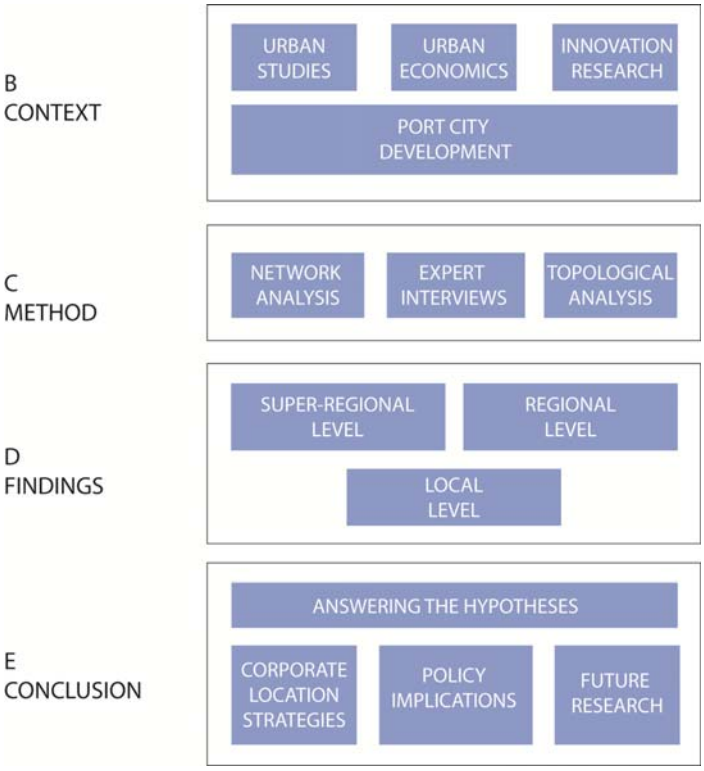

Figure 4
Overview of the study

In outlook, the implications of the research for corporate location strategies, policy and future research are summarized, concluding Section E of the study.

This work is based on a comprehensive understanding of spatial development as the interplay of material and immaterial flows and the conception thereof. It makes a theoretical and empirical contribution to the understanding of places as nodes in multi-scalar spatial systems in the case of the maritime economy in Germany. The results challenge the existing spatial ambitions of private and public actors and provide a new perspective on sustainable development strategies.

B. Context

In order to arrive at a case study design and methodology which centres on the interdependence of exchange processes of the maritime economy and spatial transformation, the research undertaken here transcends the disciplinary boundary between architecture and planning, economic geography and innovation and technology management. Therefore, this work is grounded in four existing bodies of research: port city development, urban studies, urban economics, and innovation research. Traditionally, urban studies and urban economics focus on distinctly separate aspects in the development of urban systems, namely social construction, and economic production. More recently, innovation studies have overcome this disciplinary divide, and stressed their interdependence in relation to the sustainable development of urban systems, based on growth and renewal. The research on port city development is informed by these three primary areas of enquiry, making specific reference to the exchange processes at work and their relevance for spatial transformation.

B.1. Port city development

For centuries, port development was closely related to urban development in Europe. The primary historic interdependence of city and port is characterized by material exchange: goods are imported via the port, and traded in the city. The urban population is provided with consumer goods, and the local industry with raw products. Trade means that locally available finance and products can be exchanged for locally unavailable goods. Conversely, local products are exported via the port in exchange for finance, available for re-investment. Access to global markets strengthens the local economy, and enables economic development based on non-local supply and demand (Geddes, 1918; Vance, 1970). Since the 1990s, however, the development paths of port and city are no longer correlated (Ducruet and Lee, 2006). From that point on, ports have increasingly developed spatial structures beyond the city boundaries, increasing the efficiency of their operations (Brandt, 2011b). Figure 5 depicts this increasing spatial separation of port and city historically.

Today, waterfront regeneration, logistic poles, port expansion, infrastructure planning, and urban expansion leave a disparate image of European port cities in terms of economic success and spatial ambitions (Hall, 2007c; Hein, 2011; Schubert, 2009). The concurrence of three specific aspects render port cities as an ideal case study for the interaction between economic activities and spatial topology: Firstly, the port and the city have been researched extensively with regard to their socio-cultural historic development, including the resultant urban form. The port-city interface, however, has not received the same amount of attention in terms of its relevance for growth and development of either node. Secondly, port cities are spearheads of globalization, and have been intensely studied in terms of their geo-strategic role in a space of flows. Furthermore, they are in some cases persistently successful cities; in

other cases, they suffer from severe decline. Thirdly, they have a strong history in negotiating spatial solutions which take multi-scalar relations into account. Port cities are positioned at the intersection of global networks and local dynamics more than other types of city, as they are key nodes in the global network of flows of knowledge and goods, and subject to extensive economic change in the way value is created and distributed.

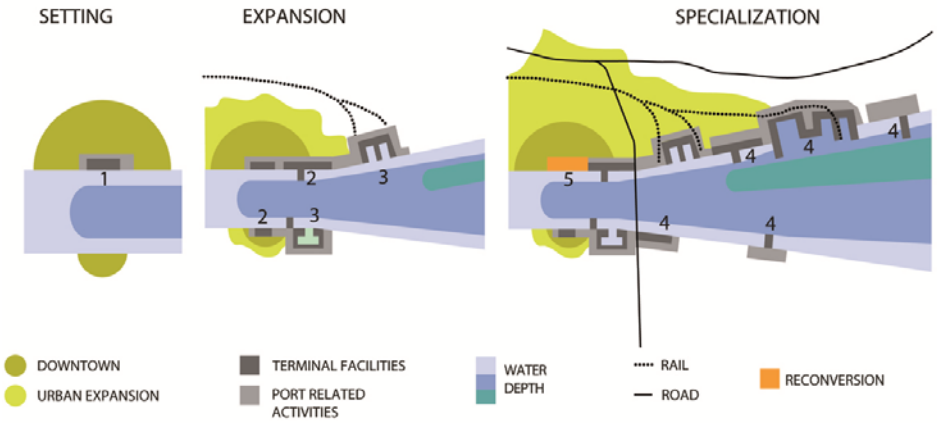

Figure 5
Anyport Model (Bird, 1963)

The modern maritime economy transcends a number of sectors, and spans across the port-city interface physically and functionally. Its functional organization evokes distinct patterns of proximities between spatial units such as terminals, logistic sites, transport corridors, and advanced producer services. It is deeply rooted in the historic local urban fabric by buildings and infrastructures such as cranes, custom houses, port authority buildings, and old warehouses. Economic activity and territory in this context bear potential for the development of synergies and innovation which stretch beyond the economic dimension, and have a social as well as ecological impact on the wider urban context.

Moreover, the maritime economy represents a complex innovation system, in which physical flows of goods are interwoven with knowledge processes. Therefore, it provides a unique opportunity to assess the spatiality of production and knowledge networks beyond the facilities of ports (Ducruet, 2007; Hesse, 2010; Jacobs, Ducruet, et al., 2010).

B.1.1. The port-city interface

The singular port and city are no longer the relevant units of analysis for processes of exchange. Logistically, a regional cluster of ports offers the opportunity for functional specialization and the establishment of feeder systems, increasing the efficiency of shipping lines (Notteboom and Rodrigue, 2005). Spatially, sites for cargo handling and distribution are connected by high capacity infrastructure, and stretched out on a regional level, as depicted in Figure 6.

Functionally, third and fourth party logistics suppliers orchestrate global supply chains with regional subsidiaries, and provide knowledge intensive services beyond the physical handling of goods. Suppliers, shipping companies, shipbuilders, service providers, and research institutions form a regional system of knowledge exchange, which is embedded in the urban as well as the port system. From a knowledge economy perspective regionalization results from the functional specialization and differentiation of locations across a region, critically affected by the availability of skilled labour and connectivity in order to capture the advantages of complementarity and competition in the advanced producer service sector on a regional level (Hall and Pain, 2006). The relative physical proximity within a region fosters knowledge exchange. However, the distinction between places that are central places in a network of knowledge flow and those that are transport places specialized in offering transport and wholesale services (Hesse, 2010) needs to be complemented by a more differentiated relational conception, which captures the relationship between the two subsystems on a regional level. The urban market remains the raison d'être of production and consumption activities as ports and transport players are bound to the markets they serve and their location patterns (Ducruet, 2007).

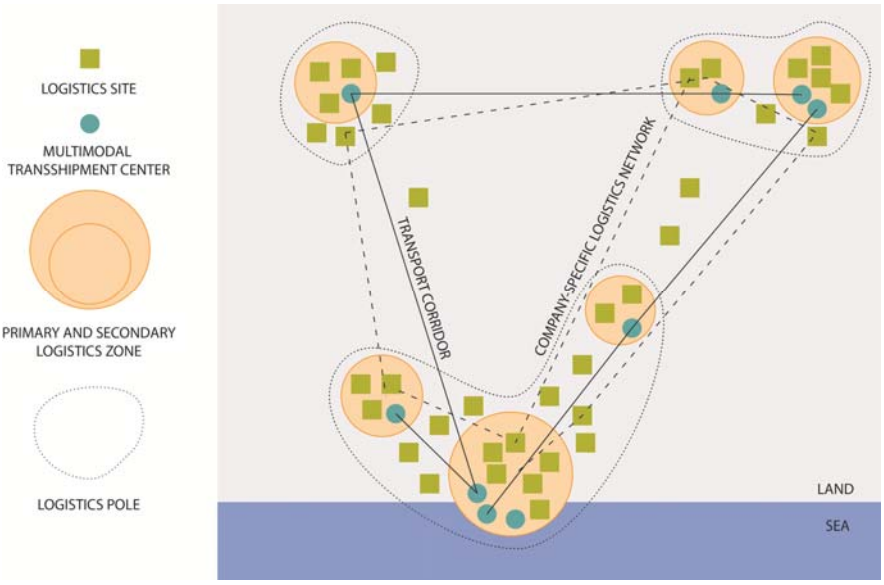

Figure 6
Regionalization of logistic activities (Notteboom and Rodrigue, 2005)

The result is a region consisting of qualitatively different places characterized by physical setting, functional activities and conceptions of meaning. Across Europe, this coexistence of transportation hubs and knowledge hubs on a regional scale can be confirmed empirically. This is illustrated in Figure 7, which superimposes the Alpha, Beta, and Gamma cities (GaWC

Classification of cities 2010-1), characterized by their relative concentration of advanced producer services (APS), with the most frequented ports and multi-port gateway regions (Notteboom, 2010). This division of cities into three different classes has been carried out based on their importance in the four segments of the knowledge economy: advertising, banking, legal, and accountancy (Beaverstock et al., 1999).

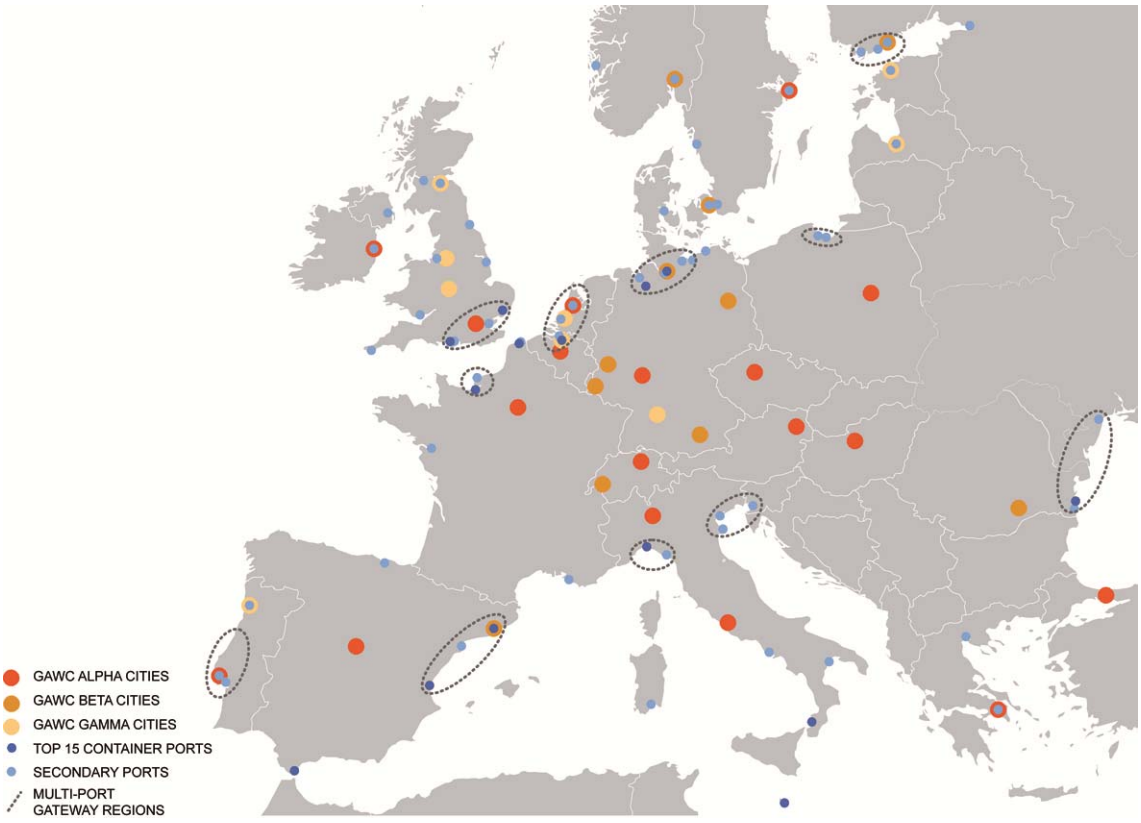

Figure 7
Superposition of multi-port gateway regions and APS hubs (Wiese and Thierstein, 2014)

Strikingly, port regions and knowledge hubs coincide in the majority of cases, supporting the argument that despite their spatial separation on the city scale, they form functional regional clusters. In some cases, the physical relationship is more distant but might still be of relevance from a functional perspective.

Based on the above insight, and the theoretical background laid out above, the port-city interface is a case where different spatial scales impact on the physical topology. The regional scale has gained in importance for the development of port cities, as it offers economies of

[1] Available through: http://www.lboro.ac.uk/gawc/world2010t.html; accessed 9th January 2012

scale and scope, as well as space for the co-existence of overlapping network logics in a field of interaction (Hesse, 2010; Notteboom and Rodrigue, 2005).

B.1.2. Port cities in the space of flows

Whereas the historical port-city interface is characterized by facilities and buildings directly and indirectly linked to the maritime industry within the city boundary, the contemporary port-city interface is different: the functional and physical organization of the maritime economy has changed. Cities have gained in importance as sophisticated market places for services and goods locally, as well as globally. This phenomenon is of particular interest in global port cities (Figure 8), which retain relatively strong positions in the global net of transportation and world city network, since urban space is redefined and re-layered functionally and physically (Brandt et al., 2010; Hesse, 2010). As a result, the spatio-functional relationship between port and city, and the wider network creates distinctly different port-city typologies as depicted in Figure 8.

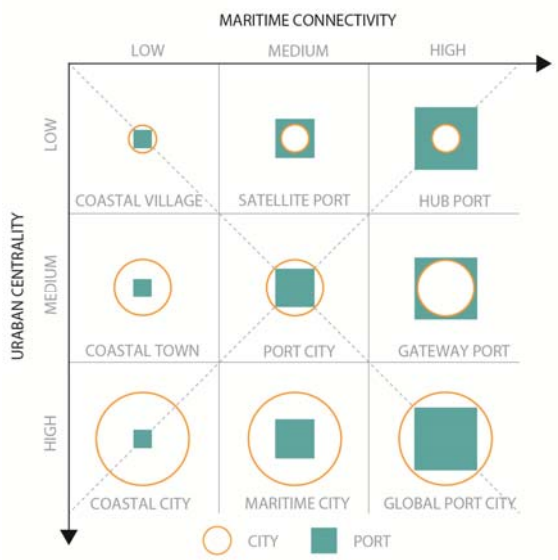

Figure 8
Spatio-functional typology of port cities (Ducruet, 2007)

The volume of goods being shipped around the globe has multiplied over the past decade. Consequently, the supply chains and markets have increased in complexity (Gereffi et al., 2005). Key factors for the competitiveness of the port are a stable relationship with other actors in the supply chain, an efficient port infrastructure, proximity to major sourcing and final markets, as well as an efficient road and rail network (Wang et al., 2007). Successful cities are nodes in a global network of knowledge creation and transformation (Castells, 2000; Sassen, 1991). In this framework, port cities can be termed places of encounter, as they facilitate the transportation of goods and knowledge. They thereby bear particular potential for the creation and exchange of knowledge (Brown et al., 2010; Hesse, 2010; Jacobs, 2008). The contemporary port-city relationship is shaped by spatial and functional interdependencies which stretch beyond the single port or city: the port and its auxiliary services – formerly an

industrial operational site – have extended their operations into other sectors. Notably, the related advanced producer services are situated and embedded in the urban system (Jacobs, Koster, et al., 2010). Individually, these are to a varying degree spatially bound to port operations (O'Connor, 1989). Overall, the industrial value chain is functionally closely intertwined with the knowledge flows in the urban system, and gives rise to the modern maritime economy as a merged entity of industrial and service operations. At the same time, the urban milieu of port cities has achieved new prominence in the light of location choice of producer service firms and property developers seeking attractive urban locations with good infrastructure (Hein, 2011; Warsewa, 2004; Wilson, 2002). On the one hand, the perpetual importance of ports in a global system of transport, the successful development of an advanced producer service sector, and an advantageous geostrategic location and morphology might be considered a predictor for successful urban development trajectories in a port region. On the other hand, many port cities fail to succeed in their spatial ambitions, and are faced with the functional realities of global competition and ongoing structural change. Recent studies in economic geography illustrate that local and global developments intersect in port cities in a particular way, which leads to spiralling positive or negative effects (Amin, 2004), rooted in the physical and functional dispositions of these cities. Figure 9 depicts the disparate trajectories of European port cities.

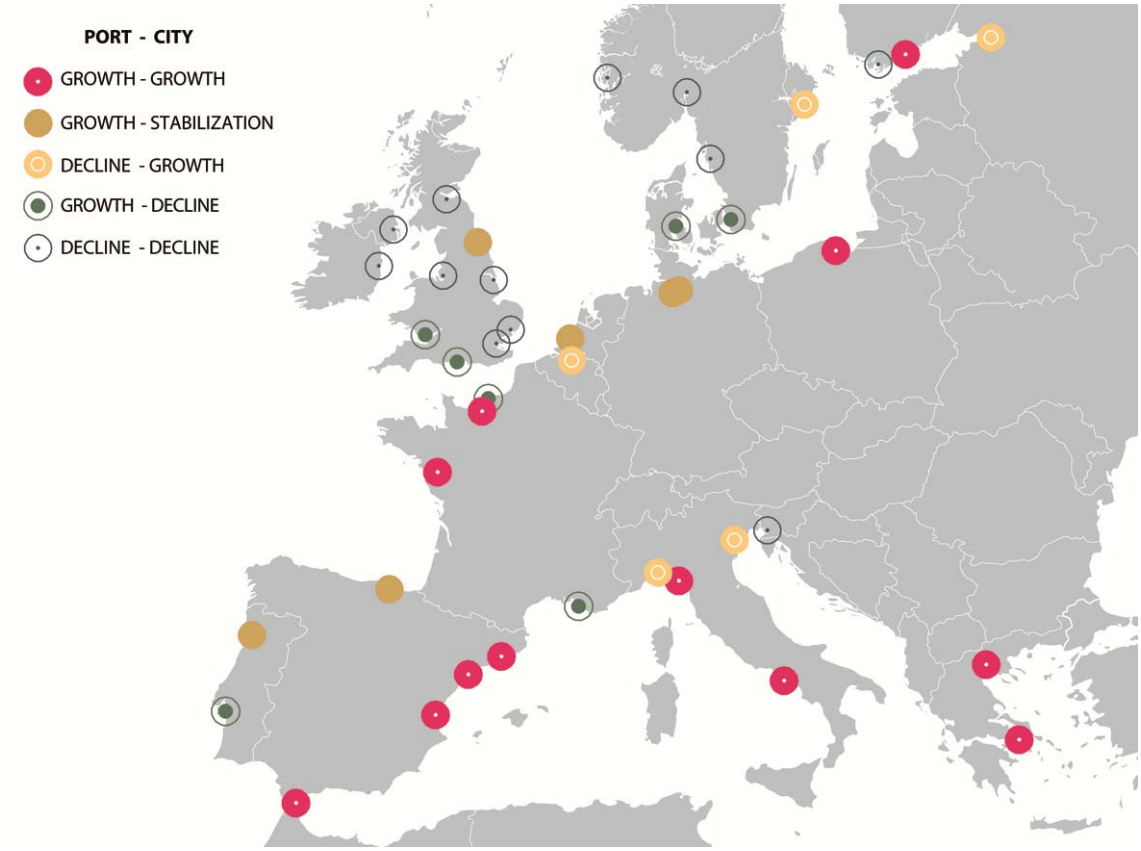

Figure 9
Port-city trajectories (Ducruet, 2007)

Against this background, only selected port cities have the opportunity to reinvent themselves as primary platforms in the knowledge economy based on pre-existing resources and achieve a sustainable balance which fosters development. The urban core is only one component in a regional economic system, which – as a whole – is in competition with other regions (Jacobs, 2008).

B.1.3. The actors of the maritime economy

The maritime economy encompasses economic and research activities namely ship building, logistics and ports, off-shore energy supply, shipping companies, education, and specialized services. This economic field is one of the growth engines for a country such as Germany, in which exports and trade are fundamental to economic success. Historically, the maritime economy in Germany traces back to the networks of the Hanseatic League, which reached across the Baltic Sea to Scandinavia. This network enabled secure shipping and trading of commodities between port cities such as Hamburg, Bremen, Danzig in Poland, or Bergen in Norway. The end of the 19th century and the beginning of the 20th represented one of the most successful periods for shipping and trading activities hitherto. After World War II, German production of aircraft and ships was closed down. In 1951, ship building in Germany was liberalized again (Verband Deutscher Reeder, 2007). The reconstruction of Germany, increase of trade with locations abroad, and the strengthening of the shipping industry were closely linked to one another. The containerization of trade fostered the position of Hamburg as one of the biggest ports in the world. Accordingly, German ship owners became powerful, while managing shipping fleets all around the world (Brandt, 2011a: 33-36). The German ports nowadays are involved in a distinct division of labour. Besides Hamburg, the ports in Bremen, and the Jade Weser Port in Wilhelmshaven are specialized in container shipping, and act as main hubs for the German hinterland. These ports on the North Sea account for 80 percent of German commodity exchange. The ports in Emden and Cuxhaven are specialized in shipping cars (Brandt, 2011a: 98).

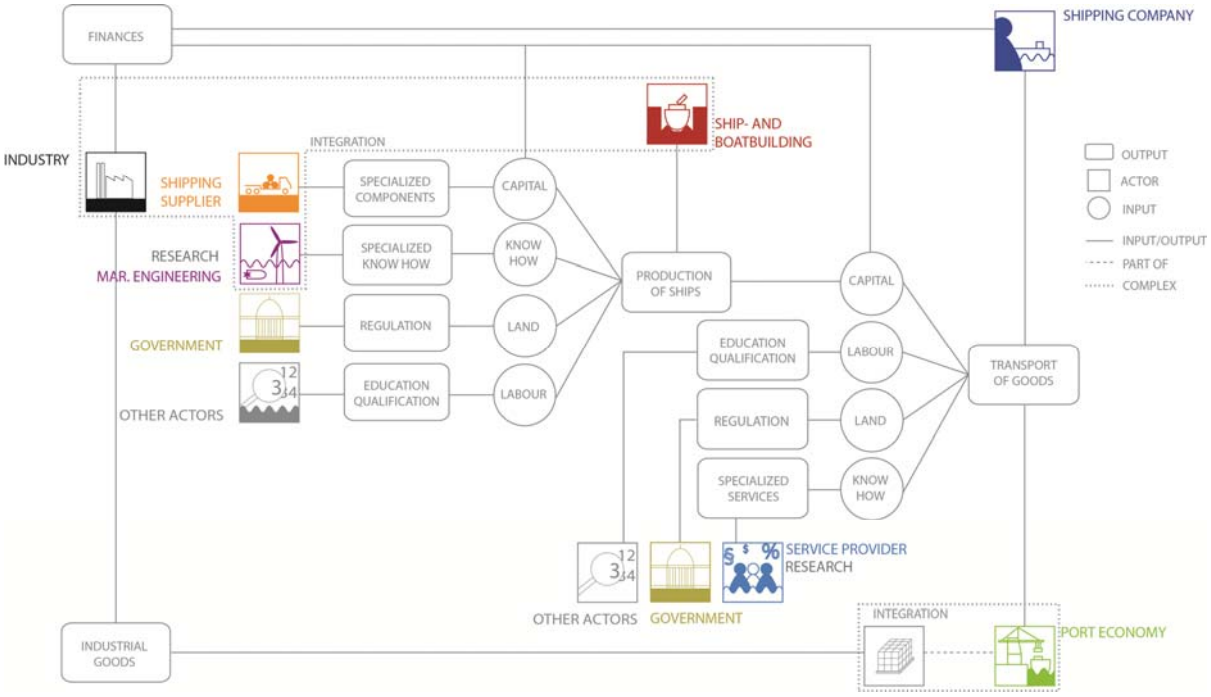

Figure 10
Input-output relations of activity fields in the maritime economy

By virtue of its logistic service, the maritime economy can be described as the "plumbing" of globalization, as globally 90 percent of goods are traded by ship (Rodrigue, 2013:160). The coordination with other networks of transportation is therefore critical for a successful port (Slack, 2007). Advanced maritime producer services seek proximity to their client base of shipping companies and port related industries, which are largely but not exclusively located in vicinity to the seaport (Jacobs, Ducruet, et al., 2010). Simultaneously, the growing terminalisation changes the way port operations are managed. Local stakeholders compete with regional and global interests for efficient transport flows (Slack, 2007). On an aggregated level, the maritime economy, which is heterogeneous in terms of its knowledge bases, represents a complex innovation system, in which physical flows of goods are interwoven with a non-physical dimension of knowledge in transfer. Therefore, the maritime economy provides a unique opportunity to assess the spatiality of knowledge networks, which reach beyond the facilities of ports (Brandt et al., 2010; Hesse, 2010).

The concept of the maritime economy combines the production, delivery, servicing and trading of maritime vessels and components in one value-adding system. Figure 10 sketches this input-output system of economic exchange processes. A general definition of the term does not exist in the literature. Approaches differ depending on the area of research. Several studies focus on the exchange of commodities, the role of logistics firms, and the organization of ports (Ducruet and Zaidi, 2013; Hall and Jacobs, 2010; Lee and Song, 2010). The shipbuilding industry as the high-tech component within the maritime economy is subject to studies concerned with inter-industrial exchange of information flows and innovation capabilities (Fei,

2011; Fornahl et al., 2012). The bearing of the maritime economy on spatial development is discussed within the context of the renewal of cities and ports. Hall and Jacobs show that the reorganization of port activities affects urban development intensively. In fact, the biggest ports in the world coincide with populous agglomerations (Hall and Jacobs, 2012: 190). Equally, headquarters functions of global firms and specialized services tend to locate in the urban environment, whereas logistics remain at the port facilities. Finally, the maritime economy contains specialized service activities, which reveal distinct locational patterns, different from other advanced producer services (Jacobs, Koster, et al., 2010). The review of these studies reiterates the heterogeneous character of the maritime economy, which includes manufacturing, services, transportation and energy, with their respective location strategies. This results in a multitude of drivers influencing spatial development in places where the maritime economy retains a strong economic position.

From a spatial perspective, the maritime economy continuously shapes the interrelation of cities and ports. However, innovation and new technologies have fundamentally restructured this relationship functionally. The ongoing extension of commodity chains has led to a further increased integration of ports in global production networks (Jacobs, Koster, et al., 2010). At the same time, global trade demands accessibility for large vessels and new port facilities, reshaping coastlines. This process comes along with an expansion of the hinterland of the port to underpin the ports functionality as a load centre (Hall and Jacobs, 2012). The recent urban transformation on the waterfront of cities such as Hamburg and Bremen has become possible thanks to the reorganization of port activities (Figure 5) and the demand for office and dwelling space in these locations. However, the physical presence of the maritime economy not only revolves around port facilities but also includes activities in financial centres or places remote from coastal areas, where further actors, such as research institutions or logistics partners are located (Brandt et al., 2010:238). Thus, the multiplicity of the maritime economy affects spatial development of port cities via a number of parallel processes and historical events. An interdisciplinary research framework is required to capture the complexity at work. The following sections lay out the theoretical basis for the empirical study.

B.2. Conception of space and place

The subject of urban studies is cities and life within cities as the interplay between socio-spatial configuration and meaning. Conceptions of space and place in the field are characterized by the multitude of approaches to the subject in the social sciences. Empirical research frequently suffers from fragmented theoretical concepts, which fail to integrate the interplay between physical and social relations in a coherent framework. Lefebvre has proposed his tripartite conception of space, which is constituted through lived space, perceived space, and conceived space (Lefebvre, 1991). It treats urban space as the result of multiple processes of generation, formation, emergence, development and implementation, which are to different degrees conspicuous, conscious and specific, but nevertheless overlapping and non-sequential in time. As such, the application of this framework as proposed in this work (and further elaborated in C.1.3) seeks to overcome the dichotomy of built environment and social science research, rendering the urban as an assemblage of material and social relations which constitutes more than the sum of its parts (DeLanda, 2006). As opposed to a static system, it understands space as the temporary product of a multitude of exchange relations – material and immaterial – giving a provisional ordering to urban life through their underlying network logic (Latour and Hermant, 1998). The urban form as the material sediment, and urban life as the immaterial field of activity are thereby equally important components of urban space. Moreover, space becomes the principal mode of social ordering and control (Harvey, 1989; Soja, 1989). Urban planning in this context focuses on the production of qualitatively different spatial conditions (Thierstein and Wiese, 2012) based on local interactions between relevant networks.

B.2.1. The production of place

If urban processes are decisive for the definition of urban space, then urban planners and economic actors are challenged to review their approach to place making and location choice: material spatial configurations do not evolve at the same speed as non-physical spatial configurations. The conception of place needs to capture the interrelation between the spatial dimensions of distance, function and process (Boesch, 1989) at a given location and at a given time. Thus, place becomes a moment in the network of ever-changing social relations defining function and process spaces at multiple scales (Madanipour, 1996). On the other hand, the existing configuration of distance space is defined by inherent boundaries, and inertia for development, exerting constant influence on the other spatial dimensions. Following the logic of overlapping and evolving socio-functional relations, place cannot be delineated by defining boundaries around it and counter-positioning it to the other which lies beyond but needs to be defined through the specificity of socio-functional relations and interconnections to that "beyond" (Massey, 1994). "Place" is here defined as a local experience, which relates to the human scale, but reaches beyond its immediate surroundings on a virtual level (Wiese et al., 2014). It is hence not constructed by a territory and confined identity but through the specificity of the mix and interconnections between form, activities and conceptions.

The denser and the more heterogeneous the concurrent interactions, the more complex becomes the conception of place as depicted in Figure 11. In regards to physical form, a site

is nested in a set of interrelated scale levels – a plot, a quarter, a city, a region, potentially even a polycentric megacity region. In terms of conception and meaning a site is the result and origin of a continuous process of appropriation, which is cross-scalar and potentially incongruent.

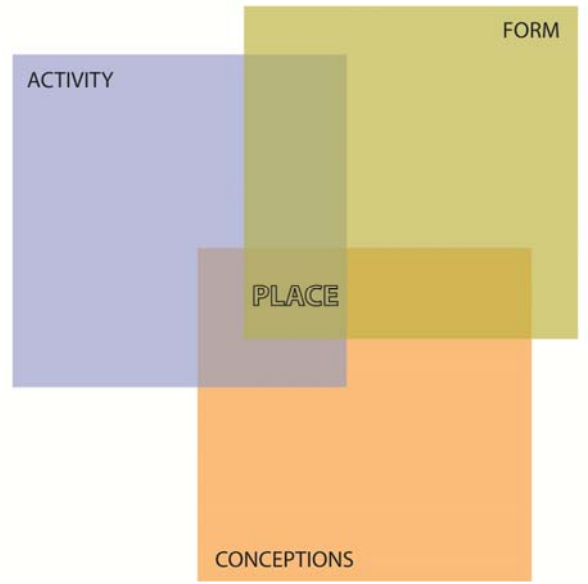

Figure 11
Components of a sense of place (Montgomery, 1998)

The challenge is to combine these two perspectives, i.e. the local and the virtual for their mutual benefit. They critically affect the flow of knowledge, goods, and people, and are intrinsically linked to the past, present, and future form of the individual city (Graham and Marvin, 2001). Furthermore, the ancient city – well defined by means of its city walls – has been morphologically replaced by an urban landscape, which integrates farmland, settlement areas, and industrial facilities into a hybrid spatial form (Batty, 2001; SAUL, 2006). The resultant urban form is morphologically discontinuous and fragmented, in contrast to Cedric Price's triadic model. This transformation from a coherent, monocentric urban form to a fragmented polycentric urban landscape is presented in Figure 12.

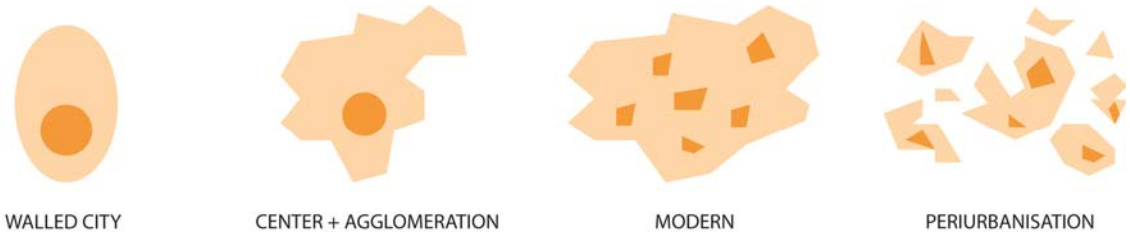

Figure 12
Urban design ecology models (ISOCARP, 2001[2])

[2] http://old.isocarp.org/pub/events/congress/2001/topic/index.htm, accessed 9th January 2012

There are a number of reasons for this new urban form. Firstly, the surface area covered by urbanized structures has tremendously increased, spurred by public transportation and private vehicle usage. New local centres of gravity have evolved while the reach of daily activities simultaneously stretches beyond the single agglomeration (Sieverts, 1997). Moreover, the urban space has become a complex field of interrelated activities through changed boundary conditions and additional factors of influence, which evolve on newly defined scale levels. Urban space is the product of local and global factors, relational and positional qualities, and material and immaterial components, which manifest themselves in a unique local configuration as a place, part of a city, a city as a whole, or a region that contains the necessary preconditions in terms of "hard" and "soft" infrastructure to generate a flow of ideas and inventions (Landry, 2008:133).

Furthermore, the diminished importance of traditional boundaries for the flow of goods, finance and money has stimulated the creation of a complex web of flows between places, which eludes human perception. However, place still matters, and the world is in no sense flat (Friedman, 2005). Quite to the contrary, the importance of place has increased: globalization has led to a fierce competition for talent and capital as a basis for prosperity (Thierstein and Wiese, 2011). Local characteristics and conditions are attractors and anchors for firms and talent as they are seen to be conducive to the creation and exchange of certain types of knowledge (Boschma, 2005) and lifestyle (Florida, 2008). Moreover, places are an integral part of human identity within an increasingly individualized world, where splintering social groups seek cohesion in particular cities, neighbourhoods (Florida, 2008) and imagery (Cresswell, 2011). However, these places are not necessarily territorially continuous, but rather a discontinuous constellation of places interlinked by travel patterns (Amann and Mantia, 1998) and virtual exchange, forming the dimension of human perceived space (Lefebvre, 1991).

From a theoretical perspective, exchange processes evolve between topology and meaning. Deleuze and Guattari define these as two kinds of assemblages: "a machinic assemblage of desire and a collective assemblage of enunciation" (Deleuze and Guattari, 1987). The former is a collection of heterogeneous elements, which are functionally networked in physical space. The latter is a collection and system of words and meanings, which synthesizes space mentally. As Löw (2001) stresses, space in the social sense is not naturally pre-existing, but has to be actively reproduced by enacting synthesis. Processes of imagination, perception, and recollection combine social assets and humans in life spaces (Löw, 2001: 225). The conception of space and place, which informs the relational multi-scalar approach, is summarized in Figure 13, with social action resulting in active and passive spatial decisions, which propel spatial development. Following the approach of systems theory (Baecker, 2007), the object itself is defined by its context and therefore the act of delineation creates qualitatively differing objects. It further stresses the structural coupling of material, mental, and social systems in creating society.

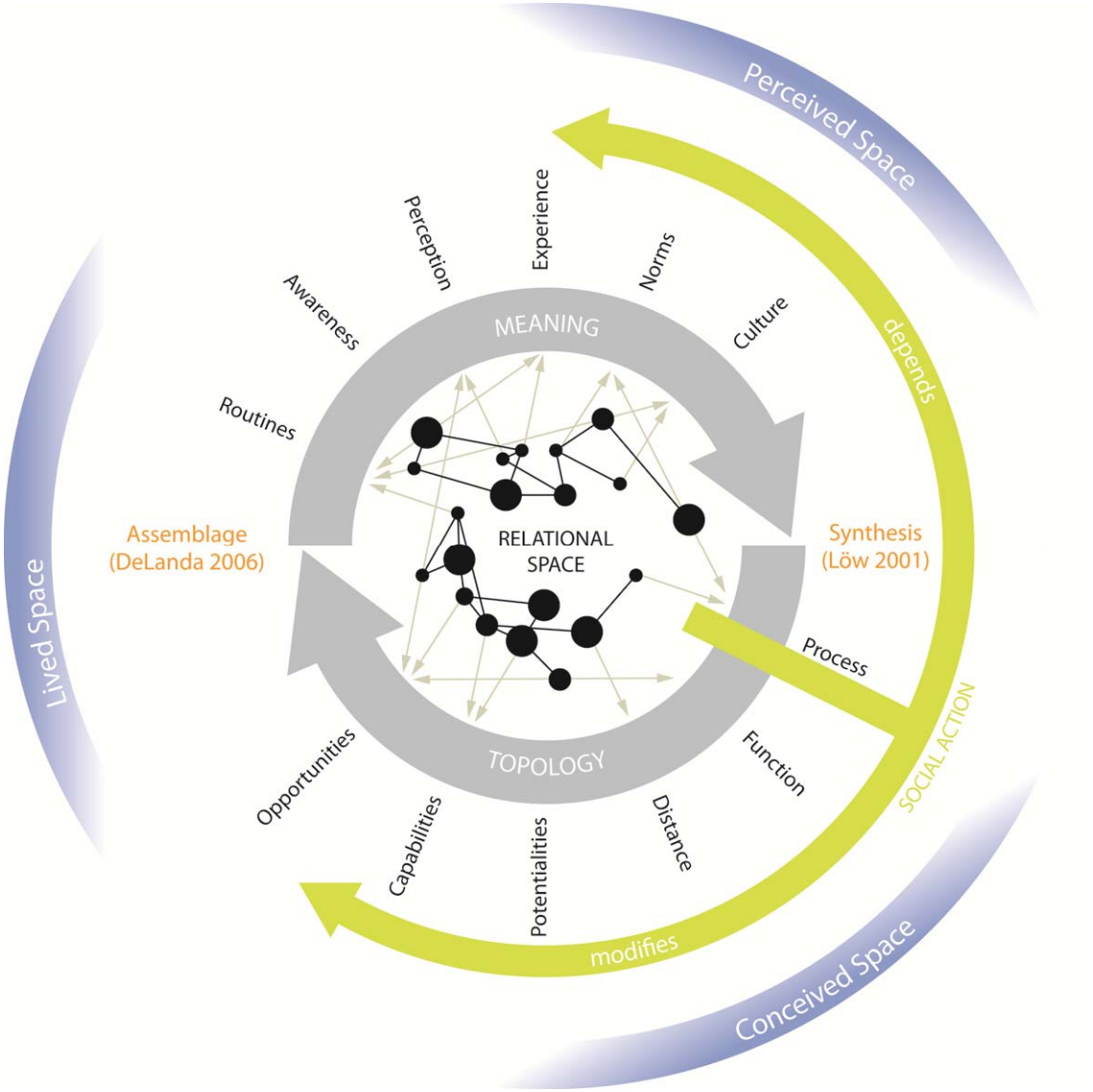

Figure 13
Relational space and spatial conceptions

While living systems create a physical boundary to their environment, mental and social systems create a symbolic-interpretative boundary. Space is thus defined by multiple co-evolving spatial dimensions and includes the symbolic interpretative dimension, which can be studied through the actors experiencing space in their daily routines.

These spatial systems are self-reinforcing and dynamic in that they are continually fed by information, which alters the system structure. Guiding for the singular action is the process of communication between physical and non-physical system components, which delineates an object from its context and thereby gives it significance (Baecker, 2007). Information as the unit of communication is therefore referred to as "a difference which makes a difference" (Bateson, 1972:448ff) and creates differentiation against a uniform background. Baecker refers to actions as closely related to communications as they punctuate and complement communication as points for future reference (Baecker, 2007:38). On this background, siting decisions are considered to be crystallization points in the communication between the organization and its environment.

The subjective delineation of different spatial dimensions by the decision maker therefore defines a particular system of interactions characterized and created by its embedded flow of information and action. Albeit there is only one overall spatial constellation conceived in spatial plans, different systems of meaning which are self-referential and structurally coupled may exist in parallel. The result is that the objective conception of place becomes impossible as meaning relies on the relation between perceived, lived and conceived space on multiple scale levels.

These principles are elucidated in the literature on performative urbanism, which centres on the potential of architectural and urban space to create a full reality only while being used in a complex sense of meaning (Wolfrum, 2008). Vice versa, places are produced "as spaces within which certain actions become possible, sensible or even necessary" (Crang, 1999:168)

Based on system theory, "a building is therefore at least a domain of knowledge, in the sense that it is a certain spatial ordering of categories, and a domain of control, in that it is a certain ordering of boundaries" (Hillier and Hanson, 1984:146). The built form regulates different intensities of engagement, redirects users' attention, allows people to meet, concentrates and disperses flows of actors (Latour and Albena, 2011). These conditions apply equally to corporate sites and urban regions, which are restrained and enabled by the existing trajectory in terms of potentialities, capabilities and opportunities for the development of built and urban form.

Against this theoretical background, the empirical research is structured along three dimensions of space: material or distance space, function space and process space (Boesch, 1989). Distance space relates to how physical spaces are configured and related to each other (Gustafsson, 2006). Functional space refers to the possibilities of physical space supporting the actions or tasks taking place within it (Gustafsson, 2006). Process space refers to evolving interactions, which create assemblages and syntheses (Löw, 2001; DeLanda, 2006), coupling material and social components.

B.2.2. Distance space

The physical topology is critical for knowledge exchange as humans are localized individuals, whose interaction is constrained by physical barriers and accessibility (Hillier, 1996a). Physical proximity and temporal concurrence are key predictors for human interaction. The aforementioned changes in industrial organization have gone along with visible changes in the built environment and spatial organisation on a number of scale levels: in Europe and elsewhere, economic activity has been concentrated in selected urban centres (Glaeser, 2011). Most remarkably, some traditional urban centres are growing, others are shrinking and new centres have emerged. In the majority of cases city attractiveness and competitiveness go hand-in-hand in so far as economically successful cities attract talent (Storper and Manville, 2006), and talent attracts capital, thereby sustaining a local buzz as well as global pipelines, which are key for innovation (Bathelt et al., 2004). This spatial concept is illustrated in Figure 14.

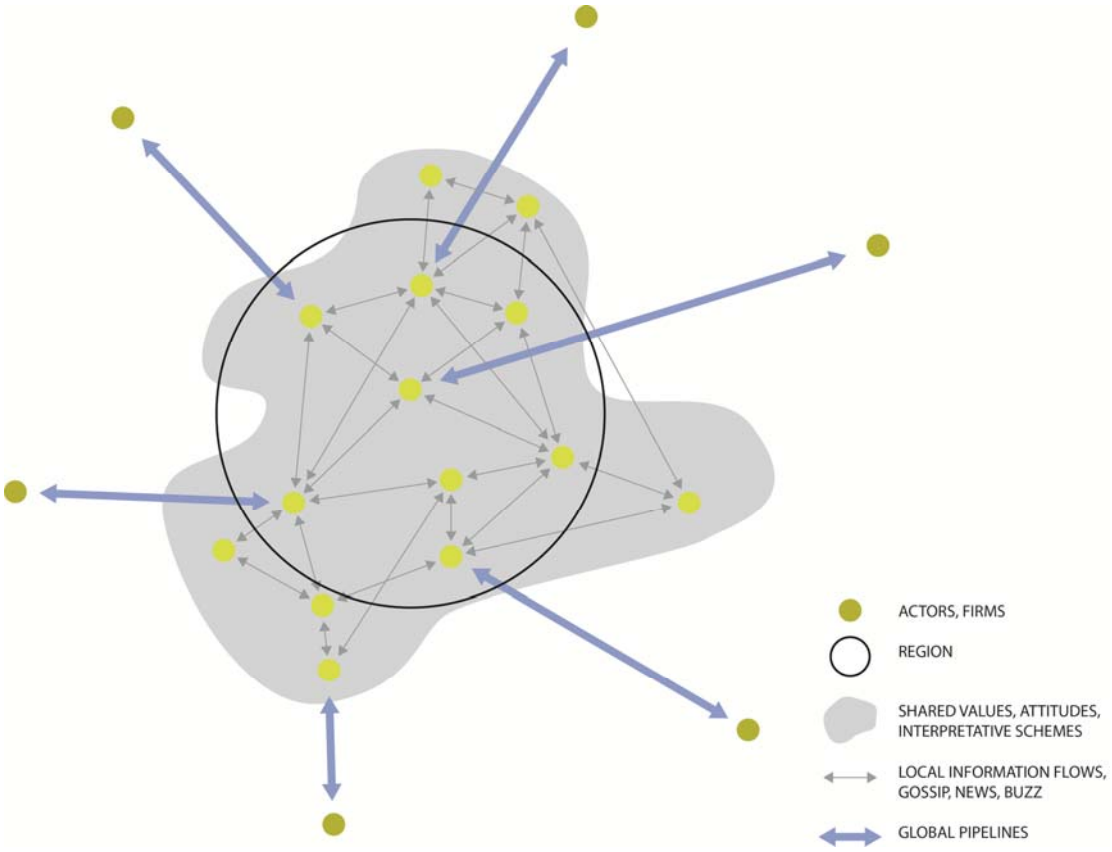

Figure 14
Local buzz and global pipelines (Bathelt et al., 2004)

While the aesthetic quality of a place is seen to contribute to city attractiveness, other factors, such as a solid economic base and opportunities for social interaction are equally influential on community satisfaction (Florida et al., 2011). Moreover, an increased degree of spatial specialization is notable on all scale levels (Sassen, 2012), which differentiates places regionally and globally as hubs for particular primary economic activities. Lastly, the fragmentation of urban functions on the regional scale levels has led to an expansion of transport

infrastructure connecting regional as well as national and international places. Consequently, corporate sites have undergone change: new headquarters emerge primarily in major cities, and sites are understood to be actively inserted into favourable milieus of competition and complementarity (Hein, 2011). Both manufacturing and service industries – with their respective focus on goods and people – take advantage of advancements in transport infrastructure to improve their connectivity. Figure 15 illustrates the basic interrelation between distance space decisions and function, which exerts influence on the opportunities, capabilities, and potentialities of economic activity.

Topological studies of the built environment have been undertaken by architects, planners, and transportation researchers to gain insight into the implications of the layout of the city's built environment on functional use patterns and urban exchange processes, and vice versa (Hillier and Hanson, 1984; Sevtsuk, 2010).

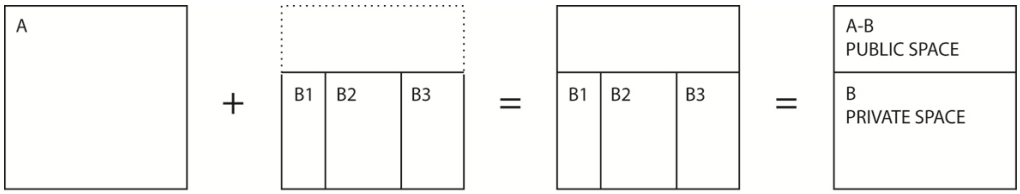

Figure 15
Configuration of elements forming distance space (Habraken, 1998)

The impact of different modes of transport and the connectivity of urban street patterns are confirmed to have a strong impact on urban development and location choices of firms and households. More specifically, street network connectivity and accessibility of built stock are considered to be quantitative measures, providing comparability across cases, with certain elements recurring across all western cities (Hillier, 1996b). Different authors have analysed component parts of urban built form while acknowledging the uniqueness of the total. Lynch focuses on the total system as an image of its constituent parts. He suggests that images are perceived by interlinking elements such as "high-speed highways, transit lines or airways, large regions with coarse edges of water or open space; major shopping nodes; basic topographic features; perhaps massive, distant landmarks" (Lynch, 1960:112). He refers to these as constituent urban elements: paths, edges, districts, nodes, and landmarks, which form the whole (47f). He acknowledges that these elements may be interpreted differently, depending on the scale and context which they are viewed in. Rowe and Koetter have termed the urban as a collage of fragments (Rowe and Koetter, 1978:149), suggesting that this approach allows for contradiction and thereby simultaneously embraces "change, motion, action and history" as key influences. Baccini and Oswald have coined the term "Netzstadt". Their approach stresses the open nature of the overall system, which consists of nodes, connections and borders (Baccini and Oswald, 1998:53). Based on the topological analysis of the territory, the Netzstadt model proposes criteria for the comparative evaluation of the built and unbuilt environment at different scales. Shane illustrates that urban elements of Enclave, Armature and Heterotopia are recombined to form distinctly different

urban structures in historic and contemporary cities (Shane, 2005, 2011). His definition of urban elements makes specific reference to their dual function as organizational devices and containers (Shane, 2011:37).

The research in the field is ongoing, and there is no one dominant school of thought; however, the importance of multi-scalar analysis, and the need to consider other spatial dimensions beyond the urban form – namely function and process space – is increasingly acknowledged and a strictly nested relationship between scale levels is rejected.

In addition, new measuring and modelling techniques have generated opportunities for a science of cities (Batty, 2013) to evolve. The above theoretical blocks show that key parameters are likely to emerge in an iterative process of empirical and theoretical advances. On the local level, architects and urban planners have stressed the importance of diversity in built form and function (Thierstein and Wiese, 2012) and good quality public spaces (Gehl, 2010) for the creation of interesting, vibrant places. On the larger scale, urban designers and urban geographers have focused on the interplay of infrastructure and density, with the works of Christiaanse and Koolhaas providing key contributions at the interface. "Open City" and "the City as Loft" develop an approach to urban design which is non-prescriptive (Sigler and Christiaanse, 2009), but focuses on the creation of "adaptable, flexible and at the same time powerful and authentic spaces" (Baum and Christaanese, 2012:9). It explores the contribution of built form to creating an "open city that gives all its inhabitants access to the resources and possibilities available". Koolhaas' work takes another perspective, stressing the transformative power of a single urban element. He suggests focussing all efforts on the individual intervention and ceasing to aim for "stable configurations but for the creation of enabling fields" (Koolhaas et al., 1995: 959ff). The super-regional level has most prominently captured in the work of Sieverts. "Cities without Cities" (Sieverts, 1997) stresses the use of the urbanized landscape in day-to-day life. It proclaims the dissolution of the historic European city as a relevant scale for contemporary fields of action, and calls for new tools to be employed to actively shape the super-regional space.

In summary, the above texts make reference to spatially restrained urban areas and locations within a larger context. They have in common that they acknowledge the interdependence of distance space decisions on other spatial dimensions, namely function and process space. They thereby seek to overcome the global standard urbanization model of the 20th century (UN Habitat, 2013) and replace urban master planning by a more refined, multi-dimensional approach to the production of space. Furthermore, they conceive spatial intervention as the result of a specific trajectory which continues to evolve over time. The next section traces the existing debates further on function space.

B.2.3. Function space

The interrelation between different distance space elements within the urban context has been instrumental for the definition of overall urban built form in the approaches discussed in the previous section. However, it is not only physical interrelations which construct the urban, but also the composition of urban functions as enablers for activities in their day-to-day use. The field of urban studies has experienced a paradigmatic shift in the past 50 years,

in that larger scale mono-functional enclaves (Park et al., 1997) have been condemned for being unable to provide the flexibility and diversity of functional use required to provide sustainable and vibrant spaces. Shane attributes this to a shift in the patterns of interactions between constituent elements. Extending the historic series of ISOCARP 2001 he suggests including the megacity in order to recognize the "enormous scale and potential to include agricultural development, as well as mass mobility and modern communication systems" (Shane, 2011: 40) making up the urban ecology.

Functional network studies have a long tradition in the practice of architecture and urban design based on the fact that building typologies can determine functionality. The modernist movement with its credo of form follows function (Sullivan, 1922) equally acknowledges this determinism of built form by proclaiming that it should be derived solely from functional considerations. The approach was developed further on a number of scale levels and later informed the concept of "the functional city" proposed by CIAM in the 1930s, proposing that land planning would be based upon function-based zones centred around dwelling, working, recreation, and transportation. Embedded in the then current political, social and economic context, it was the declared aim of this functional concept to support "the creation of a physical environment that will satisfy man's emotional and material needs and stimulate his spiritual growth" (Mumford, 2000:172).

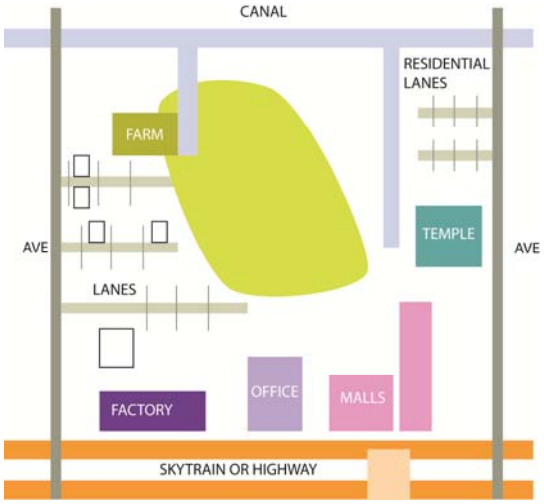

Figure 16
Configuration of elements forming function space (Shane, 2011)

The fundamental shifts in the functional organization of work towards flexible specialization (Piore and Sabel, 1984), the break-up of the traditional family model, and the differentiation of demand patterns across all social groups (Noller, 1999) have rendered such programmatic universalism obsolete. The knowledge economy has given rise to new priorities in the development of urban spaces, which satisfy the contemporary needs for interaction, flexibility and accessibility.

However, the local functional relationships persist to underpin the activities in urban quarters as generically depicted in Figure 16. The mixed-use paradigm has been complemented by a focus on flexibility and adaptability, as the spheres of working and living are increasingly overlapping and interchanging. The dynamic landscapes that these networks create are embodied in real spaces, which restrain and foster our physical movement and interaction by physical and functional differentiation, resulting in qualitative differences in the built environment. However, spatial meaning and form is critically affected by the activities and processes taking place therein.

B.2.4. Process space

The interrelationship between structure and agency is a longstanding debate in social sciences. Understanding functional space as a social structure, draws attention to the way it influences human behaviour and the fact that humans are capable of changing the functional structure they inhabit (Bourdieu, 1990). From a functional point of view, structure and agency define the trajectory of industrial organization, as functional spatial structures condition human interaction, and vice versa. From a spatial point of view, moreover, the interaction of humans with the built environment also facilitates the recursive relationship between built environment and social processes. Löw describes this as a constant iteration between spacing and synthesis (Löw, 2008) in the creation of the urban.

Levebvre (1991) follows this theoretical trait and rejects the notion "that empty space is prior to whatever ends up filling it" (Lefebvre, 1991:15). He introduces a triadic understanding of space as constituted by a lived, perceived and conceived dimension. Lived space refers to the qualitative dimension of situated practice. Perceived space is the empirically observable expression of space. Referring back to the discussion on place outlined previously, it acknowledges that space is not perceivable as an objective phenomenon. Levebvre's qualitative dimension thus involves the appropriation of space by the human mind and body and the resultant interaction and behaviour. The third dimension, conceived space, refers to the representation of space as knowledge systems (Lefebvre, 1991:361). Hence, Lefebvre's work focuses on space as social construction, and lays focus on the synthesis of the triad, which in turn impacts perception and behaviour.

The reciprocal relationship between material and immaterial constituents of space is further stressed by Hillier, who draws a distinction between the phenotype and the genotype of a locality (Hillier and Hanson, 1984:38), where the genotype is the underlying ordering principle of processes evolving in space, and the phenotype its manifestation in the physical topology. Equally, he stresses the role of the built environment in the provision of "a certain spatial ordering of categories, and a domain of control" (146). The importance of space for economic activity further implies a temporal aspect of ordering, which conditions action by existing material and immaterial spatial dependencies. Bourdieu stresses the importance of deciphering the logic of a field before attempting to understand the habitus (Bourdieu and Wacquand, 1996), rendering Levebvre's concept of perceived space as a pre-condition for understanding spatial action. The space of flows (Castells, 1999) adds an operational facet to process space in that it acknowledges the role of the dynamic elements which shape space.

It refers to "the material arrangements that allow for simultaneity of social practices without territorial contiguity" (Castells, 1999:19) and refers to electronic circuits and fast transportation corridors as facilitators of communication between distant places, which impact on the socio-functional structure of space independent of distance space. Figure 17 illustrates the flow of activities at the interface of function and distance space.

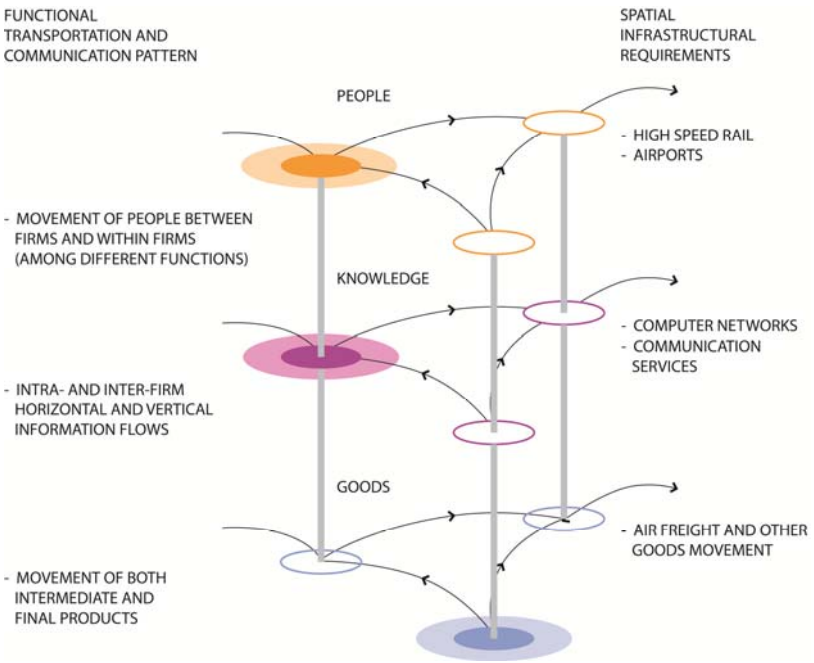

Figure 17
Flow of elements forming process space on global to local scale levels (Shane, 2001)

In summary, the understanding of space along the three dimensions of distance, function and process (Boesch, 1989) integrates built environment research with the urban studies research agenda around the use value (Lefebvre, 1991) of the city for exchange processes. It conceptualizes the physical and non-physical components impinging on spatial transformation as resources, which are actively reproduced physically, functionally, and mentally. Public and private actors are challenged to apply their limited resources most effectively to achieve differentiation.

B.2.5. Urban governance

In the geographic composition of land, qualitative differences are self-evident. Natural resources are unequally distributed, limiting certain activities to particular zones across the globe. Access to the sea, or certain climatic conditions, for instance, create qualitative differences. In the light of the abovementioned theoretical debate, however, the constitution of space encompasses many more resources – which bear potential for differentiation due to their uniqueness as local resources – than urban geography alone (Penrose, 1959; Thierstein et al., 2012). The physical space remains a key constituent in this regard as it structures life, guides physical interaction, and symbolizes meaning (UN Habitat, 2013). If this structure is both the medium and the outcome of social action (Giddens, 1984), it is a self-referential

system in itself, which "cannot be defined either as attached to the material morphology [...], or as being able to detach itself from it. It is not an in-temporal essence, nor a system among other systems or above other systems. It is a mental and social form of simultaneity, of gathering, of convergence, of encounter." (Lefebvre, 1996). In a similar vein, Löw suggests that spaces are not naturally existent but rather have to be actively produced by humans through synthesis (Löw, 2001:225). As such, the perspective of the individual is inherent in spatial conception.

In summary, the qualities of the individual city need to be decoded from its co-existing and penetrating relational logics, which exert a strong impact on past, current and future development (Thierstein and Wiese, 2012). As illustrated in Figure 18 places are interlinked functionally by systems of infrastructure, meaning and governance. These relational logics based on the physical flows of people and goods, as well as the non-physical flow of finance and knowledge create fields of interaction, which withdraw themselves from visual perception. The spatial extent of these fields and their intrinsic logic cannot be delineated a priori but has to be revealed empirically as part of the conception of the city (Boudon, 1999). This process precedes the product and lays the basis for sustainable development strategies (Thierstein et al., 2010). Only thereafter can it be stated which forces exert a lasting influence on the local and instruct the strategy of development (Berking and Löw, 2008; Bourdieu and Wacquand, 1996). Hence, successful places are a result of a multitude of inter-related network logics and fields of interaction imprinting on the local urban environment, as perceived by the user (Montgomery, 1998).

Increasingly, the spheres of influence, perception and the network extent fail to coincide. The challenge for urban governance in this context is facilitation of connectivity between the different spheres of action (Salet et al., 2003:389). While in other areas functions remain wholly within the public services, the field of urban and economic development has seen an increased fusion of public and private spheres. "Contemporary cities and economic actors operate not as mutually exclusive or competing geographical configurations, but rather as densely superimposed, interdependent forms of territorial organization" (Brenner, 1999:433). The context of the European cities, where space for development is scarce, poses particular challenges to the renewal and addition of "urban space" into that mix. These cities are to a large extent already built, and come with a history of development, which can hinder adaptation to changing demands locally and globally. The existing urban fabric imposes restraints, and increased cargo flows undermine urban amenity (Hall, 2007c). Spheres of control, influence and objective occasionally reach far beyond the city limits and nevertheless affect local development. Rather than being a territorial unit, a city consequently consists of numerous sites in spatially stretched relations (Amin and Thrift, 2002), or fields of interaction (Schumacher, 2005). However, a "spatial fix" (Harvey, 1989) is provided by "immobile socio-territorial configurations within which expanded capital accumulation can be generated […]" (Brenner, 1999). These are, on the one hand, technical infrastructures, such as transport systems, energy supplies, communication networks (Brenner, 1999) and on the other hand, knowledge infrastructures, which provide shared values, common representations, and codes (Camagni, 2002), which reduce complexity and uncertainty.

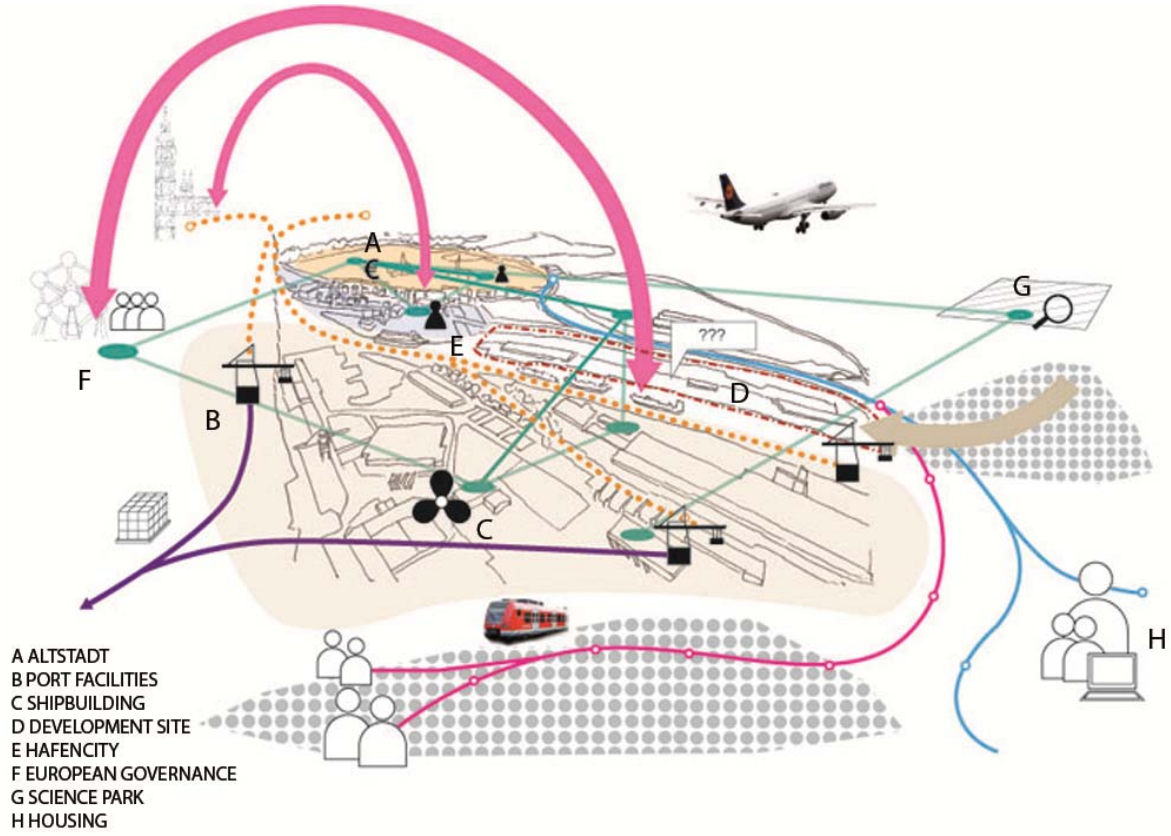

Figure 18
Development schematic of the eastern Hafencity (own illustration)

The port cities in northern Germany could be beneficiaries of the spatial fix, as it opens the opportunity for an interdisciplinary dialogue and informed development process which reaches beyond the waterfront. In the last decade, we have seen numerous European cities with the spatial ambition to re-invent themselves as post-industrial hubs of the network society (Castells, 2000). Their rational is driven by the ongoing structural change in the economy, which leads to the re-location of material-intensive activities to other areas of the world and the rising demand of non-European markets, leading to a complex web of material and immaterial flows, coordinated by means of modern communication technology and based on knowledge as a key resource. The circumstances in which cities compete make it necessary to adapt the qualities of the urban accordingly, and vice versa. An incremental approach, which carefully crafts interventions which supplement and support existing components is appropriate (UN Habitat, 2013).

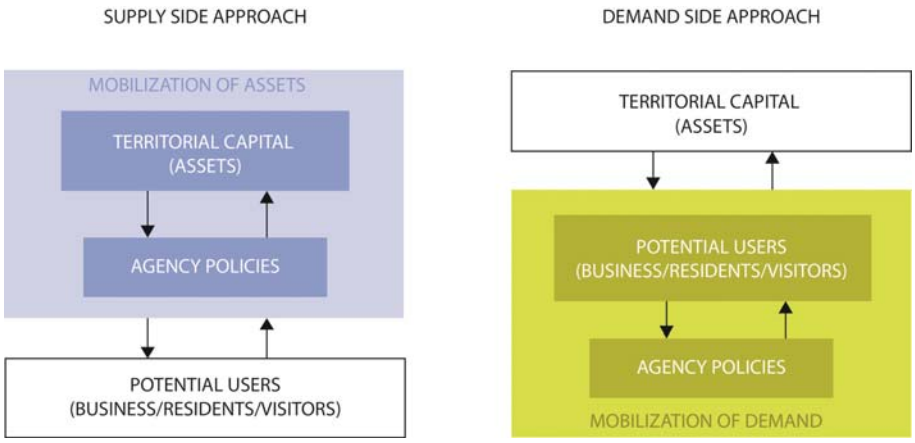

Figure 19
Policy approaches to European cities (ESPON, 2012a)

The physical restraints of the existing and the non-physical conditions of control, influence and objective make interventions of larger scale increasingly complex endeavours from a public perspective. In parallel to the overarching demands put on European cities with regard to the fulfilment of equal living conditions (German Basic Law GG Art. 72 Abs. 2 , German Planning Law ROG § 1, ESDP 1999) and global competition (Sassen, 1991), there is an intrinsic logic (Berking and Löw, 2008) to the individual city, based on its past trajectory, which is critical to the successful implementation of urban development strategies.

The development of port-city regions would benefit from such a tailored approach, building upon the supply and demand of resources as plotted in Figure 19. The selective mobilization of assets by strategic development efforts, and the mobilization of demand are key drivers of sustainable economic development. On the supply side, port cities across Europe possess waterside land in vicinity to the urban core, a rich cultural heritage and mature governance structures (Schubert, 2009; Warsewa, 2004). On the demand side, the situation varies greatly,

and a more refined approach evolving around potential users and agency policies is needed to successfully re-set the traditional port-city as a competitive and attractive destination. Currently, the divergence of economic development across European port cities is significant (Ducruet, 2011; Figure 9), and in several cases urban regeneration efforts have failed to lead to economic growth. The actors in the maritime economy are past and present users of the port-city. They have been subjected to structural change and global competition, as described in previous sections. Their network of functional relations is expected to reveal distinct patterns of spatial organisation strongly impacting on urban form at the port-city interface, and vice versa.

B.3. Urban economics

Countries, regions, and cities compete globally for economic strength and human capital (Camagni, 2002; Florida, 2008). The reduction of trade barriers and the strengthened competition globally have made these resources the critical factor for economic success trans-regionally. Simultaneously, structural change has altered material and communication flows and changed the field conditions for cities. The city depends fundamentally on external supplies and produces goods and services beyond local needs in order to be competitive.

Morphologically, the distinction between urban and rural areas has vanished. The ancient city – well defined by means of the city walls – has been replaced by an urban landscape which integrates farmland, settlement areas, and industrial facilities into a hybrid spatial form (Sieverts, 1997; Figure 12). Differentiation is generated by land price (Alonso, 1964), morphology and relative attractiveness (Hirschman, 1958; Myrdal, 1957), and recursivity generated through agglomeration economies (Hoover, 1948). The surface area covered by urbanized structures has tremendously increased, spurred by mass transportation and car usage (Rodrigue, 2013). Industrial uses have relocated from the city centre to the periphery, making cities more liveable. Globalisation has extended their trading reach, and increased their demand for differentiated consumer goods. As centres of command and control, they are enmeshed in a global network of interdependencies (Sassen, 1991).

The basic Keynesian model (Figure 20) of urban economy depicts the flow of capital between private households, firms and government, constituting the primary economic exchange processes.

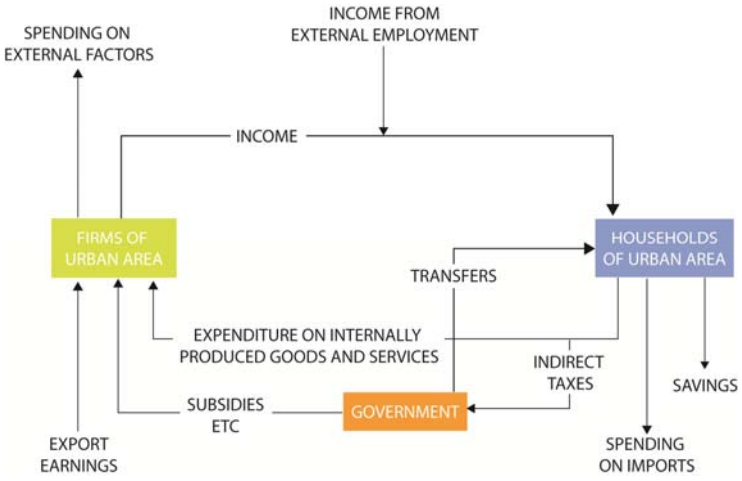

Figure 20
Basic keynesian model of the urban economy (Harvey and Jowsey, 2004)

Households receive their income from employment in the local economy. Additional funding is provided through government transfers. They spend money on consumption locally, or purchase from elsewhere. A share of the income flows back to the government in the form of indirect taxes, and a share is put into savings. The firms in an urban area profit from local

consumption as well as export earnings. Furthermore, they may receive subsidies or tax breaks from the government as an incentive. Their profit is spent on salaries as well as on external factors, such as investment operations. Even this basic model renders contemporary urban systems as open: flows of income transcend the boundary of the agglomeration, particularly in a global economy, where primary cities are at the forefront of national economies (Glaeser, 2011), and form global networks (Sassen, 1991). On a regional scale, opposing centrifugal and centripetal economic forces propel spatial development.

B.3.1. Centripetal forces

The urban economy is characterized by a certain critical mass of economically active individuals creating a market for goods and services. The density and diversity of cities make it distinct from other forms of settlement in a number of ways. The self-re-enforcing manner of these dynamics has led to the continuous growth of many urban areas.

The "relatively large, dense and permanent settlement of socially heterogeneous individuals" (Wirth, 1938) constitutes a pool of labour as well as a sophisticated market for local firms. In an advanced economy, more and more specialized goods and services are provided in response to the increased differentiation of clients' needs in respect of flexibility, quality and cost. The larger the agglomeration, the more suitable labour becomes available, attracting more firms to settle in the area and tap into the sophisticated labour pool (Thierstein and Wiese, 2011). At the same time, the market matures as increasing numbers of households settle and demand sophisticated goods and services from inside and outside the local economy. Local services in particular contribute to an increase in employment in urban areas through concentration effects. This results in urban amenities which reinforce the attractiveness of an area further by offering a large variety of private goods and services, but also indirectly funded amenities such as the availability and quality of public infrastructure (Glaeser and Maré, 2001), which becomes possible through increased tax revenues.

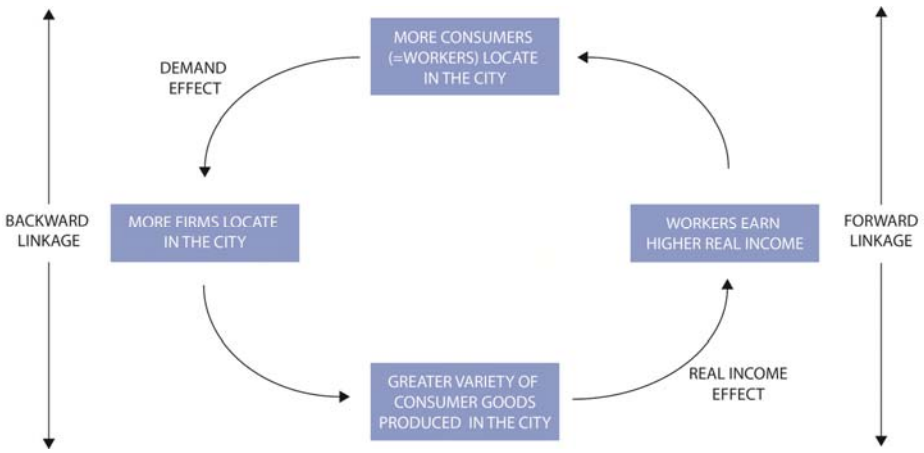

Figure 21
Circular causality in spatial agglomeration of firms (Thisse and Fujita, 2000)

The density and diversity of an urban area brings forth further economies, which firms take advantage of: the high level of specialization means that complementary activities – vertically and horizontally – can be sourced locally. With the advance of technology and increased competition, the sophistication and fragmentation of value chain processes increases (Henderson et al., 2002). The earning potential rises, and more consumers are attracted to the urban agglomeration. As a result, firms tend to concentrate on their core competency, increasing the need for vertically complementary goods and services (Wildemann, 2003). The result is a self-reinforcing dynamic of spatial agglomeration as plotted in Figure 21.

From a household perspective, horizontal complementarities provide a wider range of services, providing more customized responses to client needs. As the attractiveness of a site increases, agglomeration effects occur. The competition among firms in the local market further intensifies the specialization process (Glaeser et al., 1992).

The density of urban areas facilitates a more efficient use of public services. Public transport reduces the dependency on the car, and improves the connectivity within a large agglomeration. It further re-enforces growth through rapid access to the centre from suburban locations. The provisioning with other public services is also more efficient in densely populated areas. Libraries, opera houses, and universities draw on a critical mass of people in order to survive. Utilities, such as water, gas, energy, and sewage can make use of more efficient systems when demand and supply is spatially concentrated.

The centripetal forces stem from economies of scale and scope, which make urban areas in several respects more sustainable as a system for production and consumption. They are widely referred to as Marshall's externalities (Marshall 19,30), Jacob's externalities (Jacobs, 1969), and Porter's externalities (Porter, 1998), producing "untraded interdependencies" through technological complementation, economic diversification and clustering respectively, which impact positively on urban development (Storper, 1995). The centripetal forces stem from economies of scale and scope, which make urban areas in several respects more sustainable as a system for production and consumption. Despite these benefits of geographic agglomeration, there are also opposing centrifugal forces at work.

B.3.2. Centrifugal forces

Internal and external factors, such as scarcity of land or the re-direction of transport routes can restrict the growth of an urban area and lead to stagnation or even shrinkage. As a consequence the vertical and horizontal dimension of urban development is affected as the position in the hierarchy of cities as well as its gravitational force is reduced. The cyclic nature of scale and scope results in a path dependency of urban development.

The continued growth in the number of households and firms leads to continued growth of the urbanized area. Since building height is restricted, technologically and economically, and existing structures cannot be adjusted arbitrarily, cities grow predominantly horizontally rather than vertically. In consequence, the travel distances within the urbanized area increase, along with transport costs, congestion, and pollution resulting in the global standard urbanization model of the 20th century (UN Habitat, 2013). These diseconomies of scale have

an adverse effect on urban growth if suitable alternatives for firms and households exist. Furthermore, the increasing attractiveness of an urban core leads to a rise in demand for land, and consequently in land prices, which affects use patterns.

Traditionally, the core of the city benefits most from the dynamics of concentration, complementarities, and connectivity. The demand for land is therefore particularly high in the centre of the city. The supply of land, however, is limited, and in a mono-centric constellation, the amount of land available away from the core increases successively in relation to distance from it. Most generally, the land value and rent-earning capacity of land therefore decreases from the core to the outskirts.

Von Thünen captured the relation between land use and land value in a model which assumes that uses compete for land in a given agglomeration and locate where they can maximise their net gain (von Thünen, 1826). In the case of households, these are overall utility maximising considerations, and in the case of firms, these are profit maximising decisions. As a result of the excellent accessibility, the space in inner city locations tends to be occupied by non-area intensive, high value-adding services and commercial outfits, while housing and production functions are pushed towards the outer areas.

The process of globalization, improved transportation, and communication technology has increased the systemic dependencies between cities. Coming back to the Keynesian model (Figure 20), export earnings, spending on external factors, income from external employment and spending on imports have all been affected positively. Simultaneously, mobility and connectivity by means of physical infrastructure and sustained by relatively low costs enable the spatial adjustment of firms and households to changing economic conditions.

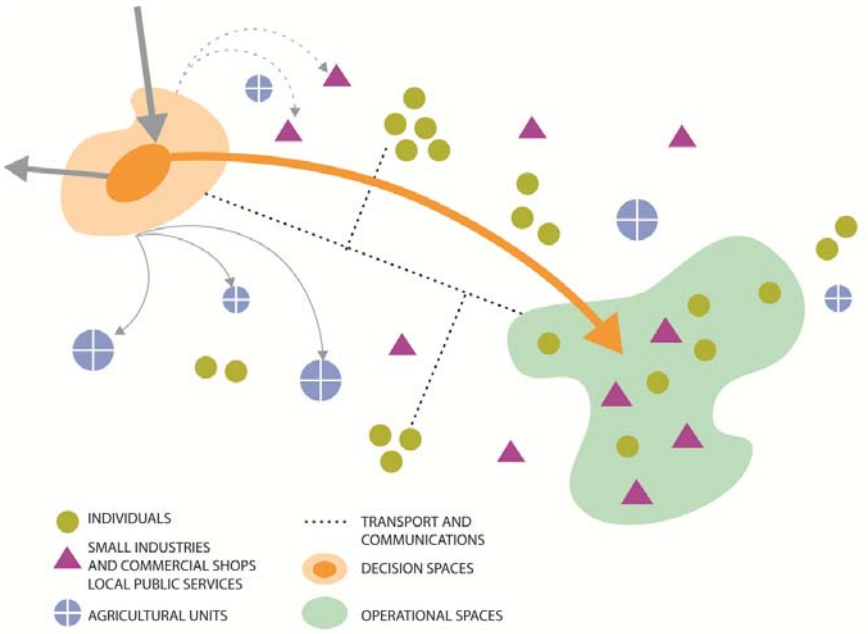

Figure 22
Spatial competition (Perroux, 1988)

In an early spatial model, Myrdal and Hirschman developed a regional pole concept revolving around mobile production factors relating the development of one urban area to that of another one (Myrdal, 1957; Hirschman, 1958). Labour and capital are considered as mobile production factors, which are attracted to flourishing centres of production and consumption (see B.3.1) to the disadvantage of another area.

The allocation of uses to geographic locations follows a complex logic of functional and spatial dependencies. Figure 22 captures this territorial interdependence of sites in a regional context. Global cities form the core of a spatial configuration, which is the result of the competition for land. Two major dynamics characterize the current debate in Europe.

B.3.3. The horizontal dynamic – towards polycentric megacity regions

The literature on spatial development stresses the potential which arises from coincidental morphological and functional polycentricity, which is illustrated in Figure 23. Rooted in current policy debates, the concept seeks to overcome the conflict between desired spatial cohesion and observed spatial fragmentation in urban systems. Morphologically, the result is a plurality of urban centres which are within commuting distance to each other in a given territory. As a result, the urban hierarchy as depicted in Figure 22 is flattened, leading to more balanced territorial development. Functional polycentricity complements the described morphology by patterns of economic interaction, which constitute economic exchange processes.

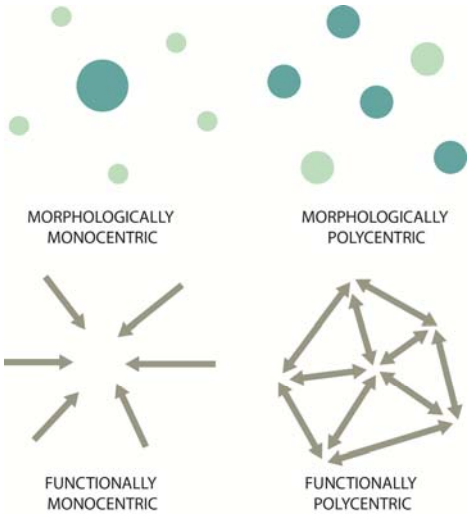

Figure 23
Morphological polycentricity versus functional polycentricity (Burger and Meijers, 2010)

As the urbanized area increases, and multiple development poles emerge, a functional specialization of places occurs, which defeats the disadvantages of endless monocentric growth, namely high transportation costs and congestion, by actively utilizing differentials in land prices and operational needs in the shape of a polycentric structure. The emergent polycentric megacity regions are

> *A series of anything between 10 and 50 cities and towns physically separated but functionally networked, clustered around one or more, larger central cities, and drawing enormous economic strength from a new functional division of labour. These places exist both as separate entities, in which most residents work locally and most workers are local residents, and as parts of a wider functional urban region connected by dense flows of people and information carried along motorways, high-speed rail lines and telecommunications cables (Hall and Pain, 2006:3).*

This concept reaches beyond the relative concentration of power in global cities, which may consist of multiple cities and their hinterlands (Friedman, 2005), which may themselves be subject to urbanisation processes (Derudder, 2006:2034), and explicitly focuses on the interdependencies within the regional economy. The extent of this new urban form is defined by close functional linkages between firms and subsidiaries, and households forming "a pattern of extremely long distance de-concentration stretching up to 150 kilometres from the centre, with local concentrations of employment surrounded by overlapping commuter fields"(Hall, 2007b:6).

The performance of the regional economy adds value to the local economic base, and improves the positioning of the region in a national and global context, giving rise to the second dynamic.

B.3.4. The vertical dynamic – towards global cities

Global connectivity and the concomitant rise of information and communication technology (ICT) has enabled firms and households to seek their location according to new priorities. Relatively low transportation costs and virtual connections mean that the place of production and consumption of goods can be spatially separated, and enables us to participate in exchange processes remotely. However, "the geographic dispersion of manufacturing plants and of office work could have gone along with a decentralization in the structure of ownership and profit appropriation [...] but such parallel decentralization of ownership has not taken place" (Sassen, 1991:30). For a number of reasons, cities remain the main hubs of decision and control functions in the world economy. Moreover, they compete on a national and international scale for the key mobile production factors: Labour and capital. Rather than a flattening out of spatial disparities, the spatial distribution of wealth and power has become more accentuated due to the increased mobility of capital and workforce (Florida, 2008), and reduced trade barriers.

From an economic perspective, the boundaries of the urban system have become more porous. Centripetal and centrifugal forces (see B.3.1 and B.3.2) operate at interrelated scale levels: locally, regionally and globally. The globalization of production and consumption has changed material flows. As a result, formerly prosperous cities have declined, and other places – mostly outside Europe – have gained in strategic importance. The functional specialization of places has become more pronounced. The global exchange of immaterial resources has increased and made talent and capital scarce resources, which are nonetheless needed

to secure prosperity. Simultaneously, cities have gained in importance as sophisticated market places for services and goods locally, regionally and globally.

As a result, the spatial development of cities is affected by their functional role in the wider network of regional, national, and global exchange processes (Grant and Nijman, 2002). More specifically, the research on world cities has shown how the locational preferences of multi-national enterprises have been decisive in shaping the urban hierarchy (Friedmann, 1986; Taylor, 2004).

B.3.5. Corporate location strategies

The strategic alignment of the organization with its environment has been a core subject in international business and management science for several decades (Lawrence et al., 1967; Porter, 1996). Location decisions can be considered as part of the brokering of fit between the organization's investment behaviour, its internal structure, and the acquisition of knowledge and human capital required to succeed in an increasingly competitive economic environment (McCann, 2002). Recent contributions to management theory stress the need for alignment between the organization's structure and its spatial configuration (Clegg and Kornberger, 2006).

However, current research on the location decisions of organizations has two failings: it has been largely focused on service industries, where different activities in the value chain are performed in the same location (Baum and Haveman, 1997), or it has focused on a single activity in the value chain, typically production (Alcácer, 2006; Myles Shaver and Flyer, 2000), without taking the wider context of industrial organization into account. At an aggregated scale, other authors have highlighted the wider implications of location decisions for economic systems (Fujita et al., 1999; Krugman, 1998), but generally considered space as a two-dimensional plane. In recent studies, the attention has shifted from national to regional and urban systems (see B.3), highlighting the diminishing importance of national borders which is spurred by institutional change and the increasing international mobility of factors of production. In a study of multi-national enterprises, Goerzen has shown that competence exploiting activities such as sales and distribution are drawn towards global cities, which alleviate the incremental costs associated with uncertainty, discrimination and complexity of doing business in a foreign environment in particular (Goerzen et al., 2013:433).

Architects and planners have largely focused on the local interplay between space and organizations. The research on office sites (Sailer and Ian, 2012), technology parks (Kukula, 1993) and corporate architecture (Messedat, 2005) explores the interrelation between corporate spatial decisions and exchange processes. In summary, this work falls into two categories: studies on the internal structure of sites, and studies on the impact of corporate locations on their environment. In practice, there is a shift from the 1970s to today from inwardly focused, hierarchically structured urban sites through more openly structured peripheral sites to the emergence of a new type of urban site which consciously inserts the corporate site into the urban environment (Katz and Wagner, 2014). However, this research leaves the symbolic and real presence of firms very much detached from the functional context of organizations and industries and their communication networks (Noseda and Bideau, 2001).

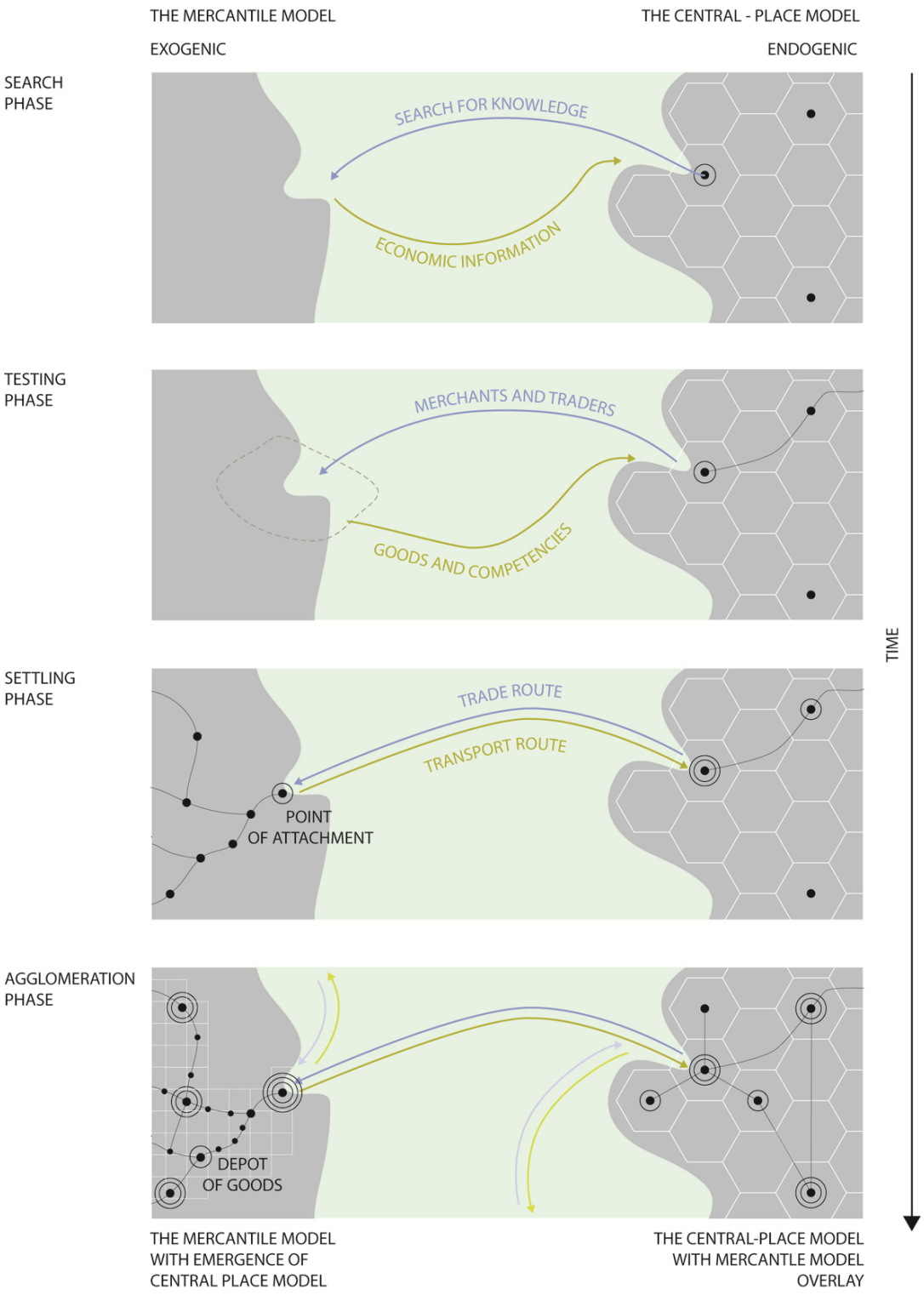

Figure 24
The mercantile model of exogenic and endogenic growth (Vance, 1970)

Despite the breadth of this research, few studies focus on corporate locations in the urban context across the dimensions of distance, function, and process space. Such research requires a trans-disciplinary approach and an analytical framework which is relational and multi-scalar. In an early conception depicted in Figure 24, the mercantile model by Vance traces the mutual interdependence of exogenic and endogenic growth, creating spatial transformation in a relational model of port cities (Vance, 1970). It originates from the search for new markets and products, and explains urban spatial transformation and proliferation as the result of localized and globalized exchange processes. The emergent points of attachment are the economic hinge between territorially discontinuous global systems of exchange, which superimpose Christaller's pattern of endogenic growth (Christaller, 1933).

The singular location decision is contingent upon the activities the economic actor seeks to perform. A growing body of research suggests that firms use location decisions to acquire capabilities (Chung and Alcácer, 2002), which in turn suggests that the exploration of the dynamic relationship between capabilities and location across space and time is necessary to understanding the implications for urban environments and places. The following section focuses on the connection between space and innovation activities.

B.4. Space and Innovation

Across Europe, innovation is considered the key driver of growth and prosperity (BMBF, 2012; ESPON, 2012b). There are a number of dependencies, which underpin this assumption. Firstly, innovation enables competitive advantage (Bathelt and Glückler, 2011) intensified globalization and the opening up of markets has enabled firms and consumers to source products and services globally. The more established a commodity or service, the more likely it is to be provided by competitors elsewhere. As a consequence, price becomes more relevant than quality, and high production costs in Europe frequently become prohibitive for mass production. Innovative products and services can achieve higher prices and thereby sustain competitiveness in the local economy. Secondly, innovation fosters sustainable development (Boschma and Iammarino, 2009) a critical factor for prosperity is the continuous investment of capital infrastructure and amenities. Innovation leads to the investment in places and people by private organizations, which in turn leads to the investment in public and private infrastructure in its vicinity. Thirdly, innovation leads to greater social equity (Storper, 2004) an institutional environment which is based on education and achievement as opposed to status, race and wealth provides more opportunities to climb the social ladder. Niche markets can be served by entrepreneurial small and medium sized enterprises, which would not be viably served by larger organizations. While these assumptions can be questioned, they have undoubtedly led to innovation becoming a buzzword for policy makers, economists and social scientists in Europe and beyond. In a survey by Ernst & Young (Ernst & Young, 2012) among 840 industry leaders worldwide, the capacity for research and innovation was identified as Europe's key asset for attracting foreign investment in the future.

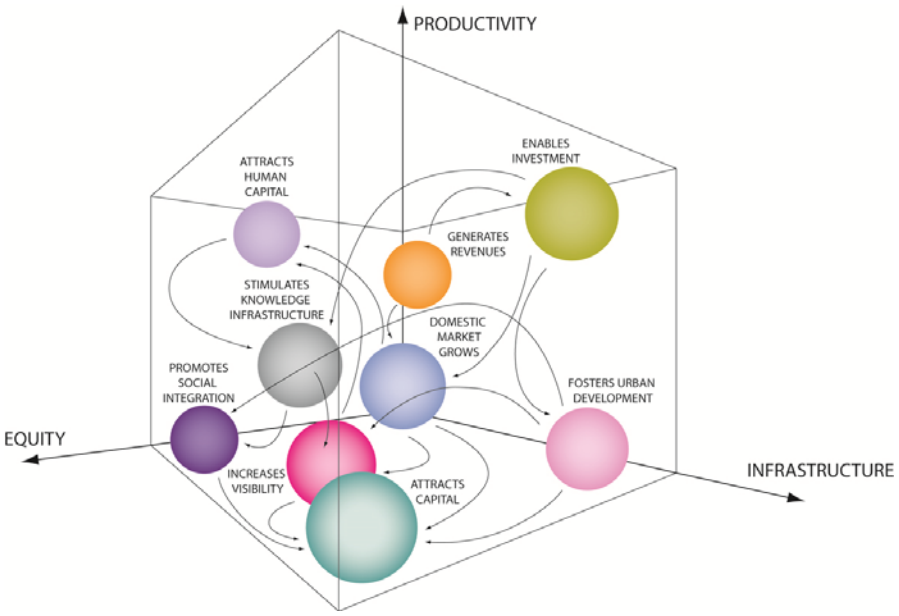

Figure 25
Dimensions and context of innovation and competitiveness

Although innovation has always been a key driver of economic development (Hall, 1998), the extent and pace of industrial change over the past fifty years has increased the importance of innovation for economic development (Schumpeter, 1934) global competition, liberalization and technological advances have drastically altered the way organizations operate (Brown et al., 2010; Derudder and Witlox, 2010). In order to remain or become competitive, they need to respond to changes in their vicinity and respond to opportunities and threats more rapidly. From a spatial perspective, the ability to produce and absorb knowledge is considered key to innovation and sustainable economic success. Moreover, the "'right" configuration of spatial and relational proximity is crucial for the success of firms (de Jong and Freel, 2010; Nooteboom, 2000; Schamp et al., 2004). As a result, the "dynamic interplay of innovation, imitation and improvement" (Hall and Pain, 2006) is sustained by a territorial accumulation of physical, economic, and networking assets, which creates an innovation ecosystem as illustrated in Figure 26.

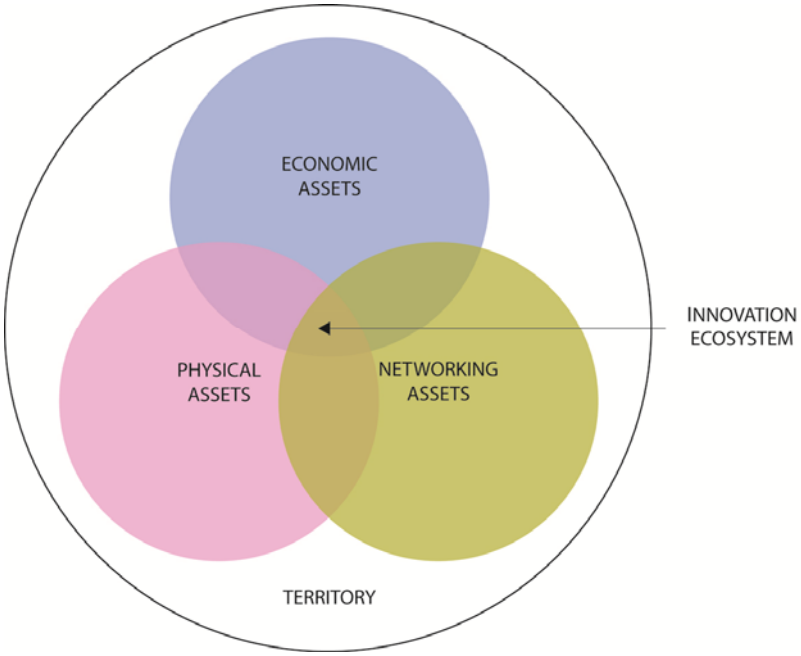

Figure 26
Territorial embeddedness of innovation ecosystems (Katz and Wagner, 2014)

As knowledge can be of various forms and types, knowledge transaction depends on a variety of factors. Most critically, tacit knowledge transfer is catalysed by proximity between actors (Boschma, 2005). Physical proximity means short geographical distance and is held to catalyse knowledge transfer by increasing the likelihood of planned and unplanned interaction (Eriksson, 2011; Storper and Venables, 2004). Other forms of proximity, such as cognitive, institutional and organizational proximity are based on the networking assets of actors, and are held to broaden the bandwidth of communication by shared systems of meaning (Boschma, 2005; Gertler, 1995; Torre and Rallet, 2005).

B.4.1. Industrial dynamics

Central to the historical debate on innovation is the impact of supply side – science and technology push – versus demand side – market pull-factors, and their causal relationship to innovation output (Dosi, 1982). More recently, both streams have been united under the systems of innovation approach (Edquist, 1997), and complemented by additional factors in the institutional environment to form the triple helix model of industry, academia and government (Etzkowitz and Leydesdorff, 2000). This systemic approach integrates the exogenous and endogenous factors impinging on the organization into one model. The interaction of organizations and their environment is central to the literature on innovation systems (Edquist and Hommen, 1999; Nelson and Nelson, 2002), with additional weight being given to institutions, vertical and horizontal links among firms, science and industry bridging mechanisms, and user-producer interaction (Malerba and Orsengio, 1996; Edquist and Johnson 1997). In this context, institutional structures encompass the set of national, regional, or sector specific factors "supporting and moulding efforts to advance technology" (Nelson and Nelson, 2002: 265). Pivotal are education and vocational training regimes, legal and regulatory influences, investment practices, as well as principles of industrial organisation, such as financing and unionization (Patel and Pavitt, 1994; Hall and Soskice, 2001).

One strategy for sustaining competitive advantage despite high labour costs is to sustain premium prices by offering customized solutions to clients. Advances in machine technology, ICT and a higher level of education enables firms to respond to the increasingly differentiated needs of businesses and consumers (Miles et al., 1995). The paradigm of flexible specialization (Piore and Sabel, 1984) has re-introduced quality as a competitive advantage in a sense which had been abandoned following the rise of industrial mass production at the beginning of the 20th century. Whereas raw materials and specialized machinery were key input factors in mass production, flexible specialization is based on well-trained operatives and knowledgeable managers who can reap the benefits of current market needs and translate them into customized products. As a result, the firm is less exposed to unstable markets and able to apply their competencies in a variety of value chains.

This perspective has proven particularly useful in sectoral studies, where a complex set of factors from within the private and public sector is seen to bear upon innovation activity; these include common culture, legal framework, education, customer preferences, and institutions (Freeman, 1987; Lundvall, 1992). Furthermore, the organizational and structural complementarity and proximity (Boschma, 2005; Gertler, 1995; Knoben and Oerlemans, 2006) of firms involved in one value creation systems is seen to foster innovation as depicted in Figure 26.

The interfaces of different fields of activity are a major source of learning and innovation (Yli-Renko et al., 2001). Through direct contact with products, services, and personnel the exchange of knowledge is fostered, which gives new momentum to commercial development through its complementary to the existing knowledge and technology base (von Hippel, 1994).

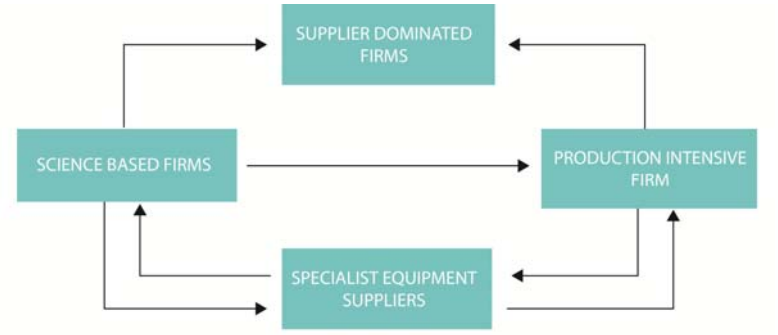

Figure 27
Intersectoral patterns of innovations (Pavitt, 1984)

The literature on strategy stresses the importance of multiple factors in achieving a strategic fit between the organisation and the competitive environment by means of aligning competencies and goals along the restraints and opportunities offered by the market (Lumpkin and Dess, 1996; Naman and Slevin, 1993; Venkatraman, 1989). The resource based view of the firm extends analysis into the factors which constitute the unique constellation of physical, human, and organisational resources in a firm as a base for organisational advantage (Nahapiet and Ghoshal, 1998; Penrose, 1959; Wernerfelt, 1984). The notion of the learning organisation embraces both approaches and demands that a firm adjusts capabilities and efforts dynamically on the basis of its knowledge base, and information and knowledge acquired from the continuously changing environment in order to remain competitive (Garvin, 1993; Kogut and Zander, 1994; Slater and Narver, 1995). As such, the strategic adjustment process is evolutionary and path dependent in that it builds on pre-existing resources of the firm.

The globalization of production and consumption, the increasing specialization of firms, and the acceleration of trade have increased the number of interfaces within industrial value chain systems. Those systems comprise a "connected set of activities, which is concerned with planning, coordinating and controlling materials, parts and finished goods" (Stevens, 1989). The inclusion of material and information flow underpins the importance of the integration as a system as key to the concept. Hence the knowledge economy is inseparably linked to the traditional economy by fields of activities which cross-sectorally introduces knowledge and information handling processes into the value-adding process (Kujath, Pflanz et al., 2007; Wiese and Thierstein, 2011). This focus is particularly pronounced within advanced producer services which provide high value input to the economy (Taylor, Hoyler et al., 2010). Figure 28 illustrates the interrelatedness of material and knowledge flow in an illustrative value creation process.

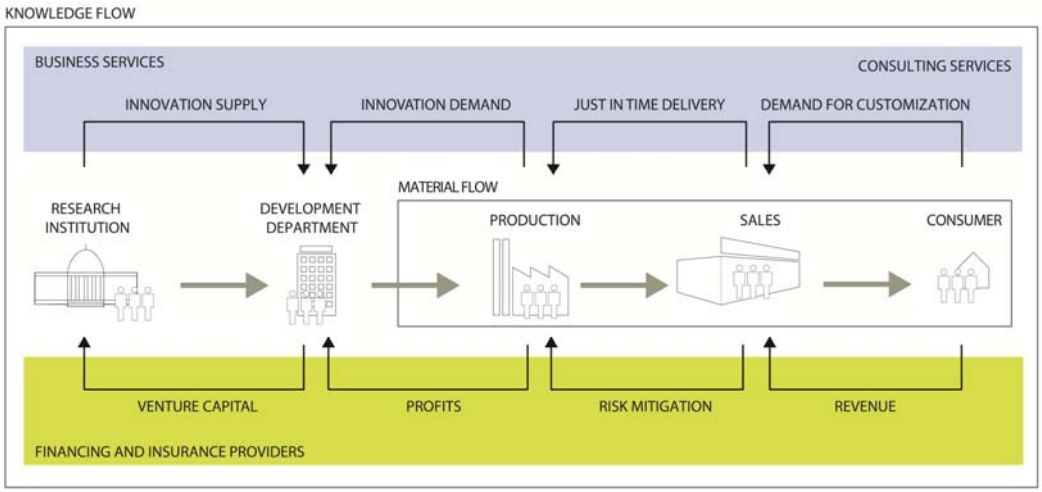

Figure 28
Value chain system

Across different industries, numerous approaches to inter-firm governance exist. Gereffi et al. have differentiated four different modes of governance: market, module, relational, captive and hierarchy (Gereffi, Humphrey et al., 2005). Depending on the governance mode, these interfaces require constant alignment or explicit co-ordination in order to realize the benefits of spatial and organizational de-integration: the role of these externalities has been stressed in the literature on organizational learning and innovation (Pyke, Becattini et al., 1990, Saxenian, 1991). Their realization hinges on the absorptive capacity of the firms involved (Cohen and Levinthal, 1990), since the capability of the firm to continuously absorb and create knowledge with the help of external linkages is a prerequisite for the creation of new knowledge through organisational learning (Garvin, 1993, Kogut and Zander, 1994). The creation and transmission of knowledge furthermore depends on the type of knowledge base (Gertler 2008), and the mode of knowledge creation (Nonaka, 1994). Value chain systems give actors access to technology, capital, supplies, expertise and markets and most importantly knowledge about these critical resources in related activity fields (Hall and Robbins, 2007). As stressed in the literature on sectoral systems of innovation, the dominant knowledge bases, the nature of industrial organization, and the influence of competitive and regulatory dynamics - tend to vary by industry (Pavitt, 1984; Malerba, 2005).

Moreover, different modes of knowledge are critical for different phases of the strategic alignment of the firm with its environment and the innovation process respectively (Utterback, 1996). In early phases most particularly, firms are seen to increase the depth, breadth, and efficiency of knowledge exchange (Yli-Renko, E. et al., 2001) through informal interaction, creating capability differentials, which can subsequently be exploited for gaining competitive advantage (Hall, 1992; Macpherson, 2005). In the more defined phases, formal interaction arrangements tend to dominate. At every stage, a mixture of tacit and explicit modes of knowledge are involved; as such the two forms are complements which rely on each other. Figure 29 distinguishes four different modes of knowledge creation along these two generic knowledge types (Nonaka, 1994).

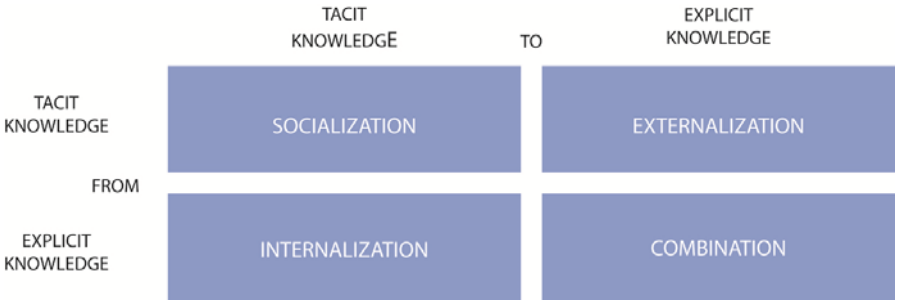

Figure 29
Modes of knowledge creation (Nonaka, 1994)

B.4.2. Knowledge creation and application

Knowledge is a production factor for both the input and the output side of value addition (Amin and Cohendet 2004: 15). In order to transform knowledge into value, firms create and exploit specific competences. The attraction and retention of the respective talent is critical to sustaining competitiveness and innovation (Thierstein and Wiese, 2011). Knowledge as an output is created, for instance, by scientific research, whereas distribution functions exploit competence in serving the market (Goerzen, Geisler Asmussen et al., 2013). In order to study the spatial consequences of knowledge application and creation as well as collective learning, further differentiation is required.

Since Polanyi published his work on the tacit dimension (Polanyi, 1966), it is acknowledged that knowledge has a strong spatial relation, and that codified and tacit knowledge are mutually dependent (Kujath and Schmidt, 2010). Whereas codified knowledge might be transmitted via ICT without any friction losses, tacit knowledge is considered to be geographically located, or socially embedded (Amin and Roberts, 2008). Gertler provides three arguments for the spatial foundation of tacit knowledge: firstly, tacit knowledge is difficult to exchange over long distances since it is rooted in experiences acquired during learning processes. Secondly, it is context specific in terms of language, shared values, or culture. Finally, the innovation process turns into social action in which learning structures become relevant, and, as such, it involves institutions and organizations enabling access to learning (Gertler, 2003:78f). Gertler suggests a further distinction between analytic, synthetic and symbolic knowledge to capture the systematic differences in knowledge bases and innovation processes across industries (Gertler, 2008). Analytical knowledge predominates in those industries where scientific knowledge derived from deductive models is highly important. This includes activities such as engineering and scientific research. This type of knowledge tends to be codifiable, and therefore less dependent on physical proximity for its exchange. Synthetic knowledge, however, dominates in sectors where innovation originates from the application and recombination of existing knowledge. This knowledge type is for example present in consulting activities, where services are individually customized based on previous experience. It tends to be driven by specific problems, which arise from the interaction with clients and suppliers. The dependence on a particular context, set of routines, and practical skills makes it less codifiable and more dependent on the tacit dimension. Hence, spatial proximity is

considered a necessary prerequisite for the exchange of synthetic knowledge. Symbolic knowledge, which is applied in activities in media and advertising, is characterized by its strong semiotic and affective nature. It is highly context specific and its economic value arises precisely from its intangible character (Asheim, Coenen et al., 2007), making it difficult to transfer across space. Due to its nature and association with the creative industries, we consider it as marginal with respect to the maritime industries.

Our understanding of the maritime economy, in which knowledge production is interwoven with the trade and production of goods, and its relevance for spatial development processes is based on three constituent parts: firstly, the nature of its knowledge base, and the catalytic effect of spatial and relational proximity. Secondly, the social process of knowledge creation is interwoven with the production and trade of material goods. Thirdly, innovation as the valorisation of generated knowledge in the form of a tradable product or service, driving economic development. This process of interactive knowledge generation evokes a complex interplay between spatial and relational proximity on different scale levels. The innovation system contains "the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge" (Lundvall, 1992). Therefore, the intersection of manufacturing, research and development, and advanced services is emphasized.

Conceiving knowledge creation as a process implies interwoven and coinciding patterns of development, production, and application thereof in products and services. The synthesis is an evolving innovation system which, in the case of the maritime economy, is affected by technological change and the restructuring of value chains.

To analyse this innovation system, the patterns of proximity between the actors in the maritime economy and their functional role in the process of innovation are paramount. Zillmer suggests an approach which enables the analysis of knowledge in transfer. In her comprehensive analysis of different service activities, she identifies four different types of generic activity related to industrial clusters: high-tech, transformation services, transaction services, and media/information services (Zillmer 2010:113ff). Her approach focuses on the relations between single actors as the active parts in the network, rather than the inherent knowledge stock or the aggregated level of technological regimes. It assumes a non-arbitrary selection of partners, and distinguishes product and process related services, making it particularly useful for the analysis of the maritime economy (Appendix F.7 Table 15). Furthermore, it considers services and manufacturing activities as complementary in value production (Bryson and Daniels, 2010: 83ff). This approach is intrinsically relational, since it centres on collaboration between actors for the purpose of knowledge generation.

Transaction services are defined as those value-adding activities which organizations perform at the interface of different knowledge spheres. It focuses on the organization and management of economic transaction (Kujath and Schmidt, 2010: 46), and includes advanced producer services, such as insurances, financing, or law, which are the backbone of the global economy.

Transformation services are provided by those actors which deliver their non-material input to material focused parts of the industry, and thereby shape the product as such. This includes research and development activities as much as consultants delivering input to, for instance, the high-tech industry. The focus is on the transformation of existing knowledge into new knowledge for the benefit of a different economic application (Kujath and Schmidt, 2010: 46). The refinement of materials such as metal is strongly dependent on the research. For example, the shape and consistency of ship hulls has been developed significantly due to new production processes in metal working, and new materials. The results are plans or templates for wider series of production.

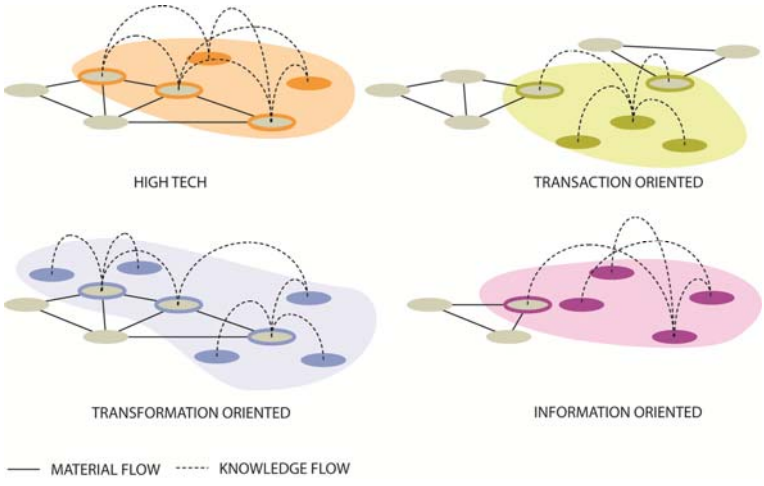

Figure 30
Subsystems of the knowledge economy as network topologies (based on Zillmer, 2010)

As a functional group, high-tech actors are concerned with the production of material goods. The value added to the system rests firmly thereon. As opposed to the former two groups, the material input is valued at cost rather than in conjunction with non-material components. It revolves around the production of knowledge intensive material goods by integrating new knowledge in products and processes (Kujath and Schmidt, 2010: 45). A typical high-tech product is the computer chip, which enables complex control techniques within maritime navigation or supply chain management. Since high-tech activities are defined by the invention of new products, transformation processes tend to refine these materials accordingly.

Finally, relations based on media and information services involve activities which transform knowledge into a standardized good. In the case of the maritime economy, these are predominantly educational relations, where guidance and instructions for action are provided. This type of knowledge is considered as preparation for future application. For example, masters and skippers of ships practice their skills in simulators before employing them in reality. The nature of the exchange processes underlying these subsystems of the knowledge economy are illustrated in Figure 30.

B.4.3. Implications for spatial development

The role of space as a catalyst for knowledge exchange has to be viewed in the context of the subsystems of knowledge production as well as urban economics, creating spatial differentials between places, and a potential advantage for urban areas due to density, diversity, and connectivity. As a socially, organizationally, culturally and physically embedded resource (Granovetter, 1985) the transfer of tacit knowledge in particular is promoted through face-to-face communication. Direct contact enables the participating parties to exchange imperfect knowledge or insight in a realm of mutual trust and reciprocity (Nohria and Eccles, 1992, Storper and Venables, 2004). Furthermore, the co-presence of two or more individuals offers additional control of the transmitted message, as questions can be asked directly, and information or reasoning can be added when necessary in order to guarantee transmission. Moreover, physical proximity opens additional channels of non-verbal communication, where physical co-presence enables the transmission of knowledge embodied in processes and artefacts through observation and use. The urban environment in particular offers a rich co-presence of functional and physical components, stimulating the creation of new knowledge by mimicking and complementing. In summary, face-to-face interaction opens up three distinct sources of learning: interaction, monitoring and a shared information and communication ecology (Malmberg and Maskell, 2006).

The discussion of proximity in the context of innovation research has a long tradition. The success of Silicon Valley and Third Italy have been discussed with regard to the role of spatial proximity (Saxenian, 1991). More recently, the concept of regional innovation systems has stressed the role of local ties between public and private organizations for creating a "milieu" which has a positive bearing on innovation activity. Consisting of shared values, common representations and codes, a strong sense of belonging, trust, common professional background and economic specialization the environment of the milieu facilitates transcoding, ex-ante coordination and a permanent substratum for collective learning (Camagni, 2002). However, only a limited number of empirical studies have delineated the size or extent of such a system spatially (Lüthi, Thierstein et al., 2011). Research has been undertaken into the structure, form, and quality of milieus in the context of advanced producer service firms, illustrating that those polycentric Mega-City Regions which are able to combine agglomeration economies and global network economies in a multi-scale innovation and production system – complemented by top-quality urban amenities – will be better placed to constantly reinvent themselves and to sustain global competition (Lüthi, 2011). The result are overlapping and trans-scalar knowledge activities, which manifest themselves in nodes of multiple knowledge connections of varying intensity and spatial distance, as a place in a web of trans-scalar and nonlinear connections (Amin and Cohendet, 2004).

For the abovementioned reasons with regard to differing knowledge bases, dependencies within the value chain and industrial dynamics in respect of increased competition and globalized markets, a relational multi-scalar study on the maritime industry has the potential to provide further insight into the role of space for innovation activity within specific sector settings.

Our understanding of the maritime economy and its relevance for spatial development processes is based on three constituent parts: firstly, the nature of knowledge, and its reference to spatial and relational proximity. Secondly, the social process of knowledge creation is interwoven with the production and trade of material goods. Thirdly, innovation as the valorisation of generated knowledge fosters economic development. This process of interactive knowledge generation evokes a complex interplay between spatial and relational proximity. The latter emerges owing to the activities of people as socially and historically situated while innovating. Therefore, we derive an understanding in which the non-place-specific processes of manufacturing, advanced producer services, and research and development penetrate place-specific ones, and vice versa (Henderson, Dicken et al., 2002). Intra-sector differences in the knowledge base and knowledge processes need to be accounted for in order to explore the role of spatial transformation.

B.5. Synthesis

Three areas of existing research inform the understanding of port-city development drawn on in this work. Urban studies inform the understanding of urban transformation as interlinked with social exchange processes. The emergence of configurations and meaning, which guide spatial processes are partly immaterial, and embodied in governance and reputations of places (Lefebvre, 1991). Urban economics provides the systemic models for material and knowledge exchange processes between the various agents sustaining spatial development on a number of scale levels. Lastly, innovation research differentiates spatial dependencies in accordance with their functional conditions along the value chain.

The distance space dimension treats the territorial assets as material, institutional, and symbolic resources of the urban context. These are found to have a structuring effect on the production of place, since they restrain and catalyse certain development paths. However, the individual site is a crystallization point of functional and process based interdependencies.

The functional dimension treats the maritime economy as a sophisticated value chain system that transcends the sectors around transport, services and manufacturing as well private and public actors. Furthermore, the maritime economy is strongly affected by structural change, which fosters the importance of advanced producer services as intermediates in the production process, the relocation of labour intensive parts, and new development paths, such as wind energy (Fornahl, Hassink et al., 2012). These developments fundamentally affect the functional interfaces within the maritime economy.

The process dimension puts the emphasis on the knowledge networks of the actors in the maritime economy, and treats knowledge creation as an interactive process. The value chains in this part of the economy include everything from low-tech manufacturing to knowledge intensive industries, where knowledge production is a complex process that is strongly interlinked with the transformation and exchange of goods (Hall and Hesse, 2013; Hesse, 2013). Moreover, the nature of knowledge calls for a differentiated approach, which takes account of the fact that various forms of proximity are key for the transfer, application, and generation of knowledge (Vissers and Dankbaar, 2013). The more knowledge is based on experience and learning by doing, the more likely it is that actors will seek personal contacts and geographical closeness. Relational proximity is then used to complement these geographically bound knowledge resources. In this regard, geographic and relational proximity are counterbalanced in order to sustain learning processes and the influx of new information (Malmberg and Maskell, 2006:8f). Setting the relevant processes of knowledge creation in the context of the wider spatial development, the question arises as to how different types of knowledge evolve in different patterns of proximity between urban centres in northern Germany.

By studying the activities and sites contained within the maritime economy, we aim to improve the understanding of the ongoing differentiation of spaces initiated by the creation of knowledge in a highly complex economic field, which is deeply ingrained in the identity of port cities. This prompts the question of how the different types of knowledge networks involve cities and regions in northern Germany in an urban system, and ultimately affect

spatial development in places beyond port cities. This research requires an analytic approach, which takes the heterogeneity of the maritime economy into account, and further reflects innovation oriented cooperation on value-added relations. We take a closer and inductive look at the composition and relationships within the maritime economy in order to evaluate the role of knowledge transfer for spatial development, the interdependence of activity fields, and between spatial co-location and distant collaboration.

B.5.1. Overview of empirical studies to date

Scholars from a broad range of disciplines have extensively examined port cities, both historic and contemporary. Architectural and planning practitioners, as well as historians of the built environment have explored waterfront transformation as the frontline of urban regeneration, and as part of the shift to a post-industrial economy. Social and urban geographers have examined the redevelopment of waterfronts for high-end uses as well as the displacement of the urban working class. Transport and economic geographers have focused on the position of ports in spatially extensive supply chains and global production networks, the regionalization of logistics activity and port governance reform. The following table provides an overview of the key empirical contributions to date.

Port cities are currently studied through different disciplinary perspectives that tend to amplify the mistaken impression that ports and cities are islands of unconnected actors and stakeholders (Hein, Hall et al., 2013). An integrated and evolutionary analysis of the complex intersection of these disciplinary perspectives and a comprehensive analysis of diverse aspects of port cities has yet to be undertaken: any such an analysis must link research on the built environment, metropolitan spatial form and spatial planning with analytical concepts such as agency, networks and institutions. Likewise, various research methods need to be linked, varying from case studies to discursive approaches, and economic network analysis.

Table 1
Overview over empirical studies

Distance Space					
Local Scale		**Regional Scale**		**Global Scale**	
Jacobs 2008	Co-location of port related functions and advanced producer services in the city centre of Rotterdam	DeJong and Freel 2010	Higher R&D expenditure is positively related to collaboration with more distant organizations in Dutch high-tech firms.	Malerba and Orsengio 1996	Patterns of innovative activities differ systematically across technological classes, but are similar across the countries for each technological class.
Florida, Mellander et al. 2011	Beauty is significantly associated with community satisfaction in the US. Other significant factors include economic security, schools, and social interaction.	Eriksson 2011	Density of economic activities contributes to the performance of plants within a short distance. The composition of economic activities is more influential farther away.		
Hillier 2014	The generic city expresses economic and social processes through generic function – the fact of movement without regard for its specific purposes – but only within an envelope of possibility defined by the human mind. This envelope defines what can and cannot be a city.	Oswald, Baccini et al. 2003	An exemplary study shows how the Netzwerk method effectively identifies the existence of a non-place that is becoming a place.		
Shaver and Flyer 2000	In the US Firms with the weakest technologies are mor likely to geographically cluster. Location decisions of heterogeneous firms are characterized by adverse selection.	Chung and Alcacer 2002	Firms in lower tech industries invest in US states with low technical capabilities, whereas research intensive industries are more likely to locate in states with high R&D intensity.		
Sailer and Ian 2012	Spatial distance measures based on detailed configurational analysis outperform simple Euclidean distance metrics in predicting social ties.	Batty 2001	Aggregated urban structures persist in spite of rapid and volatile micro change at more local levels of locational decision-making.		

Function Space					
Local Scale		**Regional Scale**		**Global Scale**	
Sevtsuk 2010	The basic act of laying out streets, parcels and buildings can affect the location choices retail and service land uses, thereby shaping the economic structure of the city.	Glaeser and Mare 2001	A portion of the urban wage premium in the US is a wage growth, not a wage level, effect. This evidence suggests that cities speed the accumulation of human capital.	Ducruet and Lee 2006	The port-city evolution appears to be gradual rather than linear or chaotic, and in many cases largely influenced by regional factors and local strategies
Naman and Slevin 1993	Performance among firms was positively related to the measurement of fit with the environment.	Glaeser, Kallal et al.	Local competition and urban variety, but not regional specialization, encourage employment growth in industries. Knowledge spillovers might occur between rather than within industries, consistent with the theories of Jacobs.	Ducruet 2007	Factors such as port hierarchy, land/sea, port/city, and logistic/intermodal oppositions create north-south and east-west patterns.
Jacobs, Koster et al. 2010	This result suggests that APS, and not only AMPS, provide services to the maritime industry and specialised maritime services tend to agglomerate near other services Proximity to customers however is more important than proximity to these advanced service providers.	Goerzen, Geisler et al. 2013	MNEs have a strong propensity to locate within global cities, but these choices are associated with a nuanced interplay of firm- and subsidiary-level factors, including investment motives, proprietary capabilities, and business strategy.	Jacobs, Ducruet et al. 2010	Port-related APS activities follow the world city hierarchy, a number of port cities stand out because they act as nodes in global commodity flows and as centres of advanced services related to shipping and port activities.
		O'Connor 1989	Maritime services are not necessarily located in the busiest port, but rather in the city with the most diverse service sector.		
		Boschma and immario 2009	Related variety contributes to regional economic growth based on export and import data by Italian province.		

Process Space					
Local Scale		**Regional Scale**		**Global Scale**	
Montgomery 1998	Identifies 12 essential conditions for achieving the necessary 'fit' of built form to activity and image. The interplay of form, activity and image is critical for urban design.	Notteboom 2010	The container handling market is more concentrated than other cargo handling segments in the European port system, as there are strong market-related factors supporting a relatively high cargo concentration level.	Beaverstock, Smith et al. 1999	Aggregated results from the analysis of APS links produces 55 world cities at three levels: 10 Alpha world cities, 10 Beta world cities and 35 Gamma world cities.
Alcacer 2006	Production and sales subsidiaries are more geographically dispersed, and R&D subsidiaries are more concentrated, moreover more-capable firms collocate less than less-capable firms, regardless of the activity performed.	Brandt, Dickow et al. 2010	The network analysis reveals an interconnection of the individual regions in Germany and segments with in part positive feedback effects.	Ducruet and Zaidi 2013	Geographic proximity is one main explanatory factor in the emergence of port systems, other logics also appear, such as specialized and long-distance trading links.
Schamp, Rentmeister et al. 2004	Local practices emerge through the integration of international practices in national and local institutions and innovations targeting the national market.	Hall and Pain 2006	A long-continued process of concentrated deconcentration has produced clusters of up to 50 cities constituting networked urban reg ions.	Taylor 2004	Database of global service firms' locations and transfer that into an analysis of the world city network.
Fei 2011	Shipping organisations can apply appropriate IT to facilitate effective knowledge transfer to reduce knowledge wastage caused by outflows of personnel.	Yli Renko et al. 2001	Social interaction and network ties dimensions of social capital are associated with greater knowledge acquisition in UK high technology ventures.	Lüthi, Thierstein et al. 2011	interlocking firm networks in the German High-Tech sector are more globalized than networks in the Advanced Producer Services sector.
Macpherson 2005	Corporate solutions to crisis are significantly dependent on existing experience and systems of organising, manager's perception of the crises, and access to relevant knowledge.	Saxenian 1991	Computer systems firms in Silicon Valley are responding to rising costs of product development, shorter product cycles and rapid technological change by focusing and building partnerships with suppliers, both within and outside of the region.		

B.5.2. Subject of this thesis

The review of the literature has identified corporate location decisions as an important driving force in physical and functional spatial development. The corporate site becomes the interface of internal corporate resources to those external to the organization. The multiplicity of different sites is a critical factor in urban systems, as specialization and variety critically affect the attractiveness and competitiveness of places. The relative location and functionality of sites to each other has become a guiding factor in economic exchange processes and the locale of value creation. The effect of spatial dimensions on innovation activity has been studied in singular areas of the economy. Preliminary results give little indication of how urban planners and architects in the public and private sector can interact and actively nurture the specific economic activities which underpin the culture and identity of places. Further research is required at the intersection of the fields of urban studies, urban economics, and innovation research. Port cities are of particular interest owing to the intersection of material and knowledge flows, and the well documented historic interrelation between port and city. Furthermore, the effects of globalization and structural change have differentiated port cities around the world from each other, suggesting that the processes of spatial transformation are particularly pronounced.

C. Research Methodology

The design of this research is critical to the contributions this work can make to academia. As urban studies is in itself a multidisciplinary field and this research spans a number of disciplinary areas, the design presented in this chapter is developed specifically around the subject of this thesis. The development of port cities is studied through a detailed case study of the interaction between actors in the maritime economy with the urban environment. The case study design is derived from an interaction framework, which sets out basic assumptions derived from the current state of knowledge outlined in Section B. This framework, which also defines the limitations of the study, is explained in the first section of this chapter. On this basis, the research question and a number of hypotheses which inform the empirical work are arrived at in the second section. The case study design approaches the subject from three distinct methodological perspectives. Data and methodology are explained in the first part of the second section of this chapter. The expected findings and limitations of the study are explained in the last part.

C.1. Case Study Design

The case study presented is an empirical enquiry into the real-world context of port cities (Yin, 2009). The research framework shown in Figure 31 sets the case study in the specific theoretical context, which is derived from the current debates in the field. Port cities are situated at the interface of global and local developments, which stimulate both functional and spatial dynamics. The research framework brings together the functional perspectives of knowledge networks and industrial value chains with the spatial perspective of proximity and connectivity as mutually reinforcing processes, which foster knowledge transfer and innovation propensity. The capability to innovate is considered a prerequisite for competitiveness. The design acknowledges the interrelatedness of scale levels and the complementarity of physical and organizational proximity in catalysing exchange processes.

Places for knowledge generation and innovation are assumed to arise from the proximity to firms and technologies, which are complementary as well as in competition with each other. Formal and informal ties provide different opportunities for the exchange of knowledge between corporate actors in the maritime economy. The regional scale bears a particular potential, as it enables physical proximity between sufficiently differentiated spaces for functional specialization to arise, thereby accommodating material and knowledge based activities simultaneously. This co-existence is hypothesized to increase the competitiveness of port cities, as it fosters advances in technology and functional specialization based on complementarity of knowledge assets and absorptive capacity. The functional dependency of industrial value chains and knowledge networks in turn foster proximity organizationally and spatially.

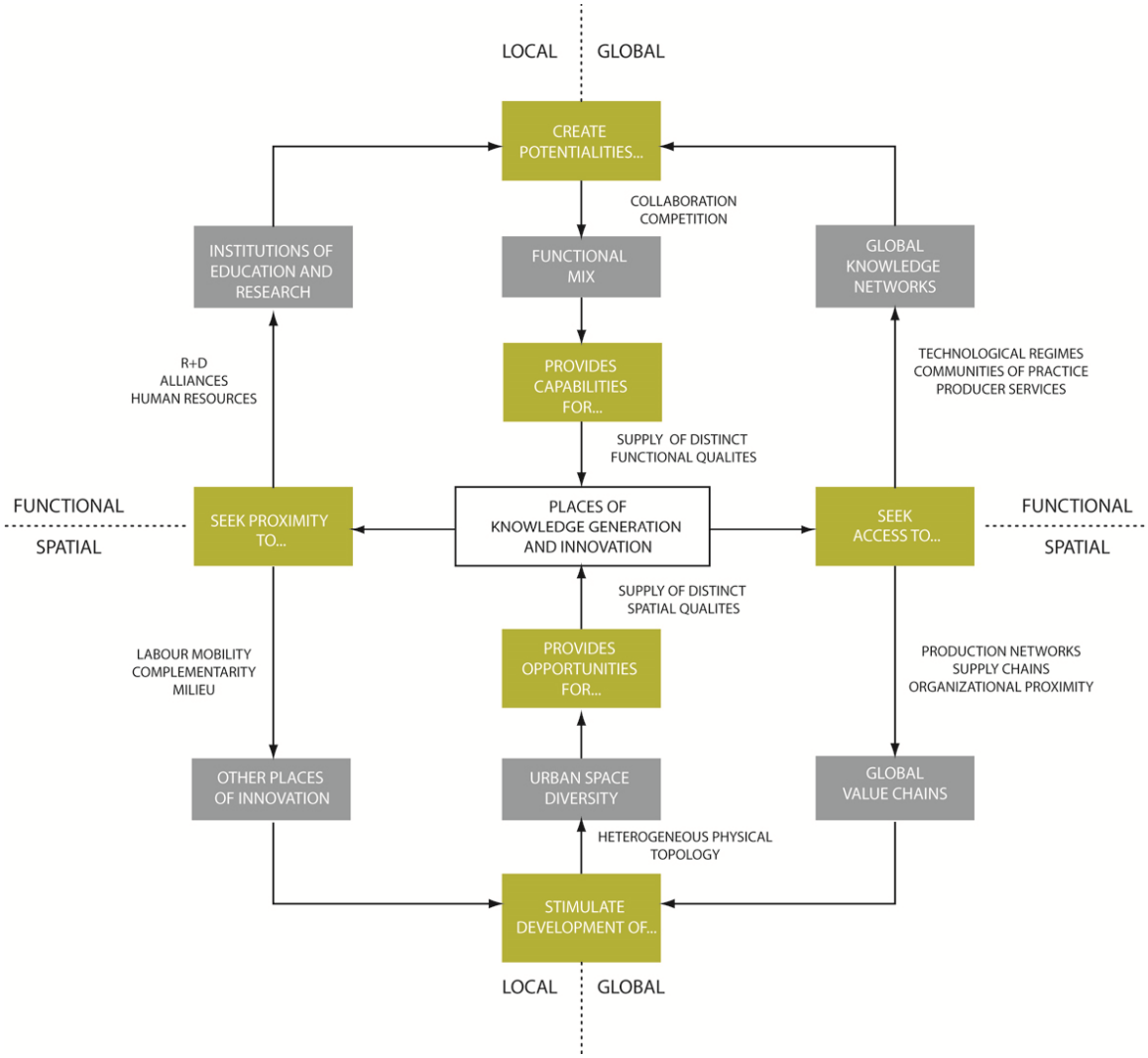

Figure 31
Research framework

The focus of this research is the interaction between the actors in the maritime economy and the urban environment. At the outset of this study, it is not clear how the phenomena of this interaction can be extrapolated from the wider urban context, although the presence of the maritime economy is considered to be critical to the future development of port cities. The basic assumptions which are presented in the following section guide the research design, but also acknowledge the open ended nature of this enquiry.

C.1.1. Basic model of spatial production

The urban environment is considered a catalyst for situated processes of value creation, by providing capabilities, potentialities, and opportunities. Simultaneously, qualitatively different spatial conditions are created by, and reproduced through fields of economic interaction at different scale levels. Interaction is conceptualized as communication between at least two sub-systems. It comprises verbal and visual communication, and is evaluated against its capacity to transform either system through the process of communication.

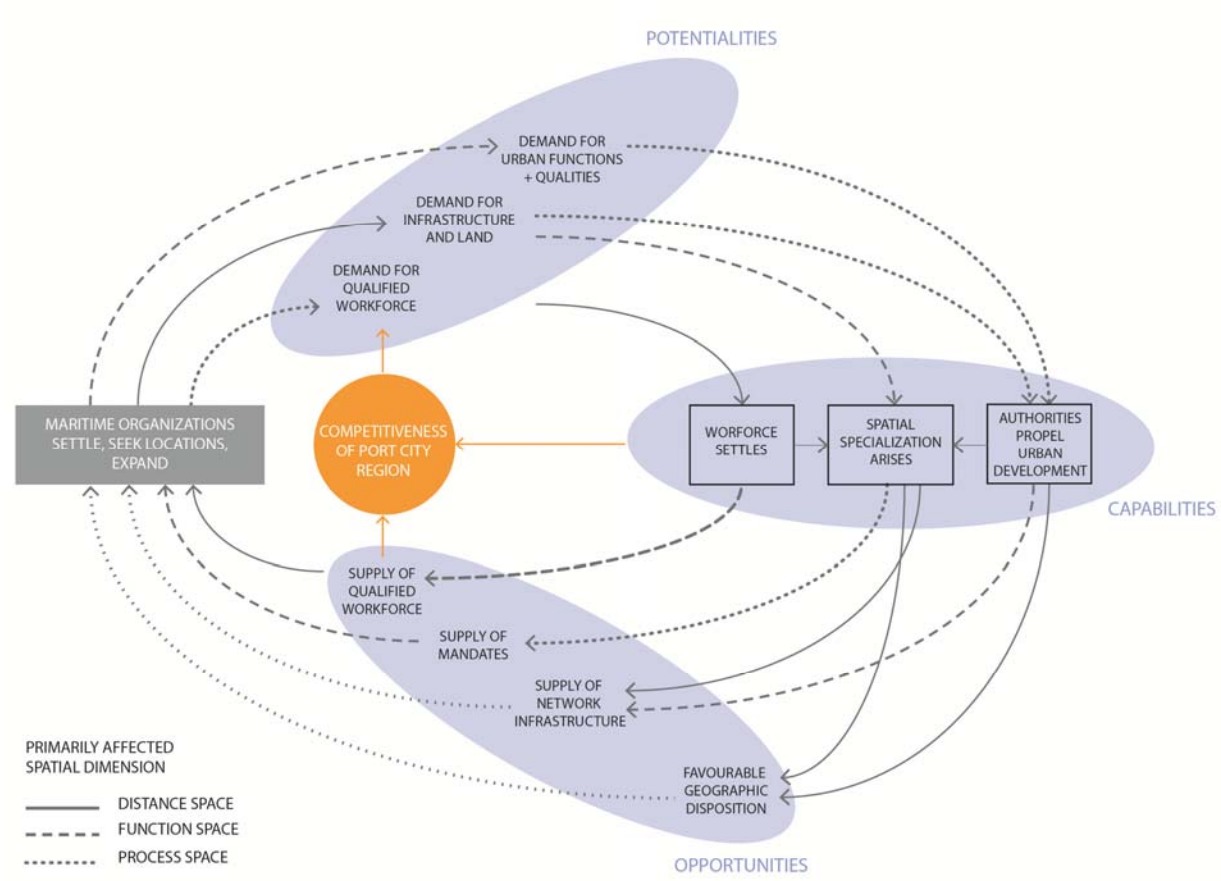

Figure 32
Simplified conceptual model of spatial production

As maritime organizations settle in port cities, they create a demand for qualified employees, infrastructure and land as well as urban functions. Although these constitute very different resources, they have equal bearing on physical and functional spatial development. The pull-force creates potentialities, which urban planners are challenged to find solutions for. In the next phase, the workforce settles and the spatial configurations chosen are the basis for spatial specialization to arise. The assemblage of the resources creates capabilities for further development. Availability of qualified employees, competencies and infrastructure contribute to the establishment of a favourable overall location and create further opportunities for development. The system as depicted in Figure 32 reinforces itself in that it in increases the competitiveness of a port-city.

This model is a simplified interaction model, which allows us to define the study area and sampling strategy for this research. It has not been empirically tested, but is informed by the empirical studies to date, which have revealed these key interdependencies.

C.1.2. Definition of key terms

The fields of urban studies and urban economics are characterized by their multi-disciplinary nature and multiplicity of research approaches. In some cases, terminology is used interchangeably in one area of study, but has a different meaning in another area. As this can

inhibit understanding, we seek to define the key terms employed in this study in the following section.

The relational conception of space prioritizes the interaction of different elements over the absolute qualities of space. It acknowledges that the configuration of constituent parts defines a quality which has more explanatory power in terms of urban development than the sum of its parts. Furthermore, we consider the quality of a space to be first and foremost the extent to which that space satisfies the expectations of a community (Rapoport, 1970) and supports its needs. In the case of the maritime economy these are expected to be defined by the values pursued by the community for its economic development.

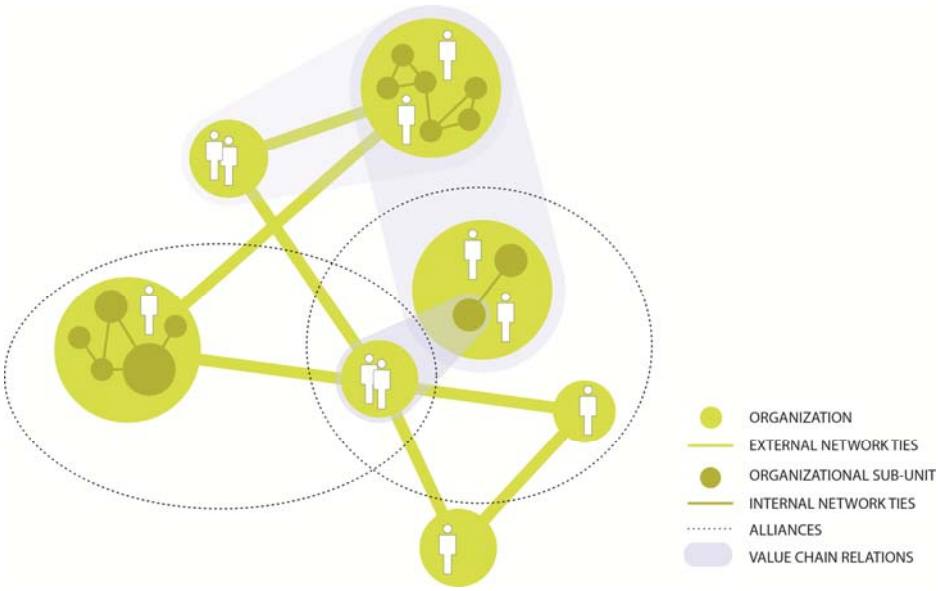

Figure 33
Actor network model of organizations

The actors in the community are in our case the organizations. This unit of analysis is an aggregation of variable size, with small, medium, and large organizations each considered sufficiently coherent, stable, and self-governing entities as shown in Figure 33. However, it is noteworthy that in most cases, organizations do not interact directly, but that individuals interact face-to-face or over a distance (Kogut and Zander, 1994; Vissers and Dankbaar, 2013), which could undermine the validity of our study. The organization and the community, however, are held to provide the primary interpretative schemes and frames of reference, which are relevant to collective learning and knowledge applications leading to innovation (Malmberg and Maskell, 2006; Orlikowski, 2002).

Structurally, the community of the maritime economy transcends the economic sectors of Manufacturing (NACE Section C), Professional, Scientific and Technical Activities (NACE Section M), Transportation and Storage (NACE Section H), Education (NACE Section P), Administrative and Support Service Activities (NACE Section N). Other sectors, which might be of

relevance in certain activity fields are Construction (NACE Section F) and Financial and Insurance Activities (NACE Section K). The NACE classification draws on economic activities by using common resources: "capital goods, labour, manufacturing techniques or intermediary products are combined to produce specific goods or services" (Eurostat, 2008: 15). Thus, it is a reference system focusing on input-output relations and a commonly used production base. It is not tailored to take cross-disciplinary knowledge processes into account.

As a heterogeneous cluster of activities, the inner logic of cooperation and innovation within the maritime economy is critically affected by the flow of knowledge within and across activity fields (Brandt et al., 2010). In accordance with these considerations, 13 different activity fields have been defined, that are part of the maritime economy. These are: boat building, port corporations, port logistics, maritime services, maritime education and professional development, maritime science, marine engineering, marine engineering science, shipping companies, shipbuilding, shipping supplier and other economic and science actors. Knowledge intensity varies across and within these activities. Therefore, a definition is adopted which is applicable to cross sectorial activities and different functional profiles. Hall considers all those activities as knowledge intensive, whose ratio of highly qualified personnel is above the average of all services (Hall, 2007a: 49). More specifically, Legler and Frietsch define shipbuilding and shipping as knowledge intensive branches (Legler and Frietsch, 2006:22).

As the focus of our research is the interaction of economic actors with the urban environment, we consider knowledge as a process (Nicolini et al., 2003; Vissers and Dankbaar, 2013), which is catalysed by qualities of the environment, which in turn are an assemblage of three dimensions: distance, function, and process space. The meaning and delineation of these spatial dimensions is discussed in section B.1 of this thesis. Key to our definition of space is the simultaneous consideration of physical and non-physical entities and flows, which define the use value of space for the maritime economy. As opposed to the exchange value, which is the market price for space, the use value captures all spatial qualities which contribute to the satisfaction of a community's needs (Lefebvre, 1991) – in our case that of the maritime economy. As elaborated in section B.1, the maritime economy is assumed to be a critical stakeholder in the development of port cities as a whole.

C.1.3. Sampling Strategy and Multi Methods Approach

The combination of different theoretical strands of research as presented in section B has informed the research framework. In order to support the validity of the framework, both as a means to addressing the complexity of the research subject, and to increasing the reliability of our results, the sampling strategy triangulates different methods and data sources.

Three distinct approaches are employed to improve the understanding of the use value of the built environment. Firstly, the interaction between nodes is analysed employing social network analysis. Tracing and evaluating real-world interactions improves the understanding of the functional structure and dependencies of the community and delineate the scale of spatial processes. Secondly, this thesis inquires into the appropriation of space by actors through a set of structured expert interviews. The lived space of interaction is set in context

with the findings of the network analysis. Thirdly, the relation to spatial form is analysed with particular attention given to configuration and topology. The assumption that the dimensions of space are recursively linked, allows the matching of the three methodological approaches with Lefebvre's triad of spatial production as depicted in Figure 34.

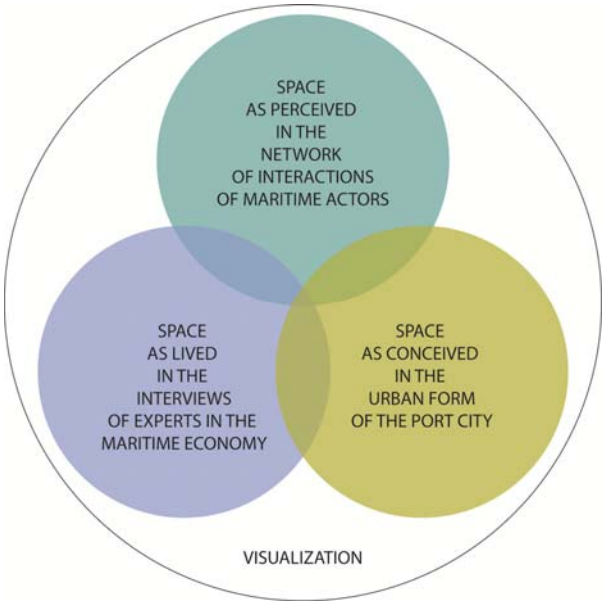

Figure 34
Triangulation of methods

The network data constitutes a snapshot of real-life interactions among firm locations, which defines distance, function and process space from a particular point of view. It represents spatial practices as they are perceived within the maritime economy. Expert interviews allow us to gain an insight into additional functional and spatial aspects which affect spatial production and the concurrent role of different frames of reference in the appropriation of space as lived by the actors. Topological analysis captures the sites as nodes in their built configuration. Urban planning and design conceives space primarily as the built form, which is derived from past conceptions and inform future conceptions of socio-political processes in urban planning.

C.1.4. Study area

The maritime economy plays an important role in the industrial evolution of Germany. The export of goods constitutes half of the nation's gross domestic product, with motor vehicles, machinery and equipment and chemical products being the main drivers of export. Germany is also an important destination for consumer goods and industrial components from China and the US. Economic and research activities such as ship building, logistics and ports, offshore energy supply, shipping companies, education and specialized services provide input and support to value chain systems, which span the globe. The German ports nowadays are involved in a distinct division of labour. Besides Hamburg, the ports in Bremen and the Jade

Weser Port in Wilhelmshaven are specialized in container shipping and act as main hubs for the German hinterland. These ports of the Northern Sea account for 80 percent of the German commodity exchange. The ports in Emden and Cuxhaven are specialized in shipping of cars (Brandt, 2011a: 98). The study area comprises locations and typologies of firms in five Federal States in the north of Germany. This spatial unit represents the second tier level in the decentralized German administration. These are: Hamburg, Bremen, Schleswig Holstein, Niedersachsen and Mecklenburg-Vorpommern. The geographical extent is depicted in Figure 2.

Recent transformations of port cities, waterfront regeneration, logistic poles, port expansion, infrastructure planning and urban expansion leave a disparate image of port cities (Hall, 2007c; Hein, 2011; Schubert, 2009). The research to date lacks rigorous analytical insight into the relation of physical and functional processes, which affect the use value of space on interrelated scale levels. A focused study on the sector of the maritime economy has the potential to reveal important relations between work processes, spatial organisation, and urban form for which there is currently no data.

C.2. Operationalization and Data collection

Our understanding of the maritime economy, in which knowledge production is interwoven with the trade and production of goods, and its relevance to spatial development processes, is based on three constituent parts: firstly, the nature of its knowledge base and the catalytic effect of spatial and relational proximity. Secondly, the social process of knowledge creation, since this is closely related to the production and trade of material goods. Thirdly, innovation as the valorisation of generated knowledge in the form of a tradable product or service, driving economic development. This process of interactive knowledge generation evokes a complex interplay between spatial and relational proximity on different scale levels. The innovation system contains "the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge" (Lundvall, 1992). Therefore, this work aims at an understanding in which the intersection of manufacturing, research and development and advanced services is emphasized.

A multifaceted methodology is required in order to assess the heterogeneity in the maritime economy. The chosen approach explores the composition and relationships employing three methodologies and data sources, which are presented in the following section.

C.2.1. Network analysis

Social network analysis (SNA) reduces the relationships between different entities to a finite set of nodes, linked by classified connections (Pryke, 2008). Nohria and Eccles have outlined the strength of SNA for the purpose of analysing corporate networks and conclude that organisations are "suspended in multiple, complex, overlapping webs of relationships and we are unlikely to see […the whole picture….] from one organization" (Nohria and Eccles, 1992:4). The dataset used in this research is culled from large scale surveys in the maritime economy carried out by the Norddeutsche Landesbank – Regionalwirtschaft (Brandt et al., 2010: 241f). Data access was exclusively provided by the project leaders. Detailed reports on this analysis are provided by Norddeutsche Landesbank (Nord/LB, 2009).

Initially, the database was built by gathering information from commercial resources, associations and networks, business directories as well as the internet. Subsequently, the actors were asked to name their partners, with whom they cooperate for the purpose of (1) education and qualification, (2) temporal co-working on innovation oriented projects and (3) long-term strategic cooperation. In addition, the data contains structural indicators such as the firm size, employment, turnover, innovation activities and expenditures and ambitions in research and development. The questionnaire for this survey is included in Appendix F.1. All in all, the network contains 1,873 actors and 4,174 network links. The database provides insight into the ties between individual firms and organizations which sustain their capability to innovate.

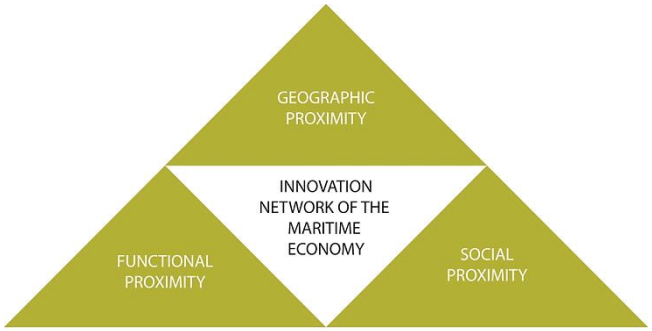

Figure 35
Three dimensions of network analysis

Social network analysis (SNA) is applied to assess the relations between different functions and knowledge types within the maritime economy. SNA allows assessment of the importance and relations of individual actors with regard to their functions and fields of activity. Social groups within the network can be assessed by applying measures of modularity. By geocoding the data in GIS, the network reveals insight into the geographical proximity of actors. This bundle of methods depicted in Figure 35 is based on the understanding that "the structure of relations among actors and the location of individual actors in the network have important behavioural, perceptual, and attitudinal consequences both for the individual units and for the system as a whole" (Knoke and Kuklinski, 1982: 13). With regard to economic geography and spatial development, the choice of method suggests that "networks are an appropriate conceptualization of inter-organizational interaction and knowledge flows" (Ter Wal and Boschma, 2009: 740). This thesis applies this relational approach in the context of knowledge networks in the maritime economy.

The multi-facetted set-up of the analysis involving visualization, and quantitative methods of network analysis enables us to understand the heterogeneous cluster of the maritime economy. To be successful, network analysis requires a clear definition of the boundaries of the system. Although our approach is promising in the sense that the actors in the maritime economy are captured by scanning the aforementioned registers of business circles and public associations, the involved actors might have links to other economic fields, too. For example, producers of pistons might supply ship builders and car producers at the same time. Therefore, this company might be part of the maritime economy and the mobility sector. Hence, the data from our analysis represents only a part of the economy, and the reference to urban systems is not complete, as other economic parts might reveal different network structures. While the spatial structure of relations and the urban environment can be analysed systematically by means of network analysis tools, the causalities and trends, as well as the perception of these patterns of interaction cannot. The location decision of firms and the interaction of the firm with the spatial environment are human affairs, into which further insights into the current situation may be gained through the eyes of the actors involved (Yin, 2009).

C.2.2. Expert interviews

A series of expert interviews is conducted to validate results from other methods, inform the interpretation of results by revealing causalities and trends, and collecting context information, which complement insights gained by applying other methods (Flick, 2009:166). Furthermore, the interviews were instrumental to the selection of relevant embedded case study areas and to refine built environment hypotheses for the third research block on urban topology. The thematic focus of the interviews was at the centre of the research question, "Which qualities of the built environment catalyse the activities of the maritime economy?" The results informed the response to all three hypotheses as well as delivering additional insights on the complexities of industrial organization which affect the heterogeneous conglomerate of the maritime economy.

As the interviewees were selected on the basis of their technical process oriented and interpretative knowledge with reference to their specific professional sphere of activity (Bogner et al., 2009:46), the interviews were structured along the following key dimensions:

- How does your organization interact with internal and external partners?
- How important is spatial proximity to suppliers, markets, clients and education establishments for your firm?
- How long has the establishment you work in existed and to what extent has it changed as a place to work over time?
- Does your firm pursue an explicit location strategy?
- What influence does the location of your firm have on its competitiveness and the ability to innovate?
- What kind of interaction and communication routines does your organization follow?
- What is special about your site? Is there anything you cherish in particular?

As it consists of expert interviews, the data collected is expected to reveal different and even disparate precepts for activities, but also collective orientations and social interpretative patterns (Bogner et al., 2009). The individual experts' knowledge is assumed to have a significant impact on the practical conditions of other actors in their professional field. The interviews covered all fields of activity in the maritime economy in northern Germany.

As part of the triangulation of methods, the interview approach provides more qualitative evidence, which complements the quantitative data underlying the network analysis. As such, the evidence is softer and less easily measurable than larger data sets, which are limited to a carefully defined number of indicators. The in-depth face-to-face interviews provide a rich database on the key dimensions of the study, which could not have been gathered by other means. In particular, it allows the researcher to understand the key drivers and underlying processes of the actors, and the interplay between location strategies and urban form. By

studying the interviewee's understanding of "meaning in their lived world, describing their experiences and self-understanding, and clarifying and elaborating their own perspective on their lived world" (Kvale and Brinkmann, 2009:116), previously unconsidered factors were added to the study.

The selection of interviewees was accorded particular care to ensure they were recognized experts in the field, sufficiently senior to be representative and reflect the wider industry context, and prepared to talk openly about the relevant areas. Following the compilation of a long list of 30 individuals, 15 interviews were conducted. As experts, they present the view of their firm, which is part of the network of the maritime economy. The interviews conducted in May and June 2013, took place at the respective workplace of the interviewee. The average duration was just over 60 minutes. In order to ensure an accurate reflection of the experts' views, the interviews were conducted in German, the first language of both the interviewer and the experts. All interviews were undertaken by the researcher to avoid any misconceptions or misinterpretations of the questions and answers, and to allow the ad hoc addition of further questions in the course of the interview when necessary to elicit meaning. As part of the upfront briefing, the experts were given a summary of the results to date and the head questions (Appendix F.3). Consent to record the interviews was given by all experts, and the recordings were subsequently fully transcribed. An interview record sheet ensured that all impressions and non-verbal communication were captured immediately after the meeting.

The evaluation was undertaken in two methodological steps as depicted in Figure 36 focusing on a number of distinct aspects in the course of the research.

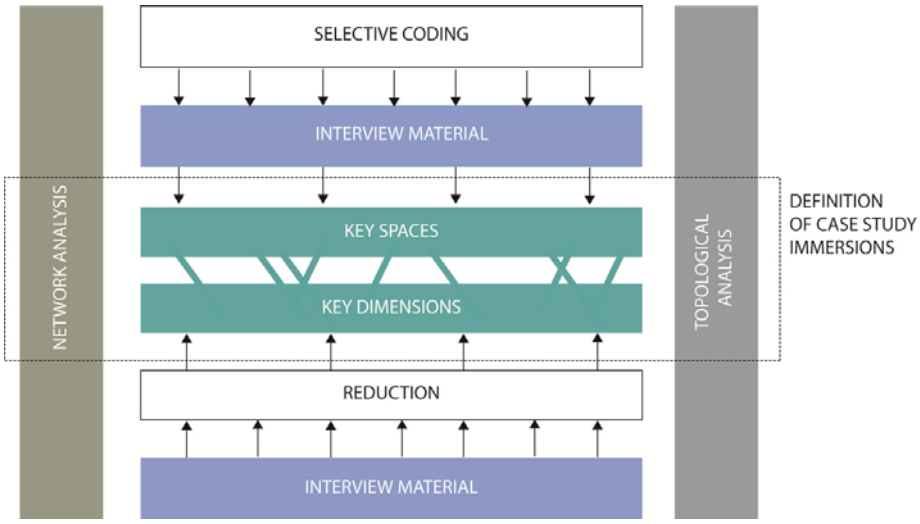

Figure 36
Interview evaluation approach

The first step is a bottom up analysis of responses across all experts. This involved paraphrasing, generalizing, and reducing the original answers to arrive at a limited number of key statements (see Appendix F.4). This approach is inductive insofar as the criteria of analysis are derived from the material itself. The second step is a top down approach utilizing selective coding of the transcribed answers (see Appendix F.5). As this is a deductive approach, the criteria are prior formulated, theoretically derived aspects of analysis. The combination of these two approaches ensures that new, previously unconsidered factors in the interview material and that previously derived theoretical or empirical evidence can be validated and further refined. All works were carried out with the help of AtlasTi 7 to ensure validity and robustness of the results.

The interviews complement evidence from other methods rather than being statistically relevant on their own terms. The material collected is qualitative and the findings are indicative rather than factual. Despite the material being statistically irrelevant, it provides a rich source for refining our understanding of the activities and perceptions of actors in a complex field of interactions as experienced and practiced by experts in the maritime economy. Table 4 in Appendix F.3 provides a list of dates, locations and activity fields of the interviews. For reasons of confidentiality, the names and companies of the interviewees remain undisclosed.

The interview results are included in the various sections of this thesis as their semi-structured nature provides a rich source of data. Key results, which are instrumental to the validation of other empirical evidence and theoretical assumptions, the identification of causalities and trends and refinement and construction of the case studies on urban form are presented as direct quotations. The translations of the original quotations are provided in Table 4 in Appendix F.3. A third perspective on spatial processes is provided by topological urban analysis, complementing the triangulation.

C.2.3. Topological Urban Analysis

Topological studies of urban form enable the researcher to evaluate spatial configurations at various scale levels. The basic elements of the analysis are the graphic representation of buildings and streets. In the analysis, a distinction is drawn between buildings, which are start and end points of journeys, and places of condensed economic activity and nodes in the street network, which are public spaces through which trips pass, a method which was pioneered by Sevtsuk (Sevtsuk and Mekonnen, 2011) and is operationalized by the Urban Network Analyst (UNA) extension in ArcGIS. The focus of the analysis is on measures of accessibility, which allow us to understand the proximity and relation between different sites in distance space. Two distinct measures are employed: reach and betweenness. The method allows us to assign parameters such as number of employees, the activity field or the floor area to sites and weigh the computation respectively. Figure 37 shows the graph representation used as basis for UNA in conjunction with the urban plan. The reach measure captures how many surrounding elements each location includes within a given search radius of the network.

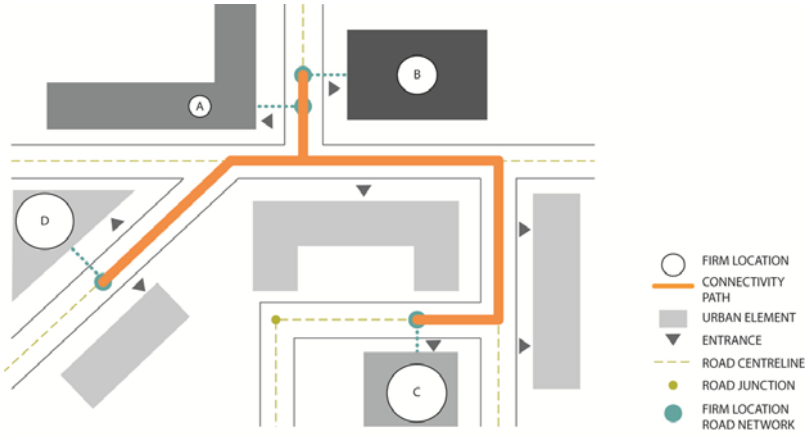

Figure 37
Principles of urban network analysis

The example in Figure 37 would generate different reach values depending on the search radius, with three being the maximum. The betweenness measure computes the fraction of shortest paths between pairs of other elements in the network that pass by the element. In the example in Figure 37, location A would have a higher betweenness value than B, C and D.

There are a number of readings of the measures, which depend on the context of application and the type of parametric data included. In the context of corporate networks, the reach measure gives an indication of how easily accessible a location is from other locations in the network. This accessibility is computed under consideration of the urban network as a whole and therefore sets the corporate network into relation to the urban form. The assumption, that physical proximity influences interaction levels means different activity fields in the network can thereby be assessed. On a more general level the accessibility of the urban network from individual sites can be a measure of spatial quality and key sites and actors can be evaluated in terms of their relative accessibility from other network nodes.

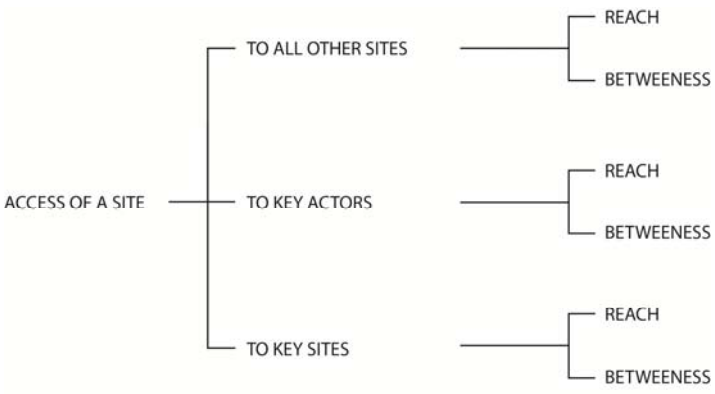

Figure 38
Classification of access measures in the analysis by destination type

Three types of destination are employed in our study: the topology of buildings in general, key actors, and key sites, as listed in Figure 38. In order to capture general accessibility to built form, all buildings are used as destinations. To capture accessibility to specific destinations, corporate locations, key actors, and key sites are defined as destinations.

The definition of the system boundary and the relevant radii for the analysis is important for the study of topological urban networks (Knight and Marshall, 2014). For the purpose of this study, the system boundary has been chosen in three steps. Firstly, the analysis focuses on the urban area, which is classified as an urban morphological zone in the corine landcover (Simon et al., 2010). Secondly, the area is limited to those urban areas, in which firms in the maritime industry are present. Lastly, the urban area for the topological study has been delineated as a coherent urban zone. In terms of topology and governance, this was achieved by making the area continuous and aligned with the smallest administrative unit, namely statistical areas (StatistikamtNord, 2014). For the purpose of this study, three radii have been included, based on the theoretical and empirical research to date (see B.1 for a detailed discussion). An unlimited radius was applied to analysing the selected total area. A radius of 1800m is defined as an extended awareness radius for reach and betweenness. In addition, a distance of 600m is chosen for reach and betweenness, representing the immediate neighbourhood. It is important to recognize, that the purpose of the analysis is not to measure accessibility in the sense of transportation studies (Borzacchiello et al., 2010), which would require a more refined approach to the mode of transportation and travel behaviour, but rather to explore objective measures of spatial organisation, which can be mapped back to the process of spatial production and location choice of firms.

The research framework developed in section C.1.1 and the operationalization have implications for the expected findings as well as the boundary of the empirical research.

C.2.4. Scope of the empirical study

The case study design elaborated in the previous sections is derived from the motivation for the study, the need for further research and the research question. By triangulating the methods employed, underlying principles of spatial and functional organization are expected to be revealed which are specific to location choices in the maritime industry. Furthermore, the analysis seeks to gain insight into the interplay between different scale levels, which nurture processes and performance within the maritime industry. Lastly, patterns of spatial organisation, which bear evidence of the evolutionary development of the maritime industry and the port cities within the study area are targeted.

The case study is led by the research framework and model of spatial production, which are derived from the context presented in Section B. In order to fulfil these expectations, the empirical enquiry will move continuously from inductive to deductive approaches: the limited scope of the study geographically and industrially renders the development of concepts and categories to a degree inductive, although reference to other sources of evidence is made wherever possible. The testing of concepts and categories developed in preceding empirical research is deductive and generally seeks to decode the maritime industry as a conglomerate of sectors, which have inherent properties.

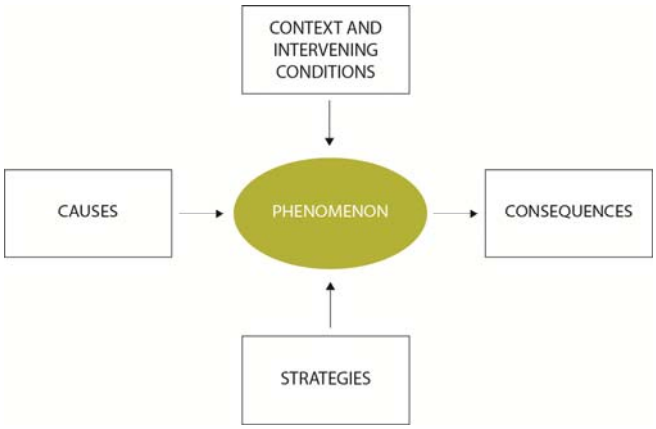

Figure 39
Paradigm model

The explanatory power of this case study is underpinned by the combination of methods, which deliver exploratory as well as descriptive components, giving us the opportunity to embed the phenomenon in a context of causes and consequences, which has relevance for the urban development of port cities. Moreover, the understanding of the specific context and the strategies taken to address the location choice of firms in the maritime economy is improved. Figure 39 summarizes the case study design with regards to the phenomenon under investigation.

Our research has limitations. The single case design does not allow us to make any generalizations beyond the study area of northern Germany. However, the development of port cities and the maritime industry cannot be considered without international comparison, and references to developments elsewhere are included as and where appropriate. Further research will have to be conducted to test the validity of the framework beyond the current case study.

The research question limits our scope to the maritime industry and certain aspects of the built environment. Urban qualities, however, are multifaceted, as suggested by urban studies research. Aspects such as public awareness, social cohesion, and urban governance, which have a bearing on the urban development and corporate architecture of port cities have not been included in the case study. Analytically, the focus rests on spatial topology, with some additional aspects included in the interviews. This limits the explanatory power of the results for port city development in general.

Lastly, industrial location choice is a highly complex process, which involves factors internal to the firm as well as external conditions on a number of scale levels. This work does not claim to consider all these aspects holistically. The focus is on exploring the link between the firm location and the urban context, which is considered critical for the evolution of the port-city interface, and which is largely missing from the formulation of spatial strategies for urban development in port cities.

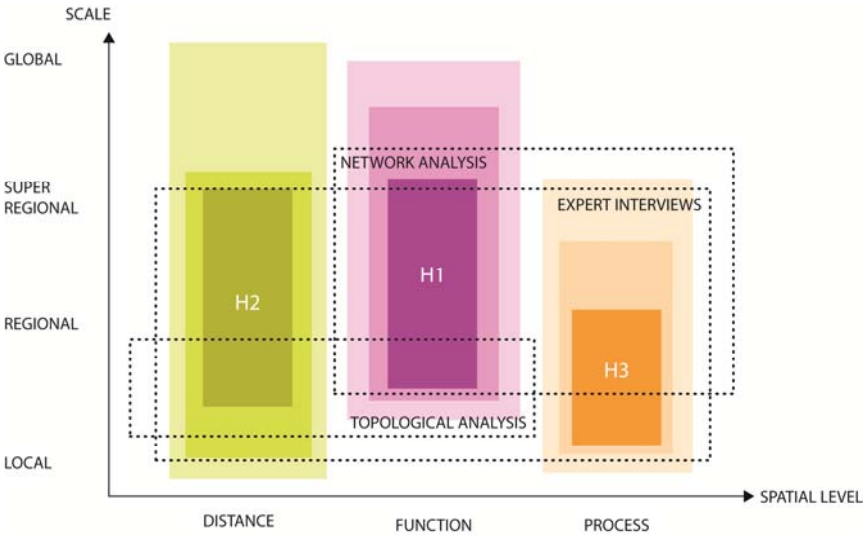

Figure 40
Research design and limitations

The focus area and limitations of the study are depicted in Figure 40. The findings presented in the following section should be considered on this basis.

D. Findings

This section turns to the empirical data and presents the results of the analysis of the topology of the port-city interface in northern Germany. These findings have been collated in an iterative process, which is mapped out in Figure 41. Economic exchange processes are researched in conjunction with spatial configurations on multiple scale levels from super-regional to local. Particular attention is given to the visualization of results, as a means of revealing underlying interdependencies of perceived, lived and conceived space. The chapter is organized as follows: the first part presents the findings on the super-regional scale level and embeds them in the spatial dimensions of distance, function, and process space. The next part relates to the regional level and delineates functional spatial specializations, which are spatially prominent and result from interactions of multiple spatial dimensions and scale levels. The last part analyses distinct local areas, which are found to have particular relevance to the system as a whole. This allows for a discussion of topological characteristics that relate to location decisions across scale levels and spatial dimensions.

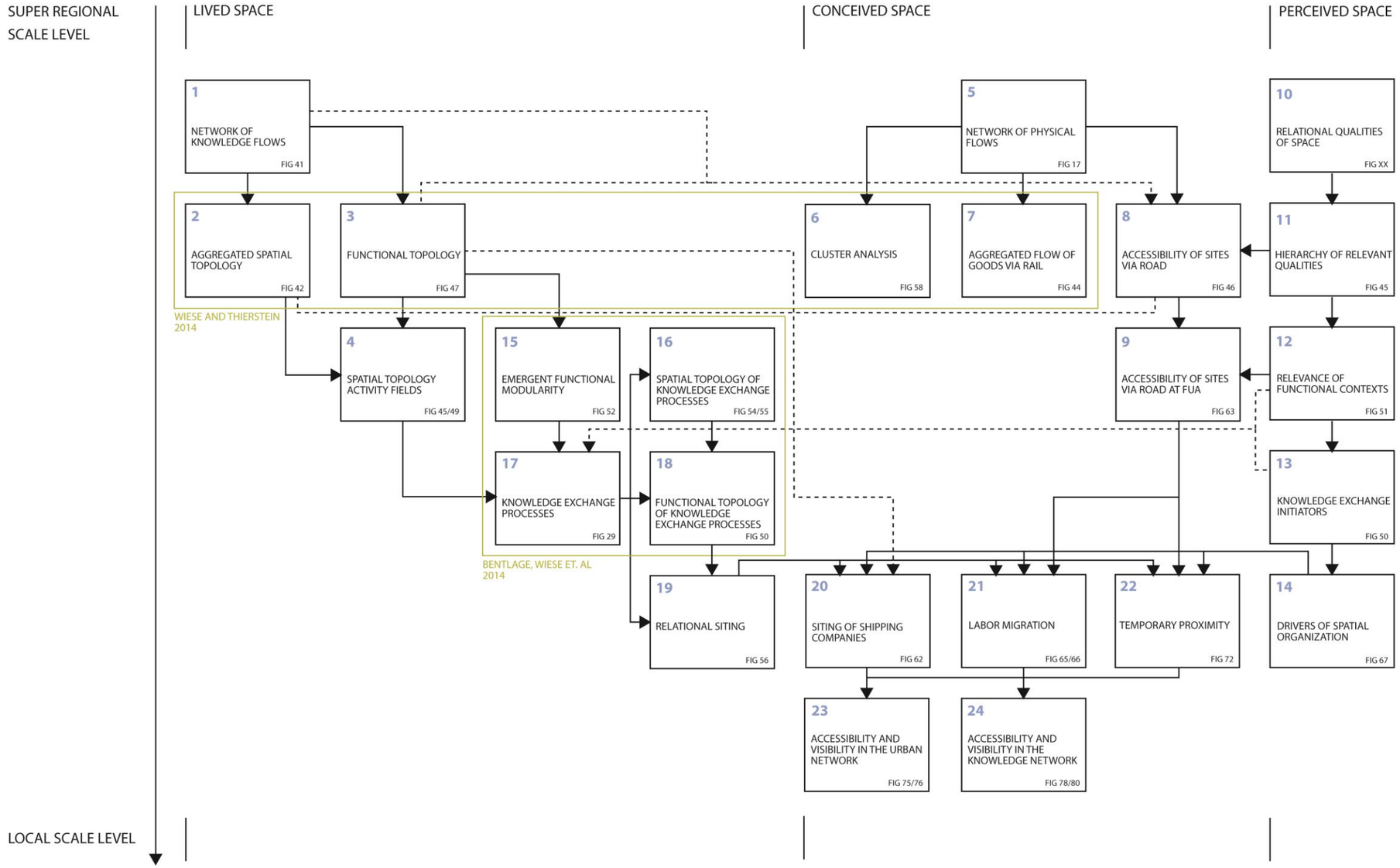

Figure 41
Overview of the research process

D.1. Super-regional level

The network analysis presented is based on survey data of 4495 firms in the maritime sector, which was gathered between 2008 and 2010 by the Norddeutsche Landesbank, one of Germany's major state owned regional banks. The questionnaire which this data is derived from is enclosed in Appendix F.1 of this thesis. In an initial phase, the database was built by gathering information from commercial resources, associations and networks, business directories as well as Internet resources. This database displays accommodation statistics across the maritime economy in Germany. Alternative approaches to establishing such a resource will fail because of misclassification of the sub-branches of the maritime economy. This, in particular, holds true for maritime services, shipbuilding suppliers and marine engineering, which are not conceptualized in official statistics. The dataset comprises locations and typologies of firms in five Federal States in the north of Germany. This spatial unit represents the second tier level in the decentralized German administration. These are: Hamburg, Bremen, Schleswig Holstein, Niedersachsen and Mecklenburg-Vorpommern and covers an overall area of 87,800 km², which this research treats as the super-regional scale. Figure 2 delineates the area of study in the context of Europe. The multi-port gateway region of Northern Germany as indicated in Figure 7 forms part of this extent. The relational data represents collaborations between firms for the purpose of innovation and professional development. It is therefore a unique database, allowing exploration of the interrelation between spatial location and economic exchange processes. Functionally, these firms are part of the maritime economy, which consists of seven aggregated fields of competence: ship- and boatbuilding, shipping suppliers, marine engineering, shipping companies, maritime services, port economy and other actors. The definition thereof is provided in Appendix F.2. The interview results presented throughout this section are extracted from a series of 15 in-depth interviews with firms across all fields in different locations within the study area, which are also part of the network data set. A list of interview partners is provided in Table 3 of Appendix F.3.

The organizations are from all the Federal States across northern Germany, however 39% are based in Hamburg, which is given its relatively small geographic area of only 755 km² the highest concentration. Based on their field of activity, the organizations fall in seven subgroups, with the strongest being marine engineering, maritime services, port logistics and shipping companies. The majority of organizations contained in this data base are small and medium sized establishments, with 40% employing less than ten employees. A large proportion – of 43% of the organizations – were founded after 1990, although the sample also contains 33% of firms, which have existed before 1975. Descriptive statistics on the organizations are displayed in Appendix F.2.

D.1.1. The maritime economy in Germany

Firstly, all relations which derive from the survey on collaboration are mapped in GIS to reveal the spatial reach of the network. Figure 42 shows the network reaching far beyond the northern German region. While the organizations surveyed are sited within the confines of the study area, they collaborate with partners Germany wide. Secondly, the data was aggre-

gated at district level (Landkreise) to show centres of gravity and their mutual interdependence more clearly, which is depicted in Figure 43.

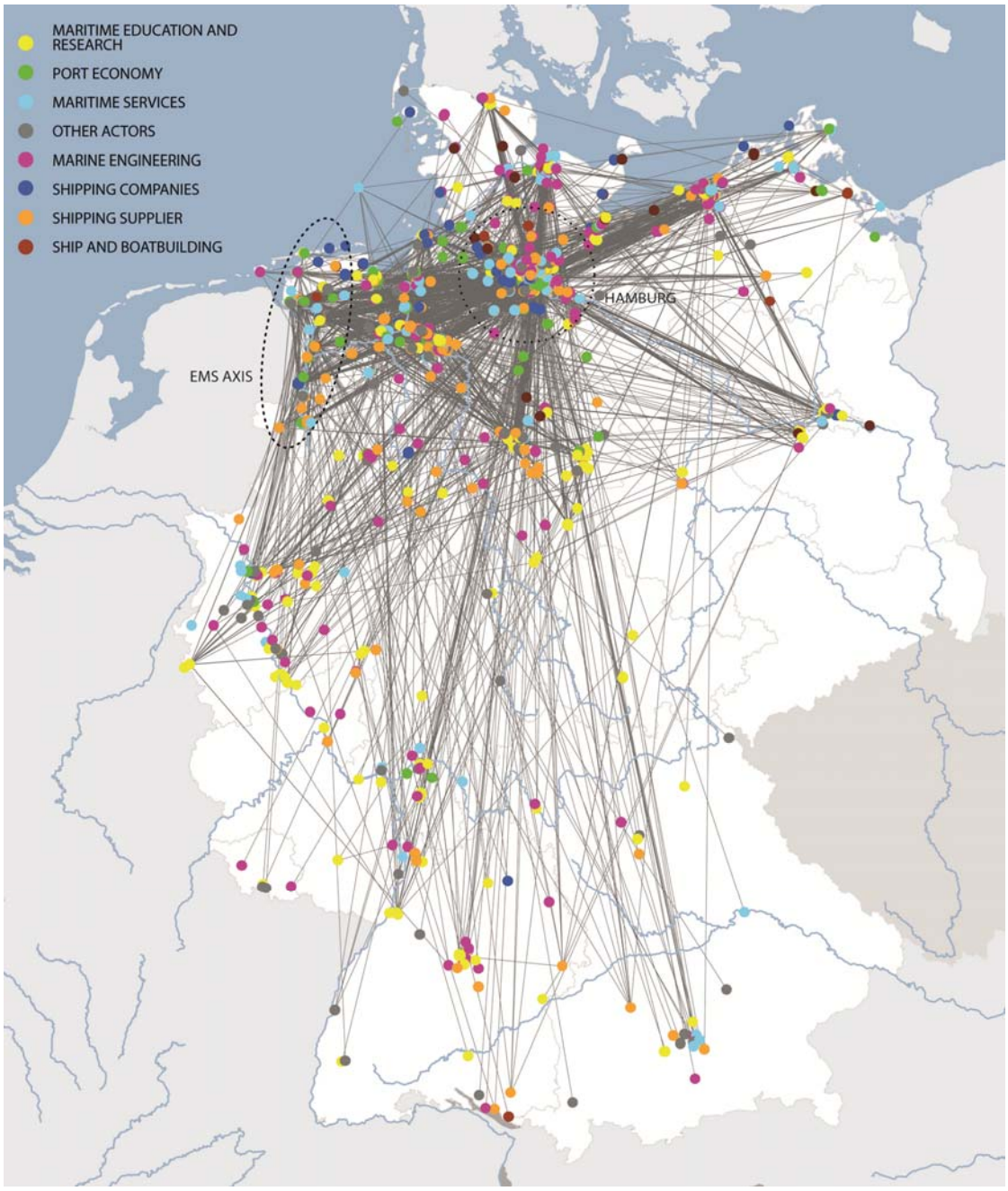

Figure 42
The network of the maritime economy full dataset on single firm basis

On the super-regional scale, Hamburg clearly dominates, with the majority of firms locating there generating a high degree of network centrality in the overall network. The secondary port cities, Bremerhaven, Cuxhaven, and Wilhelmshaven exhibit strong links with Hamburg. A further axis of collaboration is evident along the river Ems to the west, also strongly linking into Hamburg. The network gravitates along the coast of the North Sea, where the main sea-

ports are located. There is a striking asymmetry of the network towards the west, with significantly fewer links into former Eastern Germany.

Focusing on the connectivity of firms, derived from the total of connections per firm weighted according to their intensity and displayed in Figure 43, a more distinct spatial pattern becomes evident on the super-regional scale. Those locations in the vicinity of the larger, established agglomerations of Hamburg and Bremen stand out as particularly clustered and connected. High degrees of connectivity are observed in more remote locations, too, namely along the river Ems and the area north of Hamburg. The majority of firms are located in relative proximity to the ports, which are respectively in the main urban agglomerations in the case of Bremen and Hamburg. In these two areas, this study seeks to gain more insight into the local spatial configuration from a functional and qualitative angle.

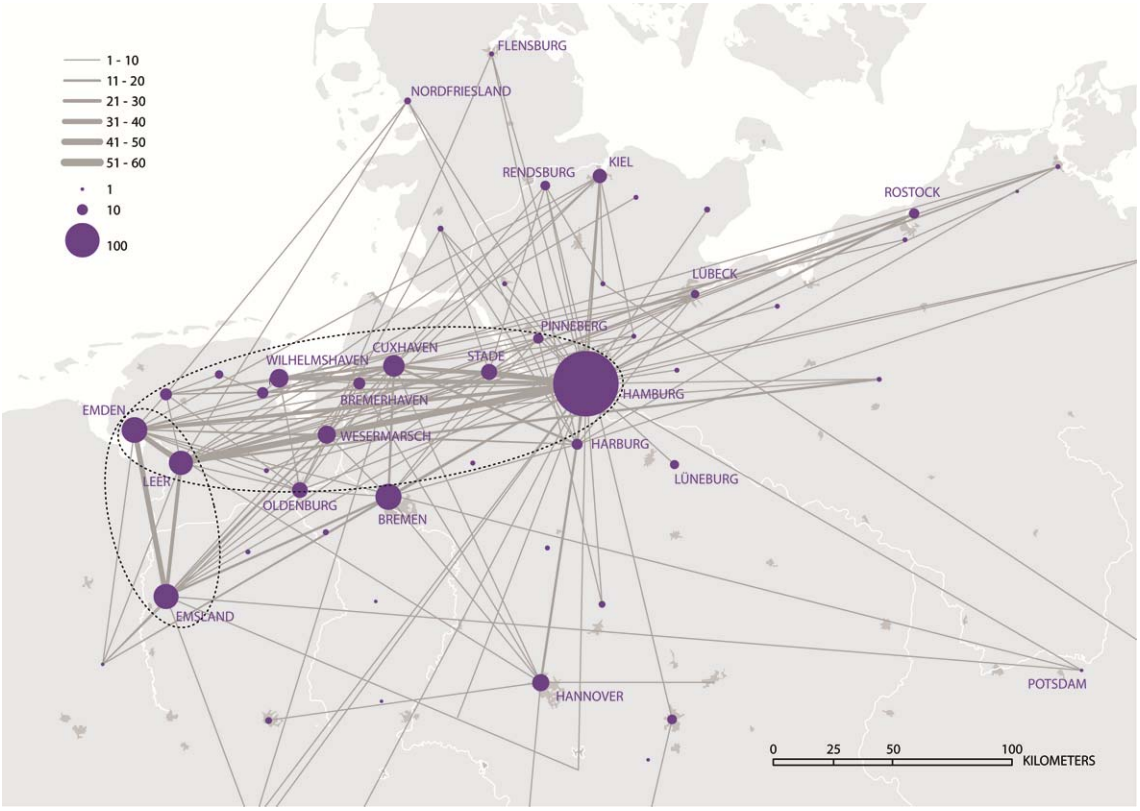

Figure 43
The network of the maritime economy at district level

Previous research has shown, that ports have developed spatial structures beyond their city boundaries increasing the efficiency of their operations, leading to sophisticated new spatial constellations of hub and feeder ports (Lee et al., 2008; Notteboom and Rodrigue, 2005) and integrated corporate supply chains (Olivier and Slack, 2006; Robinson, 2002). As a result, the port is tied into a network of transport from the seaside and landside. The following analysis therefore explores the mutual alignment of knowledge and freight flows on the super-regional scale.

In contrast to the primary network data as mapped out in Figure 42, Figure 43 displays the connectivity values of firms, derived from the total of connections per firm weighted according to their intensity. The more distinct spatial pattern, which becomes evident on the super-regional scale, emphasizes the importance of Hamburg, but also diminishes the relevance of Hannover. In order to test for alignment with material flows at the same scale, level seaside and landside transport volumes are referenced.

Based on maritime transport (Eurostat, 2005b) and railway freight data (Eurostat 2005), Figure 44 maps the physical connectivity by freight flow (Wiese and Thierstein, 2014). The port of Hamburg dominates in terms of coastal connectivity with Bremen and the ports of the Weser-Ems Region representing secondary hubs. Hamburg stands out as a centre of landside distribution, but Bremen and Weser-Ems also clearly show their relevance on the regional level. Logistically, Braunschweig and Hannover appear as major destinations for goods within the region. Set into relation with the knowledge connectivities of the former analysis, the strong link between Bremen and Hamburg persists. The relevance of Hannover in the logistic flow, however, is absent in the analysis of the data on collaboration. Potentially, hinterland logistic hubs are not as relevant for innovation and professional development as nodes, which involve trans-shipment from seaside to landside. It may, however, also suggest that other relevant organizational ties exist, which reach beyond those captured in the maritime economy, or that the two systems are to be regarded independent of each other.

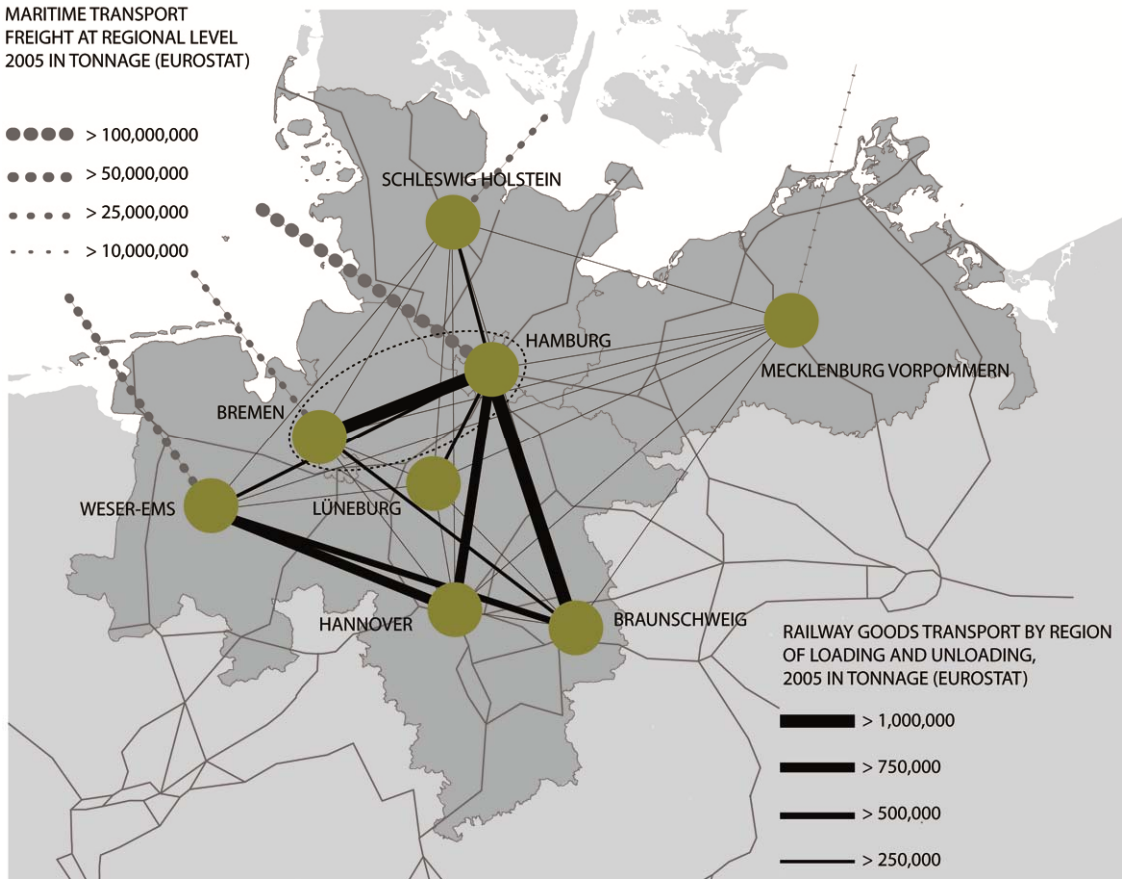

Figure 44
Freight traffic flow via rail (Wiese and Thierstein, 2014)

In conclusion, the results indicate a degree of alignment of actual material flows and knowledge flows within the northern German super-region, with shared centres of gravity at this level, namely Hamburg, Bremen and Weser-Ems. However, the lack of refined relational data on other modes of transport limits the validity of these findings.

The reduction of the interview results reveals the spatial proximity to partners as a key driver for location choice within the maritime economy, but also points towards other considerations, such as functional proximity, accessibility and the availability of talent to sustain competitive advantage.

With regard to physical infrastructure, a critical factor for the evolution of networks is expected to be physical connectivity via road. Firstly, it enables face-to-face contact on the super-regional level. Secondly, it sustains the material flow, which is heavily dependent on road distribution, with approximately 70% of all goods being transported via road in 2011 (Hütter, 2013). The following part of the study measures the differences in road accessibility across maritime economy sites.

The road network is of particular relevance as this study focuses on the relational positioning of sites in space, rather than localized qualities of space. That is, in lieu of describing the densities of opportunities across arbitrarily defined territorial units, the measure defines the density of opportunities of each individual site in relation to all other sites, which is critical for the conception of sites at the port-city interface. More specifically, it measures the ease with which each site can be accessed from surrounding destinations in a network. The betweenness of an edge or node, *i* , is defined as the fraction of shortest paths between pairs of vertices in a network that pass through *i* (Freeman, 1977; Sevtsuk, 2010). If more than one shortest path is found between two vertices, as is frequently the case in road grids, then each of the equidistant paths is given equal weight, such that the weights sum to unity. The betweenness measure is mathematically defined as follows:

$$b_i = \frac{\sum_{s<t} g_i^{(st)}/n_{st}}{\left(\frac{1}{2}\right) n(n-1)}$$

Where $g_i^{(st)}$ is the number of geodesic paths from node s to node t that pass through *i* and n_{st} is the total number of geodesic paths from s to t. In contrast to most other accessibility measures, the betweenness index used here is the choice of locational pairs that the index is estimated with. This is of particular relevance to this analysis, as we are not limiting the computation to a specific subset of destinations, but assume that all nodes, irrespective of size and type, are equally likely to generate trips (Sevtsuk, 2010).

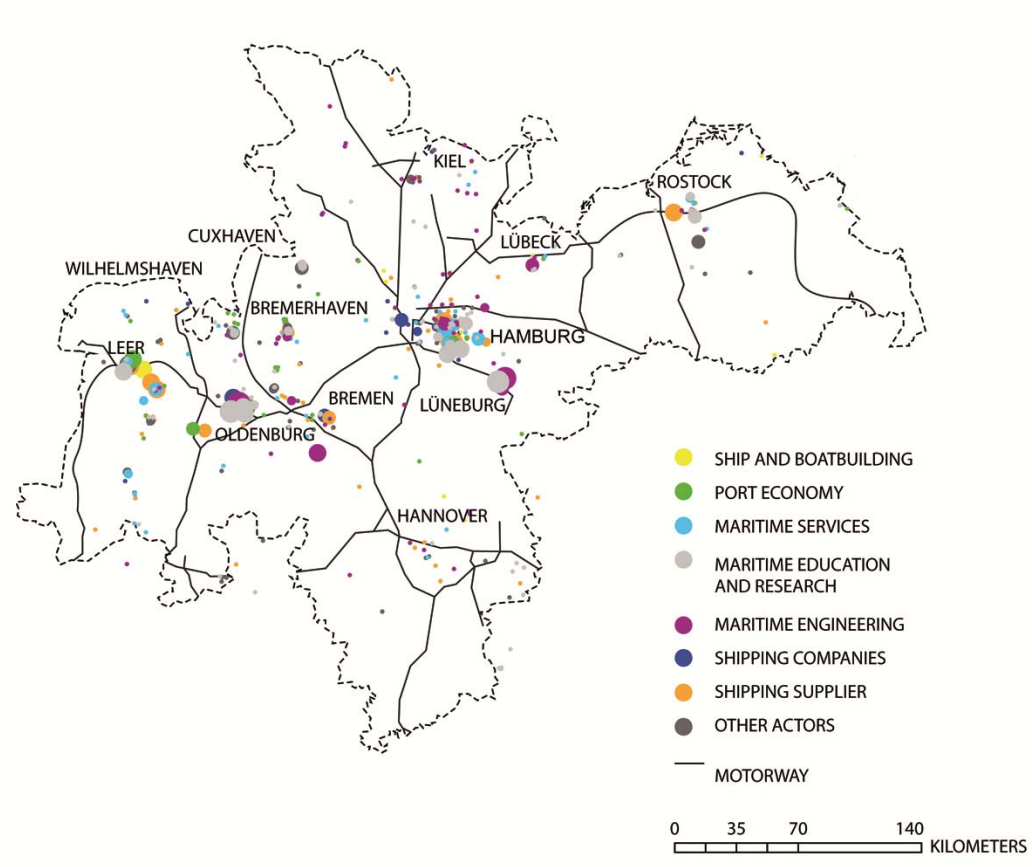

Figure 45
Betweenness of sites on the super-regional level

The betweenness values of all sites are depicted in Figure 45. Across all fields in the maritime economy, the sites of marine engineering firms and maritime science firms exhibit the highest betweenness values on the super-regional level. The full table of betweenness values is provided in Appendix F.6.

Figure 46
Perceived importance of factors for location choice

Moreover, shipping suppliers feature high betweenness values. This finding is validated by the conception of industry experts, who identified accessibility as one of the key drivers of location choice.

The interviews provide further detail on the perceived role thereof for the maritime economy. In particular, firms in the port logistics field have stressed this and hold that:

> *[…] Our critical success factors are actually the retention and further development of transportation systems in the hinterland. (port logistics firm, Hamburg, Ref 15/006)*

Actors from the maritime services also referred specifically to the role of accessibility and, for example, state:

> *I do not need my own office in Hamburg, as I can be there within one hour. (port logistics firm, Bremen Ref 11/042)*

This suggests that accessibility can substitute permanent proximity by providing the opportunity to be temporarily present in other locations as long as the transport infrastructure facilitates it.

The role of accessibility is therefore found to be twofold. Firstly, freight flow is directly dependent on the accessibility of a location by ship, rail and road, which leads to the aggregation of material intensive activities which are directly and indirectly linked to the transport chains of the maritime economy at key points in the transportation network. This is supported by the high betweenness values for marine engineering and shipping suppliers. Secondly, accessibility facilitates knowledge exchange through face-to-face interaction, which is primarily provided by road and air connections within the area under study.

While these results point towards a degree of spatial correlation between knowledge and material flow and highlight the relevance of spatial proximity in the context of the maritime economy, the heterogeneous composition of the maritime economy makes it difficult to delineate distinct spatial patterns, which are resulting from exchange processes. The following section therefore seeks to decipher the functional organization of the maritime economy further in order to inform the analysis of the spatial topology, which is critical for the promotion of exchange processes on the regional and local scale.

D.1.2. The functional organization of the maritime economy

The concept of the maritime economy combines the production, delivery, servicing and trading of maritime vessels and components in one input-output system as illustrated in Figure 10. As a heterogeneous cluster of activities, the inner logic of cooperation and innovation is critically affected by the flow of knowledge within and across activity fields (Brandt et al., 2010; Hesse, 2010a). Accordingly, there are 13 different subareas that make up the maritime economy. These are: shipbuilding, boat building, port corporations, port logistics, maritime services, marine engineering, marine engineering science, shipping companies, shipping

supplier, maritime education and professional development, maritime science and other economic and science actors. These can be aggregated to the 7 activity fields of ship- and boatbuilding, port economy, maritime services, marine engineering, shipping companies, shipping suppliers and other actors as depicted in Figure 47 and defined in Appendix F.8.

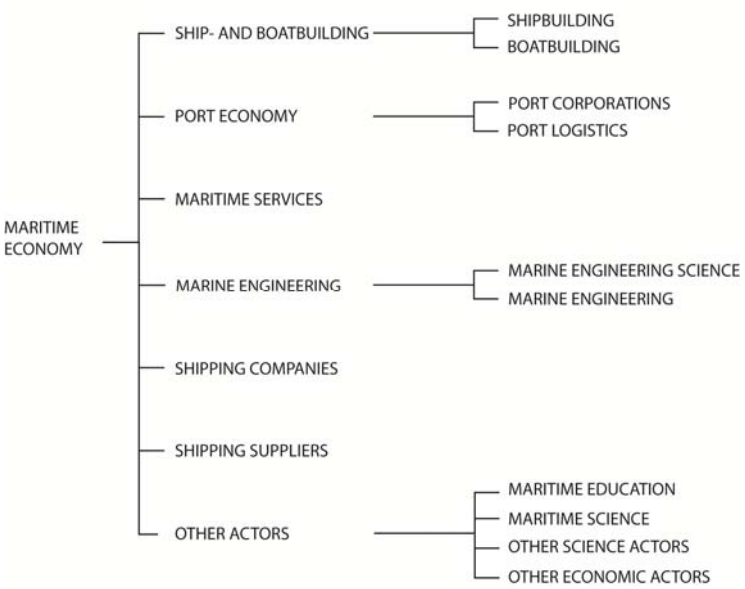

Figure 47
Activity fields of the maritime economy

Research to date suggests that space is of particular relevance to those exchange processes which involve the production and application of knowledge as primary value-adding activity (von Hippel, 1994). Since the knowledge intensity varies across and within these activity fields, this research adopts a definition of knowledge activities which is applicable to cross sectoral studies and different functional profiles. Hall considers all those activities as knowledge intensive, whose ratio of highly qualified personnel is above the average of all services (Hall, 2007a: 49). This is in line with Legler and Frietsch (Legler and Frietsch, 2006: 22), who define shipbuilding and shipping companies as knowledge intensive branches.

The following network analysis informs our understanding of the functional organization of the maritime economy, by tracing the patterns of collaboration and knowledge exchange between activity fields. Within the maritime economy of northern Germany, the data reveals strong links across and within activity fields. Figure 48 illustrates the cumulative interrelationships between activity fields based on the survey data. The strong ties between shipping companies and shipbuilding, as well as suppliers to the shipbuilding industry stand out as relations across traditional manufacturing boundaries. Collaborative ties run alongside traditional value chain relationships, with the shipping company providing the finance and scope to the builder, and the supplier providing specialist parts to the latter. The large number of ties between research and marine engineering indicate a high degree of knowledge exchange and compatibility reflecting the research-intensive nature of this activity. Within the field of activity of marine engineering, strong internal ties are present.

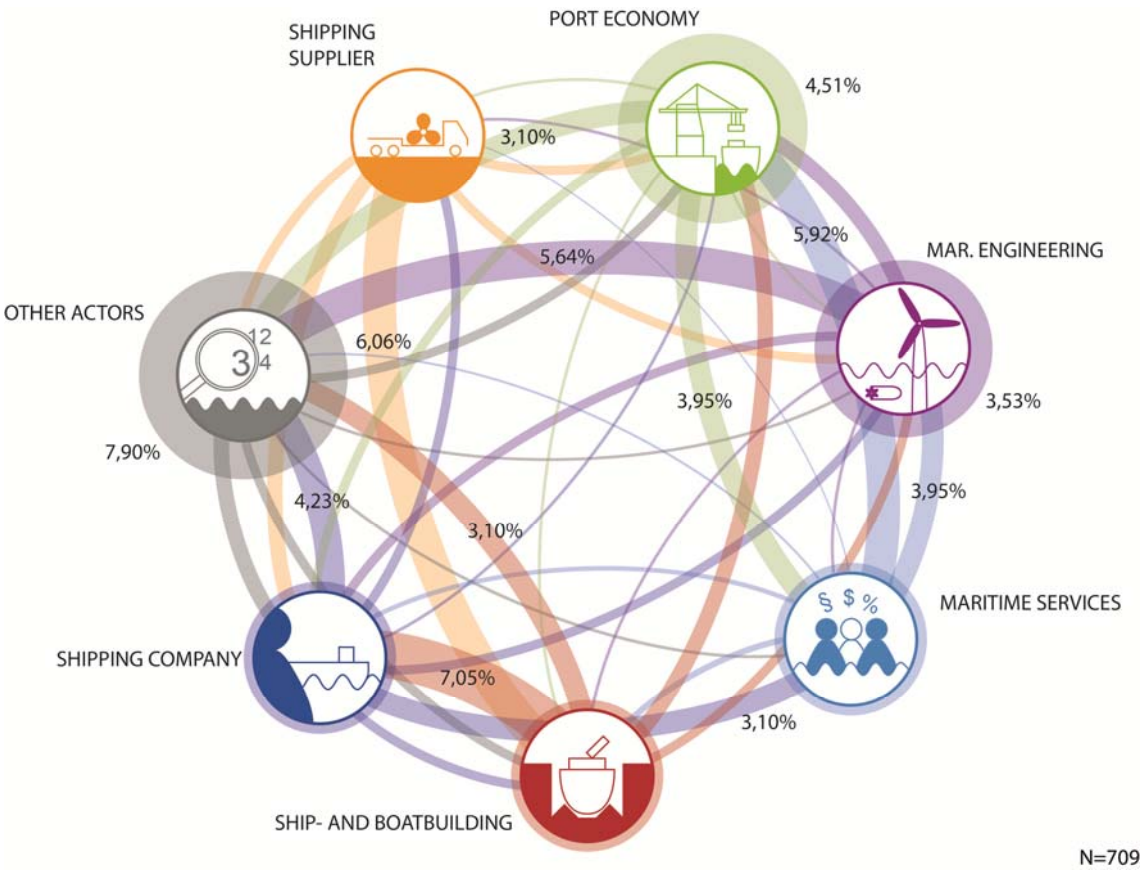

Figure 48
Maritime network of functional cooperation (Wiese and Thierstein, 2014)

This high degree of collaboration is an indication of complementary and specialized knowledge bases between firms which is further explored in Figure 49. The ties between port logistics and service providers confirm that the industry-service interface is fundamentally important to a successful maritime network (Brown et al., 2004; Jacobs, 2008).

The relative lack of ties between shipping companies and port logistics hints at the absence of functional proximity between these firms and their activities. The value chain of vessel construction and commissioning and the logistic value chain which is involved in the formation of multi-modal networks (Robinson, 2002), thus cannot be regarded as functionally intertwined.

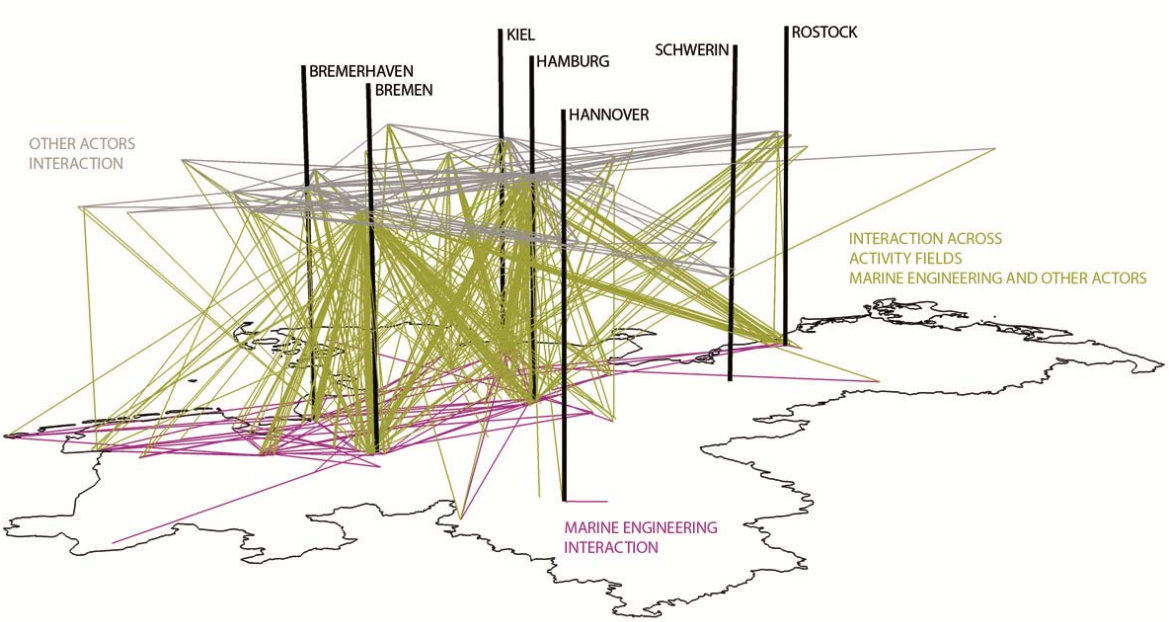

Figure 49
Spatial network of interaction between two key activity fields

The strong functional link between the activity fields of marine engineering and other actors is complemented by a spatial pattern, which suggests a distinct pattern of spatial organization depicted in Figure 49: Hamburg, Bremen, Kiel and Rostock form regional nodes with overlapping spheres of functionally related sites.

The selective coding of the interviews for the functional context of exchange (see Appendix F.5 for the coding guide) indicates research collaborations as the dominant perceived context. Furthermore, education and professional development and regulatory interaction are referred to as important contexts, which foster collaborative ties between actors. An overview of these interview coding results is provided in Figure 50. The interviews affirm the existence of three functional clusters within the maritime economy, namely vessel construction and charter, maritime transportation, and maritime research and development. These functional clusters are perceived to be more important with regard to cooperation for innovation than the aforementioned activity fields. Figure 51 superimposes the the different rationales

to delineate subsets of the data. Whether these form distinct patterns of spatial organization requires further analysis across other scale levels, however the siting of marine engineering and research facilities feature particularly high regional accessibility in the road network.

Based on the processes of knowledge creation and application within the industry summarized in B.4.2, the maritime economy network represents a complex economic field in which different knowledge types are employed. Since knowledge is produced in interaction, the network is expected to dissolve into smaller groups of actors that have strong relations with one another based on value or knowledge complementarities (Bentlage et al., 2014). To better understand the structure and inner life of a complex network various approaches exist that enable to detection of communities within an entire network (Newman, 2004). In the following approach, these small-worlds, or sub-networks are detected by applying Newman's modularity algorithm (Newman, 2006).

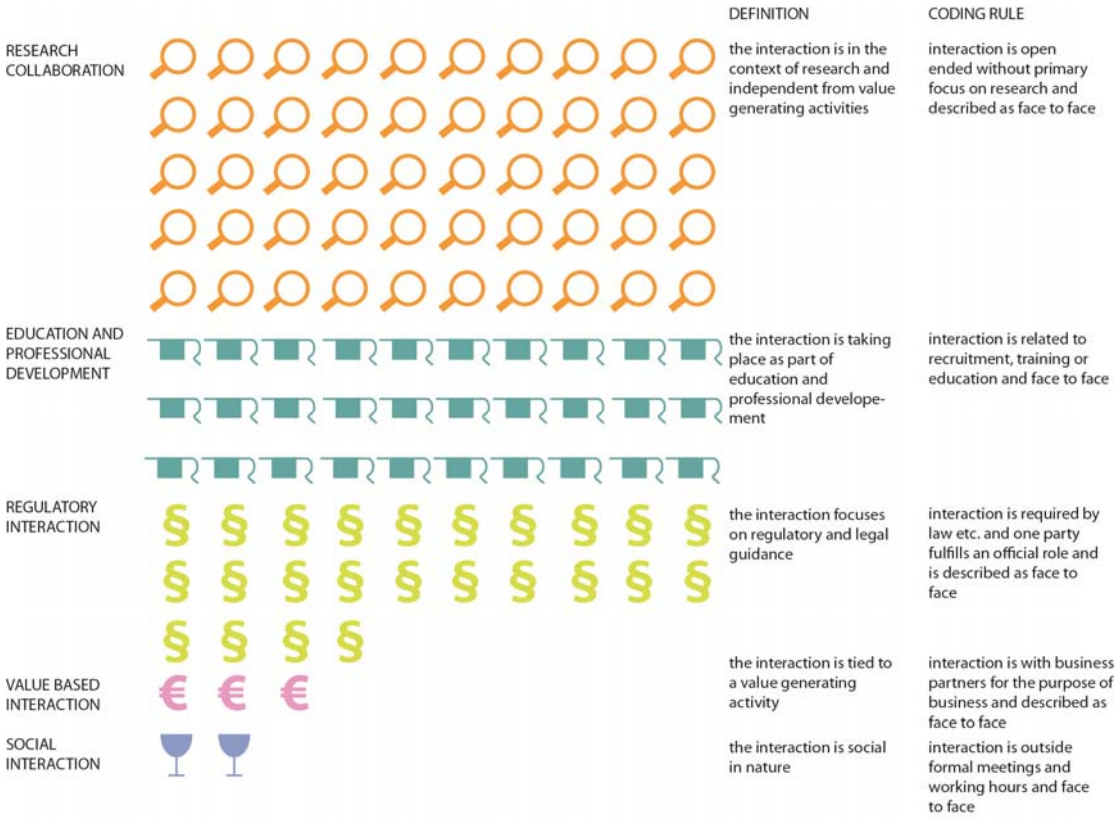

Figure 50
Perceived role of interaction contexts

The modularity of a complex network represents an index for the community structure between the network nodes, which might have quite different characteristics than the overall network. Not least, the modularity provides insights into common activities revolving around the functional characteristics of an actor and the type of knowledge. Newman (2006: 8578) defines modularity as "the number of edges falling within groups minus the expected number in an equivalent network with edges placed at random". The technique focuses on the links between the actors. Belonging to a module consequently represents intense linkages

within this sub-network. This internal interaction is more intense than the connectivity to external nodes. It thereby informs our understanding of the production of knowledge as a complex process in which services, manufacturing and qualification activities are interwoven. Moreover, the hypothesis is that cognitive proximity is an important mechanism in shaping such sub-divisions of networks and therefore, modularity may concur with communality between actors, providing additional explanatory power to the afore defined collaborative relations and different knowledge types.

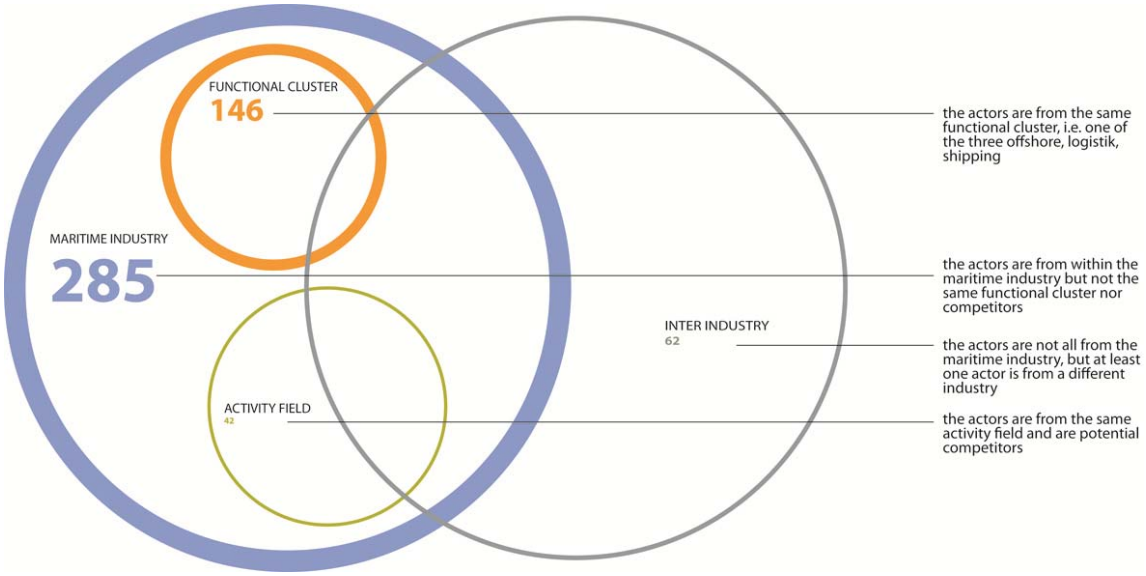

Figure 51
Perceived relevance of functional contexts

The modularity calculation indicates reliable results with a value of 0.584. The closer it is to 1, more clearly the communities are differentiated (Blondel et al., 2008; Lambiotte et al., 2009). The entire network of the maritime economy dissolves into 48 different modules, which starkly differ in terms of size and composition. See Appendix F.1 for descriptive statistics on the entire network.

The following section focuses on the five biggest modules in the data set. In total, these contain 1,055 out of 1,871 actors. These modules have more than 150 nodes each and clearly differentiate in terms of functional composition and spatial range. Firstly, their functional composition is revealed, which is marked by the fields of activity the actors belong to. In a second part of the analysis, the geographic range of the modules is considered in detail. Table 2 shows the quotient of specialization of each module according to Glaeser (Glaeser et al., 1992). This measure is defined by:

$$specialization = \frac{m/M}{n/N}$$

With m number of actors within an activity field of a module, *M* number of actors in a module, *n* number of actors within an activity field of the entire network and N the total number of actors within the entire network. Values above 1 indicate that the module has a higher share in an activity field compared to the overall share of the whole sample. A value below 1 indicates that the share of a field of activity is below the average (Glaeser et al., 1992: 1141).

	MODULE				
AREA OF SPECIALIZATION	1	2	3	4	5
BOAT BUILDING	0,29	0,00	0,81	0,44	0,00
PORT CORPORATION	0,10	0,63	**1,61**	**1,60**	0,56
PORT LOGISTICS	0,42	0,25	**2,88**	**1,77**	0,19
MARITIME SERVICES	0,82	0,26	**1,41**	**1,06**	**2,21**
MARIT. EDUCATION AND PROFESS. DEVELOPMENT	**1,10**	0,00	**3,12**	0,00	**1,99**
MARITIME SCIENCE	**1,53**	**2,48**	0,96	0,52	0,31
MARINE ENGINEERING	0,73	**1,95**	0,19	0,55	0,15
MARINE ENGINEERING SCIENCE	**1,03**	**2,51**	0,22	0,31	0,07
SHIPPING COMPANIES	0,88	0,33	**1,20**	**1,31**	**1,96**
SHIPBUILDING	**2,16**	0,16	**1,15**	0,84	**1,95**
SHIPPING SUPPLIER	**2,53**	0,27	0,63	0,88	0,86
OTHER ECONOMIC ACTORS	0,55	**1,39**	**1,03**	**1,40**	0,89
OTHER SCIENCE ACTORS	0,97	**1,61**	0,49	0,96	0,63
NO. OF LINKS	636	320	247	224	232

Table 2
The five biggest modules and the quotient of specialization (Bentlage et al., 2014)

For instance module 1 –ship-building and suppliers –reaches a value of specialization in the field of shipping suppliers of 2.53, followed by shipbuilding with a value of 2.16 and maritime science with a value of 1.53. It is therefore contains a higher share of actors from these fields than the overall sample. Finally, the values for maritime education, professional development and marine engineering science are slightly above 1. Module 1 is strongly oriented towards manufacturing combined with engineering and qualifying tasks. In other words, this module represents the core of the cluster revolving around the production of ships in the maritime economy (Bentlage et al., 2014).

Module 2 displays high values in the fields of maritime science, marine engineering and marine engineering science. In contrast to module 1, cooperation in module 2 is underpinned by research and development activities and is less production oriented. Module 3 is strongly specialized in maritime education and professional development and port logistics. Module 4 represents a community in which port corporation, port logistics and shipping companies maintain intense corporate networks. Finally, module 5 is strongly specialized in service activities ranging from education to maritime services, and displays high shares of shipbuilding

and shipbuilding suppliers. Thus, this module is placed at the intersection of the services and the manufacturing parts of the maritime economy.

While the module analysis supports the interview results in that distinct functional subsystems exist, it differentiates the role of maritime education and professional development as a critical network component for three out of the five modules. To analyse this innovation system, the focus is laid on the patterns of proximity between academic, public and private actors in the maritime economy and their functional role in the process of innovation. This application of the approach devised by Zillmer is tailored for the analysis of knowledge in transfer. In her comprehensive analysis of different service activities she settles on four different types of generic activity related to industrial clusters: high-tech, transformation services, transaction services and media and information services (Zillmer, 2010:113ff). The focuses is on the relations between single actors as the active parts in the network rather than the inherent knowledge stock or the aggregated level of technological regimes. It assumes a non-arbitrary selection of partners and distinguishes product and process related services, making it particularly useful for the analysis of the maritime economy. The matrix of the applied categories is provided in Table 15 of Appendix F.9. The operationalization treats services and manufacturing activities as complementary in the value production (Bryson and Daniels, 2010:83ff). It is intrinsically relational since it centres on collaboration between actors for the purpose of knowledge generation.

A closer look at the types of knowledge interaction within the modules reveals important characteristics in terms of shared knowledge bases, which Figure 52 provides an overview of. As elaborated in section B.4.2 of this thesis, knowledge production is a continuous process, in which previous knowledge is expanded and complemented by new knowledge. Each actor is embedded in a professional context of knowledge, which determines in which form knowledge is appreciated, accepted, i.e. absorbed and made available for further development. For instance, scientific knowledge production is expressed in journal articles. These reflect previous study in the field and highlight one's own and new contributions to research. In contrast, knowledge production in engineering results in patents or plans for product development. Knowledge generation in services tends to initiate new processes, which could not have been managed without it (Bentlage et al., 2014).

The analysis of the above indicates that there is a relation between the functional proximity of actors and their shared knowledge typologies in the sample. Each module shown in Figure 52 revolves around a distinct type of knowledge relation. The full data mapped in provided in table 3 in Appendix F.7.

Module 1 displays intense manufacturing activities. Knowledge here is predominantly produced by transformation process, since the share of transformation links within the module accounts for 53.1 %. Knowledge production correlates with the exchange of material goods. Furthermore, transaction links reach a share of 30.0 % as a result of intense knowledge relations between maritime sciences and ship builders and their suppliers. In other words, actors within this module potentially complement explicit knowledge applied in transformation processes with experience based knowledge in order to control and implement these transformation tasks (Niehues et al., 2012).

Module 2 is also specialized in manufacturing activities. Predominantly, the actors carry out engineering and science activities, but in contrast to the module 1 it focuses stronger on the development of new products, since high-tech relations with a share of 29.8 % are very significant. The modules 3 and 4 are mainly formed by transaction links revolving around functions of port facilities. Moreover, links within module 3 are characterized by information relations and reach a share of 19.0 %. Contrastingly, module 4 is less specialized within port logistics and has a higher share of high-tech links than the former module. Thus, both modules have broad activities in services in common but differ clearly in terms of second-tier activities. Whereas, module 3 is oriented towards education and qualification, module 4 links services with high-tech activities. Finally, module 5 is clearly defined by transaction links between maritime services, maritime education and professional development, shipping companies and shipbuilding. Thus, tacit knowledge plays an important role and is applied in a heterogeneous network relations ranging from education activities and services towards shipbuilding.

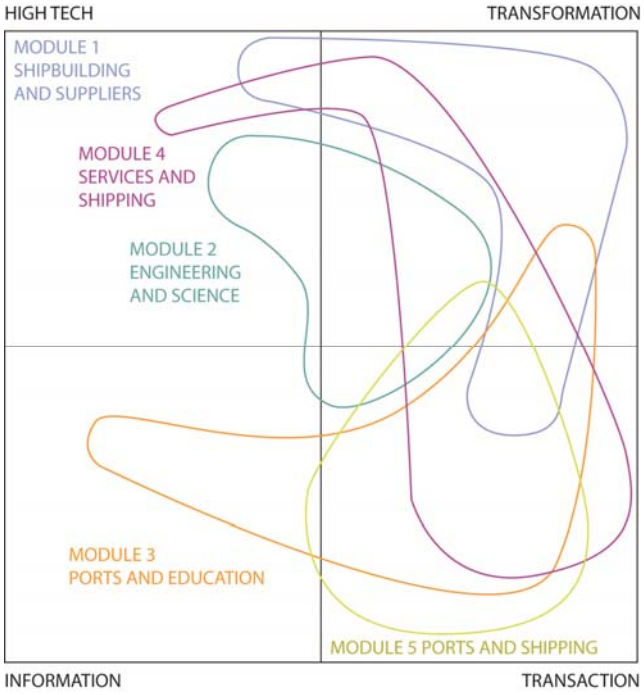

Figure 52
Visualization of knowledge relations within selected modules (calculation: Michael Bentlage)

The existence of differentiated behaviour regarding location choices depending on the knowledge type in transfer is further affirmed by the interviews, which suggest that different scale levels carry relevance for different nodes within the maritime economy network as depicted in Figure 53 (see Appendix F.4 for the reduction approach).

While logistic firms refer predominantly to the national to global context in their responses, the marine engineering field makes stronger reference to the national and super-regional scale. Across all scale levels the super-region is considered to have the strongest direct bearing on business operations followed by the national context and the global context. Interest-

ingly, the national context was considered to have the least bearing on business operations in the field of maritime services.

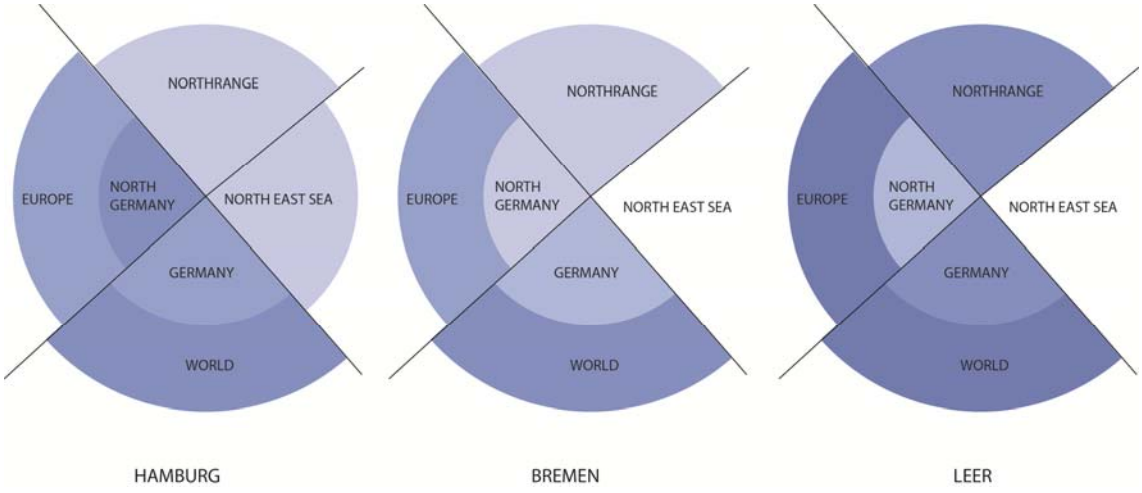

Figure 53
Perceivd relevance of different scale levels for business operations

In summary, the analysis on the super-regional level reveals functional ties, which reflect both organizational and technological proximity. Value chain relations underlie some of the relations, suggesting complementarity develops on the super-regional scale, where a choice of different locations which meet the individual needs for space and accessibility is available. How these relations evolve spatially requires further analysis, as complementary specialized clusters are expected to be organized in geographical proximity and capture a functional position within the wider urban system.

D.1.3. Knowledge in interaction

The following analysis considers the knowledge types "in interaction" in more detail. The maritime economy spans the sectors transport and storage, services and manufacturing. Therefore, by nature, value chains in the maritime economy integrate labour and material intensive processes as well non-physical processes, which draw exclusively on the skills and knowledge of workers. Thus, the application and generation of knowledge combines different activities ranging from practical experience to formalized and standardized procedures (Bentlage et al., 2014).

The prominent knowledge exchange types in the maritime economy are transaction and transformation processes, representing 1,260 and 1,609 co-operations respectively. Furthermore, the network contains 626 high-tech relations, and 301 information links. While transformation processes are based on explicit knowledge, transaction processes revolve around implicit knowledge sources. The expectation is that the spatial range of these networks is clearly different and that spatial proximity is more important for experienced based

knowledge interaction as it cannot be easily codified. Figure 54 and Figure 55 depict the spatial reach of transaction and transformation oriented exchange processes.

Figure 54
Transaction-oriented knowledge exchange processes

Figure 55
Transformation-oriented knowledge exchange processes

The actors involved in transaction processes form three observable triangles. The first one is located between the cities of Hamburg, Bremen, and Bremerhaven. To a large extent, the "Alfred Wegener Institut" in Bremerhaven, which carries out research in the field of oceans, the atmosphere, and climate change, pins down this triangle. With a weighted degree centrality of 176, this research institute is the fourth best interlinked among all actors (Bentlage et al., 2014).

The second triangle draws on links between Hamburg, Leer, and Papenburg. In this sub-network, Meyer Werft GmbH is dominant. Based on the number of links, it has a degree centrality of 173. Meyer Werft, therefore, is ranked fifth, and mostly establishes transaction links to actors in port authorities, port logistics, and maritime services. These actors tend to be concentrated in Hamburg around port facilities. Furthermore, ship-owners are located in Leer and maintain co-operations with Meyer Werft as well.

The third triangle is less striking in form. The actors of it are located in Hamburg, Papenburg, and Emden. Emden hosts a high share of employment in high-tech branches (BBR, 2011) and is, therefore strongly specialized in knowledge intensive manufacturing.

Interestingly, Hamburg functions as an anchor point for all three triangles, since it lies at the point of superimposition of the most intense edges. There are only a few cross-links between these triangles. This spatial pattern indicates an emerging hierarchy in which Hamburg captures the highest rank, and acts as a hub. Bremen is a second-tier city in this system. Actors located there tend to form links predominantly to Hamburg but also to a lesser extent to the aforementioned nodes of the triangles.

The transformation-oriented network notably extends into the middle and south of Germany, where suppliers and development partners are located. This finding complements the freight flow analysis depicted in Figure 44, which suggests part of this network is more hinterland bound than others.

Transaction oriented processes exhibit different functional relations, as depicted in Figure 55. The number of links in both cases is almost equal. However, actors operating with transactional knowledge are more concentrated on a discrete number of cities in coastal proximity. Above all, Hamburg remains the most central position in this sub-network. The re-occurring triangle formed by Hamburg, Bremen and Bremerhaven suggests that these cities form an urban system with a hierarchical tendency.

The relational visualization provided in Figure 56 refines the spatio-functional organization of collaboration along the four knowledge types outside Hamburg. The overall network consists of two polycentric activity spaces around Hamburg. Filtering the data for transaction and transformation based collaborative ties makes the selectiveness of the siting evident. Considered on transaction based ties alone, Emmen, Emden, Bremen and Wilhelmshaven form a closely knit activity space with Hamburg. The relational activity space of transaction based exchange processes is less polycentric and more loose in nature.

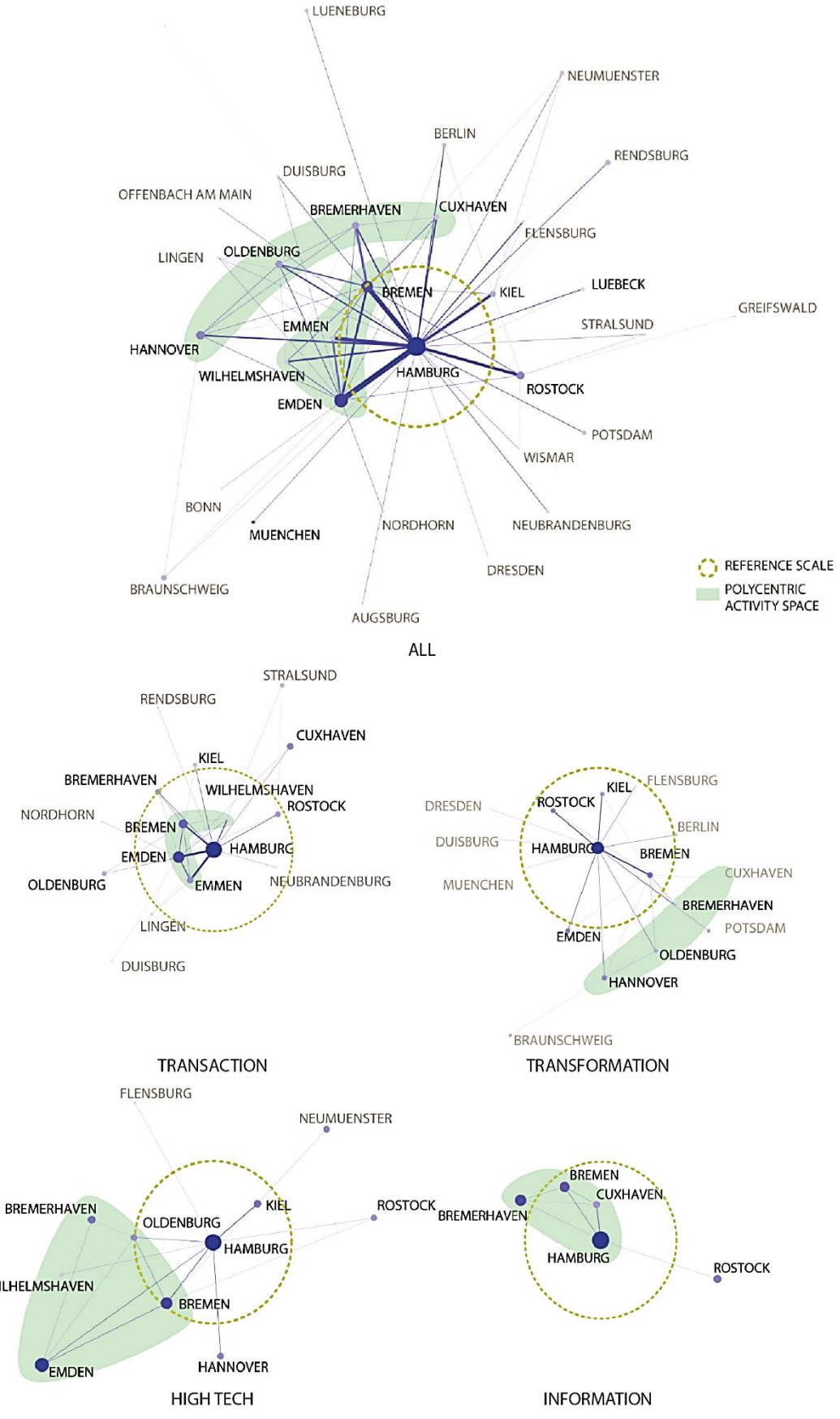

Figure 56 Relational visualization of the network based on actor centrality and betweenness

These results are matched by the perception of experts in the interviews, where a key marine engineering consultant states:

> *If you have partnerships, which you are engaged in for a longer period of time and you know how your partners think […] then I would say the scale of the western European Union is the limit. Nowadays, it is not a problem to fly from Hamburg to Italy at the drop of a hat. As soon as you have to change three times, this becomes prohibitive. (marine engineering firm, Hamburg, Ref 02/091)*

From an infrastructure perspective, the accessibility in the region is facilitated by a polycentric road system, which allows of efficient travel times between nodes. The spatial pattern of organization around these is distinct, if the type of knowledge in transfer is considered. Figure 57 overlays the resultant spaces outside Hamburg on the regional scale. The extent of these spaces stretches distances of 100km and more.

These findings support the notion of a physically separated, functionally networked polycentric organization put forward by Hall, Pain et al. 2006.

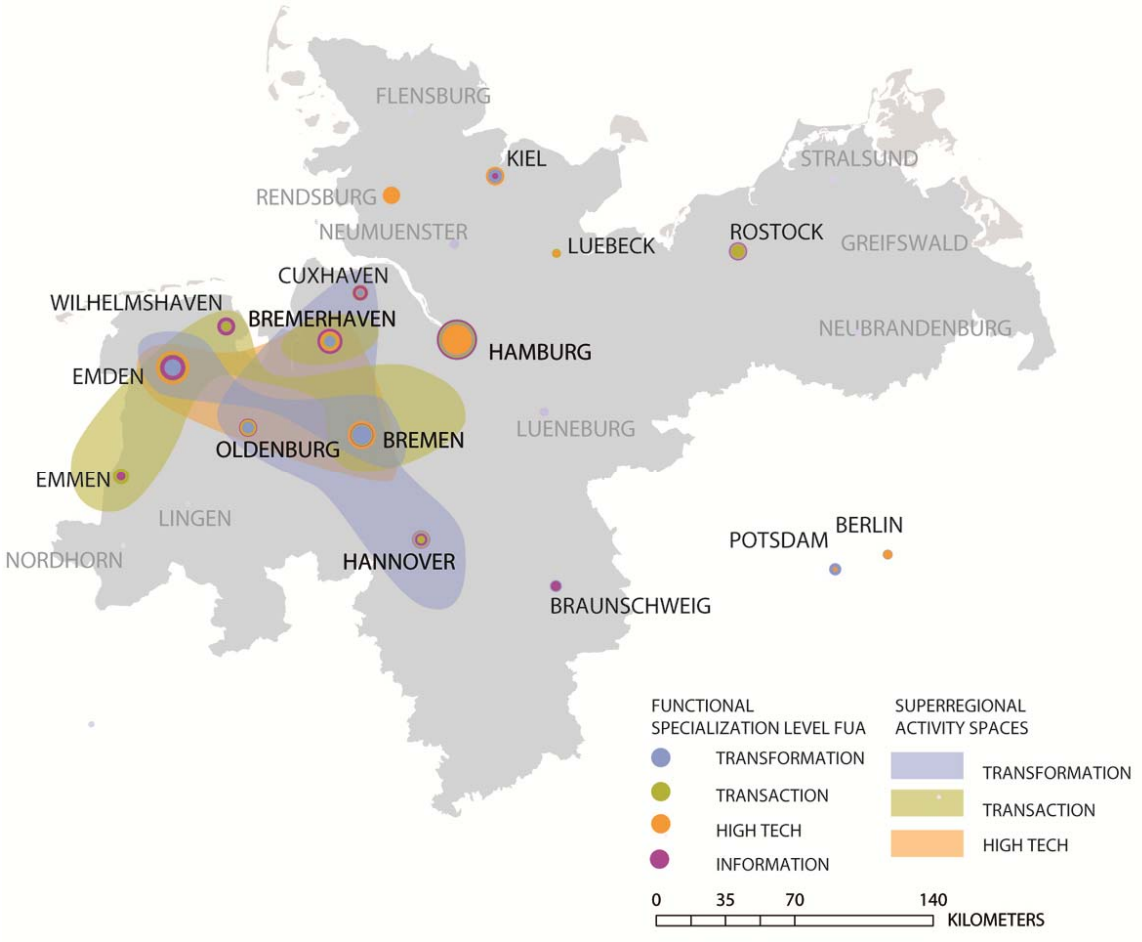

Figure 57
Superregional activity spaces outside Hamburg

The following section seeks to complement these findings with the analysis of clustering patterns, which are spatially more refined. The debate on knowledge spillovers centres on the local context as a milieu, which allows for the establishment of contacts with potential cooperation partners, and to exchange knowledge without the pre-existence of formalized value chain relationships or collaborative ties. It suggests that certain localities foster informal exchange, and provide a raised potential for innovation by ensuring availability and visibility of potential partners (Bathelt et al., 2004; Marshall, 1930; Storper and Venables, 2004) as a basis for "untraded interdependencies" (Storper, 1997) due to physical proximity. The following analysis seeks to delineate those localities on the regional level.

D.2. Regional Level

Previous research suggests that functional spatial specialization and differentiation are strong drivers of spatial transformation (Hall et al., 2006; Taylor, 2004). Particular importance is attributed to the regional scale, which in turn is "… not defined by natural boundaries, because they are wholly the artefacts of the cities at their nuclei: the boundaries move outward – or halt – only as city economic energy dictates" (Jacobs, 1984: 45). This chapter considers the regional level from three angles. Firstly, it seeks to establish whether functional clusters imprint as spatial clusters within the region. We have identified modules on the super-regional scale, which represent a functional community structure, but have not yet established whether a spatial correlation exists. The delineation of the regional scale has previously been achieved at the level of functional urban areas (FUA). Following the approach developed by Lüthi (Lüthi et al., 2011), the second part analyses the physical connectivity between sites on the FUA level. The third part looks at one particular phenomenon, the attraction of talent to places within the regional context, sustaining the argument that "these places exist both as separate entities, in which most residents work locally and most workers are local residents, and as parts of a wider functional urban region connected by dense flows of people and information carried along motorways, high-speed rail lines and telecommunications cables" (Hall and Pain, 2006:3). This section, which focuses on findings on the intermittent regional scale, concludes with an outlook of multi-scalar interdependencies of the maritime economy.

D.2.1. Spatial clustering

Current research underlines the importance of local and global processes of cooperation and competition for sustained learning (Porter, 2000; Simmie, 2004). Whereas the super-regional reach of the innovation system of the maritime economy has been explored in section D.1 of this thesis, the following analysis explores the existence of localized clusters of actors in order to delineate spatially relevant entities for further analysis of the topology of such places. Two types of clusters are distinguished in this approach: firstly, horizontal clusters, which contain firms in a defined spatial reach to each other, which "do not necessarily have close contacts to one another or intensive input-output relations involving substantial physical transactions. Rather, the respective firms benefit from their co-location through which they are well informed about the characteristics of their competitors' products and about the quality and cost of the production factors that they use. Advantages of proximity arise from continuous monitoring and comparing"(Bathelt et al., 2004:36).

Secondly, vertical clusters, which consist of firms, which are interlinked by existing or potential value chain relations. "The idea behind this is that, once a specialized industry cluster has been established, the firms of this cluster develop a demand for specialized services and supplies. This creates an incentive for suppliers to be near these firms because they form important markets. In locating close to these markets, the suppliers can gain economies of scale and distribute large parts of their production at low costs" (Bathelt et al., 2004:37).

By applying a spectral algorithm, non-overlapping communities are computed, which are differentiated from the overall data set by fewer than expected interconnections between them. The product of B and an arbitrary vector x can be written

$$Bx = Ax - \frac{k(k^T x)}{2m}$$

A is the adjacency matrix and *k* is the vector whose elements are the degrees of the vertices. The communities derived by the algorithm, which are no more than five kilometres apart from each other, are treated as horizontal clusters. The analysis has computed 21 communities of more than ten firms, which are more strongly connected internally than externally within the overall network (Newman, 2006). These communities are considered as clusters and analysed in accordance with their spatial and functional configuration on the regional to local level (Wiese and Thierstein, 2014).

As shown in Figure 58, "complementary" as well as "competitive" clusters of firms exist, whose activities are complementary in input-output relationships as in Figure 58a, but also potentially compete with each other as in Figure 58b. In addition, there is a clear spatial demarcation of "operational" clusters versus "strategic" clusters. In the case of Hamburg, operational clusters related to the port economy stretch along the south of the river Elbe towards more de-central locations as in Figure 58a whereas strategic clusters related to service and administration activities cluster more centrally Figure 58b.

The analysis reveals that very few existing co-operations embedded in the dataset on innovation and education evolve at the local level. No single area within a five kilometre radius accommodates a critical number of actors, who are engaged with one another via a community structure. On the local inner city level, clusters of complementary and competitive activities are identified, albeit at a scale which is regarded as too large for unintended knowledge spillovers for neighbouring effects to occur. The local level appears to have limited importance for knowledge exchange in the cooperative network of the maritime economy.

However, the interrelatedness of spatial scales and interconnectedness of different spheres of activity through knowledge exchange points towards spatial integration rather than fragmentation on the regional scale. Since vertical clusters evolve around supplier relations, clusters are researched around actors displaying high centrality in the overall network. Figure 59 shows the distribution of weighted degree centrality. This measure is calculated by the sum of links of an actor multiplied with the weights of its network links (Freeman, 1979). In our data, these weights differ between 1 and 3. Hence, one actor with one triple weighted link is as important as an actor with three single linkages. Thus, high values of weighted degree centrality could either be the result of a high number of low rated links or a lower number of highly classified connections.

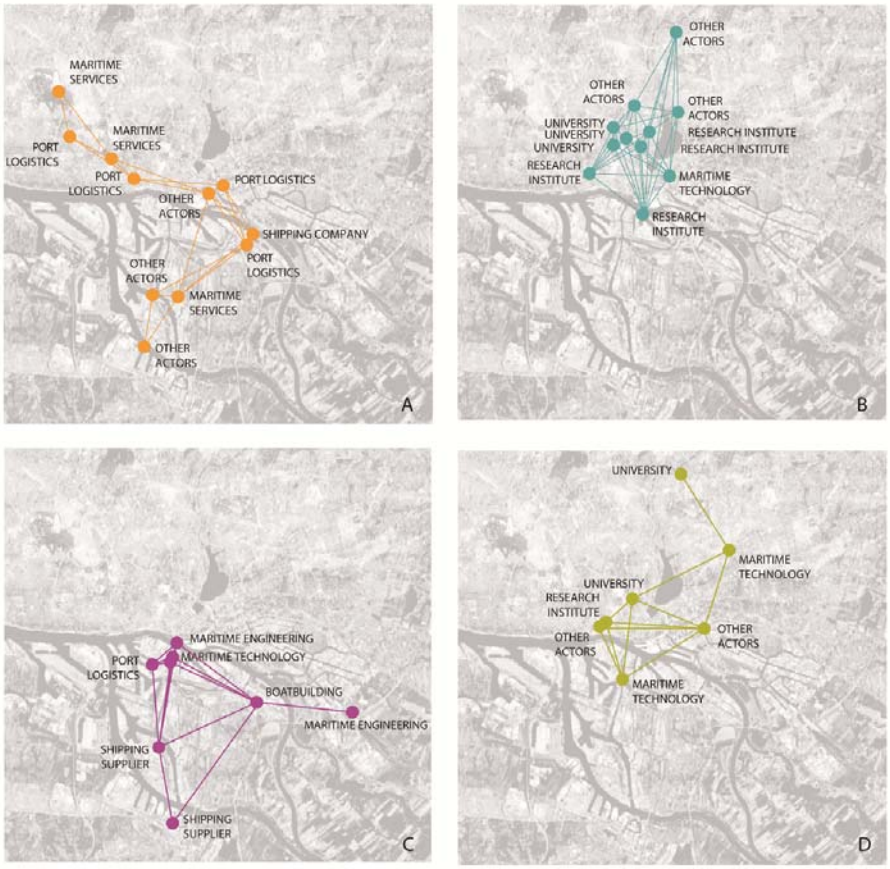

Figure 58
Local clusters of firms within four separate modules in Hamburg (Wiese and Thierstein, 2014)

The actors are ranked according to their weighted degree centrality. The slope begins at the value of 393 and decreases steeply. The second most connected actor has a weighted degree centrality of 272, followed by 266. Therefore, the slope is similar to a power decay function, and may provide a scale-free network (Barabási, 2009: 412), which indicates that the network structure is independent of its size. The network of the maritime economy revolves around a limited number of actors as central nodes (Bentlage et al., 2014).

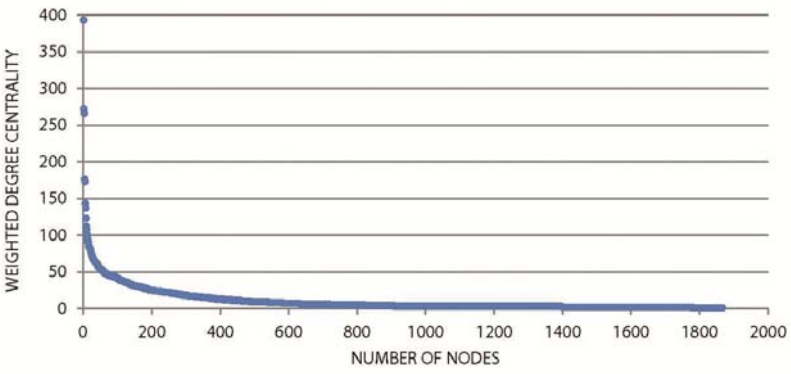

Figure 59
Weighted degree centrality distribution, n: 1,873 actors and 4,174 network links (Bentlage et al., 2014)

Interestingly, among the top ten actors in terms of weighted degree centrality are five actors classified as marine engineering science and, therefore, act as public institutions. The most connected actor – Germanische Lloyd AG – provides maritime services in various fields. This company has meanwhile merged with the Norwegian shipping company, Det Norske Veritas (DNV). Meyer Werft, which operates in the field of ship building, is ranked on sixth position, followed by Hamburgische Schiffbau-Versuchsanstalt GmbH, providing expertise in marine engineering, and Briese Schiffahrts GmbH & Co. KG, operating as shipping company. Hamburger Hafen und Logistik AG, which organizes and manages port activities within Hamburg reaches the thirteenth highest value. The ranking is provided in Table 10 in Appendix F.4.

Figure 60 depicts the spatial context of these actors at the local level across the region. Wheras the first two diagrams exhibit a strongly embedded site, within the centre of Hamburg, the third one is more peripheral to the agglomeration. The shipbuilding site of Meyer Werft in Papenburg lacks any form of clustering in its vicinity, with a small number of actors situated in immediate adjacency. The last diagram of the shipping company Briese Schiffahrts GmbH & Co depicts a strong cluster in the immediate vicinity of the actor as well as a reasonable number of actors within close reach. This site is in Leer on the Ems Axis, a medium sized town of 34.607 inhabitants (31.03.2013). These results suggest that the different actors are situated in fundamentally different local settings, despite their commonly high degree of centrality in the super-regional network. Transaction-oriented actors, such as Germanischer Lloyd AG, Hamburger Hafen and Logistik AG and Shipping Companies appear to be more likely situated in clusters than others.

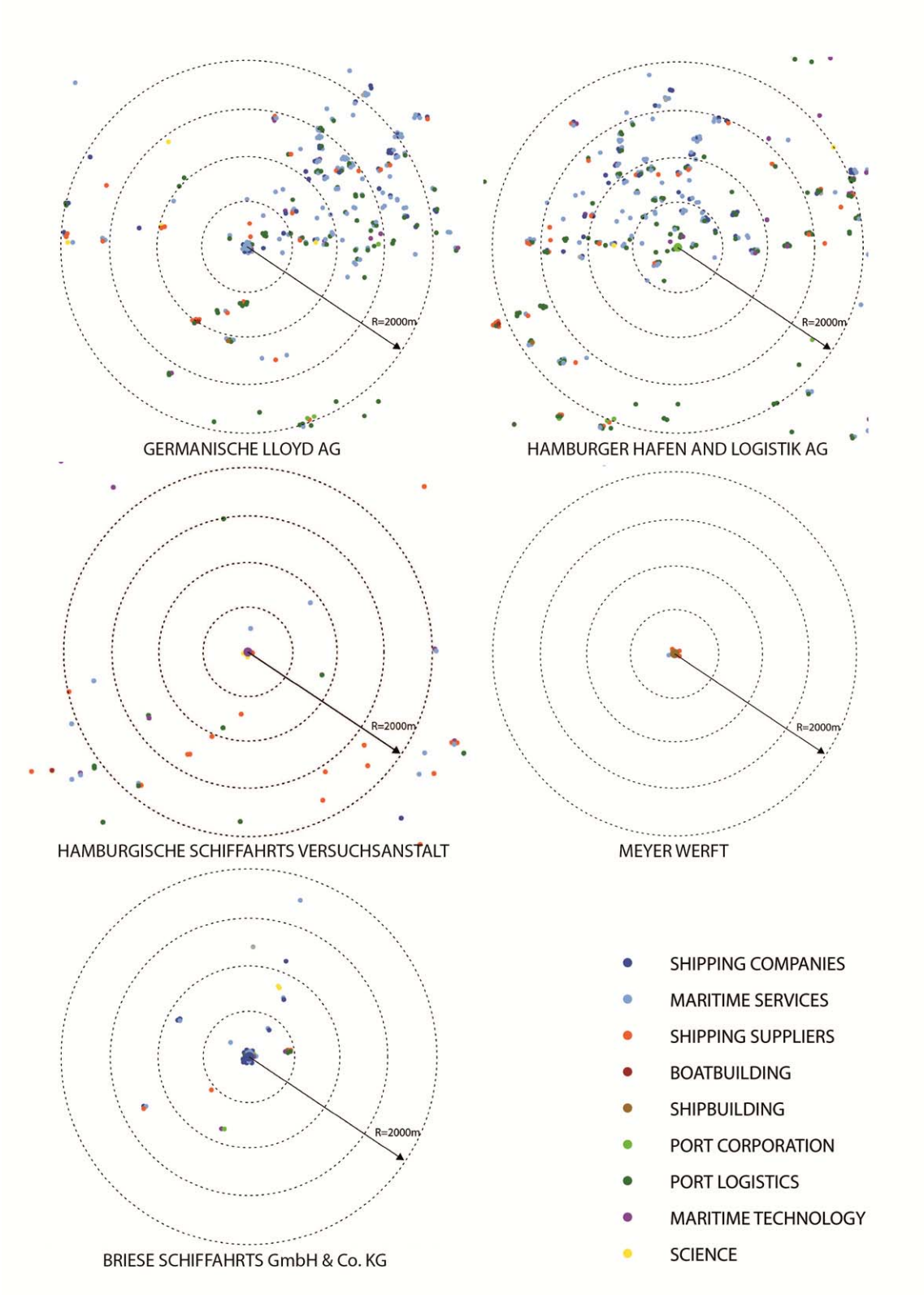

Figure 60
Clustering around key network actors in comparison

These results are a first indication, that shipping companies have a clustering effect in their immediate vicinity as well as their local context. The interview results further affirm the clustering of firms around key actors, by providing repeated reference to the role of shipping companies in particular.

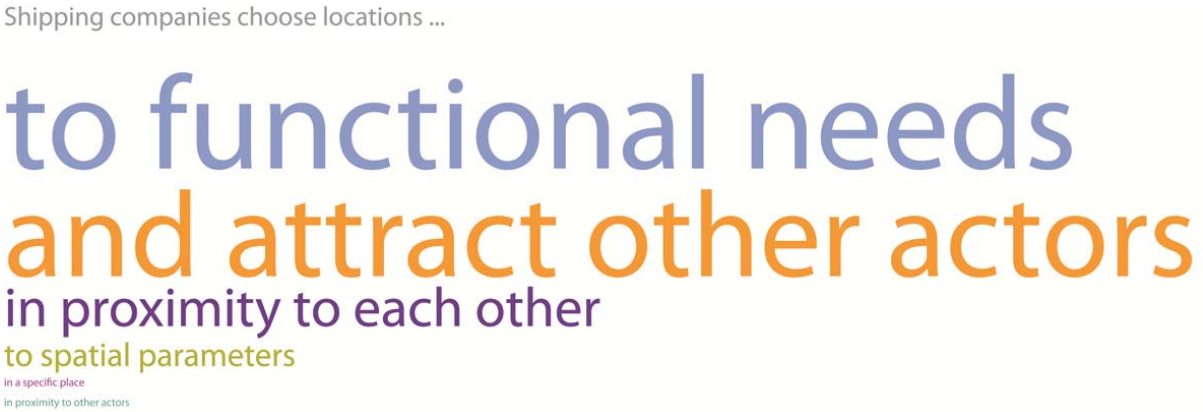

Figure 61
Perceived drivers of location choice of shipping companies in Hamburg (N=33)

Based on this data, the formation of an increasingly steepening hierarchy in the super-region is confirmed empirically, with shipping companies concentrating their operations in Hamburg between 1980-2012 as depicted in Figure 62.

Functionally, shipping companies take a pivotal between the transaction and transformation-oriented part of the maritime economy, as they are key decision makers for vessel investment and construction, accreditation and flagging as well as freight routing (Bentlage et al., 2014).

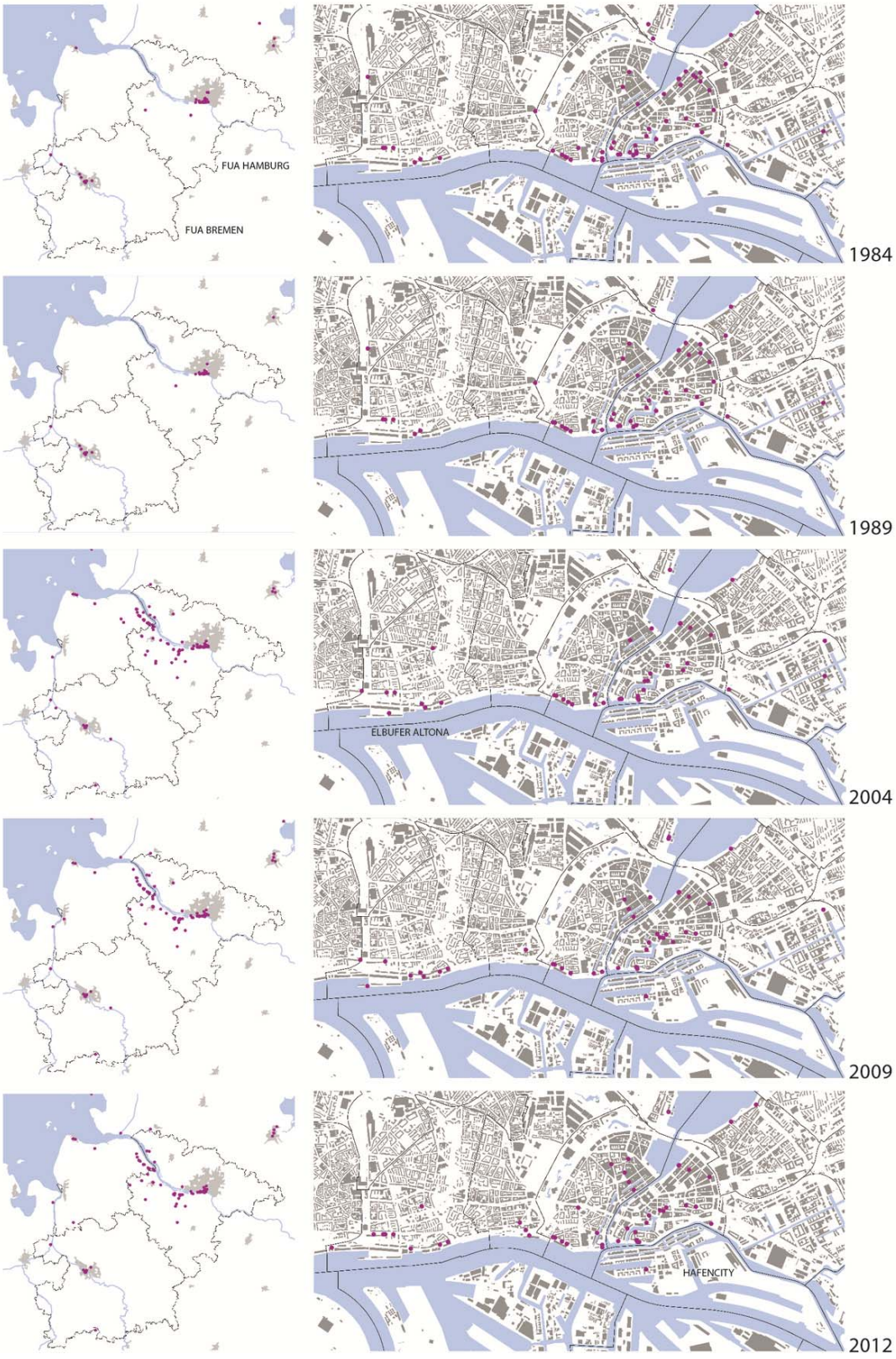

Figure 62
Shipping companies in central Hamburg 1984-2012 (VDR, 2012)

In summary, the role of clustering for sustained innovation activity and collaboration within the maritime economy can be considered an overlay of industrial complexes, social networks and agglomeration effects (Simmie, 2004). The social networks appear to be of particular relevance as one of the interviewees' states:

> *An array of clubs and traditions and so on exist, where the same people meet again and again. I believe this is something, which is particularly pronounced in port cities and I also believe that it is this, which helps agreements to be found relatively quickly, even if tough conflicts arise. This is due to the level of trust, which is built in those clubs. There are multiple examples of this. (research institute, Bremen, Ref 04/037)*

Another expert reaffirms the importance of social cohesion:

> *The maritime industry is a "relationship management" market, because when you are in this sector you need to know exactly who to contact to get something. The market doesn't have long lead times; it is the credibility, and in the end it is to some extent the proximity to these partners, which allows you to meet for a meal out or attend an event. (marine engineering and supplier, Hamburg, Ref 02/47 + 02/67)*

In line with other studies (Kloosterman, 2008; Wolfe and Gertler, 2004), the local scale does not reveal a critical mass of functionally interlinked actors. The role of associations and clubs as intermediaries needs further exploration. Functionally, the identified clusters are heterogeneous, with space intensive operations, such as shipbuilding and testing facilities seeking more peripheral locations to the core city.

D.2.2. Accessibility and complementarity of functional fields

While the centrality measure employed in the previous section singles out those actors, who are central in the knowledge network, the UNA betweenness measure (Sevtsuk and Mekonnen, 2011) indicates which actors have most easily access to other actors in the network. On the level of the functional urban area, the same computation is employed as introduced in section D.1.1 of this thesis to explore the spatial dimension of the network of collaboration at the regional scale.

As the role of accessibility in the maritime economy is two sided, with the transportation of goods being directly linked to access to transportation and knowledge exchange linked to human interaction, focus is laid on the topology of the road network which supports face-to-face interaction.

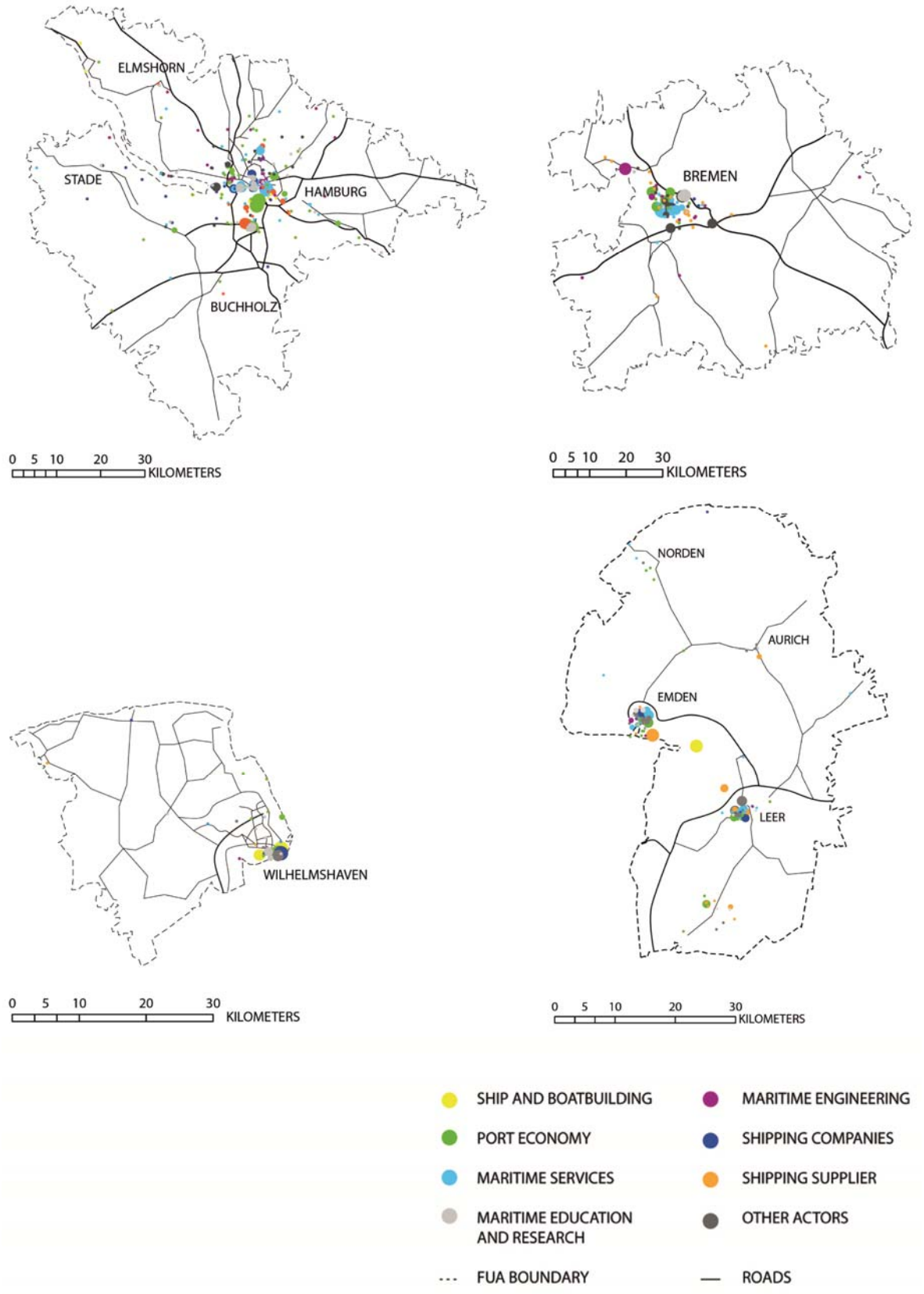

Figure 63
Betweenness of sites in functional urban areas

As expected, the choice of the functional urban area as a boundary results in a new hierarchy of locations, with the sites in the centre of the agglomerations featuring more strongly than on the super-regional scale. Interestingly, actors at different fields of activity have the highest betweenness measures across the FUAs analysed, which represents the potential area that can be reached within 45 minutes by car from the FUA center. While in Hamburg shipping suppliers are sited on the periphery of the urban core are by far the most accessible, maritime service firms and shipping companies feature the second highest value. The hierarchy of locations within the FUAs is provided in Table 6ff of Appendix F.4 .The significance of the regional scale for the functional interaction is re-iterated in the expert interviews, which make specific reference to the importance of accessibility of partners for business.

> *We are quite well accessible; for people, who arrive by train, that's a quarter of an hour, twenty minutes to here. From the airport, it is exactly the same. […] Obviously, there are nicer sites within the port, I would say, and, yes, we would quite like to be there, but that would not have a major advantage. At least our business and the accessibility of our customers would hardly benefits from it at all. (maritime service firm, Hamburg, Ref 01/068)*

In Bremen, marine engineering and science as well as maritime service firms and shipping companies occupy the most accessible sites, which suggests differences in the spatial organization across FUAs. The Jade-Weser region features sites in the shipbuilding and port economy as the most accessible. However, there is a clear absence of maritime service firms in Wilhelmshaven, which one of the interviewees explained as follows:.

> *I believe that the service sector in Wilhelmshaven doesn't really have a chance. […] there are many ports, which transship an incredible amount of tonnage, even though they have nothing to do with services at all […]. There is no air connection, which I think is actually an essential factor for consultants and the whole maritime service sector. (port logistics firm, Hamburg, Ref 09/084)*

Yet again, different actors are occupying the most accessible sites in the functional urban area surrounding the Ems Axis. Shipbuilding and suppliers are standing out along with shipping companies. The phenomenon on the Ems axis is referred to by one interviewee, who states:

> *Well, I would say, this is a great advantage for us, as, to put it simply, we are much closer due to these advantageous site constellations, closer to the demands, the conditions and the potential partners, than if we were located somewhere completely different or they were located somewhere else. (research institute, Leer, Ref 12/038).*

Overall, the interview results underpin the existence of distinct regional subsystems of functional complementarities, where key actors benefit from their physical proximity and accessibility on the regional level. Spatial development is therefore potentially driven by the needs

of the dominant actors, which seek to optimize their sites to suit operations and business models. The consequences of this are highly various and the number of factors, which influence spatial embedding extend beyond the scope of this research. Processes of value creation and informal exchange across all industrial fields have previously been found to be heavily dependent on the attraction and exchange of qualified personnel (Feser, 2003), as well as historic interdependencies (Krugman and Paul, 1994). The following section focuses on the process of labour migration and its spatial consequences.

D.2.3. Attracting talent and agglomeration processes

In accordance with current innovation research, the capability to innovate heavily depends on knowledge exchange and development, which in turn is heavily dependent on the availability of human capital (Pinto, 2009; Thierstein and Wiese, 2011). The following analysis maps the spatial agglomeration of human capital on the regional scale and develops an insight into the causes and effects of human capital agglomeration on the maritime economy based on the interviews. The lack of data specific to the maritime economy forces us to refer to the classified NACE data, when evaluating the role of different forms of talent across activity fields.

The maritime economy is a conglomerate of sectors, which transcends the economic sectors of Manufacturing (NACE Section C), Professional, Scientific and Technical Activities (NACE Section M), Transportation and Storage (NACE Section H), Education (NACE Section P), Administrative and Support Service Activities (NACE Section N). Other sectors, which might be of relevance in certain activity fields are Construction (NACE Section F) and Financial and Insurance Activities (NACE Section K). The NACE classification draws on economic activities by using common resources: "capital goods, labour, manufacturing techniques or intermediary products are combined to produce specific goods or services" (Eurostat, 2008: 15).

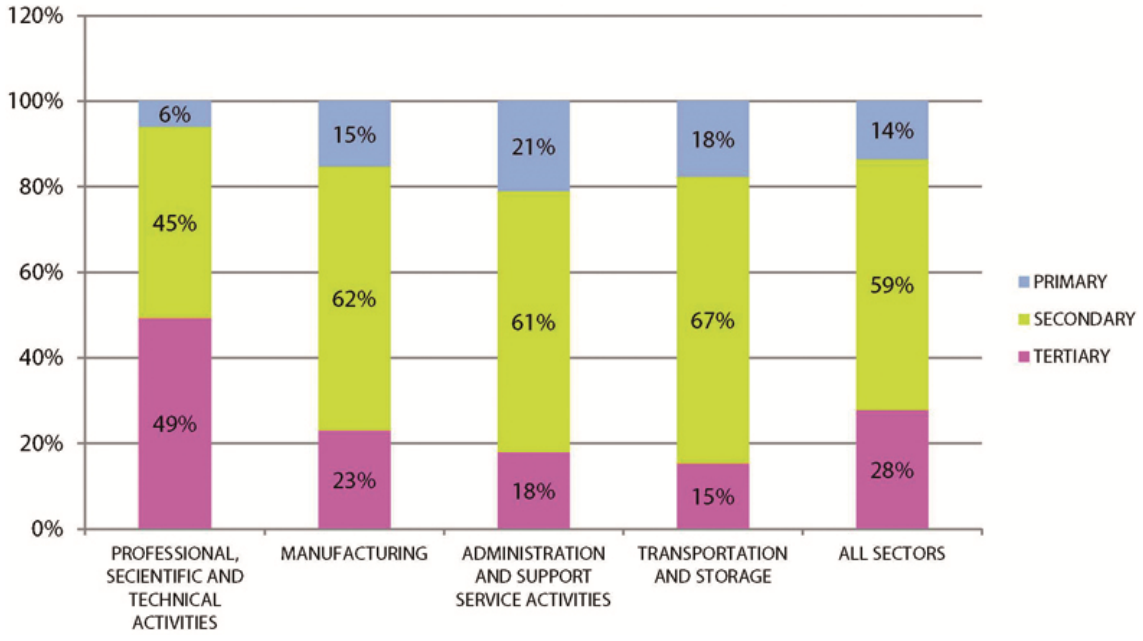

Figure 64
Eduation levels across economic classifications (Eurostat, 2010a, b)

The data displayed in Figure 64 shows the heterogeneity of the human capital base across sectors, with professional, scientific and technical activities featuring 49% of the employees with a tertiary education. Manufacturing, which contains Shipbuilding and Shipping suppliers includes on average 23% of employees with a tertiary education. Administrative and support activities follow with 18% and Transportation and Storage with 15% tertiary educated employment. Although knowledge intensity and innovation capability depend not solely on education level – and the dual system in German secondary education suggests a high level of skills and knowledge in the secondary education underpins innovation (VDI/VDE, Nord/LB et al. 2010) –it is the highly educated young professionals, who are most likely to migrate within and across activity fields and thereby support the exchange of knowledge (Rohr-Zänker, 2001; Thierstein and Wiese, 2011). These roles are embedded in a number of fields of activity in the maritime economy, especially shipping suppliers and maritime services.

Using the migration of young professionals between 18 and 30 years of age as a proxy for the attractiveness of a destination for the workforce generates the highest values for Hamburg, Hannover and Bremen, and the lowest values for Osnabrück, Rendsburg-Eckernförde and Emsland. The immense attraction of Hamburg is illustrated in Figure 65, as the aggregated effect of migration of young talent between 1996 and 2012.

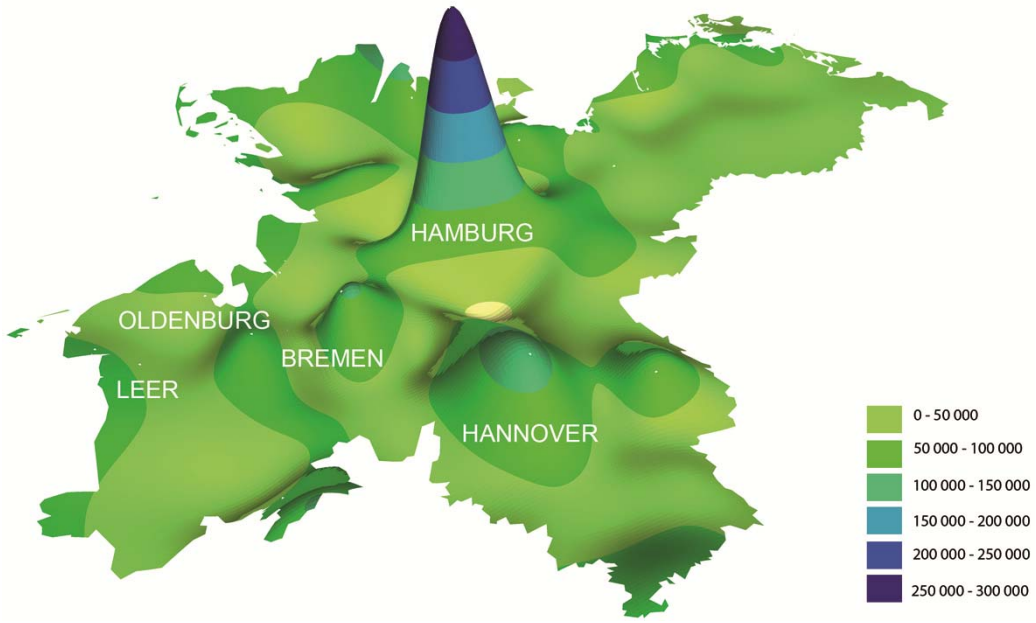

Figure 65
Attracting talent – migration of 18-30 year olds between 1996-2012 (Destatis, 2012)

The interviews confirm the importance of selected destination attractiveness for retaining and developing talent for the maritime economy and make specific reference to spatial advantages in that respect.

> *Of course it is simpler to recruit employees in Hamburg than to get them to move to Wilhelmshaven […]. Numerous firms are already here,*

> *plenty of work opportunities, which means it is easy to motivate people to come to Hamburg […]. Consequently, however, there is also a much higher level of competition for human resources (port logistics firm, Hamburg, Ref 07/51)*

The multiplicity of offerings in diversified urban economies can both foster and hamper the attractiveness for talent, as one expert elaborates:

> *If we take the classic industrial employees, wearing a fluorescent yellow jacket, they strongly identify themselves with the place of work. Other employees from IT or process engineering…, in these sectors we do compete with Siemens, Universities and other schools and the competition is quite fierce. (port logistics firm, Hamburg, Ref15/086).*

More remote locations on the other hand appear to benefit from a less mobile labor market.

> *Since the shipping companies have reached a certain size, we don't have a problem recruiting externally anymore […] another advantage of this site is that in such a small town everybody knows each other and competition is not as fierce as it is sometimes the case in large cities or Hamburg. We don't poach each other's employees, neither do we have fluctuation or worry about finding young talent in our business. Moreover, the town has become more attractive in itself. There is a quality of life here, good schools, although there is not that much going on culturally. (shipping company, Leer, Ref 05/005,006,010)*

On an aggregated level, the expert interviews allow us to map cause and effect relationships in the flow of talent in the regional context of the maritime economy in Germany, as summarized in Figure 66.

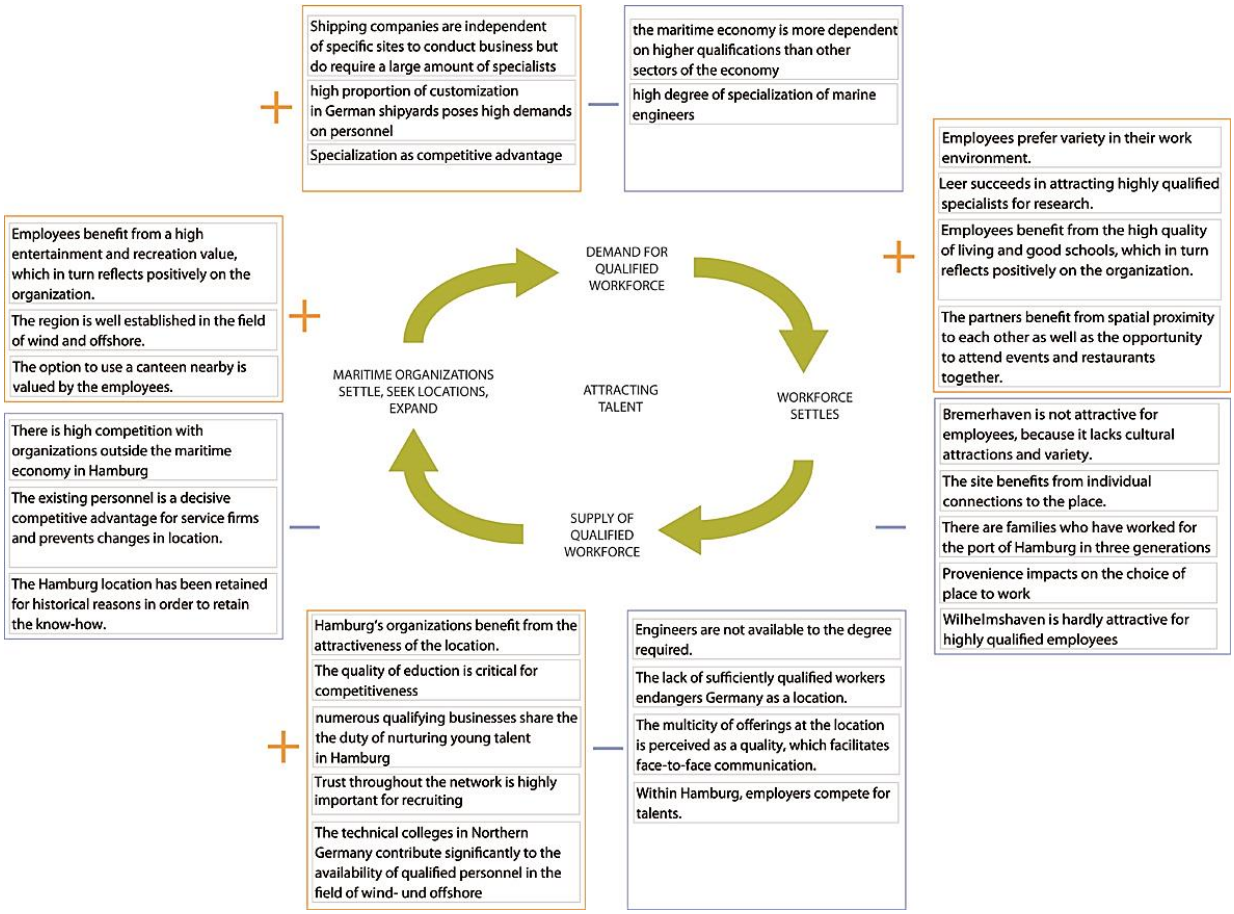

Figure 66
Perceived cause and effect of labour mobility

The findings presented in this section do not give an unambiguous result with regard to the existence of spatial patterns of organization on the regional scale, which result from exchange processes in the maritime economy. They reveal however, that there are three processes, which critically affect regional spatial configuration. The analysis of cluster suggests that key actors, which are involved in transaction-oriented processes are more likely to be situated within clusters of firms, and this seems to be of particular relevance to shipping companies. Furthermore, some actors appear to substitute the lack of physical proximity with temporary proximity by making use of locations, which feature good accessibility to regional centres. Lastly, there is reason to believe that the availability of talent affects the ability to sustain localized innovation systems. In this respect, Hamburg features as the most diverse and attractive labour market. Based on these insights and due to restraints in time and scope, the following local analysis focuses on Hamburg.

D.3. Local Level

The topology of the built environment is the result of long term spatial development, which is constantly evolving alongside the functional dependencies and processes of exchange among actors local and distant. The actors in the maritime economy have traditionally exerted a strong influence on port city development, as their physical and functional infrastructure is distinct and embedded in the culture and identity of those cities. By means of the network analysis, interviews and supporting data three specific processes have been identified, which bear on local spatial development from a relational perspective, and inform the local analysis: the attraction of talent, the production of temporary proximity and the clustering around key actors are seen to affect location choices and spatial patterns of organization- in the maritime economy.

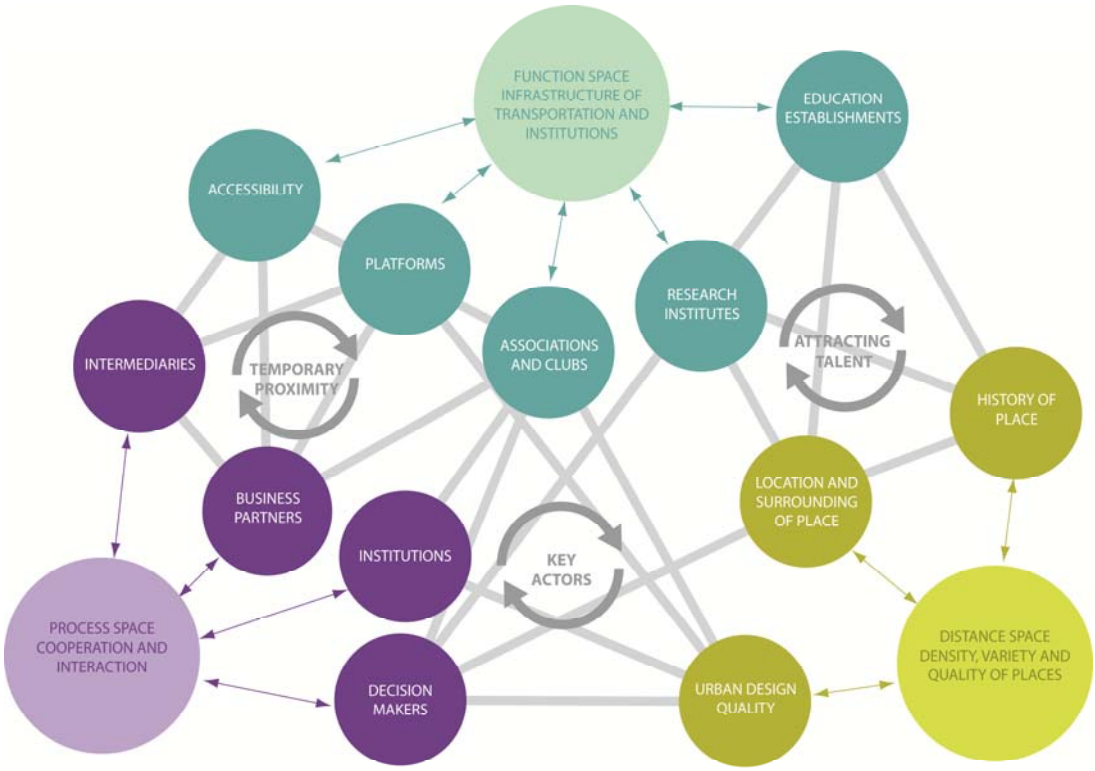

Figure 67
Perception of local relations revealed by experts in the interviews

The analysis on the local level therefore seeks to establish how these relations are embedded in the spatial topology of the local network and the wider urban context. Hence, sites are firstly analyzed in relation to other sites in the maritime economy. Secondly, the positioning within the overall urban topology is subjected to analysis.

Due to restraints of time and scope, the local analysis is focused on Hamburg. The reason for this selection is that Hamburg features most notably in the super-regional network on both the transaction and the transformation exchanges, as well as on the regional level, with competition and complementarity expected to influence location choices more distinctly

than in the urban contexts of Bremen, Jade-Weser, or Ems Axis. This is reiterated by a number of experts referring to the special position of Hamburg:

> *What makes Hamburg special is the density of actors, which is comparatively high. There is a decent testing facility, nearly all relevant classes are available, most shipping companies are sited here, plenty of maritime services, the key suppliers have some sort of representation and if you choose to look at the total area within a 200km radius, there is a reasonable number of shipyards as well. (maritime research, Hamburg, Ref 14/055)*

On a global scale, Hamburg features as a Beta Plus City in the hierarchy of the GaWC Network (Figure 7). Therefore, Hamburg is considered to have the highest significance in the network of global advanced producer service firms within the study area. The relevance of Hamburg on a global scale has also been repeatedly addressed in the interviews (Figure 53), and is generally acknowledged to have a high significance for the maritime economy as a whole, which is subjected to intense globalization processes (Ducruet and Notteboom, 2012; Hall and Jacobs, 2010; Jacobs, Koster, et al., 2010). To complement the relational, multi-scalar research perspective on the local level, the study area around Hamburg is delineated for further local analysis.

The empirical results up to this point suggest that interactions between corporate sites and the urban network are multi-faceted and specific to the knowledge exchange activities of the individual actor. Transformation-oriented interaction takes place on larger scale levels and in less central locations. Moreover, the attractiveness as a labour market and place to live and work is seen to contribute to the ability to attract human resources. In the northern German super-region this applies to Hamburg in particular. By limiting the following study to Hamburg only, one area is subjected to local level research. Furthermore, the analysis presented focuses on the urban topology, or more specifically, on accessibility of sites to each other and in relation to the urban context. The previous sections have identified a number of functional focal points which have specific relevance for the maritime economy in the context of our research, most notably shipping companies, locations facilitating temporary proximity, such as event locations, and trade associations, as well as institutions of education and professional development. These sites have been added to the original dataset of collaboration as locations, which have hosted industry events over the last two years. A list is included in Appendix F.4 for reference. In order to establish the spatial relevance of these for the urban topology in Hamburg, the Urban Network Analysis measures of betweenness and reach are employed (Sevtsuk and Mekonnen, 2011).

D.3.1. Local study area

The selection of the study area implies the delineation of a specific area, which is subject to analytical measurement. Previous research has shown that the selection itself has a high impact on the outcomes (Knight and Marshall 2014). The issue is termed Modifiable Area Unit Problem, or MAUP, and can introduce a significant bias to spatial analysis, as different shapes and levels of delineation lead to different results while using the same data base (Openshaw,

1984). In order to overcome this issue, a behaviourally-based scale and unit definition, which is relevant to the subject of analysis, provides the best basis (Zhang and Kukadia, 2005).

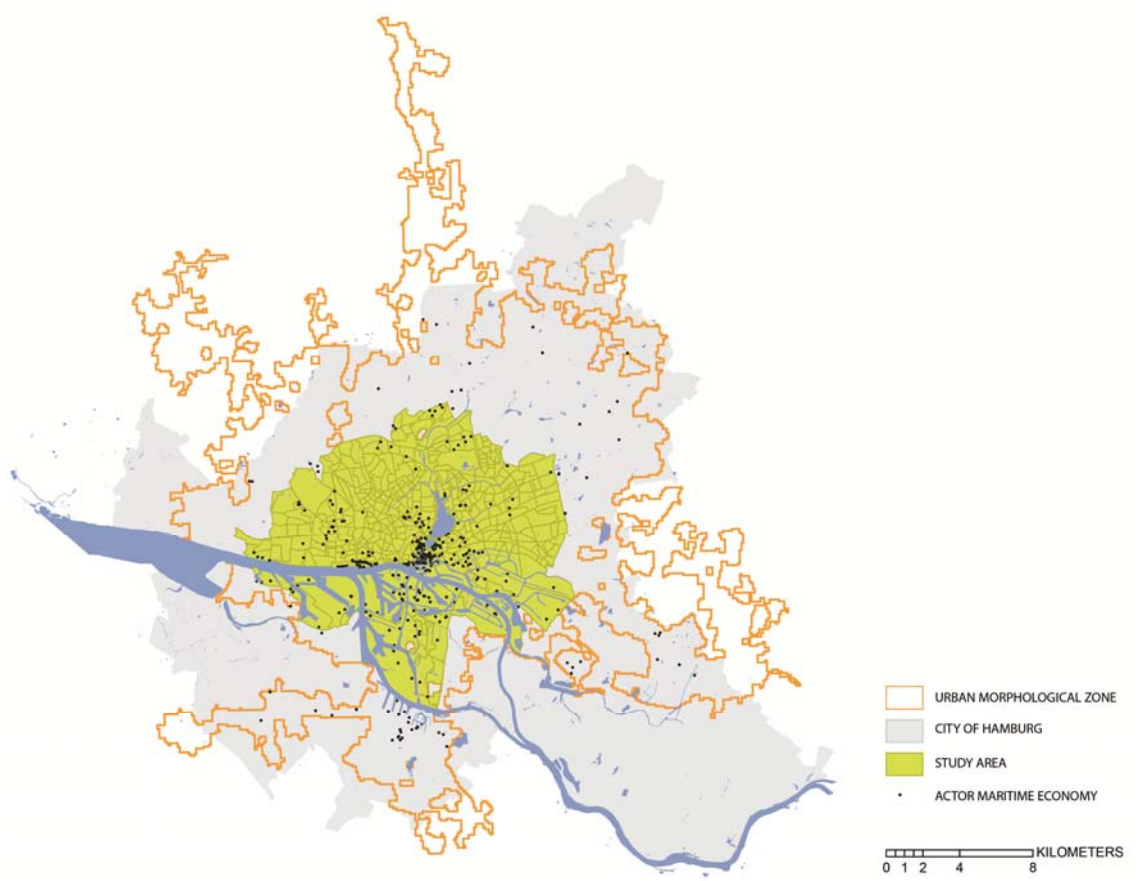

Figure 68
Local study area in Hamburg

In the context of this study, the area has been selected according to the three spatial dimensions of the relevant distance, function and process space. The distance space is defined by the urban morphological zone of Hamburg, as delineated by land cover classes, which form "A set of urban areas laying less than 200m apart" (Simon et al., 2010). This data from 2006 is available from the website of the European Environmental Agency [3]. Primarily, it aggregates urban land use classes as defined by Earth Observation data with 2.5 m spatial resolution in conjunction with a number of basic indicators. The function space of the study area is wholly part of the extent of the functional urban area of Hamburg. This implies that the city-region is conceptualized as a functional entity rather than an administrative territory or a continuous built-up area (ESPON, 2004). The process space is derived from the dataset on the sites of the maritime economy and includes those continuously adjoining statistical urban zones in which organizations of the maritime economy are located. The data on statistical urban

[3] http://www.eea.europa.eu/data-and-maps/data/urban-atlas accessed 17.03.2014

zones was obtained from the Statistikamt Nord in April 2014. This approach produces an urban area of 172,343 km² depicted in Figure 68 which is subjected to topological analysis.

D.3.2. Exploratory analysis

The study area contains a number of different corine land use classes, which are in some instances linked to functional use patterns, such as port areas and industrial and commercial units. The sites of the maritime economy are spread across the four land use classes continuous urban fabric, discontinuous urban fabric, industrial and commercial units and port areas. The definition of these is included in Appendix F.10. for reference. In line with the research framework, the spatial process of innovation and collaboration is expected to be facilitated by urban form as distance space facilitates proximity, function space affects building use and the combination thereof creates and urban topology, which facilitates processes of exchange among actors.

In a first approach clusters of actors are mapped by activity fields in Figure 69. The most central locations are dominated by shipping companies, maritime service firms and other economic actors including associations and regulatory bodies. Interestingly, marine engineering and science functions share the central locations with the former. Port logistic functions are situated to both sides of the river Elbe. Shipping suppliers and Shipbuilding sites are located outside the urban center.

This research approaches the urban form and function from a relational perspective and seeks to establish patterns of spatial organisation. The study is limited to the planar configuration of buildings, functional use and the primary network of roads, which are referred to as urban topology. Studies of urban topology in the past have largely been qualitative and lacked the analytical rigor, which would allow transferability. By applying a relational approach, which combines qualitative and quantitative methods, the study is aligned with the research on other scale levels and allows for generalization and cross-case comparison in the future.

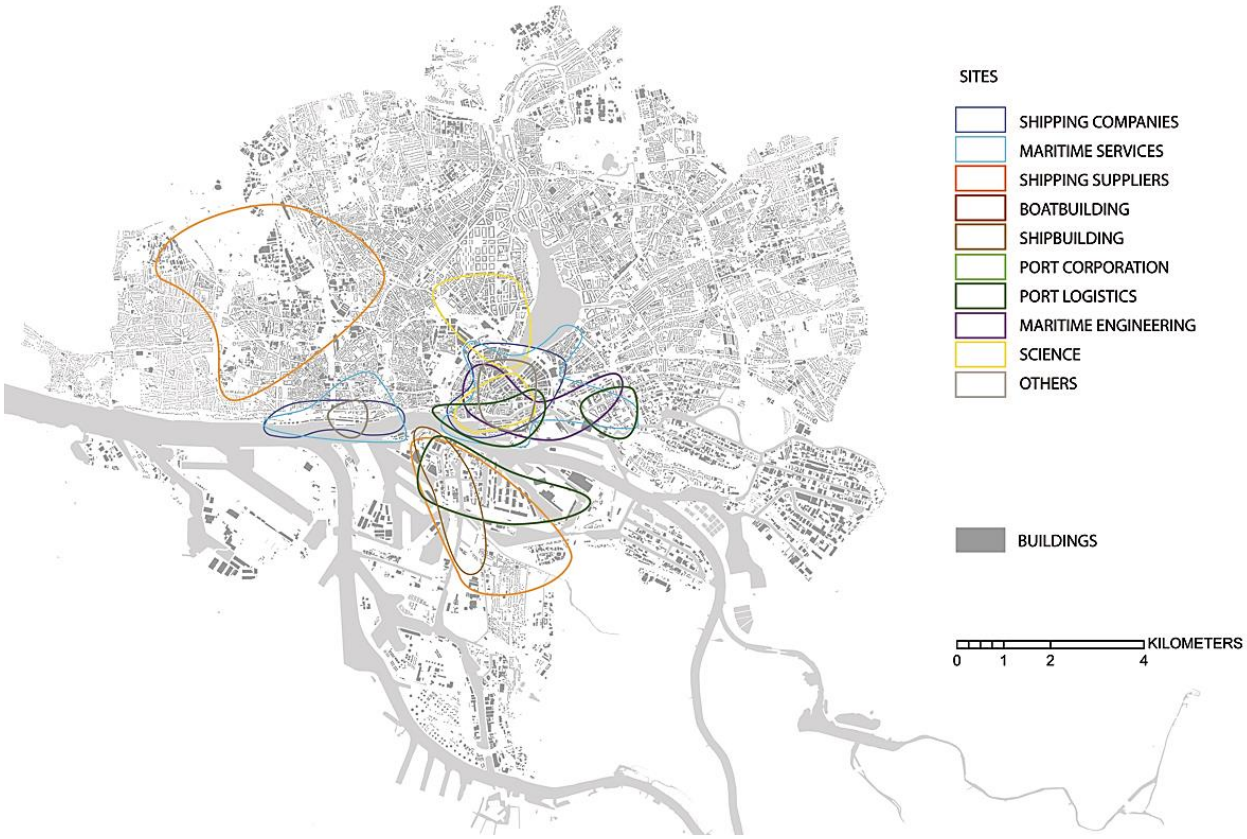

Figure 69
Clusters of corporate locations in the study area

The two variables, which are used for the analysis of the urban topology within the local study area are betweenness and reach. The data on building structure and primary and secondary roads is obtained from OpenStreetMap Databank[4]. The road network employed in the analysis is generated purposively for the Urban Network Analysis Application in ArcGIS and was supplemented with Google Earth data as needed. The betweenness value of a destination captures the fraction of shortest paths between pairs of other sites in the network that pass by a site (Freeman, 1977). In Figure 70, location *L1* on the left features a higher betweenness value than *L2* on the right. At the local scale, it is therefore an indicator as to how much passing traffic it will receive, when actors are on their way from origins to destinations within the study area. In the case of actors in the maritime economy, which are not necessarily dependent on footfall, it constitutes a measure of visibility and representation within the urban environment.

[4] http://download.geofabrik.de/europe/germany/hamburg.html; accessed 11.01.2014

Figure 70
High (L1) and low (L2) illustrations of the betweenness measures of locations

The reach value of a destination is determined by the number of destinations available within a certain radius. In Figure 71, the location *L1* on the left has a higher reach value in a radius r than the location *L2* on the right. When considering the sites of all other actors, this is due to the number of network destinations in its vicinity. When considering the urban fabric in its entirety, this is due to the density of buildings or urban destinations in its vicinity

Figure 71
High (L1) and low (L2) illustrations of the reach measures of locations

Previous morphological studies of urban form suggest that the spatial characteristics of buildings, parcels and their immediate surroundings could influence the suitability of a location for particular activities (Hillier, 1996b). From a relational perspective, siting choice determines the proximity, visibility and accessibility of actors for existing and potential business partners and other urban actors.

D.3.3. Spatial relations among actors of the maritime economy

The spatial organisation of the maritime economy at super-regional and regional scale level has been discussed in sections one and two of this chapter. In order to understand the principles of spatial organisation locally, this section examines the scale of the urban context of Hamburg. An overview over the local context of Hamburg is provided in Figure 83ff of Appendix F.11. The study area contains 127 locations in the maritime economy and other locations, which are places facilitating temporary proximity or education and professional devel-

opment or both, and are therefore additional destinations on journeys undertaken as part of the activities in the maritime economy. Based on the interviews, these are summarized in Figure 72.

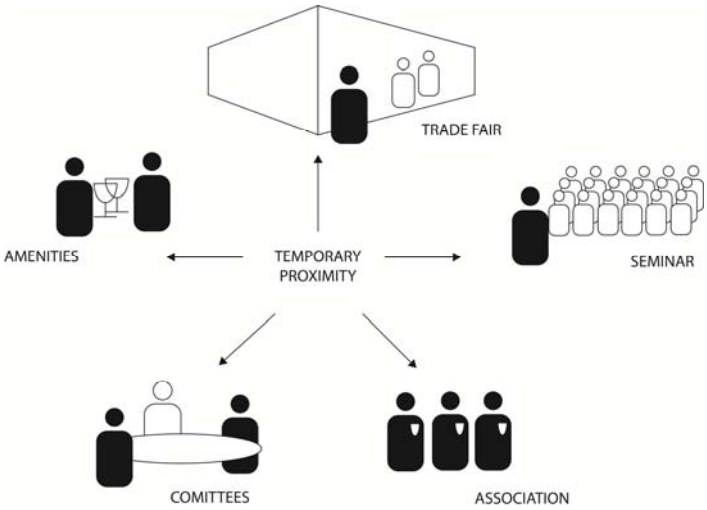

Figure 72
Places found to facilitate temporary proximity

This approach allows for each site's location in our case study area to be characterized along two types of indicators. The first analysis measures the ease with which a building can be accessed from surrounding locations in the street network employing the reach measure. The second estimates the probable frequencies of passersby at each building using the betweenness measure. Lastly, the apparent patterns of corporate siting are captured. In this case, our aim is not to quantify the ease with which a location is accessed by visitors or passersby from other locations in the network, but rather to capture the topology of the destinations in the context of the network.

In the first step of the analysis, the UNA betweenness measure is used to capture the potential of a location to be passed on route to other destinations, which could be partners within the maritime economy or other relevant destinations. The expected outcome is a measure of the likelihood of a location being reached in an unplanned trip, and the visibility a destination has in the context of the maritime activities, as its exposure by means of the occupied building is greater. In order to capture the entire study area and without making further assumptions as regards travel mode or sub networks, an infinitive radius has been chosen.

Figure 73
Betweenness of sites, radius N=∞

The betweenness scale is chosen as relative to the average betweenness value of all destinations in order to allow comparability to other urban contexts, although time and resource restrictions did not allow for these to be included in this case study. Shipping companies are on average the destinations with the highest betweenness values in this analysis. Their locations on the Elbufer Altona, Hafencity and in the Altstadt feature high centrality within the context of locations overall. As the banks of the river Elbe and the edge of the Alster are prestigious locations and major urban axes, namely - Elbchaussee, Palmaille and Baumwall run along the water - the sites are most likely to be passed on journeys between other destinations.

The literature on innovation suggests that unplanned face-to-face interactions critically affect the potential for knowledge exchange between actors (Faulconbridge, 2007; Gertler, 1995). As each location is considered as a potential space for knowledge exchange within the organization, the immediate environment is considered a potential space for knowledge exchange within and beyond the organization, especially when the location is embedded within a dense urban environment (Katz and Wagner, 2014). Existing research into travel modes and the walkability of neighborhoods stresses the relevance of topology for the distances in reach. Mixed land use, improved street connectivity and higher densities of destinations are found to support the exploration of surrounding areas by foot (Rodríguez and Joo, 2004). The trip length varies across studies depending on speed (Bornstein and Bornstein, 1976), attractiveness (Zacharias, 2001) and purpose of the trip (Geddes and Vaughan, 2014). Based on a trip length of unplanned encounter of 5 minutes and a 20 minute radius towards a predefined destination, the two radiuses of 600m and 1800m have been chosen. This is particularly important as the data may not capture all destinations and the analysis may reveal further sites, which feature certain characteristics in terms of topology. Therefore, the search radius of 1800m also caters for the inclusion of yet undefined sites, which are in equal reach of locations included in the dataset, as they are situated within overlapping radii of pedestrian reach. This principle is schematically described in Figure 65.

Figure 74
Illustration of potential sites in equal reach from two existing sites

The reach measure employed rates locations with regard to the ability to access other locations in the maritime economy within the 600m and 1800m radius. The computation with the 600m radius identifies locations in the Altstadt as advantaged over all other parts of the agglomeration, as the number of destinations is highest due to the density of sites. The graph in Figure 75 demarcates these sites starkly. Locations in the Hafencity or Elbufer Altona are already out of reach for those firms situated in the Altstadt as the distance is greater than 600m in most cases. The highest reach values reside with up to 100 destinations within a 600m radius apply to shipping companies and maritime services as well as other economic actors, and education and professional development locations. In some instances, these sites double up as locations, which foster temporary proximity.

The same analysis with a reach radius of 1800m offers different results, as illustrated in Figure 76. The actors situated in the Altstadt are now within reach of the locations, which are peripheral to the Altstadt, such as the Hafencity and Ring. However, locations further along the Elbe do not benefit from this increased reach radius. Maritime service firms still capture the highest reach values, with up to other 254 locations within the 1800m radius. Taking the average reach by activity field, maritime services are on average the best positioned actors to reach a high number of destinations within the 1800m radius depicted in Figure 76.

The relative location of sites, occupied by actors in the maritime economy, offers insight into the spatial preferences and advantages of the actors across the maritime economy network. The aggregated results allow conclusions in regards to spatial patterns of organization of this particular network. As largely office based activities their siting is independent of narrowly defined land use classes and is attracted to urban locations, which feature accessibility to complementary business partners, visibility and functional complementarity. The interviews have confirmed the diversity of approaches organizations take to location choice, depending on their corporate strategy and culture. Traditional local shipping companies are for instance absent in the Hafencity. This was attributed to the non-availability of space at the point when major relocations were undertaken. The Elbufer Altona was developed between 2001-2005, whereass the first section of the Hafencity was completed in 2009. Moreover, the development faces polarized views in the local community. However, the Hafencity appears to attract international actors, the siting of which propels the international reputation and attractiveness of the area.

In general terms the local analysis confirms the findings on other scale levels in that the actors of the maritime economy have differentiated priorities which relate to the exchange processes they are engaged in.

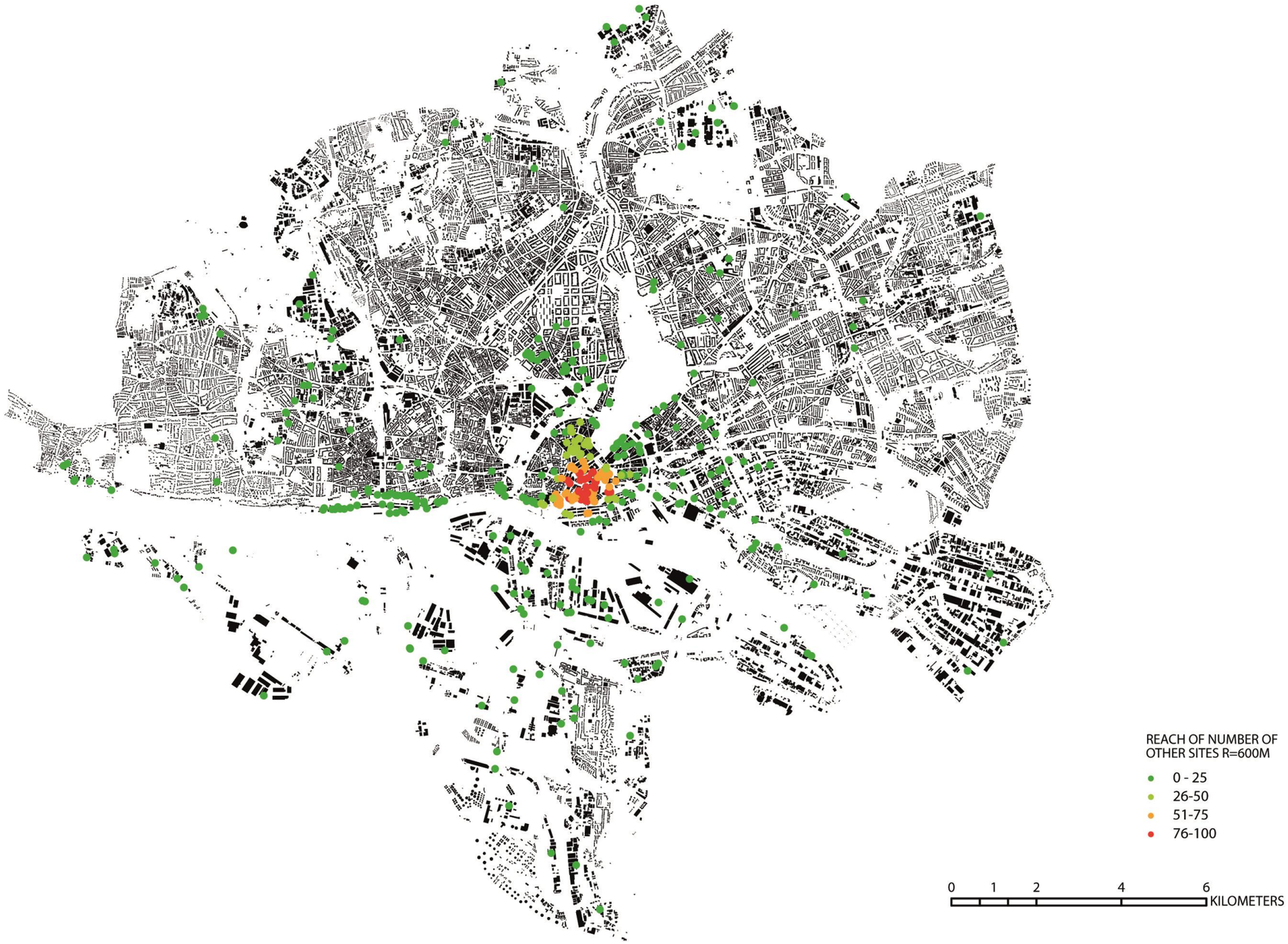

Figure 75
Reach of sites, radius N=600m

Figure 76
Reach of sites, radius N=1800m

However, the featured sites are also embedded in the wider urban topology, which is the result of multiple coexisting development logics. The following section seeks to explore the topology of sites in the maritime economy and other urban sites contained in the study area.

D.3.4. Spatial relations of the maritime actors in urban context

Fundamentally, reach-to-built-volume in the built environment is affected by three distinct qualities of urban form. First, the measure can increase if the destination buildings that the index is computed to are larger in volume. If neighboring buildings in a ten-minute walking range around a location of interest have either larger footprints or are taller in height, keeping the spacing of buildings and the geometry of the street network constant, then the reach measure of the location rises. Second, if the number of neighboring buildings rises (that is, if a higher number of buildings per linear length of street segments exists, keeping building sizes and the geometry of the street network constant), then the reach-to-built-volume also rises. And third, if the density of buildings per linear length of streets is maintained, and the sizes of destination buildings constant, then the reach measure can also increase if a building has advantageous access to the street network. Corner parcels, for instance, have a higher reach-to-built-volume than middle parcels, all else being equal (Figure 70f). Each of these three variables — plot size, linear density of buildings, and street network geometry — affect the outcome of the reach measure.

The interviews conducted point towards a significant impact of the wider urban context on the activities of the maritime economy.

> *[…] We are attractive as a city, which means we currently have no difficulties in filling vacancies. This is something we need to keep up, as it is a critical factor for our success that it is enjoyable to live here and that there is also affordable accommodation. People do earn a lot of money, but it is quality of life that ensures our success (port logistics firm, Hamburg, Ref 15/008)*

However, this is not necessarily suggesting causality, as another actor states:

> *I think the entire question of attractiveness and economic location factors is secondary. The decisive point is that we are dealing with a pre-existing concentration in Hamburg, which is pre-existing and that the head offices were already partly in place. Where this kind of critical mass pre-exists, it exerts an enormous gravitational force. (research institute, Bremen, Ref 04/011)*

Employing the betweenness measure on all buildings contained within the study area reveals the buildings along main arteries as the most exposed to passing by traffic. However, the graph depicted in Figure 78 shows no obvious correlation between sites in the maritime economy and those with the highest betweenness values in the overall urban network of sites. Transferring the value relating to the building in the urban context onto the actor who resides therein, makes it possible to rank the actors in terms of their relational accessibility advantage in the overall urban context. The aggregated result across activity fields in Figure

77 displays a hierarchy of urban embeddedness, with the highest average value for event locations, other economic actors and shipping companies.

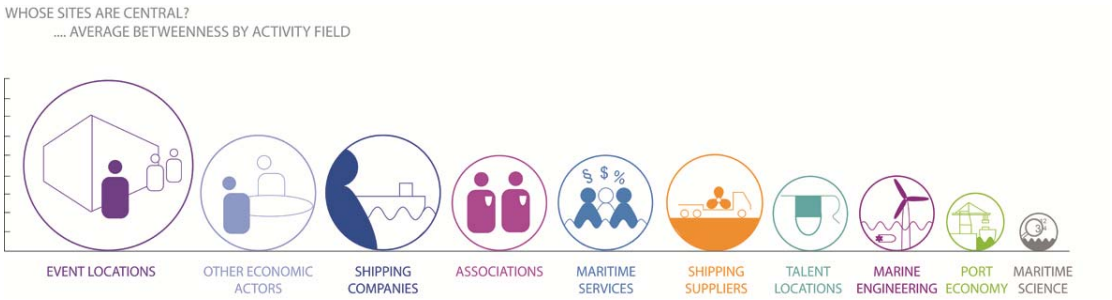

Figure 77
Hierarchy of average betweenness values in urban setting by activity field

It is worth noting that maritime science, port economy, marine engineering actors and talent locations are at the tail end of the hierarchy and are less embedded within the urban context than other economic actors and shipping companies, port corporations, maritime services and shipping suppliers. Most notably, other actors are associations and unions, which traditionally exert a strong regulatory influence on the maritime community as detected in the coding analysis of the interviews depicted in Figure 50.

The reach measure in the urban context as a whole allows us to measure the granulty of the surrounding urban environment, as the values are lower in zones which have larger plot sizes and more space in-between individual sites. The graph in Figure 79 reveals that the majority of sites are situated in zones of medium granulty, with a reach of 200-400 urban sites within a 600m distance. The granulty drops significantly in zones south of the river Elbe.

The urban areas with the highest reach values to urban destinations are the city quarters of Altona and St. Pauli. Within the data set, maritime science actors, shipping companies and other economic actors including associations and public institutions are found to be sited in relatively dense urban areas. These are followed by marine engineering and maritime services actors. The interpretation of this finding needs to take the size of buildings into account, with footprints of commercial units generally being larger than residential units. Moreover, the field of activity in maritime services is heterogeneous in terms of types of knowledge exchange processes the actors engage in. Lastly, universities, public institutions and associations are less likely to re-locate and hence have historic advantages in that they occupy some of the most prominent urban sites.

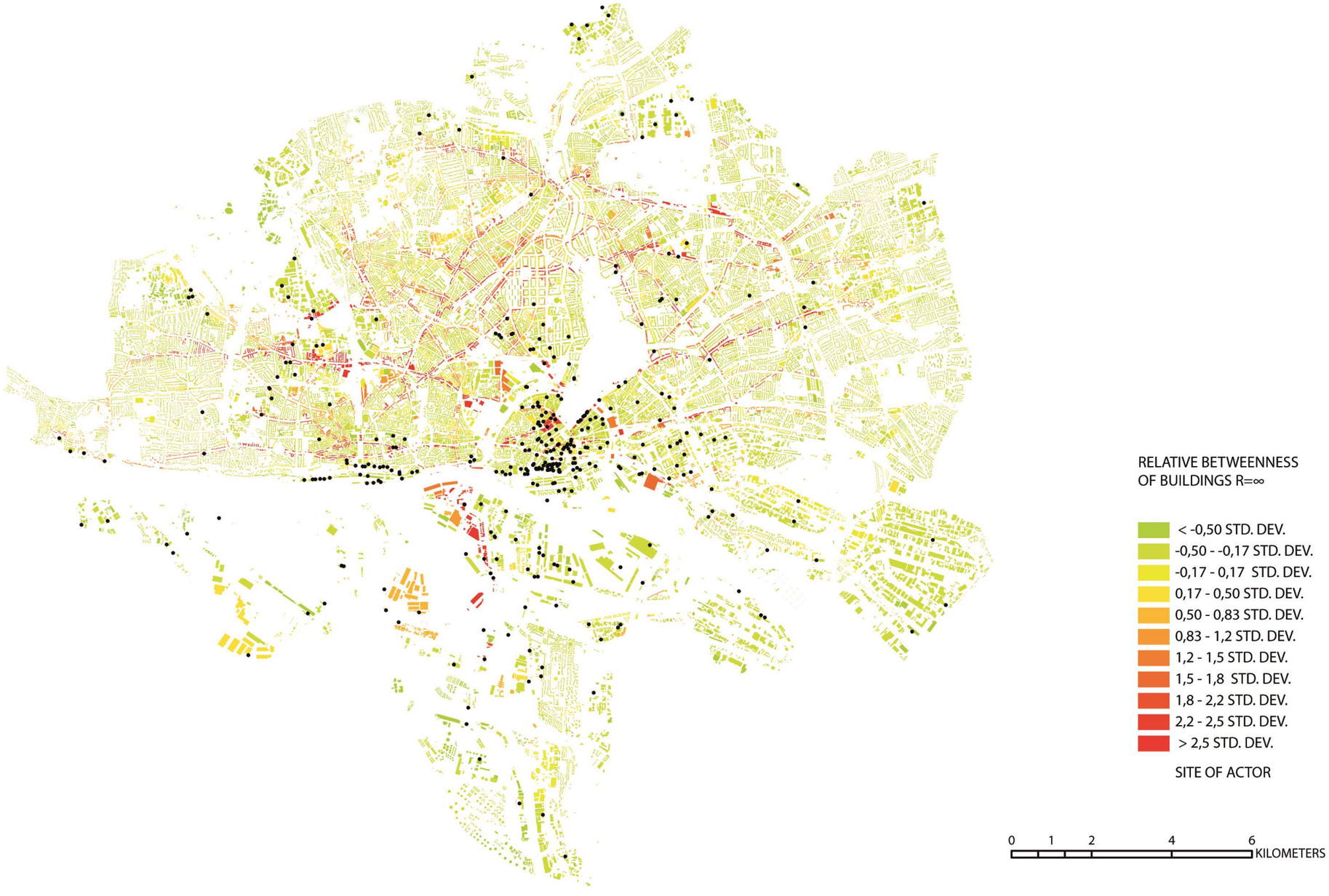

Figure 78
Betweenness of all buildings, Radius N=∞

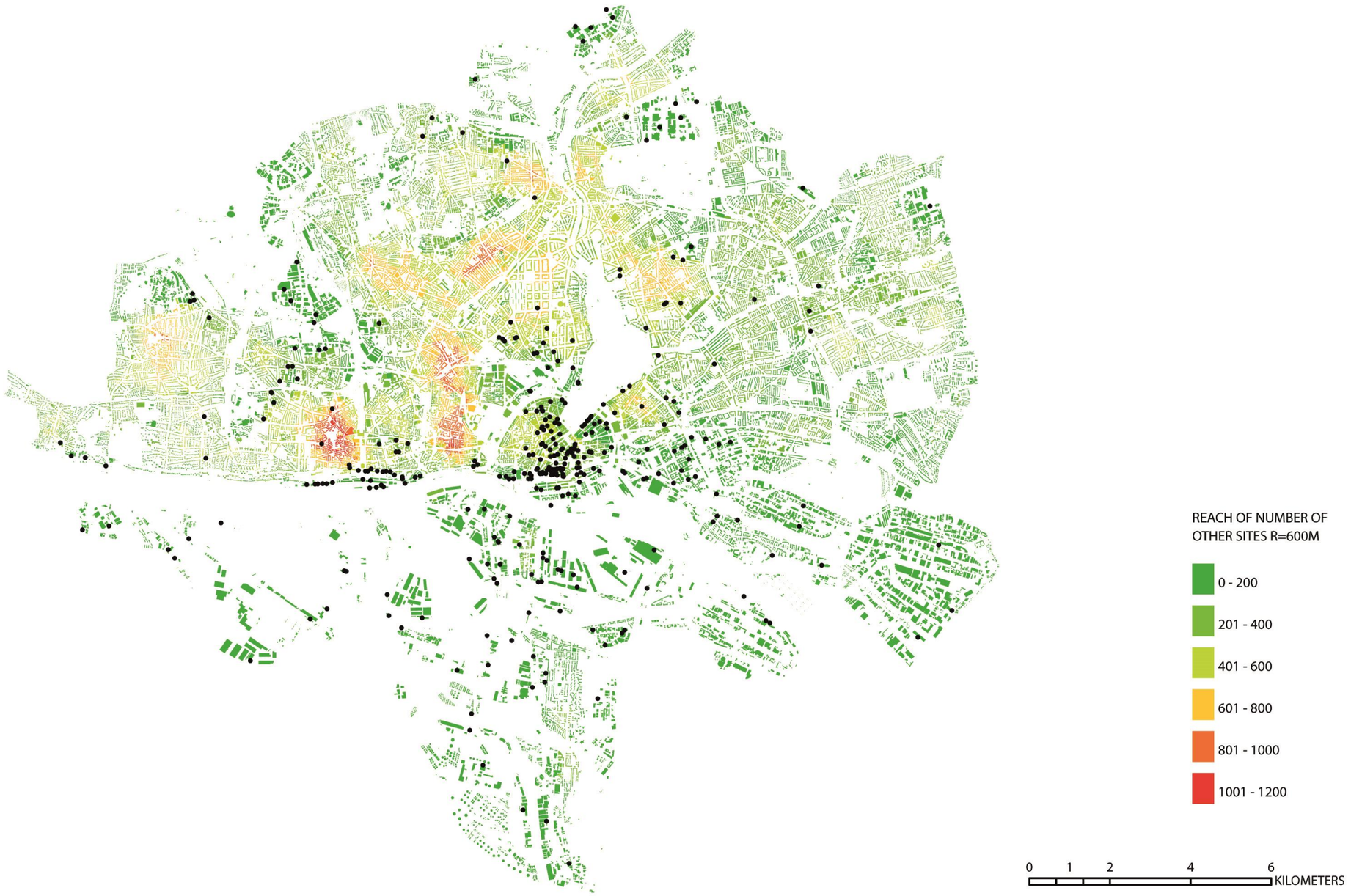

Figure 79
Reach of urban sites, radius N=600m

The empirical findings presented are transcending the super-regional, regional and local scale and map the topology of the port-city interface from three distinct perspectives, which reveal the spatial logic of the economic exchange processes and places of encounter. The space of the port-city interface is therefore triangulated from the perceived relevant relations, the lived network of collaboration, and the spatial form conceived in the topology of the built environment. Empirically, it draws on existing approaches in the area of study and focuses their application on the cross-scalar, relational approach, which is integral to this work. The subsequent conclusion provides a summary of the key findings and lays the basis for the discussion in the subsequent section.

E. Conclusion

The conceptualization of the maritime economy as an innovation system enriches the discussion of technological and structural change, and focuses it on those instances where the port and city retain synergies functionally and spatially. The transcendence of the sectors transportation and storage, manufacturing and services implies that actors which draw on knowledge as a key resource, and actors relying on physical labour and land interact, with production factors shifting gradually between these poles. In those parts of the maritime economy, where a strong physical relation and interdependence with port facilities remains the critical factor for location choice, the topology revolves around these hubs. Other actors benefit from distinctly urban locations, which enable them to take advantage of information flows, quality of life and specialized partners. The overall spatial development is intertwined with the evolution of corporate and transportation networks on the land- and seaside, and thus benefits from the trans-scalar context. The current industrial development is not merely a trend away from the traditional maritime trade and the manufacturing of vessels, but also a qualitative change within the overall economy in so far as knowledge intensive processes are intervowen with material flows. New actors have developed their competencies and oriented themselves towards the modern maritime economy. This, particularly, holds true for service firms, as they provide services not only for the maritime economy but also for other subsystems, such as marine engineering.

The analysis shows three important findings for the maritime economy and its impact on spatial restructuring. Firstly, the network of the maritime economy is predominantly held together by actors in the maritime services, shipbuilders and research institutions. Thus, the network centres on advanced producer services, manufacturing and research institutions involved in knowledge exchange processes. It involves transaction, high-tech and information-oriented exchange which requires mediation between tacit and codified knowledge forms on a continuous basis. Shipping companies have particularly high betweenness centralities and act as bridging actors between the fields of logistics and transportation, vessel development and construction, and development of components.

Secondly, conceiving knowledge as an interactive process, in which transaction, transformation, high-tech and information processes are carried out, informs the interpretation of the findings relating to cognitive and spatial proximity. Whereas spatial proximity is still crucial for experienced based learning, cognitive proximity becomes even more crucial in the context of globalization, since actors are able to expand their absorptive capacity beyond their immediate spatial reach. This interplay is important for the sustainable development of the maritime economy in a regionalized and globalized trading environment. The empirical results reveal that the maritime economy revolves around certain knowledge bases and the specific cognitive proximity between these actors. A common sense of understanding and a shared language drives specialization in engineering and high-tech activities with strong

tendencies towards local clustering of first tier suppliers locally. Maritime services, however, spread their networks in a regional spatial range.

Thirdly, reflecting these findings with regard to the urban system in the northern part of Germany, three constitutive elements can be identified. The first one is a centralization of maritime services in the main cities, particularly in Hamburg. These services are assumed to be attracted to enhanced urban-based opportunities for face-to-face contact and greater accessibility for personnel to national and global partners. Furthermore, these services are partly provided by consultants who equally serve other industries. Secondly, certain activities in manufacturing, such as shipbuilding and ship suppliers are concentrated in remote areas along the Ems axis. These actors strongly depend on the availability of highly qualified personnel. Since these actors are located in less dense areas, geographical proximity seems to be less important for enabling knowledge spillover and in some instances supports the more long term orientation of these activities. However, geographical proximity between shipbuilders and their suppliers leads to localized supplier clusters. This is due to the necessity to lower the risk of delays in production or ad-hoc problem solving. Finally, as a third element of this urban system, gatekeepers such as shipping companies and research institutions emerge as actors connecting the production part and the service oriented activities of the maritime economy functionally and spatially.

The ongoing structural change has induced changes in the power and control structures of the maritime economy and thereby interlinks spatial development strategies in Germany with the globally operating system in the maritime industry. This points towards the need for an integrated spatial policy since the re-organization of economic networks is strongly linked to a relocation of activities in the maritime economy, and the potential for the alignment of private and public location strategies. The merger of the shipping companies Germanische Lloyd and the Norwegian competitor DNV is an example of such a change. The headquarters of the DNV GL Group is located in Norway, whereas its ship classification activities remain in Hamburg. Similarly, the planned merger of Hapag Lloyd and Hamburg Süd could change the current situation as it aims to establish a competitive logistic enterprise in terms of size and market shares. The main shareholders in Hapag Lloyd are the City of Hamburg, the logistics provider, Kühne & Nagel, and the travel agency, TUI. The debate on the floatation on the stock market of this new enterprise is proof that the maritime economy in Germany faces competition from other powerful global actors, such as Maersk, MSC, or CMA CGM. Besides this ongoing reorganization of corporate structures, public-private initiatives in education contribute to the qualification of the maritime economy as an innovation system. The Kühne Logistics University in Hamburg was established in the year 2003 as a collaboration between the Technische Universität Hamburg and the Kühne foundation. The studies in the context of logistics and management aim to secure the provision of young human capital in Hamburg (Bentlage et al., 2014).

This study has limitations. Further research is required to triangulate these findings with more qualitative methods in the context of the maritime industry. In addition, the specific role of shipping companies is worth exploring, as they are situated at the intersection of

manufacturing and transport-related value added processes. Access to interview partners in this area was limited. Furthermore, it would be worth applying the chosen methodology to another industrial cluster in order to establish in how far the findings with regard to the production of industrial spaces are transferable. Lastly, the existence and typology of distinct patterns of organisation within the maritime economy, which has been traced in this research, needs to be reflected with regard to the governance of value chains and territories. The limitations of time have not allowed for this to be included in the work presented. However, the findings allow for the following discussion on the port-city interface as an industrial space.

E.1. Discussion

The triangulation of research methods has provided a case study data base, with a number of findings on the local, regional and super-regional levels. Based on the theoretical background of this work, the following section discusses the findings in the context of the current debates and the theoretical framework.

E.1.1. Perceived space in the network of interactions

Economic networks have been studied intensively in the field of economic geography in order to ascertain the extent of proliferation of an increasingly deepening urban hierarchy (Sassen, 1991; Taylor, 2004) and new regional development models (Hall and Pain, 2006). The research presented in this thesis differs from the approach of other empirical studies in so far as it is based on actual, reported interaction for the purpose of innovation and professional development. Most of the empirical studies to date assume that belonging to an industrial cluster or multi-sited organization in itself results in knowledge exchange or that the presence of headquarters functions in itself creates interaction. The approach chosen is therefore truly relational as the primary data source is a survey containing interaction data.

Furthermore, the empirical research to date has focused on specific professional fields (law, advertising, architects) with a general bias towards the creative industries. As innovation increasingly occurs in inter-disciplinary areas of science and technology, the results are hardly transferable owing to the heterogeneity of knowledge bases and interaction processes within more complex industrial clusters. The results reveal distinct subsystems of knowledge transaction within the maritime economy, which hinge on the value chain relations.

From a functional perspective, the findings confirm the evolution of spatial specialization as suggested by Hall and Pain, and more specifically, Ducruet, in the positing of multi-port-gateway regions. The relationship between scale and function however is not linear or nested but rather to a varying degree multi-scalar, as the maritime economy has distinct global, regional and local subsystems, which are intertwined with exchange processes.

In the context of industrial complexes, the current debate on the space of flows (Castells, 1999), ignores more traditional exchange processes or reduces them to transportation flows. In terms of siting, however, those material intensive operations are the most difficult to deal with on account of their complexity. Whereas law-firms and consultants can chose almost any office building, the real estate behind production and development facilities is less ubiquitous and the sunk costs comparably high as they are often purpose built, space intensive developments. The findings from a distance space point of view are therefore unique, as they must take material and immaterial flows into consideration. Strikingly, the subsystems of logistics and transportation, vessel development and construction and development of components extend to different geographic areas. The dual centre of systems of transaction and transformation based interaction is Hamburg. Within Hamburg, however, these distinct subsystems are yet again characterized by differentiated urban forms and relations.

The theoretical proposition of multi-scalar networks can be confirmed as along with the existence of subsystems in accordance with knowledge types, which are critical for innovation.

The network analysis has proven to be a valid analytic method in deciphering the complexities of the maritime economy based on a value-adding typology of transaction, transformation and information-oriented knowledge exchange processes. Location choice, however, is not only predominantly informed by analytic means as perceived in the network relations. The expert interviews provide insight into the lived space and spatial practices which influence the siting and appropriation of space of actors.

E.1.2. Lived space in the expert interviews

The space of the maritime actors is characterized by a multitude of cultural, physical and historical circumstances, which are not necessarily congruent with the network relations analysed above. This "ecology of circumstance" (Amin and Thrift, 2002:77) impacts heavily on spatial decisions as the "politics of place" (Massey, 2007:15) can ultimately shape local and global relations. In the case of the shipping companies in Hamburg, this has been affirmed by the physical agglomeration and orientation of other actors towards the former. Regardless of the existence of exchange relations between the shipping companies and the expert interviewee, they were referred to as key actors in the maritime economy. Furthermore, regulatory actors, such as the Germanische Lloyd and the Reeder Verband, are reported to exert a strong influence on traditional local actors, whose location decisions appear to be influenced by their relative location, whereas foreign actors lack that physical relatedness. Gertler's concept of different forms of proximity (Gertler, 2003) proves useful in that physical, cultural and organizational proximity are complementary when it comes to the establishment of exchange relationships on different scale level.

On the super-regional scale, the "constellations of mobility" (Cresswell, 2011) produce discontinuous spatial entities, which are held together by cultural and organizational proximities. From a functional perspective, temporary proximity substitutes the need for local colocation as long as accessibility is provided. This finding is critical for the understanding of the interrelationship between transaction based and transformation based exchange processes, as the latter are often space intensive operations, which do not allow for spatial closeness in the urban context. Based on the interviews, the importance of places as differentiated local constellations has been stressed with regard to the attraction of talents. From inside the organization, the siting governs access to partners, informal exchange and the labour market and thereby shapes performance beyond the local context. From outside the organization, the place attracts talent and provides identity within the globalized context. Recent corporate developments reflect these spatial ambitions within their conceived scope. This is an extension of Podolny's (Podolny, 2001) finding that networks provide the pipes and prisms of the market and renders places as contributors to the prismatic effect. The urban form, which Löw describes as being continuously reproduced by spacing and synthesis (Löw, 2001), is reflected in the topology of the relational network of sites.

E.1.3. Conceived space in urban form

Spatial development is driven by the decisions of a multitude of actors. The research presented focuses on location decisions of organizations seeking to optimize their economic processes, which involve the exchange of knowledge and material across the organization's

boundary. The literature on spatial development stresses the trend towards spatial fragmentation (Hesse, 2008) in the context of logistic operations and the removal of the urban rural divide (Sieverts, 1997) on the regional scale. The analysis of the super-regional and regional physical accessibility of sites is broadly in line with these trends. As the study focuses on multi-scalar relations, it contributes to the current debate by providing the empirical evidence of shifting relations depending on the system boundary. Functionally, the findings confirm the networked character of value-adding operations, which bear relevance to the maritime economy. In their current form, these are the result of planning and policy interventions as well as actor based decisions. Certain locations, such as research sites and port infrastructure, are subject to direct decision making by institutions and political actors. Other sites are shaped by planning policy and land use patterns, prior to individual location decisions. The development of mixed use urban schemes on land formerly occupied by port operations is therefore a precondition for the emergence of new proximities between new and traditional actors in the context of Hamburg. However, the availability of "loft spaces" (Baum and Christaanese, 2012), which can be appropriated for different uses has clear limitations, when it comes to production or research intensive operations, which require purpose built facilities. The resultant enclaves on a regional scale, can be considered as embedded in a larger "enabling" field (Koolhaas et al., 1995) as long as the accessibility is provided between locations when temporary proximity is required. The case of the maritime economy in northern Germany provides insight into the port-city interface which goes beyond the functional interdependence and improves the understanding of multi-scalar place specific processes. However, the case study is also highly specific and has certain limitations.

E.1.4. Specificity of the cases and limitations of the study

This thesis is composed of three parts, which seek to make a contribution to current research from both a theoretical and empirical angle. In the first part, a theoretical framework is constructed, which is distinctly interdisciplinary and seeks to overcome the divide between morphologically and functionally focused research in the area of study. The need for multi-scalar research on the port-city interface from a relational perspective is carved out of the current debates in urban studies, urban economics, and innovation studies. The literature and debates in these fields are too broad to be fully reflected in the scope of this work. The selected texts and studies are therefore chosen on the basis of conceptual complementarity in order to guide the research and support the interpretation of the findings.

This work centres on the impact of location decisions of firms. This is an area, which has gained prominence in recent studies in economic geography as a main driver of spatial development. It has to be said that the siting alone is not an adequate predictor of sustainable spatial development. Other factors, such as planning policy, availability of housing and attractive locations exert a strong influence on prosperous development. This research does not attempt to offer a holistic model, but rather focuses on relational siting as a prerequisite for and a result of economic exchange processes.

The triangulation of methods utilized throughout this research seeks to improve the validity of the results. Spatial development is considered to be a complex, socially embedded pro-

cess, which resides at the interface of social science and scientific research. The choice of methods has been guided by the research question, the specific theoretical framework as well as practical grounds. While the research methodology is case specific, it seeks to overcome the disciplinary divides in the field by offering a refined triangulated approach incorporating social network analysis, expert interviews and topology research, which may be transferred to other cases and contexts.

Accordingly, the research presented draws on data from a number of sources. Every effort has been made to validate the data used and eliminate flaws. It has to be acknowledged, however, that the data has limitations. The network data set on the maritime economy is derived from survey data, which was gathered between 2008-2010 by Nord/LB. Changes will have occurred within and subsequent to that period, which the research does not capture. The interviews were conducted in 2013 and their content therefore reflects a more recent state of affairs. However, the assumption is that spatial development processes are evolving at a pace which does not change fundamentally within five years. Lastly, the topological study relies on open source data on street and building layout, which needs to be used with caution for possible omissions and mistakes. The type of topological study this research employs is focused on the relational positioning, which renders the accuracy of detail less critical.

Finally, the findings presented are limited to the case study boundary and the geographic scope. While port cities across Europe face the impact of structural change and globalization, the northern German region is specific in a number of ways: firstly, the German federal system gives the state of Hamburg and the state of Bremen the opportunity to govern the key port-city interfaces. The coastline of Germany falls within five jurisdictions overall. On the negative side, the existence of five different political entities in the region makes cooperation and prioritization difficult and has led to a lack of alignment with regard to the spatial ambitions pursued. Secondly, the German economy has certain characteristics, which critically affect economic exchange processes as studied in this thesis. Hall and Soskice (Hall and Soskice, 2001) have described Germany as a coordinated market economy, which is characterized by the presence of cooperative systems between economic agents, specialized manufacturing and a high level of industrial organization in contrast to liberal market economies such as the US and the UK. Thirdly, German history, with the re-unification of east and west renders the constellation of actors and institutions within the maritime economy unique. It has to be noted that none of these factors have been researched as part of the case study, and that caution has to be applied in the interpretation of findings beyond northern Germany.

E.2. Results

The case study has revealed a number of findings, which are presented in Section D. In the following section a synopsis is presented, which refers back to the research framework and centres on the role of the maritime economy in sustaining the competitiveness of port cities. More specifically, the research question asks what the role of the built environment is in sustaining exchange processes across the activity fields of the maritime economy at different scale levels. In the first part of the research, the interactions are analysed from a functional perspective and connectivity patterns, urban hierarchies and localised systems of value chains are revealed, which informed further analysis. These quantitative findings are complemented by expert interviews, which have identified additional dimensions to the complex interplay between economic exchange processes and space. Lastly, the topological analysis has traced spatial configurations within which knowledge exchange in the maritime economy is embedded. The empirical findings in conjunction with the theoretical background provides the basis for answering the hypotheses.

E.2.1. Answering the hypotheses

The initial hypotheses have gained strength from their empirical and theoretical elaboration. Conclusions are presented on the basis of the findings and discussion provided in the previous chapter.

> *Hypothesis 1: If the material flows of goods and the immaterial flows of knowledge are intertwined, then there are places of encounter, which feature in both systems.*

The first hypothesis, can be confirmed with detailed findings with regard to the existence and nature of places at the intersections. The flows of knowledge and goods intersect on the regional scale. However, places of encounter are frequently imperceptible, as the sites of production and logistics involved in goods flows are enclaves with little visibility and footfall. However, the interviews have confirmed the intertwined nature of the knowledge and good flows on these sites. Furthermore, the network analysis has revealed distinct subsystems of knowledge exchange processes, namely transaction and transformation based, with the latter exhibiting a strong spatial correlation with good flows. As a result of the space intensive nature of production and logistics, these subsystems exhibit stronger functional polycentricity than transaction based operations. Although Hamburg stands out as a dual core for material goods and immaterial knowledge flows, there is a clear divide between the two on the local spatial level. The geographic disposition in Hamburg, with the modern port on the south banks of the river Elbe and the urban core on the north bank, makes the port-city interface highly conspicuous on the city skyline. Other dual centres, which feature in the network of goods flow and knowledge flow, do not have the strength of Hamburg in transaction-oriented exchange; they are, however, localized systems, with transformation-oriented goods and knowledge flows as in the case of Emden. The findings allow very limited insight into the evolution of these intersections. Nevertheless, certain conclusions can be drawn from the theoretical debate and the data on shipping companies.

Hypothesis 2: If the built environment is the coagulated product of processes of production and consumption, then changes are visible in form and structure which reflect organizational change.

In the case of shipping companies, the data collected over a number of years suggests an increasing concentration in Hamburg. Given the role of shipping companies as gatekeepers between the production of vessels and maritime trade, they emerge as key decision makers and opinion leaders at the port-city interface. As suggested by the literature, key actors are drawn towards urban centres as they rely on consultants and service providers to handle uncertainty. Moreover, they exert agglomeration forces themselves.

The reliance on staff mobility to facilitate knowledge exchange regionally and globally has emerged as a key finding from the case study. The road and airport infrastructure are stepping stones for the discontinuous spatial fields, which facilitate knowledge exchange processes. Cohesion is provided by organizational proximities, which have evolved under the influence of the globalization of vessel production and commissioning and new technological complexes in the case of marine engineering. The integration of port services and port logistics with turnkey operation solutions has led to integration along the material flow. The resultant geographic proximity or remoteness is found to be dependent on the type of knowledge exchange process.

Hypothesis 3: If the built and un-built environment catalyses processes of production and consumption, then successful urban areas feature distinct patterns of spatial organisation.

Overall, a polycentric spatial organisation can be empirically confirmed. The spatial specialization of ports is mirrored by spatially specialized nodes for maritime science and engineering and logistics. Not surprisingly, the latter occupy sites which feature high accessibility and betweenness. Transaction-oriented processes, however, seem to benefit disproportionally from geographic proximity and tend to cluster in proximity to other knowledge intensive services and key actors and decision makers. In such instances, location decisions are expected to be highly dependent on the availability of sites at any given time. The agglomeration effect in Hamburg as a global centre for advanced producer services is reinforced by its attractiveness as a diversified labour market and place to live. The analyses in this case study allow us to confirm the hypotheses set out at the beginning of the research. In terms of the wider implications, two areas arise as arenas for decision making, which may benefit from the presented results.

E.2.2. Corporate location strategies

Corporate location strategies have been studied extensively in the architectural and urban design literature and the literature on economic geography. However, changes in the way we work, supported by modern technology and the globalization of production and consumption have failed to eradicate local differences. The findings of this case study suggest the need for more interdisciplinary and multi-scalar research which unravels the relational complexities between agents and scales. In the context of the maritime economy, material

exchange processes and knowledge intensive processes emerge as intertwined across multiple scale levels. Location decisions are therefore assumed to depend heavily on value-adding activity as well as the strategy of knowledge acquisition deployed by the individual organization. If the firm relies heavily on the socialization of knowledge (Nonaka, 1994) as a source for competitive advantage, geographic proximity to multiple decision makers and institutions appears to be preferred. If the organization is engaged in medium to long terms alliances based on the externalization and internalization of knowledge, organizational proximity can substitute for permanent geographic proximity and allow for more remote location strategies. This mode of operation appears particularly suitable for production based value-adding activities, which are space intensive and encounter high investment in the case of relocation. Lastly, only a few actors in the sample appear to be independent of geographic proximity in the sense that their value-adding activity is purely based on the combination of explicit knowledge. In theory this may, however, be the case where large integrated multi-disciplinary organizations persist. The research presented does not provide insight into intra-firm networks of multi-site organizations. Based on previous research (Lüthi, 2011) it has to be acknowledged that multi-site strategies may overcome the spatial conflict between being close to the material processes and benefitting from urban advantages by providing organizational coherence across multiple sites. Lastly, this research has not generated sufficient insight into the restrictions on optimization of corporate sites imposed by policy makers and land owners to be conclusive in this respect. Other research has highlighted how planning policy as well as the availability and cost of land govern corporate location decisions.

E.2.3. Future research

This case study has drawn on empirical material, which was gathered and analysed in accordance with the aim of the study. In the course of the research, additional lines of enquiry have emerged, which – if pursued further – would have potentially altered the findings and results. The limitations of scope and time have not allowed for additional facets to be explored and will therefore be left to future research. In particular these areas are:

The triangulation of methods in this case study has proven a valid methodological concept, which could be fruitfully employed if other networks and actors are included. However, the methods employed to seek insight into the role of urban form need to be further developed beyond the urban topology in order to guide urban design and planning studies in practice.

Moreover, the visualization techniques used in this work have only evolved over recent years and need to be further refined in order to allow effective communication across disciplinary boundaries. The availability of spatial data and the ability to reduce the complexity of the data hinges on effective visualization techniques and software, and the work makes a contribution in that respect. As professionals in the field, architects and urban designers could expand their scope as brokers at the interface of analytic and spatial knowledge.

Research in urban economics needs actively acknowledge the multi-scalar relational nature of processes driving spatial advantage. The viability of the categories and patterns employed and identified needs to be tested in other industrial complexes and geographic scopes.

Accessibility has emerged as a key functional factor of spatial development at the port-city interface beyond the transportation of goods. The impact of infrastructures such as seaports and hub-airports so far has been insufficiently integrated with the multi-scalar evolution of economic networks. Which interfaces in value chain systems and global-local networks benefit most from accessibility? In which cases can a remote location be as beneficial as a central one, and what are the consequences for urban design and planning? Further research is required into these areas in order to derive answers.

Furthermore, the evolution of spatial constellations and patterns can only be addressed in research over time. The pace of industrial change over the last 50 years has been unprecedented and resultant changes in urban form are likely to take many years. The empirical research presented in this thesis is largely synchronic. Future research would benefit from diachronic studies including multiple time sections in order to reveal trends and changes in relations.

E.2.4. Policy implications

This thesis takes an analytical approach to the interdependence of specific economic exchange processes and spatial interaction. The results point towards complex multi-scalar systems, which govern knowledge exchange and the propensity to innovate in the case of the maritime economy in northern Germany. The implications for policy are therefore twofold: firstly, current conceptions of urban development as driven by advanced producer services fail to address the differentiation within these value-adding activities. The spatial conflict between being close to the material flow and the urban buzz needs to be addressed by regional concepts which capture both material and knowledge flows. Secondly, the role of key actors from the private and public sectors in driving the location decisions of others needs to be acknowledged and governed. Attracting and retaining the right type of actor appears critical for sustainable spatial development of port-cities which have ambitions as modern maritime places on every scale level.

F. Appendices

F.1. Survey Maritime Economy Germany

Fragebogen zum Gutachten zur Stärkung der Maritimen Wirtschaft Niedersachsen und Weiterentwicklung gemeinsamer Projekte und maritimer Cluster mit anderen Küstenländern

Die Maritime Wirtschaft ist heute stärker denn je ein bedeutender Impulsgeber und Wachstumstreiber für Wertschöpfung und Beschäftigung in Niedersachsen. Neben der Schiffbauindustrie, der Reederei- und Hafenwirtschaft haben sich technologieintensive Branchen wie die Offshore-Windenergie, die Meerestechnik oder die Blaue Biotechnologie an niedersächsischen Standorten etabliert.

Mit dieser Befragung soll die gesamte Bandbreite der Maritimen Wirtschaft erfasst werden. Die niedersächsische Maritime Wirtschaft ist in ein wettbewerbsfähiges, eng verzahntes maritimes Netzwerk des norddeutschen Küstenraumes eingebunden. Zur Untersuchung der regionalen und überregionalen Netzwerkstrukturen stehen daher neben einer Bestandsaufnahme und einer Potenzialanalyse die Kooperationsbeziehungen der maritimen Unternehmen und Betriebe im Mittelpunkt. Aus diesem Grund möchten wir Sie nach Ihren Kooperationspartnern in den verschiedenen maritimen Branchen sowie im Wissenschafts- und Bildungssektor befragen.

Für die Auswertung Ihrer Angaben ist bedeutsam, ob es sich dabei um folgende Arten der Zusammenarbeit handelt:

- langfristig strategische Geschäftsbeziehungen (z.B. Forschungs- und Entwicklungspartnerschaften, langfristige Lieferverträge, langfristige Dienstleistungsverträge),
- fallweise Kooperation mit Geschäftspartnern, auf die Sie regelmäßig zurückgreifen (z.B. Einzel-Aufträge für spezifische Problemlösungen), oder um
- Ausbildungskooperationen

Bitte beantworten Sie die folgenden Fragen nur für das Unternehmen bzw. den Betrieb an Ihrem Standort.

Ihre Angaben werden selbstverständlich vertraulich behandelt.

Die Auswertung erfolgt in anonymisierter Darstellungsweise.

Alternativ können Sie den Fragebogen im Internet unter

www.nordlb.de/maritim-niedersachsen ausfüllen!

1) Kontaktdaten		
	Name des Unternehmens/ Betriebs:	
	Ansprechpartner:	Funktion:
	Straße:	PLZ, Ort:
	Tel. Nr.:	E-Mail:

2) Unternehmensdaten	
a)	**In welchem Jahr wurde Ihr Unternehmen / Betrieb gegründet?** ……
b)	**In welchem Bereich der Maritimen Wirtschaft sind Sie schwerpunktmäßig tätig?** (Bitte ankreuzen) ❑ Schiffbau ❑ Schiffbauzulieferindustrie ❑ Meerestechnik ❑ Reedereiwirtschaft ❑ Maritime Dienstleistungen ❑ Hafenwirtschaft / -logistik ❑ Fischereiwirtschaft ❑ sonstige, und zwar: ……
c)	**Welches sind derzeit Ihre drei umsatzstärksten Produkte / Dienstleistungen?** 1. …… 2. …… 3. ……
d)	**Wie hoch war Ihre Exportquote (Anteil der Exporte am Umsatz) im Jahr 2007?** Sie beträgt …… % des Umsatzes.
e)	**Bitte schätzen Sie die regionale Verteilung Ihrer Umsätze ein: Wie viel Prozent Ihrer Umsätze erzielen Sie in** (Summe = 100%) ….. % Niedersachsen ….. % im übrigen Bundesgebiet ….. % Frankreich ….. % Großbritannien ….. % Niederlande ….. % Skandinavien ….. % Osteuropa ohne Russland ….. % Russland ….. % übriges Europa ….. % Nordamerika ….. % Asien ….. % Übriges Ausland
f)	**Wie hat sich Ihr Umsatz für den Zeitraum von 2004 bis 2007 entwickelt? Er ist insgesamt** ❑ gestiegen, um etwa …… % ❑ in etwa gleich geblieben ❑ zurückgegangen, um etwa …… %

2

g)	**Welche Umsatzentwicklung erwarten Sie für den Zeitraum von 2008 bis 2011? Der Umsatz wird bis dahin insgesamt** ❑ steigen, um etwa …… % ❑ in etwa gleich bleiben ❑ zurückgehen, um etwa …… %
3) Beschäftigung	
a)	**Wie viele Mitarbeiter waren in Ihrem Unternehmen / Betrieb am Standort im Jahr 2007 insgesamt beschäftigt?** Bitte geben Sie den Jahresdurchschnitt an. ……
b)	**Bitte nennen Sie uns die Anzahl Ihrer Mitarbeiter (es zählt jeweils nur der <u>höchste</u> Bildungsabschluss; ggf. Schätzung):** …… ohne eine abgeschlossene Berufsausbildung …… mit einer abgeschlossenen Berufsausbildung …… mit einem Abschluss an einer Hochschule oder Fachhochschule
c)	**Wie hat sich die Beschäftigung in Ihrem Unternehmen für den Zeitraum von 2004 bis 2007 entwickelt? Sie ist seitdem insgesamt** ❑ gestiegen, um etwa …… Mitarbeiter ❑ in etwa gleich geblieben ❑ zurückgegangen, um etwa …… Mitarbeiter
d)	**Welche Entwicklung bei den Beschäftigten erwarten Sie für den Zeitraum von 2008 bis 2011? Die Mitarbeiterzahl wird bis dahin insgesamt** ❑ steigen, um etwa …… Mitarbeiter ❑ in etwa gleich bleiben ❑ zurückgehen, um etwa …… Mitarbeiter
4) Aus- und Weiterbildung	
a)	**Bildet Ihr Unternehmen Fachkräfte aus?** ❑ Ja ❑ Nein **Wenn ja, wie viele?** Ca. …… Personen befanden sich 2007 in der Ausbildung.
	Führen Sie in Ihrem Unternehmen Weiterbildungsmaßnahmen durch? ❑ Ja, überwiegend unternehmensintern ❑ Ja, überwiegend über externe Bildungseinrichtungen ❑ Nein
b)	**Besteht aus Sicht Ihres Unternehmens derzeit ein zusätzlicher Bedarf bei der Weiterbildung Ihrer Mitarbeiter?** ❑ Ja ❑ Nein **Wenn ja, in welchen der folgenden Bereiche besteht ein Weiterbildungsbedarf?** ❑ Berufsfachliche Kenntnisse ❑ Sprachkenntnisse ❑ Betriebswirtschaftliche Kenntnisse ❑ anderer Weiterbildungsbedarf, und zwar: ❑ IT & e-commerce ……

5) Kooperationsbeziehungen der Maritimen Betriebe – Netzwerkanalyse				
	❑ Unser Betrieb/ Unternehmen verfügt über keinerlei Kooperationsbeziehungen zu Betrieben, Bildungs- und Forschungseinrichtungen (⇨ Wenn dies zutrifft, bitte weiter mit Frage 6)			
a)	**Kooperationen mit Unternehmen und Betrieben in den Bereichen Schiffbau, Schiffswartung oder Schiffsreparatur (z. B. Werftbetriebe, industrielle Zulieferer)** Bitte nennen Sie uns Ihre 10 wichtigsten betrieblichen Kooperationspartner in den Bereichen Schiffbau, Schiffswartung oder -reparatur (regional und überregional bzw. international) und die Art der Kooperation.			
	Name und Standortadresse des Unternehmens bzw. Betriebs PLZ, Ortsname, Land (bei Partnern im Ausland) (Bei Geheimhaltung nur die Branche und den Standort angeben)	**Art der Kooperation** (bitte ankreuzen, Mehrfachnennungen mögl.)		
		Langfristige strategische Kooperation[1]	Punktuelle Kooperation zur Bearbeitung von Einzelthemen[2]	Kooperation im Bereich Ausbildung/ Qualifizierung
1		❑	❑	❑
2		❑	❑	❑
3		❑	❑	❑
4		❑	❑	❑
5		❑	❑	❑
6		❑	❑	❑
7		❑	❑	❑
8		❑	❑	❑
9		❑	❑	❑
10		❑	❑	❑

[1] Langfristige (mehrjährige) und auf die Erzielung nachhaltiger Wettbewerbsvorteile ausgerichtete Kooperationen
[2] Fallweise Kooperation mit Geschäftspartnern, auf die Sie regelmäßig zurückgreifen

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b)	**Kooperationen mit Unternehmen und Betrieben der <u>Reedereiwirtschaft</u>** Bitte nennen Sie uns Ihre 10 wichtigsten <u>betrieblichen Kooperationspartner</u> im Bereich der Reedereiwirtschaft (regional und überregional bzw. international) und die Art der Kooperation.			
	Name und Standortadresse des Unternehmens bzw. Betriebs PLZ, Ortsname, Land (bei Partnern im Ausland) (Bei Geheimhaltung nur die Branche und den Standort angeben)	**Art der Kooperation** (bitte ankreuzen, Mehrfachnennungen mögl.)		
		Langfristige strategische Kooperation	Punktuelle Kooperation zur Bearbeitung von Einzelthemen	Kooperation im Bereich Ausbildung/ Qualifizierung
1		❑	❑	❑
2		❑	❑	❑
3		❑	❑	❑
4		❑	❑	❑
5		❑	❑	❑
6		❑	❑	❑
7		❑	❑	❑
8		❑	❑	❑
9		❑	❑	❑
10		❑	❑	❑

5

c)	**Kooperationen mit anderen Unternehmen und Betrieben im Bereich der maritimen Dienstleistungen** **(z.B. Schiffsmakler, Schiffsausrüster, Crewing-Agenturen oder Klassifikationsgesellschaften)** Bitte nennen Sie uns Ihre 10 wichtigsten betrieblichen Kooperationspartner im Bereich maritimer Dienstleistungen (regional und überregional bzw. international) und die Art der Kooperation.			
	Name und Standortadresse des Unternehmens bzw. Betriebs PLZ, Ortsname, Land (bei Partnern im Ausland) (Bei Geheimhaltung nur die Branche und den Standort angeben)	**Art der Kooperation** (bitte ankreuzen, Mehrfachnennungen mögl.)		
		Langfristige strategische Kooperation	Punktuelle Kooperation zur Bearbeitung von Einzelthemen	Kooperation im Bereich Ausbildung/ Qualifizierung
1		❑	❑	❑
2		❑	❑	❑
3		❑	❑	❑
4		❑	❑	❑
5		❑	❑	❑
6		❑	❑	❑
7		❑	❑	❑
8		❑	❑	❑
9		❑	❑	❑
10		❑	❑	❑

d)	**Kooperationen mit Unternehmen und Betrieben im Bereich der Hafenwirtschaft (einschließlich Hafenlogistik und Hafendienstleistungen)** **(z.B. Terminalbetreiber, Umschlagbetriebe, Stauerei- u. Befrachtungsunternehmen, Schleppdienste)** Bitte nennen Sie uns Ihre 10 wichtigsten betrieblichen Kooperationspartner im Bereich der Hafenwirtschaft (regional und überregional bzw. international) und die Art der Kooperation.			
	Name und Standortadresse des Unternehmens bzw. Betriebs PLZ, Ortsname, Land (bei Partnern im Ausland) (Bei Geheimhaltung nur die Branche und den Standort angeben)	**Art der Kooperation** (bitte ankreuzen, Mehrfachnennungen mögl.)		
		Langfristige strategische Kooperation	Punktuelle Kooperation zur Bearbeitung von Einzelthemen	Kooperation im Bereich Ausbildung/ Qualifizierung
1		❑	❑	❑
2		❑	❑	❑
3		❑	❑	❑
4		❑	❑	❑
5		❑	❑	❑
6		❑	❑	❑
7		❑	❑	❑
8		❑	❑	❑
9		❑	❑	❑
10		❑	❑	❑

e)	**Kooperationen mit Unternehmen und Betrieben im Bereich <u>Fischereiwirtschaft</u>** Bitte nennen Sie uns Ihre 10 wichtigsten <u>betrieblichen Kooperationspartner</u> im Bereich der Fischereiwirtschaft (regional und überregional bzw. international) und die Art der Kooperation.			
	Name und Standortadresse des Unternehmens bzw. Betriebs PLZ, Ortsname, Land (bei Partnern im Ausland) (Bei Geheimhaltung nur die Branche und den Standort angeben)	**Art der Kooperation** (bitte ankreuzen, Mehrfachnennungen mögl.)		
		Langfristige strategische Kooperation	Punktuelle Kooperation zur Bearbeitung von Einzelthemen	Kooperation im Bereich Ausbildung/ Qualifizierung
1		❑	❑	❑
2		❑	❑	❑
3		❑	❑	❑
4		❑	❑	❑
5		❑	❑	❑
6		❑	❑	❑
7		❑	❑	❑
8		❑	❑	❑
9		❑	❑	❑
10		❑	❑	❑

f)	**Kooperationen mit Unternehmen und Betrieben im Bereich Meerestechnik** **(z. B. Offshore Technik, Unterwassertechnik, Hydrographie, maritime Umwelttechnik, Satellitennavigation)** Bitte nennen Sie uns Ihre 10 wichtigsten betrieblichen Kooperationspartner im Bereich maritimer Technologien (regional und überregional bzw. international) und die Art der Kooperation			
	Name und Standortadresse des Unternehmens bzw. Betriebs PLZ, Ortsname, Land (bei Partnern im Ausland) (Bei Geheimhaltung nur die Branche und den Standort angeben)	**Art der Kooperation** (bitte ankreuzen, Mehrfachnennungen mögl.)		
		Langfristige strategische Kooperation	Punktuelle Kooperation zur Bearbeitung von Einzelthemen	Kooperation im Bereich Ausbildung/ Qualifizierung
1		❑	❑	❑
2		❑	❑	❑
3		❑	❑	❑
4		❑	❑	❑
5		❑	❑	❑
6		❑	❑	❑
7		❑	❑	❑
8		❑	❑	❑
9		❑	❑	❑
10		❑	❑	❑

g)	**Kooperationen mit Aus- und Weiterbildungseinrichtungen** **(z.B. Universitäten, Fachhochschulen, Fachschulen und andere Bildungseinrichtungen)** Bitte nennen Sie uns Ihre 5 wichtigsten Kooperationspartner im Bereich Ausbildung und Qualifizierung (regional und überregional bzw. international).
	Name der Einrichtung/ des Instituts und Standortadresse (PLZ, Ortsname, Land)
1	
2	
3	
4	
5	

h)	**Forschungs- und Entwicklungskooperationen mit wissenschaftlichen Einrichtungen** **(z.B. Universitäten, Fachhochschulen, außeruniversitäre Forschungseinrichtungen)** Bitte nennen Sie uns Ihre 5 wichtigsten wissenschaftlichen Kooperationspartner im Bereich Forschung und Entwicklung (regional und überregional bzw. international) und die Art der Kooperation.		
	Name der wissenschaftlichen Einrichtung und Standortadresse PLZ, Ortsname, Land (bei Partnern im Ausland)	**Art der Kooperation** (bitte ankreuzen, Mehrfachnennungen mögl.)	
		Langfristige strategische Kooperation	Punktuelle Kooperation zur Bearbeitung von Einzelthemen
1		❑	❑
2		❑	❑
3		❑	❑
4		❑	❑
5		❑	❑

6) Forschung und Entwicklung/ Innovationen	
a)	**Hat Ihr Unternehmen in den Jahren 2004 bis 2007 Forschungs- und Entwicklungsaktivitäten durchgeführt?** ❑ Ja, kontinuierlich ❑ Ja, gelegentlich ❑ Nein
b)	**Wenn ja, wie hoch waren Ihre Aufwendungen für intern oder extern durchgeführte Forschung und Entwicklung in 2007 (Anteil am Jahresumsatz in %)?** ca. ..... % des Umsatzes **Wie haben sich diese Aufwendungen in den letzten drei Jahren entwickelt? Sie sind** ❑ gestiegen, um etwa …… % ❑ in etwa gleich geblieben ❑ zurückgegangen, um etwa …… %

c)	**Vergeben Sie Forschungsaufträge an externe Dienstleister?** ❑ Ja, kontinuierlich ❑ Ja, gelegentlich ❑ Nein **Wenn ja, wie hoch ist dieser Anteil an Ihren Gesamtaufwendungen für Forschung und Entwicklung?** ca. ..... %
d)	**Wie hoch ist Ihr Umsatzanteil, den Sie durch deutsche und europäische Förderprogramme erzielen?** ca. ..... % des Umsatzes. Davon entfallen ca. ..... % auf deutsche und ca. ..... % auf europäische Förderprogramme (Summe = 100 %).
e)	**Wie viele Mitarbeiter befassen sich derzeit mit Forschungs- und Entwicklungsaufgaben?** ..... Personen
f)	**Hat Ihr Unternehmen in den letzten drei Jahren neue oder merklich verbesserte Produkte oder Dienstleistungen auf den Markt gebracht?** ❑ Ja ❑ Nein
g)	**Hat Ihr Unternehmen in den letzten drei Jahren unternehmensintern neue oder merklich verbesserte Prozesse (einschließlich Verfahren zur Erbringung von Dienstleistungen und zur Auslieferung von Produkten) eingeführt?** ❑ Ja ❑ Nein
h)	**Was sind für Sie die größten Innovationshemmnisse?** (Mehrfachnennungen möglich) ❑ Zu hohes wirtschaftliches Risiko oder zu hohe Innovationskosten ❑ Fehlende Finanzierungsmöglichkeiten ❑ Organisatorische Probleme innerhalb des Unternehmens oder interne Widerstände gegen Innovationsprojekte ❑ Mangel an geeignetem Fachpersonal oder fehlendes technologisches Know-how und Wissen ❑ Ungenügende Kenntnisse über den angestrebten Markt oder mangelnde Kundenakzeptanz von Innovationen ❑ Einschränkende Gesetzgebung, rechtliche Regelungen, Normen oder zu lange externe Verwaltungs- und Genehmigungsverfahren ❑ Marktbeherrschung durch andere Unternehmen
i)	**Nehmen Sie bereits regelmäßig an Aktivitäten eines Netzwerks der Maritimen Wirtschaft teil?** ❑ Ja ❑ Nein **Wenn ja, an welchen?** 1. ..... 2. ..... 3. .....

j)	**Welches der folgenden Kompetenzfelder ist für Sie von besonderem Interesse? (Bitte ankreuzen, Mehrfachantworten möglich)**	
	❑ Innovativer Schiffbau (Neue Materialien, Schiffskonstruktion, Antriebstechnik, Mechatronik) ❑ Offshoretechnik Öl / Gas ❑ Offshoretechnik Wind ❑ Unterwassertechnik ❑ Meeresforschungstechnik ❑ Hydrographie	❑ Polar- und Eistechnik ❑ Maritime Leit- und Sicherheitstechnik ❑ Maritime Umweltschutztechnik ❑ Satellitennavigationstechnik (Galileo) ❑ Aquakultur ❑ Blaue Biotechnologie ❑ in sonstigen, und zwar: .....

Bitte schicken Sie den ausgefüllten Fragebogen im beiliegenden Freiumschlag per Post, Fax oder E-Mail bis spätestens 17. Februar 2009 an uns zurück.

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Vielen Dank für Ihre Mitarbeit!

F.2. Descriptive Statistics

Figure 80
Descriptive statistics of firms contained in the network dataset, n=1060

F.3. Expert Interviews

Figure 81
Interview briefing document

Technische Universität München

Fakultät für Architektur
Institut für Entwerfen
Stadt und Landschaft
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Interviewleitfaden

Standortverflechtungen der maritimen Wirtschaft und die Folgen für die Stadt- und Regionalentwicklung in Norddeutschland

Konzeptioneller Hintergrund

Die Maritime Wirtschaft umfasst heute viele Bereiche, die über die Tätigkeiten im Hafen unmittelbar hinausgehen: Versicherungen, Logistikmanager, Rechtsberatungsunternehmen und Personaldienstleister sind wesentlicher Bestandteil der Wertschöpfungskette des globalisierten industriellen Transportes zur See und der Maritimen Wirtschaft. Diese Tätigkeitsfelder stehen in engem Zusammenspiel mit den tradierten Bereichen des Schiffsbaus, den Reedereien und der Hafengesellschaften. Ein beträchtlicher Teil der Wertschöpfung wird heute mit der Produktion und Anwendung von Wissen erbracht, das entlang oder auch unabhängig von der Transport- und Warenkette ausgetauscht wird und den räumlichen Umgriff des Hafens weit überschreitet.

Die Wettbewerbsfähigkeit der Maritimen Wirtschaft Norddeutschlands wird maßgeblich von dem erfolgreichen Zusammenspiel dieser unterschiedlichen Akteure bestimmt und deren Fähigkeit Innovationen zu generieren und umzusetzen. Dabei spielen räumliche Zusammenhänge auf unterschiedlichen Maßstabsebenen eine Rolle. Die Einbindung in globale Netzwerke des Handels und des Transportwesens ist ebenso von Bedeutung wie die Nähe zu lokalen Institutionen und regionale Kooperationen. Die Anforderungen an Standort und Umfeld unterscheiden sich dabei traditionell zwischen produzierenden und wissensintensiven Unternehmen, werden sich aber auch an denen anderer Knoten im Netz orientieren.

Diese Studie untersucht die relative Lage von Unternehmensstandorten, die im Bereich der maritimen Wirtschaft in Norddeutschland tätig sind. Ziel ist es die Verflechtungen der maritimen Wirtschaft in funktionaler und räumlicher Hinsicht besser zu verstehen und die Folgen für die Stadt- und Regionalentwicklung aufzuzeigen.

Gesprächsziele

Ausgehend von diesen konzeptionellen Grundlagen interessiert uns

- Wie interagieren die Funktionen ihres Unternehmens mit internen und externen Partnern?
- Welche Rolle spielt die räumliche Nähe zu Zulieferern, Märkten, Kunden und Ausbildungseinrichtungen für Ihr Unternehmen?
- Wie lange existiert der Standort ihres Unternehmens bereits und inwiefern hat sich dieser über die Jahre verändert?
- Verfolgt ihr Unternehmen eine bestimmte Standortstrategie?
- Welchen Einfluss hat der Standort auf die Wettbewerbsfähigkeit und Innovationskraft Ihres Unternehmens?
- Welche Interaktions- und Kommunikationsgewohnheiten praktizieren Sie in Ihrem Unternehmen?
- Was zeichnet Ihren Standort aus? Was schätzen Sie besonders an Ihrem Umfeld?

Technische Universität München

Fakultät für Architektur
Institut für Entwerfen
Stadt und Landschaft
Lehrstuhl für Raumentwicklung

Gesprächsrahmen

Das Interview ist für 60 Minuten veranschlagt. Das Gespräch wird von Mitarbeitern der TU München geführt. Ihre Antworten werden streng vertraulich behandelt und für die Auswertung anonymisiert.

Termine

Die Interviews sollen im Zeitraum Mai bis Juni 2013 stattfinden. Die folgenden Termine stehen von unserer Seite zur Verfügung.

27./28./29. Mai 2013

12./13./14. Juni 2013

26./27./28. Juni 2013

Gerne können Sie uns auch einen eigenen Termin nennen.

Ergebnisse

Die Ergebnisse der Arbeit werden Ihnen zur weiteren Verwendung zur Verfügung gestellt und können zum Beispiel als Grundlage für zukünftige Standortentscheidungen genutzt werden.

Kontaktdaten

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Table 3
Interview partners

Interview	Location of Firm	Field of Competence	Date
01	Hamburg	Maritime Services	27.05.2013
02	Hamburg	Shipbuilding Supplier	27.05.2013
03	Hamburg	Maritime Services	27.05.2013
04	Bremen	Other Science	28.05.2013
05	Leer	Shipping Company	28.05.2013
06	Bremen	Maritime Services	28.05.2013
07	Hamburg	Port Logistics	29.05.2013
08	Hamburg	Maritime Services	12.06.2013
09	Hamburg	Port Organization	12.06.2013
10	Bremen	Port Logistics	13.06.2013
11	Bremerhaven	Maritime Science	13.06.2013
12	Leer	Maritime Education	13.06.2013
13	Hamburg	Port Logistics	14.06.2013
14	Hamburg	Maritime Science	14.06.2013
15	Hamburg	Port Logistics	14.06.2013
16	Bremen	Other Economic Actor	03.11.2014
17	Hamburg	Other Economic Actor	13.11.2014
18	Bremen	Other Economic Actor	14.11.2014

Table 4
Expert interview quotations (author's selection)

Reference	Original	Translation
01/068	Wir sind ziemlich gut erreichbar, vom Hauptbahnhof, für Leute, die mit der Bahn kommen, das ist eine Viertelstunde, Zwanzig Minuten hier raus. Vom Flughafen ist genau dasselbe… Es gibt natürlich schönere Grundstücke im Hafen, sag ich mal, wo man dann auch ganz gerne wäre, das schon, aber das bringt ja nicht den wesentlichen Vorteil. …Für unser Geschäft und für Erreichbarkeit Kunden überhaupt nicht. (maritime service firm, Hamburg, Ref 01/068)	We are quite well accessible; for people who arrive by train, that's a quarter of an hour, twenty minutes to here. From the airport, it is exactly the same. […] Obviously, there are nicer sites within the port, I would say, and yes, we would quite like to be there, but that would not have a major advantage. At least our business and the accessibility of our customers would hardly benefit at all. (maritime service firm, Hamburg, Ref 01/068)
09/084	Ich glaube, dass dieser Dienstleistungssektor in Wilhelmshaven nicht wirklich eine Chance hat...es gibt viele Häfen, die unheimlich viel Tonnage umschlagen, die aber überhaupt nichts mit Dienstleistung zu tun haben...Da habe ich null Fluganbindung, was, glaube ich, insbesondere für Consultants und diesen ganzen maritimen Dienstleistungssektor auch eine ziemlich essenzielle Bedingung eigentlich ist. (port logistics firm, Hamburg, Ref 09/084)	I believe that the service sector in Wilhelmshaven does not really have a chance. […] there are many ports, which transship an incredible amount of tonnage, even though they have nothing to do with services at all […]. There is no air connection, which I think is actually an essential factor for consultants and the whole maritime service sector. (port logistics firm, Hamburg, Ref 09/084)
12/038	…Also ich würde mal sagen, das ist ein großer Vorteil für uns ist, weil, ich will das mal ganz einfach ausdrücken, unser Ohr natürlich erheblich näher dran ist, durch diese günstigen Konstellationen an den Wünschen, an den Gegebenheiten, an den potenziellen Partnern, als wenn wir ganz woanders sitzen würden oder die ganz woanders sitzen würden (research institute, Leer, Ref 12/038).	Well, I would say, this is a great advantage for us, as, to put it simply, we are much closer due to these advantageous site constellations, closer to the demands, the conditions and the potential partners, than if we were located somewhere completely different or they were located somewhere else. (research institute, Leer, Ref 12/038).
07/51	Das ist in Hamburg natürlich schon einfacher, Leute zu rekrutieren, als jetzt nach Wilhelmshaven zu bringen….Hier sind viele Unternehmen, viele Arbeitsmöglichkeiten, so dass es schon einfach ist, für Hamburg zu motivieren, ….allerdings die Konkurrenz um die Leute, ist natürlich hier deutlich höher. (port logistics firm, Hamburg, Ref 07/51)	Of course, it is simpler to recruit employees in Hamburg than to get them to move to Wilhelmshaven […]. Numerous firms are already here, plenty of work opportunities, which means it is easy to motivate people to come to Hamburg […]. Consequentially however, there is also a much higher level of competition for human resources. (port logistics firm, Hamburg, Ref 07/51)
05/005,006, 010	dadurch dass die Reedereien auch eine gewisse Größe erreicht haben, haben wir jetzt auch keine Probleme mehr, Leute von außerhalb zu bekommen….Standortvorteil ist auch, in so einer relativ kleinen Stadt, dass sich alle kennen und es gibt nicht dieser aggressive Konkurrenzkampf, wie das manchmal in Großstädten der Fall ist oder in Hamburg. Wir werben uns gegenseitig auch keine Leute gegenseitig ab….Wir haben weder Fluktuation noch haben wir Nachwuchssorgen im Betrieb... die Stadt ist selber auch attraktiver geworden. Sie hat einen hohen Wohnwert, wir haben gute Schulen, ob wir das kulturell gesehen, ist hier nichts groß. (shipping company, Leer, Ref 05/005,006,010)	Since the shipping companies have reached a certain size, we don't have a problem recruiting externally anymore […] another advantage of this site is that in such a small town everybody knows each other and competition is not as fierce as is sometimes the case in large cities or Hamburg. We don't poach each other's employees, neither do we have fluctuation or worry about finding young talent in our business. Moreover, the town has become more attractive in itself. There is a quality of life here, good schools, although there is not that much going on culturally. (shipping company, Leer, Ref 05/005,006,010)
15/086	Wenn wir mal von dem klassischen gewerblichen Mitarbeiter ausgehen, der da mit einer gelben	If we take the classic industrial employee, wearing a fluorescent yellow jacket, they strongly

		Jacke rumrennt, die haben alle einen sehr hohen Bezug….Die Anderen, wenn wir Richtung IT oder Prozessoptimierung kommen, da allerdings konkurrieren wir mit den Siemens, den Unis, den Hochschulen und das ist schon ziemlich hart.(port logistics firm, Hamburg, Ref15/086).	identify themselves with the place. Other employees from IT or process engineering… in these sectors we compete with Siemens, Universities and other schools and the competition is quite fierce. (port logistics firm, Hamburg, Ref15/086).
02/47 02/67	+	der Markt der maritimen Industrie ist ein „Beziehungsmanagement" weil Sie in dem Markt wissen müssen, wen können Sie ansprechen, um was zu bekommen. In diesem Markt haben Sie keine langen Vorlaufzeiten… Das kommt sicherlich auch dazu, die Glaubwürdigkeit, aber letztlich ist es auch ein stückweit die Nähe zu diesen Partnern, dass man auch zum Essen gehen kann, zu einer Verbandsveranstaltung gehen kann. (marine engineering and supplier, Hamburg, Ref 02/47 + 02/67)	The maritime industry market is about "relationship management", because when you are in this sector you need to know exactly who to contact to get something. The market doesn't have long lead times; it is the credibility and in the end it is to some extent the proximity to these partners, which allows you to meet for a meal out or attend an event. (marine engineering and supplier, Hamburg, Ref 02/47 + 02/67)
15/008		…wir sind eine attraktive Stadt, das heißt wir haben bisher noch keine Probleme Arbeitsplätze zu besetzen. Daran müssen wir auch weiter arbeiten, das wird für uns auch ein kritischer Erfolgsfaktor, dass in dieser Stadt es Spaß macht zu leben und auch bezahlbare Wohnungen bekommt. Man verdient zwar viel Geld, aber das ist einer unserer Erfolgsfaktoren. (port logistics firm, Hamburg, Ref 15/008)	…we are attractive as a city, which means we currently have no difficulties in filling vacancies. This is something we need to keep up, as it is a critical for our success that it is enjoyable to live here and that there is also affordable accommodation. People do earn a lot of money, but it is quality of life that ensures our success. (port logistics firm, Hamburg, Ref 15/008)
15/006		…unsere kritischen Erfolgsfaktoren sind tatsächlich das Aufrechterhalten und die Weiterentwicklung der Hinterlandsverkehrssysteme. (port logistics firm, Hamburg, Ref 15/006)	[…] our critical success factors are actually the retention and further development of transportation systems in the hinterland. (port logistics firm, Hamburg, Ref 15/006)
11/042		Denn in Hamburg bin ich in einer Stunde, da muss ich kein Büro haben. (port logistics firm, Bremen Ref 11/042)	I do not need my own office in Hamburg as I can be there within one hour. (port logistics firm, Bremen Ref 11/042)
02/091		Wenn Sie Partnerschaften haben, mit denen Sie länger leben und wissen wie der andere tickt …dann würde ich sagen, ist das Gebiet von der Infrastruktur westliche EU grenzwertig würde ich mal sagen. Es ist kein Problem heute mal eben von Hamburg nach Italien zu fliegen. In dem Moment wo ich dreimal umsteigen muss, geht das auch nicht mehr. (marine engineering firm, Hamburg, Ref 02/091)	If you have partnerships which you are engaged in for a longer period of time and you know how your partners think […] then I would say the scale of the Western European union is the limit. Nowadays, it is not a problem to fly from Hamburg to Italy at the drop of a hat. As soon as you have to change three times, this becomes prohibitive. (marine engineering firm, Hamburg, Ref 02/091)
14/055		Was Hamburg auszeichnet, dass die Packungsdichte an maritimen Akteuren, die ist halt relativ hoch. Ich habe hier eine anständige Versuchsanstalt, ich habe hier praktisch alle vernünftigen Klassen im Zugriff, ich hab die meisten Reedereien hier im Zugriff, ich habe eine Menge schiffbaulicher Dienstleister hier, ich hab die ganzen Hauptzulieferer hier sitzen im Prinzip mit irgendeiner Dependance und wenn ich jetzt den Kreis ein bisschen weiter spanne, dann habe ich im Umkreis von 200 Kilometern auch eine ganze Menge wesentlicher Werften so sitzen. (maritime research, Hamburg, Ref 14/055)	What makes Hamburg special is the density of actors, which is comparatively high. There is a decent testing facility, nearly all relevant classes are available, most shipping companies are sited here, plenty of maritime services, the key suppliers have some sort of representation and if you choose to look at the total area within a 200km radius, there is a reasonable number of shipyards as well. (maritime research, Hamburg, Ref 14/055)
04/037		Es gibt alle möglichen Vereine und alle möglichen Traditionsbräuche und so'n Zeugs, wo sich dann dieselben Leute auch immer wieder treffen. Ich glaube, dass das etwas ist, was gerade in diesen Hafenstädten besonders ausgeprägt ist und ich glaube, das man auch dann immer relativ schnell dazu kommt, das man auch bei harten Konflikten, die sich relativ schnell einigten, das	An array of clubs and traditions and so on exist, where the same people meet again and again. I believe that is something which is particularly pronounced in port cities and I also believe that it is this which helps agreements to be found relatively quickly, even if tough conflicts do arise. This is due to the level of trust which is built in those clubs. There are multiple examples of this.

	hat was mit dieser Vertrauensbasis zu tun, die da geschaffen wird. Da gibt es ganz viele Beispiele für. (research institute, Bremen, Ref 04/037)	(research institute, Bremen, Ref 04/037)
04/011	Ich glaube, die ganze Frage der Attraktivität und der, wenn man so will, nicht im engen Sinne ökonomischen Standortfaktoren, die ist zweitrangig. Entscheidend ist, dass wir in Hamburg eine Konzentration haben, die einfach schon da ist und das die Unternehmenszentralen zu einem Teil einfach schon angesiedelt waren und da wo diese kritische Masse vorhanden ist, da hat die halt eine enorme Schwerkraft. (research institute, Bremen, Ref 04/011)	I think the entire question of attractiveness and economic location factors is secondary. The decisive point is that we are dealing with a pre-existing concentration in Hamburg, and that the head offices were already partly in place. Where this kind of critical mass pre-exists, it exerts an enormous gravitational force. (research institute, Bremen, Ref 04/011)

F.4. Reduction of Interview Results

Lfd. Nr.	Interview Ref	*Paraphrase*	Generalization	Reduction	functional Coding	spatial Coding
26	02/051	*Da drüber hinaus gibt es hier in Norddeutschland Bremen, Hamburg, Schleswig-Holstein, Mecklenburg-Vorpommern die Handelskammern zusammengetan und das sogenannte maritime Cluster gegründet. Das ist eine Dachorganisation. Das maritime Cluster da arbeiten wir auch wieder mit. Das heißt, es gibt auch dann dieses Netzwerk, wer hat eine Information.*	die Handelskammern der norddeutschen Bundesländer haben das maritime Cluster gegründet.	Norddeutschland ist eine relevante Maßstabsebene	maritime technology	Hamburg
34	02/085	*Das heißt, wenn wir eine Idee haben, müssen wir die Werft ansprechen, krieg ich überhaupt die Signale und was bewirkt das bei jemanden, der kauft ja noch ganz viele Dinge von vielen anderen Firmen zu. Das heißt, da findet eine permanente Prüfung statt. Dann kommen noch die Klassifizierungsgesellschaften, die sagen, das genehmige und das genehmige ich nicht. Wenn Sie da nicht die Möglichkeit haben, ich würde mal sagen, so im Umkreis von 250 km zu agieren oder 300 km, dann explodieren Ihnen die Kosten.*	räumlicher Maßstab entscheidend für die Effizienz im Entwicklungsstadium	Norddeutschland ist eine relevante Maßstabsebene	maritime technology	Hamburg
50	03/014	*Das kann ich natürlich schon eingrenzen, wenn wir hier von Nordeuropa sprechen, dann haben wir natürlich vorwiegend deutsche Reeder, europäische Reeder, die wir betreuen, denn eines ist klar, die ganzen Produktionsstätten liegen natürlich in Asien.*	Kunden kommen vor Allem aus Norddeutschland und Europa	Norddeutschland ist eine relevante Maßstabsebene	maritime services	Hamburg
124	06/008	*Es gibt einen internen Kampf, Hamburg, Bremerhaven, wenn man jetzt Frachtschiffsmarkt redet. Da gibt es internen Kampf zwischen den Häfen.*	es gibt Konkurrenz zwischen den Norddeutschen Häfen	Norddeutschland ist eine relevante Maßstabsebene	maritime services	Bremen
188	08/102	*B: Wobei man natürlich auch sagen muss, für einen Schiffbauingenieur ist es in Hamburg schon schwer, was anderes zu finden als beim GL, weil die Werften ja alle zugemacht mehr oder weniger, sodass man jetzt diese Situation des Abwerbens bei anderen Firmen in der Nähe nicht so hat. Aber das gibt es schon. Wenn man das ein bisschen globaler betrachtet und sagt Norddeutschland, da spielt das schon eine Rolle.*	es gibt einen Wettbewerb um Talente im Norddeutschen Raum	Norddeutschland ist eine relevante Maßstabsebene	maritime services	Hamburg
274	12/008	*wir haben ja noch, wenn man so will, eine „konkurrierende Einrichtung" in Elsfled und das hat auch so ein bisschen zum Spannungsfeld, glaube ich, beigetragen, weil es gab auch im Vorfeld der Dinge, die ich gerade vorgetragen habe, unglückliche Entscheidungen der Politik gewisse Dinge im investiven Bereich dahin zu geben und nicht hier hin zu geben, die dann aufgrund vielleicht auch ungünstiger personeller Konstellationen hier und woanders eben nicht, wie das manchmal so ist, beflügelt oder wie auch immer*	Konkurrenz zwischen den Hochschulstandorten ist nicht immer von Vorteil	Norddeutschland ist eine relevante Maßstabsebene	research and universities	Leer
328	14/013	*Die wesentlichen Seeschiffswerften, die wir in Deutschland haben, sitzen nicht unbedingt in Hamburg, sondern in der Umgebung Schleswig-Holstein, Niedersachsen, das ist ein wichtiges Faktum und ohne Seeschiffswerften kann ich keine Schiffe bauen*	Seeschiffwerften sitzen in ganz Norddeutschland	Norddeutschland ist eine relevante Maßstabsebene	research and universities	Hamburg
336	14/049	*Ich habe immer dafür geworben, dass man diese Metropolregion auf praktisch gesamt Norddeutschland ausdehnt und die gehen im Prinzip von Mecklenburg, wenn Sie wollen, bis hinten nach Papenburg auf die Seeschiffswerft.*	Hamburger Absolventen finden im Allgemeinen in Norddeutschland Arbeit	Norddeutschland ist eine relevante Maßstabsebene	research and universities	Hamburg
360	15/024	*Da gibt es ja Hochschulen, die sich um Verkehrsbetriebslehrgänge kümmern, ist Leer. Da studieren die Leute auch gerne, aber arbeiten kommen Sie dann zu uns.*	Hamburg zieht Absolventen aus Leer an	Norddeutschland ist eine relevante Maßstabsebene	port logistics	Hamburg

F.5. Interview Coding Guide

Family	Code	Definition	Anchor Example	Coding rule
Interaction	Value Based	the interaction is tied to a value generating activity	*"...die Kundennähe ist entscheidend. Entscheidend ist die gleiche Sprache, ähnliche Sozialisierungen, der Imagetransfer und natürlich auch eine ausgesprochen große Dienstleistungsorientierung. " (P3/034)*	interaction is with biusiness partners for the purpose of business and described as face to face
Interaction	Research Collaboration	the interaction is in the context of research and independent from value generating activities	*"...Wenn wir da Projekte haben in Kooperation mit Werften oder so, dann muss nachher auch wirklich, ich sag mal ganz primitiv, ein Geschäft rauskommen was besser ist, als das was man vorher hatte, damit es besser vermarktbar ist" (P1/046)*	interaction is open ended without primary focus on business and described as face to face
Interaction	Education and Professional Development	the interaction is taking place as part of education and professional developemnt	*" Leer hat diese Fachhochschule und Fachschule. Und somit auch Input, somit sitzen sie an der Quelle, können sich ihre kommenden Leute quasi angucken. Das ist für die wichtig, Praktikumsplätze etc. pp und zwar auch für die Studenten ist das wichtig. Es gibt immer mehr Frauen in der Seefahrt beispielsweise, die wollen schon wissen, mit wem sie da letztendlich irgendwann zusammen gehen. Doch mit Sicherheit ist das ein Standortvorteil. " (P6/036)*	interaction is related to recruitment, training or education and face to face
Interaction	Social Interaction	the interaction is social in nature	*"...man kennt sich eben auch mal aus dem Hamburger Nachtleben ab und zu oder so, das ist dann auch manchmal ein Vorteil, dass man mal ein Bier miteinander getrunken und da ist das dann auch einfacher und wir treffen* ***uns auch in gewissen Kreisen, zweimal im Jahr, freitags Abends und dann…"*** *(P7/095)*	interaction is outside formal meetings and working hours and face to face
Interaction	Regulatory Interaction	the interaction focuses on regulatory and legal guidance	*"Wir sind einfach das Bindeglied zwischen dem Reeder und der Versicherungswirtschaft. Ohne unsere Zertifikate, ohne unsere Klassifizierungszertifikate gibt es keinen Versicherungsschutz und damit können die Schiffe nicht zum Einsatz kommen." (P3/088)*	interaction is required by law etc. and one party fulfills an official role and is described as face to face
Actor	Activity Field	Partner within the same Activity Field	*"Mit der technischen Universität arbeiten wir sehr intensiv zusammen. Das ist natürlich auch ein Konkurrenzprozess, weil da auch einige Professoren, die meinen, sie das alles noch viel besser könnten. Von daher ist das auch eine sehr hilfreiche Konkurrenz, das ist ja eher das Entscheidende, nicht nur die Zusammenarbeit, sondern eben auch dieser sportliche Wettbewerb. " (P3/184)*	the actors are from the same activity field and are potential competitors
Actor	Functional Cluster	Partner within the same Functional Cluster	*"Offshore ist was ganz anderes. Das muss man raus nehmen.* ***(P6/18)…deutsche Reedereien, Hafenlogistik, das müsste man eigentlich*** *total trennen (P6/76)"*	the actors are from the same functional cluster, i.e. one of the three offshore, logistik, shipping
Actor	Maritime Industry	Partner within the Maritime Economy generally	*"Der Reeder ist immer der Ursprung aller Aktivitäten, er will sein Geld mit den Schiffen verdienen. Das heißt, er ist auch daran interessiert Service, Instandhaltung und Wartung zu bekommen. " (P2/021)*	the actors are from within the Maritime Industry but not the same function cluster nor competitors
Actor	Other Industry	Partner in other parts of industry	*"Bei den Gastankern sind unsere Kunden auf der ganzen Welt. Aber schwerpunktmäßig in Japan, USA, Europa, dann die Kunden sind einmal die Industrie, da haben wir Axon, Shell oder Total, Petrobras, das sind eher die großen Ölkonzerne, mit denen wir, oder Chemiekonzerne BASF natürlich auch, die werden Sie auch ständig besuchen und da gibt es auch ständig irgendwelche Konferenzen, wo wir dann auch sind und wo wir eine ganz enge Beziehung zu diesen Leuten haben. Das ist im Moment das Geschäft, welches am meisten Wissen erfordert. "(P5/034)*	the actors are not all from the maritime industry, but at least one actor is from a different industry

F.6. Empirical Data

Table 5
Actors with highest betweenness at super-regional level (author's calculation)

Rank	Code	Actor	City	Activity Field	Betw
1	90088	Mehrphasentechnologie e.V.	Adendorf	Maritime Science	144382
2	17086	Franatech GmbH	Adendorf	Maritime Technology	144372
3	80317	Handwerkskammer Oldenburg	Oldenburg	Others	98690
4	15751	Niedersachsen Ports GmbH & Co. KG	Oldenburg	Port Economy	90618
5	99533	Carl von Ossietzky Universität Oldenburg	Oldenburg	Maritime Science	86332
6	13247	Ludwig Freytag GmbH & Co. KG	Oldenburg	Maritime Technology	82702
7	14799	SkySails GmbH & Co. KG	Hamburg	Shipping Supplier	77970
8	13803	Noske-Kaeser GmbH	Hamburg	Shipping Supplier	60660
9	80065	Frommann Friedrich G. GmbH & Co.	Hamburg	Port Economy	50936
10	99006	TuTech Innovation GmbH	Hamburg	Maritime Science	50186
11	99428	Institut für Messtechnik	Hamburg	Maritime Science	49938
12	99135	DHI Wasy	Syke	Maritime Technology	47746
13	14600	Schiffswerft Diedrich GmbH & Co. KG	Moormerland	Shipbuilding	45632
14	90040	Fachhochschule Oldenburg/Ostfriesland/Wilhelmshaven (Standort Oldenburg) Institut für Rohrleitugsbau	Oldenburg	Maritime Science	44354
15	90039	Fachhochschule Oldenburg/Ostfriesland/Wilhelmshaven (Standort Oldenburg) Institut für Materialprüfung	Oldenburg	Maritime Science	44354
16	15946	Reederei Rudolf Schepers GmbH & Co. KG	Bad Zwischenahn	Shipping Company	44175
17	13048	Köster Schiffsisolierung und -ausbau Ltd.	Emden	Shipping Supplier	44088
18	15750	EWE AG	Oldenburg	Maritime Technology	43559
19	17503	Deutsche Offshore-Testfeld und Infrastruktur GmbH & Co. KG	Oldenburg	Maritime Technology	43559
20	12999	KLH Kältetechnik GmbH	Bad Doberan	Shipping Supplier	42532

Table 6
Actors with highest betweenness in FUA Jade Weser (author's calculation)

Rank	Code	Actor	City	Activity Field	Betw
1	15210	Turbo-Technik Reparatur-Werft GmbH & Co. KG	Wilhelmshaven	Shipbuilding	74
2	15927	Nordfrost GmbH & Co. KG	Wilhelmshaven	Port Economy	74
3	80035	K.u.K. Nordseeforschungsschiff-Bereederung GmbH	Wilhelmshaven	Shipping Company	66
4	13644	MWB Motorenwerk Wilhelmshaven GmbH & Co. KG	Wilhelmshaven	Shipbuilding	40
5	80334	Nationalparkamt Wattenmeer	Wilhelmshaven	Others	30
6	90012	DEWI GmbH - Deutsches Windenergie-Institut	Wilhelmshaven	Maritime Science	20
7	12225	Hafenbetriebsgesellschaft Wilhelms-haven mbH	Wilhelmshaven	Port Economy	8
8	12689	Jade-Dienst GmbH	Wilhelmshaven	Maritime Services	8
9	90032	Forschungsinstitut Senckenberg Deutsches Zentrum für Marine Biodiversi-tätsforschung	Wilhelmshaven	Maritime Science	8
10	15872	E.ON Kraftwerke GmbH	Wilhelmshaven	Port Economy	4

Table 7
Actors with highest betweenness in FUA Ems (author's calculation)

Rank	Code	Actor	City	Activity Field	Betw
1	13048	Köster Schiffsisolierung und -ausbau Ltd.	Emden	Shipping Supplier	8316
2	14600	Schiffswerft Diedrich GmbH & Co. KG	Moormerland	Shipbuilding	8280
3	13673	Navicom Emden GmbH Schiffstechnik-Navigation-Kommunikation	Emden	Maritime Services	2992
4	12754	Friedrich Dirks GmbH & Co. Distribution und Logistik KG	Emden	Port Economy	2522
5	12350	Hermann Buss GmbH & Cie KG	Leer	Shipping Company	2226
6	80305	Emsstrom	Leer	Others	2226
7	80306	IHK Leer	Leer	Others	1880
8	11335	Embdena Partnership AG, Schiffsfinan-zierungen	Emden	Maritime Services	1780
9	80142	S.P.L. GmbH	Emden	Maritime Services	1718
10	10898	Commerzbank Leer	Leer	Maritime Services	1658

Table 8
Actors with highest betweenness in FUA Hamburg (author's calculation)

Rank	Code	Actor	City	City Quarter	Activity Field	Betw
1	10175	AMS Alster Marine Services GmbH	Hamburg	Rothenburgsort	Maritime Services	55536
2	13620	Muehlhan AG	Hamburg	Wilhelmsburg	Shipping Supplier	48220
3	11507	Fehrmann Metallverarbeitung GmbH	Hamburg	Wilhelmsburg	Shipping Supplier	47756
4	80150	Motorenfabrik HATZ GmbH & Co. KG Zweigniederlassung Nord	Hamburg	Wilhelmsburg	Shipping Supplier	47256
5	13166	Lethe Yacht Galleys GmbH	Hamburg	Heimfeld	Shipping Supplier	20418
6	80192	Noblee & Thörl GmbH	Hamburg	Heimfeld	Port Economy	19134
7	14799	SkySails GmbH & Co. KG	Hamburg	Harburg	Shipping Supplier	12142
8	10717	BUREAU VERITAS S.A. Zweigniederlassung Hamburg	Hamburg	Harburg	Maritime Services	11582
9	10487	Bereederungsgesellschaft H. Vogemann GmbH & Co. KG	Hamburg	Harvestehude	Shipping Company	8934
10	13392	Marlow Deutschland GmbH	Hamburg	Altona-Altstadt	Maritime Services	7384

Table 9
Actors with highest betweenness in FUA Bremen (author's calculation)

Rank	Code	Actor	City	Activity Field	Betw
1	14332	RMS Schiffahrtskontor Bremen GmbH	Bremen	Maritime Services	3492
2	14808	Sloman Neptun Schiffahrts-AG	Bremen	Shipping Company	1758
3	20198	INROS LACKNER AG	Bremen	Marine engineering	924
4	93002	Universität Bremen Bremer Institut für Produktion und Logistik GmbH (BIBA)	Bremen	Maritime Science	858
5	80251	Bruker Daltonik GmbH	Bremen	Others	820
6	10471	Beluga Shipping GmbH	Bremen	Shipping Company	746
7	93025	Leibniz-Zentrum für Marine Tropenökologie (ZMT)	Bremen	Maritime Science	640
8	19467	Biomaris GmbH & Co. KG	Bremen	Maritime Services	566
9	99245	Diedrich Meyer GmbH & Co.	Bremen	Port Economy	518
10	19354	Minerva Versicherungsaktiengesellschaft	Bremen	Maritime Services	476

Table 10
Actors ranked by functional degree centrality[5]

Rank	Code	Actor	Activity Field	Centrality	City
1	11823	Germanischer Lloyd Oil & Gas GmbH	Maritime Services	378	Hamburg
2	92003	Center of Maritime Technologies e.V.	Maritime Science	266	Hamburg
3	92001	Bundesamt für Seeschifffahrt und Hydrographie (BSH)	Maritime Science	265	Hamburg
4	13504	Meyer Werft GmbH	Shipbuilding	168	Papenburg
5	93017	Alfred-Wegener-Institut für Polar- und Meeres-forschung	Maritime Science	151	Bremerhaven
6	12045	Hamburgische Schiffbau-Versuchsanstalt GmbH	Marine engi-neering	139	Hamburg
7	96003	MARIKO.RIS - Maritimes Kompetenzzentrum	Maritime Science	123	Elsfleth
8	10662	Briese Schiffahrts GmbH & Co. KG	Shipping Company	117	Leer
9	99417	Technische Universität Hamburg-Harburg	Maritime Science	110	Hamburg
10	13789	Nordseewerke GmbH Ein Unternehmen von ThyssenKrupp Marine Systems	Shipbuilding	105	Emden
11	90030	Gottfried Wilhelm Leibniz Universität Hannover Institut für Statik und Dynamik	Maritime Science	92	Hannover
12	12040	Hamburger Hafen und Logistik AG	Port Economy	91	Hamburg
13	94027	GKSS-Forschungszentrum Geesthacht GmbH	Maritime Science	91	Geesthacht
14	13921	Otto Wulf GmbH & Co. KG Niederlassung Cuxhaven	Shipping Company	90	Cuxhaven
15	12181	Hapag-Lloyd AG	Shipping Company	85	Hamburg
16	11166	DNV Germany GmbH	Maritime Services	84	Hamburg
17	94028	Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR)	Maritime Science	83	Kiel
18	20105	AG Reederei Norden-Frisia	Marine engi-neering	80	Norderney
19	96069	Deutsches Forschungszentrum für Künstliche Intelligenz GmbH	Maritime Science	80	Bremen
20	90007	Fachhochschule Oldenburg/Ostfriesland /Wilhelmshaven (Standort Elsfleth) Fachbereich Seefahrt	Maritime Science	80	Elsfleth

[5] Calculation: Michael Bentlage

Table 11
Actors ranked by relative spatial reach to other actors on the local level R=600m (author's calculation)

Rank	Code	Actor	Activity Field	Reach R=600m	City Quarter	Stat Zone
1	99088	Verein Hamburger Spediteure e.V.	Others	99	Hamburg-Altstadt	1008
2	80237	Shaar	Others	99	Hamburg-Altstadt	1008
3	80084	Nielsen + Partner Unternehmensberater GmbH	Maritime Services	99	Hamburg-Altstadt	1005
4	99084	Akademie Hamburger Verkehrswirtschaft gGmbH	Others	99	Hamburg-Altstadt	1008
5	99088	Verein Hamburger Spediteure e.V.	Others	99	Hamburg-Altstadt	1008
6	11849	GLA German Liner Agencies GmbH	Maritime Services	96	Hamburg-Altstadt	1005
7	10876	CMS Shipping GmbH	Maritime Services	95	Hamburg-Altstadt	1007
8	13955	Paul Günther Schiffsmakler GmbH & Co. KG	Maritime Services	94	Hamburg-Altstadt	1005
9	13487	Menzell & Co Schiffsmakler GmbH & Co. KG	Maritime Services	94	Hamburg-Altstadt	1005
10	11423	ESS European Shipping Services GmbH	Maritime Services	94	Hamburg-Altstadt	1005
11	11393	Ernst Glässel GmbH	Maritime Services	94	Hamburg-Altstadt	1005
12	14465	S & D Shipmanagement GmbH & Co. KG	Maritime Services	90	Hamburg-Altstadt	1007
13	80069	OwnerShip Emissionshaus GmbH	Maritime Services	90	Hamburg-Altstadt	1007
14	99060	HHM Hafen Hamburg Marketing	Others	90	Hamburg-Altstadt	1008
15	10997	DAKOSY Datenkommunikationssystem AG	Maritime Services	90	Hamburg-Altstadt	1008
16	17158	Fairplay Schleppdampfschiffs-Reederei Richard Borchard GmbH	Shipping Company	87	Hamburg-Altstadt	1008
17	99025	DNV Academy	Science	87	Hamburg-Altstadt	1008
18	11076	Deutsche Bank AG, DB Shipping	Maritime Services	87	Hamburg-Altstadt	1007
19	99190	Allianz Versicherungs AG	Maritime Services	87	Hamburg-Altstadt	1005
20	13365	Marine Service GmbH	Maritime Services	86	Hamburg-Altstadt	1008

Table 12
Actors ranked by relative spatial reach to other actors on the local level R=1800m (author's calculation)

Rank	Code	Actor	Activity Field	Reach R=1800	City Quarter	Stat Zone
1	12554	IMPaC Offshore Engineering GmbH	Marine engineering	256	Neustadt	3003
2	12232	HCI Capital AG	Maritime Services	254	Neustadt	3009
3	14223	Reederei Claus-Peter Offen GmbH & Co. KG	Shipping Company	254	Neustadt	3009
4	13191	Lloyd Fonds AG	Maritime Services	252	Neustadt	3003
5	99105	Kienbaum Consultants International GmbH	Others	252	Neustadt	3003
6	11237	E.R. Schiffahrt GmbH & Cie. KG	Shipping Company	250	Neustadt	3004
7	13754	Nordcapital Holding GmbH & Cie. KG - Emissionshaus	Maritime Services	250	Neustadt	3004
8	14662	Scorship Tankers GmbH & Co. KG c/o König & Cie. GmbH & Co. KG	Shipping Company	249	Neustadt	3008
9	80075	König & Cie. GmbH & Co. KG	Maritime Services	249	Neustadt	3008
10	17424	sea2ice	Marine engineering	246	Neustadt	3008
11	99082	Leitstelle Klimaschutz	Others	246	Neustadt	3008
12	99445	Howe Robinson & Company Ltd.	Shipping Supplier	246	Neustadt	3009
13	12046	Hamburgische Seehandlung Gesellschaft für Schiffsbeteiligungen mbH & Co. KG	Maritime Services	245	Neustadt	3009
14	80063	TPW Todt & Partner KG Wirtschaftsprüfungsgesellschaft	Maritime Services	245	Neustadt	3003
15	11423	ESS European Shipping Services GmbH	Maritime Services	241	Hamburg-Altstadt	1005
16	13487	Menzell & Co Schiffsmakler GmbH & Co. KG	Maritime Services	241	Hamburg-Altstadt	1005
17	13955	Paul Günther Schiffsmakler GmbH & Co. KG	Maritime Services	241	Hamburg-Altstadt	1005
18	11393	Ernst Glässel GmbH	Maritime Services	241	Hamburg-Altstadt	1005
19	92035	HSBA Hamburg School of Business Administration	Science	238	Hamburg-Altstadt	1005
20	99176	Carl Bock & Co. GmbH & Co.	Maritime Services	238	Neustadt	3009

Table 13
Actors ranked by spatial betweenness on the local level (author's calculation)

Rank	Code	Actor	Activity Field	Betw	City Quarter	Stat Zone
1	10581	Blohm + Voss Industries GmbH Ein Unternehmen von ThyssenKrupp Marine Systems	Shipping Supplier	52350	Steinwerder	18002
2	92007	Deutsche Meteorologische Gesellschaft e.V. - Zweigverein Hamburg c/o Deutscher Wetterdienst	Science	45154	St. Pauli	4010
3	14124	PROJEX-Schiffahrts-GmbH & Co. 'KG	Shipping Company	42818	Neustadt	3013
4	99055	Ehlermann, Rindfleisch, Gadow RA	Others	34408	Hamburg-Altstadt	1002
5	12098	Hans Wolkau GmbH	Port Economy	28552	Steinwerder	18003
6	13996	Peter Gast Shipping GmbH	Maritime Services	23792	Hamburg-Altstadt	1002
7	13964	PCE Treuhand GmbH	Maritime Services	23400	Hamburg-Altstadt	1002
8	80084	Nielsen + Partner Unternehmensberater GmbH	Maritime Services	22472	Hamburg-Altstadt	1005
9	13391	MarLink Schiffahrtskontor GmbH & Co. KG	Maritime Services	21704	Neustadt	3004
10	14380	Rohden Bereederung GmbH & Co. KG	Shipping Company	19830	Altona-Altstadt	21012
11	14728	Sellhorn Ingenieurgesellschaft mbH	Marine engineering	18426	Neustadt	3011
12	14214	Reederei Alnwick Harmstorf & Co. GmbH & Co. KG	Shipping Company	18274	Ottensen	24015
13	17424	sea2ice	Marine engineering	17948	Neustadt	3008
14	92023	Johann Heinrich von Thünen-Institut für Seefischerei	Science	16120	Altona-Altstadt	21010
15	11849	GLA German Liner Agencies GmbH	Maritime Services	15842	Hamburg-Altstadt	1005
16	99190	Allianz Versicherungs AG	Maritime Services	15576	Hamburg-Altstadt	1005
17	99062	Orion Bulker GmbH	Shipping Company	14534	Ottensen	24015
18	11169	Döhle Assekuranzkontor GmbH & Co. KG	Maritime Services	14456	Altona-Altstadt	21010
19	12127	Hanseatic Lloyd Chartering GmbH & Co. KG	Shipping Company	14332	Neustadt	3003
20	80190	ADM Archer Daniels Midland	Others	14302	Wilhelmsburg	16001

F.7. Module Analysis

	MODULE AND MAIN ACTIVITY				
TYPE OF KNOWLEDGE RELATION	1 SHIPBUILDING AND SUPPLIERS	2 ENGINEERING AND SCIENCE	3 PORTS AND EDUCATION	4 PORTS AND SHIPPING	5 SERVICES AND SHIPPING
HIGH TECH	**16,0%**	**29,7%**	1,6%	**11,2%**	1,3%
TRANSACTION	**30,0%**	10,0%	**65,6%**	**67,9%**	**87,9%**
TRANSFORMATION	**53,1%**	**58,8%**	**17,0%**	**16,5%**	6,0%
INFORMATION	0,8%	1,6%	**15,8%**	4,5%	4,7%
NO. OF LINKS	636	320	247	224	232

Table 14
The five biggest modules and the type of knowledge involved (Bentlage et al., 2014)

F.8. Activity Fields

The network dataset contains seven activity fields, which are defined as follows in the original reports (Nord/LB 2009, 2013:

Schiff- und Bootsbau

Die Schiffbauindustrie setzt sich generell aus einem breit gefächerten Spektrum von Werften unterschiedlichster Größenklassen zusammen, die in verschiedensten Segmenten des Schiff- und Bootsbaus aktiv sind. Sie umfasst sowohl große Werftverbünde, einige mittelständische Werften als auch kleinere Bootsbaubetriebe. Das Tätigkeitsspektrum beinhaltet die Konstruktion und Herstellung von See- und Binnenschiffen für die Güter- und Personenbeförderung sowie Schiffe für hoheitliche Aufgaben und speziell den Kreuzfahrtschiffbau. Dahingegen ist der Bootsbau maßgeblich auf die Fertigung von Booten für den Sport- und Freizeitgebrauch ausgerichtet. Eine Zwischenstellung kommt dabei dem Yachtbau zu, der in Teilen der Schiffbauindustrie eine zentrale Wertschöpfungsfunktion einnimmt. Angesichts der Auftragsvolumina und der anspruchsvollen Ingenieursleistungen bei Luxus- und Megayachten ist dieser eher dem Schiffbau zuzurechnen. Im Hinblick auf die Analyse erfolgt dabei eine Integration in den Bereich Schiffbau. Nicht zuletzt hat sich der Umbau-, Reparatur- und Wartungsbereich für viele Schiff- und Bootsbaubetriebe als wichtiges Standbein herausgebildet.

Hafenwirtschaft

Trotz der anhaltenden Schifffahrtskrise, sind die Schifffahrt und die damit verbundene Hafenwirtschaft nach wie vor für den weltweiten Güteraustausch von großer Bedeutung. Nach einer Mitteilung der Europäischen Kommission werden 74% der Güter von außerhalb der EU und 37% des innereuropäischen Binnenhandels über Seehäfen abgewickelt.1 In Deutschland profitieren alle Küstenländer mit ihren Häfen und der dort angesiedelten Hafenlogistik (Be- und Entladen, An- und Ablieferung, Lotsendienste, Schlepperdienste, Fährdienste etc.) hiervon.

Maritime Dienstleistungen

Mit den maritimen Dienstleistungen wird ein breites Tätigkeitsfeld von unternehmensbezogenen Dienstleistungen mit einem Bezug zur Seeschifffahrt und der maritimen Industrie abgedeckt. Zentrale Aktivitäten sind Schiffsmakler und -agenten, Crewing-Agenturen, Schiffsausrüster, Klassifikation und Baubegleitung, Schiffsfinanzierung über Banken und Emissionshäuser, Versicherungen und Versicherungsmakler, Havarieagenten sowie See- und Schifffahrtsrecht. Daneben werden auch klassische Dienstleistungen wie Treuhand, Wirtschaftsprüfung und -beratung den maritimen Dienstleistungen zugezählt, sofern diese auf einem fachspezifischen Wissen über die Seeschifffahrt und die maritime Industrie aufbauen. Ingenieurunternehmen sind maritime Dienstleister, sofern diese im Auftragsverhältnis zu wechselnden Auftraggebern die vielfältigsten Aufgaben mit maritimem Bezug übernehmen.

Wasserbau

Der Wasserbau beinhaltet die Teile der Baugewerbe, die sich mit dem Küsten- und Hochwasserschutz sowie mit dem Bau, der Erweiterung und der baulichen Sicherung von Wasserverkehrswegen und Hafenanlagen befassen. Neben Planung und Durchführung von baulichen Maßnahmen wird auch das Küstenzonenmanagement dem Wasserbau zugezählt.

Meerestechnik

Meere sind Ökosysteme, Ressourcenträger und Klimafaktoren – ihre Bedeutung geht weit über ihre Rolle als Verkehrsweg hinaus. Die Meerestechnik bündelt verschiedene industrielle und technische Disziplinen und liefert innovative Lösungen zur nachhaltigen Nutzung der Meeresräume. Übergreifende Merkmale der Segmente sind ihre zumeist ingenieurswissenschaftliche Grundlage und der hohe Technologie- und Forschungsgehalt der Güter und Dienstleistungen. Die Gesellschaft für Maritime Technik (GMT) definiert die Meerestechnik als „alle industriell-technischen Disziplinen, die zur Nutzung und zum Schutz der Meere dienen." Die Meerestechnik beschäftigt sich dabei nur mit einem Teil der Nutzungsmöglichkeiten der Meere. So sind nach vorliegender Abgrenzung die Meere als Transportweg, als Fanggrund oder als Urlaubsziel nicht Gegenstand meerestechnischer Disziplinen. Wählt man die wirtschaftliche Relevanz als Maßstab, so sind innovative, technologieintensive Ansätze für die Nutzung der Meere als Energiequelle der zentrale Gegenstand der Meerestechnik. Diesem Anwendungsbereich sind

- die Offshore-Technik für die Exploration und Produktion von Erdgas und Erdöl,
- die Offshore-Windenergie und andere erneuerbare Energien aus dem Meer sowie breite Teile
- der Unterwasser- und Tiefwassertechnik,
- der Seekabel und Pipelines sowie
- der Eis- und Polartechnik

zuzuordnen. Zudem sind die genannten Segmente zentrale Anwendungsfelder für andere Segmente der Meerestechnik (Hydrographie, Umwelttechnik, Küsteningenieurswesen, Meeresmesstechnik, etc.). Neben diesem Schwerpunkt finden sich andere Bereiche mit hohem technologischen Niveau und möglichen wirtschaftlichen Potenzialen wie die maritime Sicherheitstechnik, die marine Umwelttechnik, der Meeresbergbau, die Blaue Biotechnologie und das Küsteningenieurwesen.

Schiffahrt

Die Reedereiwirtschaft gehört zu den maritimen Branchen, die in den vergangenen Jahren die stärkste Entwicklungsdynamik zu verzeichnen hatten. Die Seeschifffahrt konnte lange Zeit vom starken Wachstum des internationalen Warenhandels profitieren. Die Schifffahrtsunternehmen sind in verschiedenen Geschäftsfeldern des seewärtigen Transportwesens aktiv. Das Portfolio reicht von Containerschiffen, Öl-, Gas- und Produktentankern

über Multi-Purpose- sowie Projekt- und Schwergutschiffen bis hin zum Einsatz von Spezialschiffen im Offshore-Bereich oder der Forschungsschifffahrt.

Schiffbauzulieferer

Die Schiffbau-Zulieferindustrie kann auf Grund ihrer heterogenen Struktur nicht als eigenständiger Industriebereich definiert werden, sondern umfasst eine Vielzahl unterschiedlicher Branchen, sowohl im Produzierenden Gewerbe als auch im Dienstleistungssektor. Der VDMA schätzt, dass in Deutschland etwa 400 Unternehmen im Schiffbau- und Offshore-Zuliefergeschäft tätig sind. Von den im Jahr 2007 erzielten Umsätzen dieser Unternehmen von 12 Mrd. Euro entfallen zwei Drittel auf Produkte des Maschinenbaus, 16 % auf elektrotechnische Produkte und 15 % auf Dienstleistungen, die sich zu einem festen Umsatzträger in der maritimen Zulieferindustrie etabliert haben (vgl. VDMA 2008).Für die Untersuchung der Maritimen Wirtschaft in Niedersachsen wird – auch in Abgrenzung zu den im Gutachten untersuchten maritimen Dienstleistungen – die Schiffbauzulieferindustrie wie folgt definiert:

Unternehmen des Verarbeitenden Gewerbes, die mit ihren Produkten direkt zur Ausrüstung von Schiffen im Neubau, bei Wartung, Reparatur und Umbau beitragen (beispielsweise Stahl- und Maschinenbau, Elektronik, Navigation, Schiffseinrichtung) Handwerksbetriebe, die sich mit ihrem Angebot auf die Schiffsausrüstung spezialisiert haben (insbesondere Schiffsinnenausbau, Elektroanlageninstallation, Korrosionsschutz) Schiffbaubezogene Dienstleistungen wie beispielsweise Ingenieur- und Konstruktionsbüros, spezialisierte Groß- und Einzelhändler. Gesellschaften der Arbeitnehmerüberlassung sowie Dienstleistungs- und Handwerksbetriebe mit einem universell einsetzbaren Angebot (z.B. Reinigungsunternehmen, Möbeltischlereien, Groß- und Einzelhändler) bleiben hier unberücksichtigt, auch wenn sie als Lieferanten im Schiffbau auftreten. Damit ist die niedersächsische Schiffbauzulieferindustrie in diesem Gutachten weitergefasst als im VDMA oder im VSM und unterscheidet sich sowohl sektoral als auch strukturell.

Maritime Forschung

Die Bandbreite der Forschungsfelder erstreckt sich über sämtliche zu untersuchende maritime Segmente. Dabei stechen die Forschungskapazitäten im Bereich der Meerestechnik, aber auch die nautische Ausbildung mit einer relativ hohen Anzahl besonders hervor. Die stark ausgeprägten Forschungsfelder Meerestechnik, Schifffahrt und Meeresforschung werden in den folgenden Unterabschnitten gesondert dargestellt.

Aus- und Weiterbildung

Der überwiegende Teil der Arbeitskräfte in der Maritimen Wirtschaft hat eine Ausbildung ohne expliziten maritimen Hintergrund absolviert. In die Untersuchung wurden daher neben spezifisch maritimen Ausbildungsgängen (Nautik, Schiffbau etc.) auch solche Qualifizierungsangebote erfasst, die wichtiges Grundlagenwissen für die verschiedenen Tätigkeitsund Berufsfelder in der Maritimen Wirtschaft vermitteln. Dabei ist zu berücksichtigen, dass sich das allgemeine Bildungsangebot ständig verändert und nur unscharf im Sinne der Maritimen Wirtschaft abzugrenzen ist.

F.9. Exchange Relationships

Table 15

Activity fields in the maritime economy and types of knowledge in transfer (author's definition)

	boat building	port corporation	port logistics	maritime services	maritime education and professional development	maritime science	marine engineering	marine engineering science	shipping companies	shipbuilding	shipping supplier	Other economic actors	Other science actors
boat building	HT												
port corporation	TA	TA											
port logistics	TA	TA	TA										
maritime services	TA	TA	TA	TA									
maritime education and professional development	INF	INF	INF	INF	INF								
maritime science	TF	INF	INF	TF	INF	TF							
marine engineering	TF	INF	INF	TF	INF	TF	HT						
marine engineering science	TF	INF	INF	TF	INF	TF	HT	TF					
shipping companies	TA	TA	TA	TA	INF	TA	TA	TA	TA				
shipbuilding	HT	TA	TA	TA	INF	TF	TF	TF	TA	HT			
shipping supplier	HT	TA	TA	TA	INF	TF	TF	TF	TA	HT	HT		
Other economic actors	n/a	n/a	n/a	n/a	INF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
Other science actors	TF	INF	INF	TF	INF	TF	TF	TF	INF	TF	TF	TF	TF

Transaction Services
Transformation Services
High Tech
Information

F.10. Corine Land Use Classes and Definitions

(http://sia.eionet.europa.eu/CLC2000/classes/index_html; downloaded 21.09.2014)

Continuous urban fabric

Most of the land is covered by structures and the transport network. Buildings, roads and artificially surfaced areas cover more than 80 % of the total surface. Non-linear areas of vegetation and bare soils are exceptional.
Extension:
80 % of the total surface at least should be impermeable.
This heading includes:

- urban centre types and dense ancient suburbs where buildings form a continuous and homogeneous fabric
- public services or local governments and commercial/industrial activities with their connected areas inside continuous urban fabric when their surface is less than 25 ha
- interstices of mineral areas, un-vegetated cemeteries and cemeteries less than 25 ha located inside continuous urban fabric.

Discontinuous urban fabric

Most of the land is covered by structures. Buildings, roads and artificially surfaced areas are associated with vegetated areas and bare soils, which occupy discontinuous but significant surfaces.

Extension:
Between 30 to 80 % of the total surface should be impermeable.
The continuous urban fabric class is assigned when the urban structures and transport network (i.e. impermeable surfaces) occupies more than 80 % of the surface area. This coverage percentage pertains to real ground surface. Therefore, localization of this cut-off-point requires particular attention to avoid confusion with the apparent vegetation (e.g. visible crown of trees) and permeable surfaces under trees. For example, in the streets bordered with trees, the real ground surface under the trees is mostly covered with asphalt or concrete. So, the vegetation percentage has to be estimated taking into account the shape structure and context visible on the satellite image. In particular, vegetation impact has to be underestimated in case of linear structure of vegetation.
The discrimination between continuous and discontinuous urban fabric is set from the presence of vegetation visible in the satellite image illustrating either single houses with gardens or scattered apartment blocks with green areas between them.
The density of houses is the main criteria to attribute a land cover class to the built-up areas or to the agricultural areas. In case of patchwork of small agricultural parcels and scattered houses, the cut-off-point to be applied for discontinuous urban fabric is 30 % at least of urban fabric within the patchwork area.
This heading includes:

- private housing estates, residential suburbs made of individual houses with privative gardens and/or small squares,
- scattered blocks of residential flats, hamlets, small villages where numerous unmineralized intersticial spaces : gardens, lawns can be distinguished,

- large blocks of flats where green spaces, parking areas and adventure playgrounds cover significant surface area,
- un-vegetated or smaller than 25 ha cemeteries included within discontinuous fabric,
- public utilities/communities surfaced areas less than 25 ha,
- holiday cottage houses are included in 112 if infrastructures like road network is visible in the satellite images.

  They must also be connected to built-up areas.

- troglodyte villages along streets and subterranean housings visible from the satellite image.

This heading excludes:

- vacation houses areas which are only used for recreational purposes and defined as a specific unit in the satellite image should be classified as 142.
- holiday settlements with bungalows have to be classified as 142.
- scattered main and secondary residences implanted in natural or agricultural areas when their coverage is less than 30 % of the total surface. They are assigned 242 or 243
- greenhouses are assigned to 211

Industrial or commercial units

Artificially surfaced areas (cement, asphalt, tarmacadam or stabilized e.g. beaten earth) without vegetation occupy most of the area, which also contains building and/or vegetation.
This heading includes:

- research and development establishments,
- security, law and order services (fire stations, penal establishments),
- company benefit schemes (old people's home, convalescent homes, orphanages, etc.),
- stud farms, agricultural facilities (cooperatives, state farm centres, livestock farms, living and exploitation buildings),
- exposition sites, fair sites,
- nuclear power plants, military barracks, testing pistes, test fields, biological waste water treatment plants, water houses, transformers),
- large shopping centres,
- abandoned industrial sites and by-products of industrial activities where buildings are still present.
- water retention and hydro-electric stations
- telecommunication networks (relay stations for TV, telescopes, radars.)

This heading excludes:

- extractive industry (class 131)
- oil terminals inside port activities (class 123)
- dumps , decanting basin structures (class 132)
- dockyards (class 123)
- merchant departments belonging to privative or public services (class 11x)
- places of worship : convents, monasteries, etc (class 142)

Port areas

Infrastructure of port areas, including quays, dockyards and marinas.
This heading includes :

- commercial and military ports,
- shipyards,
- fishing ports,
- yachts ports, sport and recreation ports,
- shipping and infrastructure port facilities,
- sea, river and lake ports,
- harbour stations, dock houses,
- oil terminals.

This heading excludes :

- industrial and commercial units larger than 25 ha associated with port activities (class 121).

F.11. Explanatory Maps

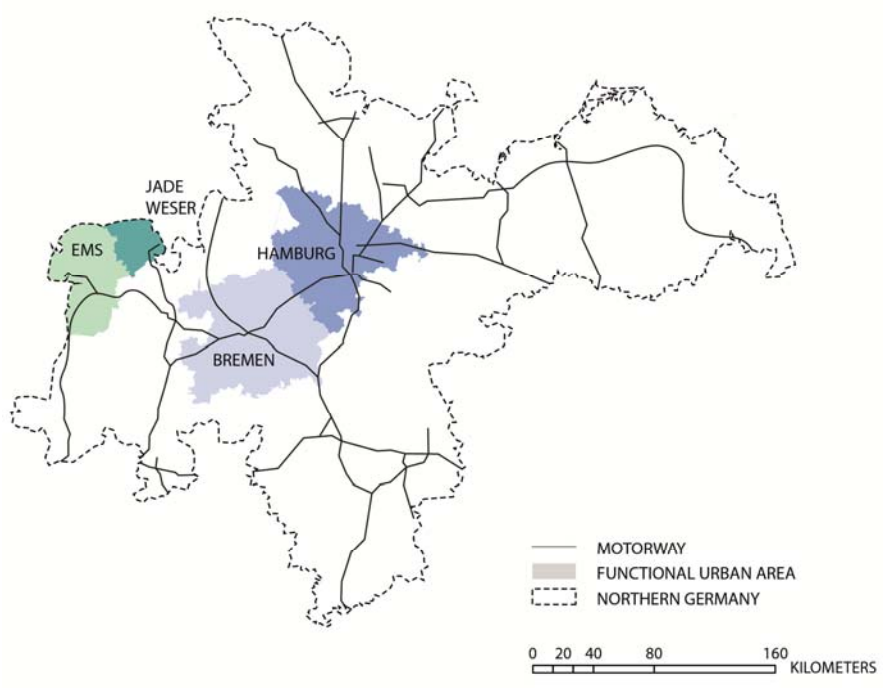

Figure 82
Selected functional urban areas in the context of northern Germany

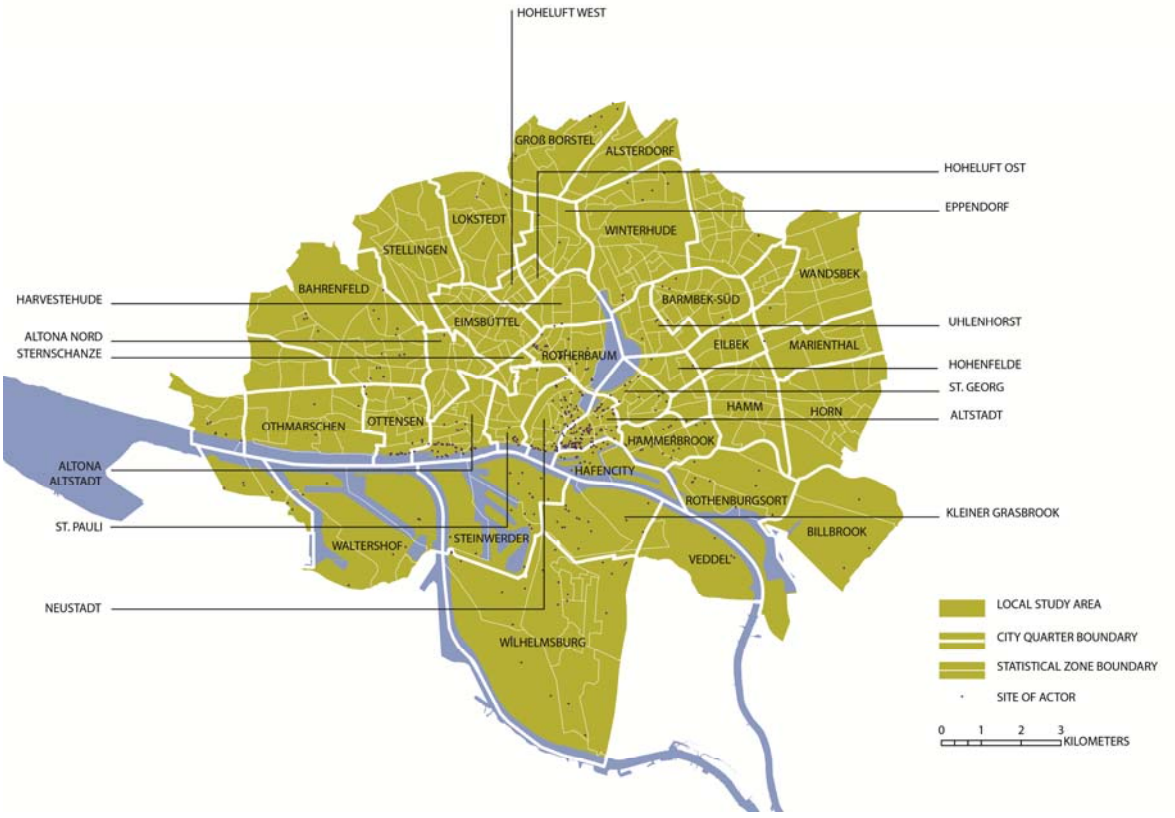

Figure 83
City quarters in Hamburg

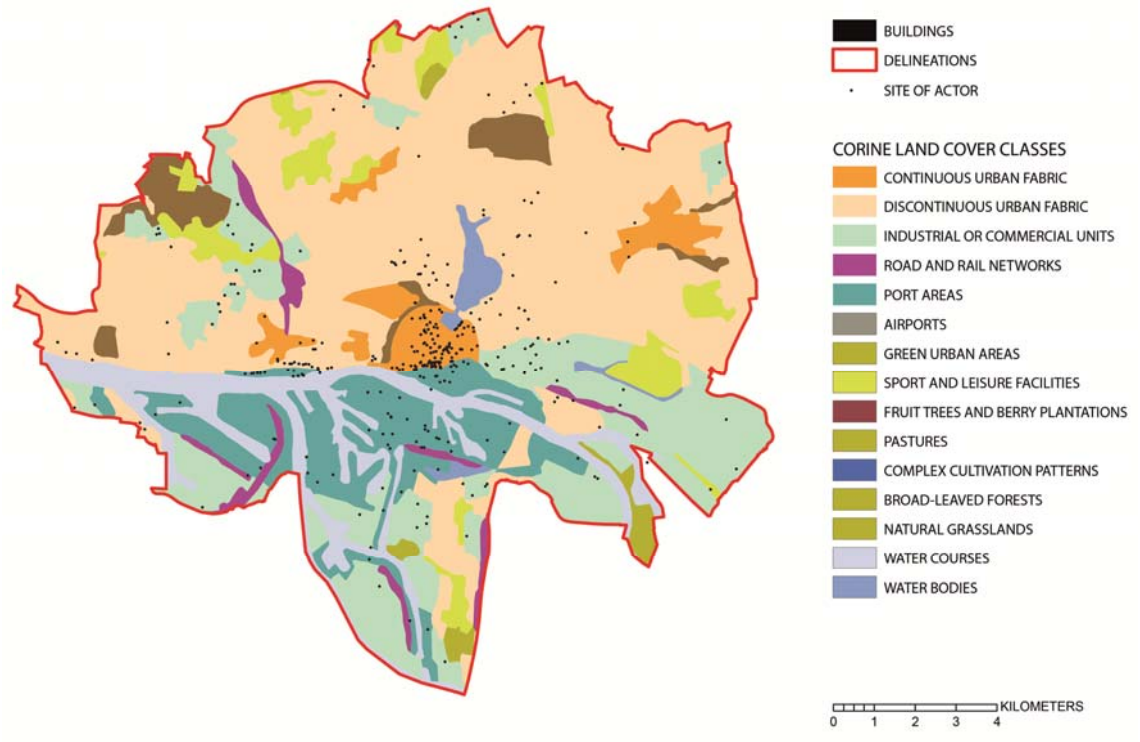

Figure 84
Sites of the maritime economy in relation to corine land cover

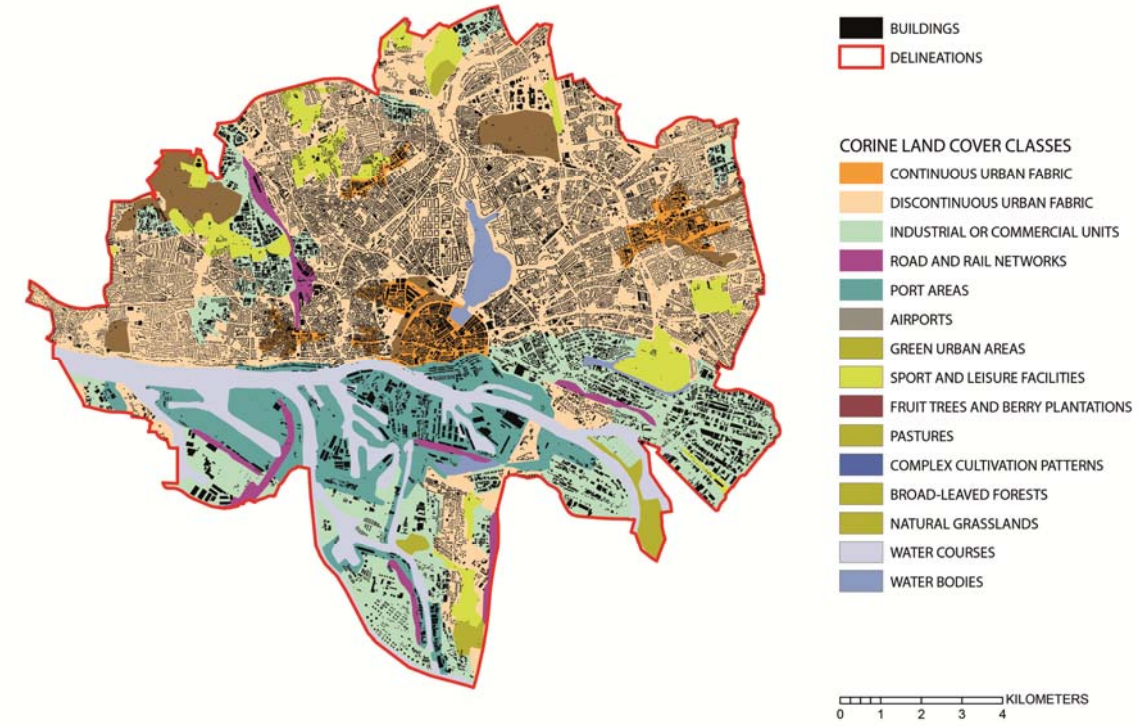

Figure 85
Building structure of Hamburg with Corine land cover in the background

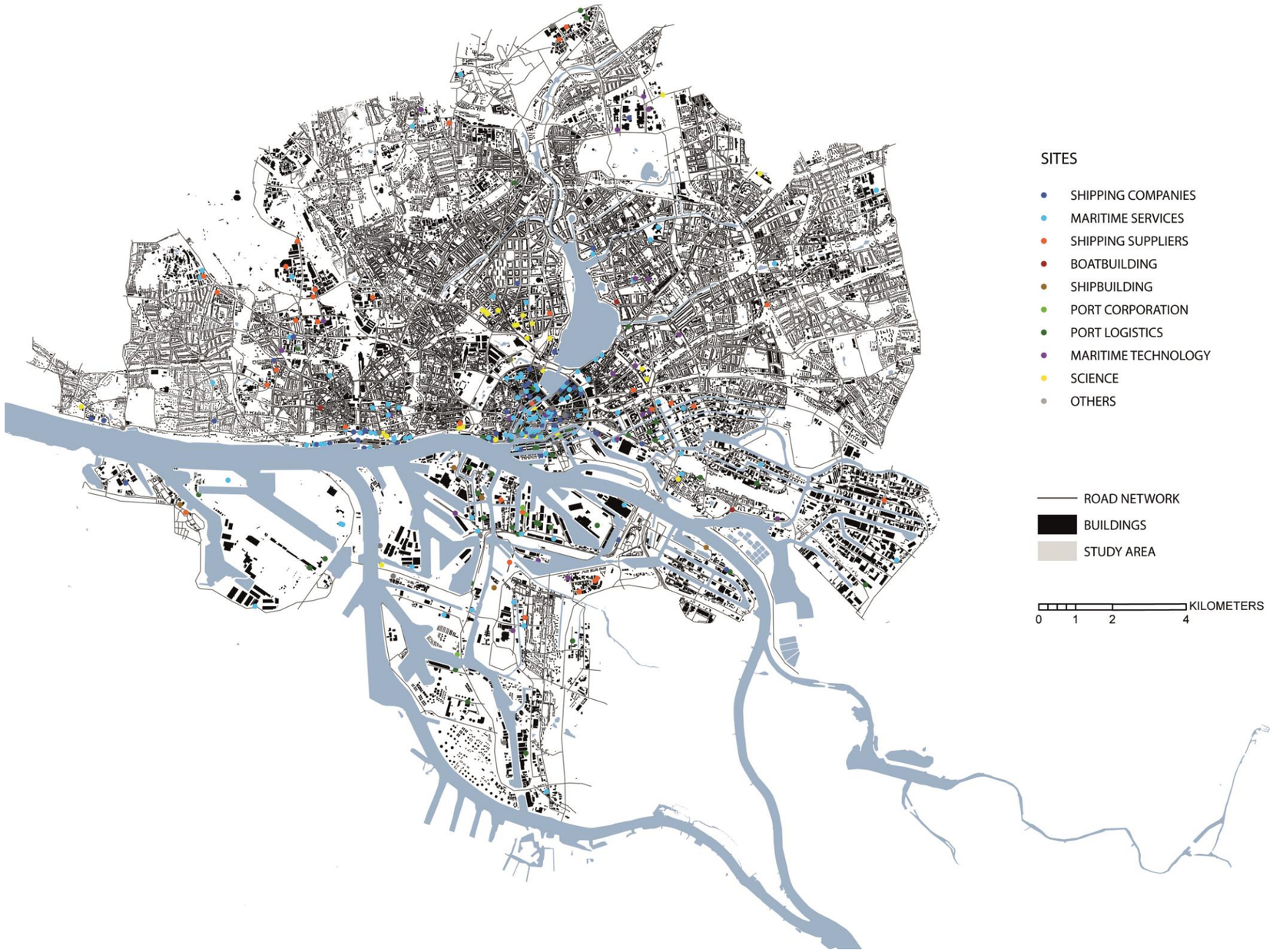

Figure 86
Corporate locations in the study area

F.12. Glossary

APS (Advanced producer services) - intermediary services provided for the production of other products or services, i.e. accountancy, advertising, banking/finance, and law

built environment - Man-made structures and their configuration that support human activity.

built form - The physical properties of buildings which determines accessibility, connectivity, and size of the structures.

conceived space - planned space resulting in the conception and implementation of built space

distance space - Physical spatial setting of structures, which determines relations and dimensions

flexible specialization – a strategy to business, which caters for the accommodation to ceaseless change, rather than an effort to control it. This strategy is based on flexible—multi-use—equipment and skilled workers.

FUA (Functional urban area) – Spatial entity which contains an urban core of at least 15,000 inhabitants and over 50,000 in total population, which can be reached within 45 minutes by car from the centre.

function space - functional dispositions and facilities in their spatial arrangement, which support human activity.

GAWC (Globalization and World City research network) – The world according to GaWC is a city-centred world of flows in contrast to the more familiar state-centred world of boundaries. Cities are assessed in terms of their advanced producer services using the interlocking network model. Indirect measures of flows are derived to compute a city's network connectivity – this measures a city's integration into the world city network. The connectivity measures are used to classify cities into levels of world city network integration. These levels are interpreted as follows:

> alpha cities: Very important world cities that link major economic regions and states into the world economy
>
> beta level cities : These are important world cities that are instrumental in linking their region or state into the world economy
>
> gamma level cities: These can be world cities linking smaller regions or states into the world economy, or important world cities whose major global capacity is not in advanced producer services.

globalization - the increased degree and speed of cultural and economic integration across the world

knowledge economy - production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence. The key component of a knowledge economy is a greater reliance on intellectual capabilities than on physical inputs or natural resources.

lived space - the experience of the three dimensional environment by the individual through associated images and symbols.

perceived space - the extent of spatial relations, produced by practices and routines.

process space - the spatial extent of human activities and economic exchanges

scale level - spatial context of Euclidian extent

spatial ambitions – concepts of spatial development and transformation

spatial topology - entity of organized spatial relationships and proximities between spatial structures.

urban system - The entity physically, economically and culturally interconnected cities, which is facilitated by infrastructure.

urban milieu - environment within cities, which is characterized by density and diversity of physical and social opportunities.

urban form - The physical totality of a city

urban element – building block of the city, which is physically and functionally distinct.

urban morphological zone - a set of urban areas laying less than 200m apart.

use value - the degree to which a commodity satisfies the needs on the consumer.

value chain – based on the process view of organizations and industries, it conceptualizes a manufacturing (or service) organization or division as part of a system, made up of subsystems each with inputs, transformation processes and outputs.

world city network – the term describes the meta-geography which is created by cities worldwide, which are interconnected by flows of capital, people and information

G. List of Figures

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I. Literature

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